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Monetary Policy Transmission and the Labour Market in the Non-eurozone Visegrad Group Countries in 2000–2014. Evidence from a SVAR Analysis

Abstract

This paper is aimed at filling the gap in existing economic research by delivering new evidence on the money-labour nexus in the emerging markets of the non-eurozone Visegrad group countries (i.e. Czech Republic, Hungary and Poland). Analyses are based on the Strucutral VAR (SVAR) models of the monetary transmission mechanism, estimated using monthly data from the 2000:1–2014:2 period. In order to obtain impulse responses, the short-run restrictions set, based on the monetary transmission theory, is imposed. Two different identification schemes are considered.

The results confirm that there exists a nexus between monetary policy, employment, and unemployment. According to the obtained estimates monetary policy shocks invoked lagged, hump-shaped reactions of output, employment and unemployment in each of the analysed countries.

Keywords: *monetary policy, output, employment, unemployment, Visegrad Group countries, Structural Vector Autoregressive models, SVAR*

JEL: *E24, E52*

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1. Introduction

Monetary policy is one of the key elements of macroeconomic policy. Nevertheless, there is a lot of confusion in economic theory and in the literature when it comes to the question of its impact on the level of real economic variables, such as output, employment, and unemployment. This issue was for years one of the main sources of controversies between the representatives of various schools of economic thought. When reviewing the existing literature, we may distinguish between three main theoretical views, which might be dubbed as: new classical, intermediate (or monetarist), and Keynesian. Each of them differs in its assessment of the positive and normative validity of the analysed relationship. Despite many efforts undertaken, neither of these competing views have come up with truly convincing and empirically valid arguments in this discussion, which makes it still an open case.

Regardless of the significant differences in theoretical views, the results of existing empirical research, based mainly on the estimates of SVAR models, tend to confirm the long-run neutrality of monetary policy as well as the existence of a short-run money-output nexus. Notwithstanding that fact, a relatively low number of studies have been undertaken to extend this research to the labour market variables (see e.g.: Sims 1986, Bernanke and Blinder 1992, Gordon and Leeper 1994, Peersman and Smets 2001, Altig *et al.* 2011). In reviewing the results of analyses performed for the Visegrad group countries, we come to similar conclusions. Labour-market-augmented SVARs may be found in, e.g., the papers by Wróbel and Pawłowska (2002) for Poland and Vonnak (2006) for Hungary, however their results are far from being conclusive.

Summing up, despite having strong evidence confirming the existence of a short-run money-output nexus, we still lack adequate proof of the relationship between monetary policy and labour market variables such as employment and unemployment in its positive aspect, as well as satisfactory knowledge about the strength of such relationship and the possibility of its normative use in the process of policymaking. This paper aims to fill this gap in the existing research through the establishment of stylised facts on the money-labour nexus in the emerging markets of the non-eurozone Visegrad group countries (i.e. the Czech Republic, Hungary and Poland).

The paper is organised as follows. An overview of the theoretical considerations on the character of the monetary transmission mechanism is presented in Section 2. Section 3 describes the methodology of the econometric model used in order to verify the hypotheses put forward in the theoretical part. In Section 4 the main features of the data used in the analyses are described, while in Section 5 the results of the econometric models' estimations are presented and discussed. Section 6 offers conclusions.

2. Theoretical Background

The issue of how the character of an undertaken monetary policy impacts on real economic variables such as output, employment, and unemployment may be best addressed within the monetary transmission mechanism setting, which makes extensive use of the Structural VAR models. In this section, the theoretical foundations of the SVAR model that will be used in further parts of the paper are developed and described.

In our analyses we address the case of a small open economy. Following Boivin *et al.* (2011), we assume the existence of wage and price rigidities, which are responsible for the fact that changes in nominal interest rates influence directly the level of real interest rates. In such circumstances, short-run interest rates are efficient instruments in the conduct of monetary policies.

The basic model of monetary transmission incorporates two classical transmission channels: the interest rate channel and the exchange rate channel (see e.g.: Mishkin 1995, Taylor 1995, Boivin *et al.* 2011). The interest rate channel is the most fundamental. It involves the influence of monetary policy on the level of real interest rates, which in turn, through the changes in the costs of capital and the relative prices of assets, affect the level of investment, consumer spending, aggregate demand, and output. Another important channel of monetary policy's impact on the economy is an exchange rate pass-through. Monetary policy influences the value of domestic currency through the interest rate parity mechanism. Alterations of the exchange rate result in changes in the relative prices of goods and have an impact on net exports, which, in turn, constitute the level of aggregate demand and output. This channel is especially important for small open economies, as the share of net exports in their GDPs is more significant than in the developed countries. Both the interest rate and exchange rate channels influence the level of aggregate demand, which according to standard macroeconomic theory has implications for the level of inflation. Monetary policy in the proposed model is usually formulated in response to changes in both output and inflation. As pointed by Grilli and Roubini (1996) and Calvo and Reinhart (2002), in numerous emerging markets monetary policy has replaced currency interventions as the main means of controlling exchange rate fluctuations. As such, exchange rates' innovations have become an important determinant which we should also take into consideration in the proposed model.

Another possible extension of the basic model may be obtained through the introduction of monetary aggregates in order to encompass non-traditional transmission channels. Among them, the most important is the so-called 'bank lending channel'. Monetary policy affects the level of bank reserves and the availability of loans, which in turn may influence the level of output. If so, the bank lending channel constitutes an important branch of the transmission mechanism and information on money supply may play an important role in the process of policymaking (Kuttner and Mosser

2002). The introduction of money aggregates also makes it possible to shape the process of monetary policy formulation in a way that is closer to reality. In such a case we assume, following Grilli and Roubini (1996), that monetary policy is derived using information on the contemporaneous values of money supply and demand as well as the data on exchange rates and lagged values of all of the other variables.

The main aim of this paper is extension of the monetary transmission model in a way which will enable us to verify the hypothesis of the existence of a nexus between monetary policy and the labour market variables such as employment and unemployment. According to economic theory we should expect that monetary policy influences employment mainly through the output channel, which entangles the combined effect of monetary policy and the level of aggregate demand. The effects of monetary policy are then transmitted also onto unemployment, as the amount of the workforce is adjusted to the new situation through the hires and dismissals in companies, as well as through people's decisions concerning their economic activity. These processes may be liable to significant lags, as enterprises try to minimise the costs of adjustments, which consist of the costs of severance payments and the costs of searching for new workers (Bentolila and Bertola 1990). According to the concept of Phillips curve, there exists a nexus between the tightness of the labour market, understood as the number of unemployed for a given job offer, and inflation. The lower is the tightness of the labour market, the greater is workers' bargaining power in wage negotiations. Such a situation leads to intensification of inflationary processes, as it causes workers to have more optimistic wage expectations. In such a case we should presume that there exists a relationship between unemployment and the level of inflation in an economy (see e.g.: Phillips 1958, Blanchard and Gali 2010).

When discussing the theoretical foundations of monetary transmission, we should also mention that empirical models may suffer from various kinds of puzzles, which according to Grilli and Roubini (1996) may be classified as: liquidity puzzles, which are a result of the use of monetary aggregates as the monetary policy instrument; price puzzles, which affect the model when monetary tightening is associated with an increase in the level of prices instead of its decrease; exchange rate puzzles, when monetary contractions cause the depreciation of a currency's value instead of its appreciation, and forward discount bias puzzles, which arise when increases in relative interest rates result in a persistent appreciation of the exchange rate of domestic currency, rather than its gradual depreciation. The liquidity puzzle is omitted through introduction of a short-term interest rate as the main device in the execution of monetary policy execution. The other puzzles are eliminated through the inclusion of exogenous variables, which serve as proxies for the expectations of economic entities. Among the variables most frequently introduced in such a role we find: oil prices, interest rates of the main trading partners, as well as nominal effective exchange rates of the domestic currency against the currencies of these other countries.

On the basis of presented review of economic theory, we can designate the main characteristics of the model that will be used in order to verify the hypothesis of a nexus between monetary policy and the labour market situation of the analysed countries. The monetary transmission mechanism of a small open economy should be described within a system of equations consisting of seven endogenous variables involving: short-term interest rates, the exchange rate, money stock, output, inflation, employment, and unemployment; as well as two exogenous variables: oil prices and short-term foreign interest rates. In such an environment monetary policy is executed through the control of short-term interest rates. It is developed using information about contemporaneous values of money stock, exchange rates, oil prices and short-term foreign interest rates, and lagged values of all the other variables. A contractionary monetary policy shock results in a decrease of the interest rate, money supply and demand, output, inflation, employment, and appreciation of exchange rates and an increase in unemployment. Output, inflation, employment and unemployment react to monetary policy shocks with lags, while money supply and demand as well as exchange rates respond to these shocks on impact.

3. Econometric Methodology

In our analyses we use a SVAR model in order to estimate the parameters of the monetary transmission mechanism that was defined in the previous section of this paper. The estimations are performed separately for each of the three non-euro-zone Visegrad group countries. Below we present the exact structure of estimated model, and analyse issues connected with its identification.

According to the adopted methodology (Christiano *et al.* 1999, 2005), monetary policy is characterised by an equation in the form:

$$i_t = f(\boldsymbol{\Omega}_t) + \varepsilon_t^i. \tag{1}$$

Eq. (1) states that monetary policy in our model is executed through the decisions of monetary authorities regarding monetary policy instrument i_t, which are a reaction to changes of the variables that form an information set of monetary authorities $\boldsymbol{\Omega}_t$, and are undertaken according to their feedback rule *f*, in the presence of monetary policy shocks ε_t^i. We assume that the shocks are independent from changes of the variables in $\boldsymbol{\Omega}_t$. In order to assess the impact of monetary policy on other variables of the model, we have to estimate their dynamic responses to the monetary policy impulse. It is possible to achieve that using a VAR analogy of a two-step procedure in which we first estimate the policy shocks ε_t^i using information contained in $\boldsymbol{\Omega}_t$, and next use the obtained estimates in order to find the responses of main economic variables to these policy shocks.

The standard VAR model, which parameters might be estimated form economic data using the OLS method, is given by:

$$\boldsymbol{y}_t = \boldsymbol{B}_1 \boldsymbol{y}_{t-1} + \cdots + \boldsymbol{B}_s \boldsymbol{y}_{t-s} + \boldsymbol{u}_t, \tag{2}$$

Where $\boldsymbol{y}_t$ is the vector of endogenous variables and $\boldsymbol{u}_t$ is the vector of economic shocks that are independent from the lagged values of $\boldsymbol{y}_t$. As such, the elements of $\boldsymbol{u}_t$ are different from the values of $\boldsymbol{\varepsilon}_t$ that we are looking for. Appropriate random variable characteristics might be extracted from the reduced version of the model, given by:

$$\boldsymbol{A}_0 \boldsymbol{y}_t = \boldsymbol{A}_1 \boldsymbol{y}_{t-1} + \cdots + \boldsymbol{A}_s \boldsymbol{y}_{t-s} + \boldsymbol{\varepsilon}_t, \tag{3}$$

obtained using a simple transformation in which we multiply both sides of Eq. (2) by $\boldsymbol{A}_0$. In such a case the relationship between $\boldsymbol{u}_t$ and $\boldsymbol{\varepsilon}_t$ is given by: $\boldsymbol{A}_0 \boldsymbol{u}_t = \boldsymbol{\varepsilon}_t$. In order to compute impulse responses, we have to know both the $\boldsymbol{B}_i$'s ($i \in 1, \dots, s$) that can be estimated, as well as the $\boldsymbol{A}_0$ matrix. The $\boldsymbol{A}_0$ is a solution of the following equation: $\boldsymbol{B}_i = \boldsymbol{A}_0^{-1} \boldsymbol{A}_i$. Unfortunately, inasmuch as multiple solutions to this equation exist and no other information about the matrix that we seek is given, the problem is under-identified. In order to solve the identification issue a special procedure, which involves imposing additional identifying assumptions must be used.

Following the considerations described in Section 2 of this article, our empirical model consists of two exogenous variables: world oil prices (p_t^{oil}) and foreign interest rate (i_t^f), and seven endogenous variables: short-term interest rate (i_t), exchange rate (er_t), money stock (m_t), output (y_t), inflation (cpi_t), employment (e_t) and the unemployment rate (u_t). In the proposed model we introduce both the employment level and unemployment rate as explanatory variables. Such a choice of variables takes into account the fact that fluctuations in the unemployment rate incorporate not only the outflows from employment, but also underlying changes observed in economic activity, and as such both variables should be treated as relatively distinct processes. On the other hand, such a specification of the models of monetary transmission can be found in the existing empirical literature, e.g. in the work of Gali (2011a). The proposed formulation of the model seems also to be in line with the specification of the transmission mechanism, which stems from the latest research in the field of DSGE models (see e.g.: Christiano *et. al.* 2011, Gali 2011a, 2011b).

As all of the countries in our sample are small open economies, they are highly exposed to adverse changes in the global economic situation. As pointed by Grilli and Roubini (1996) and Calvo and Reinhart (2002), in such a case monetary authorities will use monetary policy in order to stabilise their exchange rate levels. In order to achieve that goal, they should react to potential supply shocks and foreign monetary policy shocks, which may influence the exchange rate levels. We should thus include commodity prices, which may serve as a proxy for the supply shocks, and foreign interest rates into our model. In order to do so we use a formulation of the VAR model which allows for exogenous variables (the so-called VARX model). In such a case both the commodity price index as well as foreign interest rate enter into each equation of the model, including the policy reaction function, but are not explained by the model itself (see e.g. Górajski and Ulrichs 2016).

In order to solve the identification issue, we use, following a discussion in Christiano *et al.* (1999), Sims and Zha (2006) and Gospodinov *et al.* (2013), the method of short-run restrictions. This consists of imposing zero restrictions on the appropriate elements of the matrix of contemporaneous coefficients $\mathbf{A_0}$. We use two alternative identifications of $\mathbf{A_0}$. The first of them is based on the Cholesky decomposition, and the second is developed on the basis of the monetary transmission model presented in Section 2.

In the first of the proposed identifications, output influences both employment and unemployment, which in turn have a contemporaneous impact on inflation, through the short-run Phillips-curve-type relationship, and monetary policy. The performance of the real economy influences the nominal variables, including money supply and demand, short-run interest rates, and exchange rates. Monetary policy is formulated based on the data concerning the real variables as well as the money demand data. It is subsequently reflected by the exchange rate levels and affects all of the other variables with some lag. The decomposition of the endogenous block of the model is presented in Eq. (4), where a_{ij} are the unrestricted parameters of the matrix:

$$\boldsymbol{y}_t = \begin{bmatrix} y_t \\ e_t \\ u_t \\ cpi_t \\ m_t \\ i_t \\ er_t \end{bmatrix} \boldsymbol{y}_t = \begin{bmatrix} y_t \\ e_t \\ u_t \\ cpi_t \\ m_t \\ i_t \\ er_t \end{bmatrix}, \boldsymbol{A}_0 = \begin{bmatrix} a_{11} & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & 0 & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} & 0 \\ a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & a_{77} \end{bmatrix}. \tag{4}$$

$$\boldsymbol{A}_0 = \begin{bmatrix} a_{11} & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & 0 & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} & 0 \\ a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & a_{77} \end{bmatrix}.$$

The second identification (henceforth called the MTM theory-based identification) used in order to obtain estimates of the parameters of the monetary transmission mechanism is based on the identification scheme proposed by Sims and Zha (2006), who used the assumptions concerning the timing of monetary decisions, economic adjustments, and data availability. The proposed identification recognises the sluggish adjustment of output and prices to the changes in nominal variables. It also takes into account the fact that data concerning the real variables are available only with significant lags, which results in monetary policy reacting contemporaneously only to changes in money demand and exchange rates. The identification proposed by Sims and Zha (2006) does not take into account the labour market variables. In order to deliver new evidence on the monetary policy-labour nexus, we introduce employment and the unemployment rate as endogenous variables of the model. The resulting decomposition is given by Eq. (5) below:

$$\boldsymbol{y}_t = \begin{bmatrix} y_t \\ e_t \\ u_t \\ cpi_t \\ m_t \\ i_t \\ er_t \end{bmatrix}$$

$$\boldsymbol{y}_t = \begin{bmatrix} y_t \\ e_t \\ u_t \\ cpi_t \\ m_t \\ i_t \\ er_t \end{bmatrix},$$

$$\boldsymbol{A}_0 = \begin{bmatrix} a_{11} & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 & 0 & 0 \\ a_{51} & 0 & 0 & a_{54} & a_{55} & a_{56} & 0 \\ 0 & 0 & 0 & 0 & a_{65} & a_{66} & a_{67} \\ a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & a_{77} \end{bmatrix}. \quad (5)$$

$$\boldsymbol{A}_0 = \begin{bmatrix} a_{11} & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 & 0 & 0 \\ a_{51} & 0 & 0 & a_{54} & a_{55} & a_{56} & 0 \\ 0 & 0 & 0 & 0 & a_{65} & a_{66} & a_{67} \\ a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & a_{77} \end{bmatrix}.$$

In the proposed decomposition, the levels of employment and the unemployment rate react instantaneously to changes of output, which results in non-zero values of parameters a_{21} and a_{31}[1]. They are also interrelated, which results in the fact that we leave parameter a_{32} unrestricted. We assume that inflation is determined by the level of aggregate demand, i.e. parameter $a_{41} \neq 0$. As has already been stated in Section 2, on the basis of existing economic theory we may presume that the labour market variables interact with the price level in a short-run Phillips curve-type relationship. A lower labour market tightness level leads workers to have more optimistic wage expectations, which in turn leads to higher inflationary pressures. The existence of such a relationship results in non-zero values of the a_{42} and a_{43} parameters.[2] The demand for money consists of two components.

[1] The research was supported by the National Centre of Science within a project number DEC–2012/07/N/HS4/02708.

[2] As some researchers (see e.g. Bentolila and Bertola, 1990) point towards the possibility of the existence of significant lags in reaction of labour market variables to the changes of output due to the existence of the labour hoarding phenomenon, it is also possible to use an identification in which employment and the unemployment rate do not react to the changes of output contempo-

The first of them – transactional demand – depends on the nominal aggregate demand given by real output and price level (i.e. is given by parameters a_{51} and a_{54}). On the other hand, parameters a_{52} and a_{53} represent the precautionary demand for money. In our model these parameters are restricted to zero, as we assume that it takes some time for the precautionary component of money demand to adjust to the labour market situation.[3] Finally, we assume that the exchange rate level almost instantaneously discounts all the changes of real economic variables, and thus parameters a_{71} to a_{76} take non-zero values. In proposed identification neither output, employment, the unemployment rate nor the price level affect monetary policy contemporaneously, as we assume that appropriate economic data are available only with lags.

4. The Data

In our analyses we use monthly data from the 2000:1–2014:2 period for the three non-eurozone Visegrad group countries: the Czech Republic, Hungary and Poland. Our set consists of data of: world oil prices given by Brent crude oil 1-month Forward in EUR index from the ECB Statistical Data Warehouse; foreign and domestic short-term interest rates, which are approximated by the 1-month EURIBOR, PRIBOR, BUBOR and WIBOR interest rates; real industrial production index, which serves as a proxy for GDP; consumer price index; LFS-based employment and LFS-based unemployment rate data – obtained from the Eurostat database; data on money supply approximated by the M1 aggregate index from the St. Louis Federal Reserve Bank FRED database. Finally, it entangles also data on the nominal effective exchange rate index, based on the data on bilateral exchange rates among 67 leading world economies by Bank of International Settlements. Monthly data on employment levels in analysed countries were acquired from the decomposition of the available data on the unemployment rate and the number of unemployed. All the time series used in our estimations consist of seasonally adjusted data. Additionally, all of the variables apart from

raneously, i.e.: parameters $a_{21} = a_{31} = 0$. We do not use this in this analysis as we want to put forward a model which complies with a relatively vast number of economic theories.

[3] As pointed already in Section 2, there is a possibility that the character of the monetary policy undertaken influences labour market variables not only through the output channel, but also through the expectations channel, as the observed levels of inflation may influence wage expectations. However, as such a relationship is of rather long-term nature, due to the fact that we need at least a few successive periods of extraordinarily low or high inflation in order for expectations to change, we assume that parameters $a_{24} = a_{34} = 0$.

the interest rates are expressed in logarithms in order to assure proper interpretation of the results.

The choice of the period of analysis is motivated by the fact that this period was characterised by a relative stability of the institutional framework of monetary policy and exchange rates. The dominant strategy of monetary policy in that period was inflation targeting, introduced in the Czech Republic and in Poland respectively in January and October of 1998, and in Hungary in the summer of 2001. Also, exchange rate regimes were relatively stable in the Czech Republic and Poland, where free float regimes were in use respectively since June 1997 and March 2000. Only in Hungary were substantial changes of the exchange rate regime observed. In May 2001 it shifted from crawling peg to crawling band. In October 2001 there was yet another change, which fixed the course within the ± 15% band. Finally, the free float currency regime was introduced in February 2008. As the changes of monetary policy regimes were observed in the analysed countries mostly in the very beginning of the sample period, they should have only a minimal impact on the estimates of the model. More concerns should be raised by the fact of frequent changes of the exchange rate arrangements in Hungary. As it is not clear how such changes affect the parameters of the monetary transmission mechanism (Canova 2005), we will however restrain our analysis to the estimation of a traditional model with time-invariant parameters, following e.g. Anzuini and Levy (2007).

The time series used in presented empirical analyses were subjected to the unit root tests. ADF, DF-GLS and KPSS tests were used for this purpose. On the basis of the obtained results we came to the conclusion that it is justified to claim that all of the variables used in our model are I(1). Taking that into account, we had to cope with the problem of spurious regression which might arise in the empirical models based on such data. It should be noted however that in the economic literature there is no general consensus on how to handle this issue in monetary transmission models.

One of the proposed options is to use the Structural Vector Error Correction model (SVECM), which incorporates the cointegration structure, instead of standard SVAR models. However, such a solution has been widely criticized, as it seriously limits the practical importance and comparability of the obtained results (Faust and Leeper 1997, p. 345, Phillips 1998, Lütkepohl 2005, pp. 341–342, Elbourne and de Haan 2009, p. 10). Another way to cope with the problem of spurious regression in models based on integrated time series is to detrend the data using the procedure of first-differencing, or to extract time-varying trends with the use of statistical filters, such as the one proposed by Hodrick and Prescott. These are however frequently criticised due to the fact that they may lead to the loss of a large part of volatility of the data and thus degenerate impulse response functions. Due to the numerous controversies connected with the choice of the appropriate method of integrated data analysis, Sims, *et al.* (1990) proposed to estimate integrated and nearly integrated VAR models in levels, as it is possible that such systems of equations are still jointly covariance stationary. In such a case, consistent estimates of VAR coefficients might be obtained using classical methods and classical test statistics, and can be used as they have non-degenerate distributions. Such an approach has also been recommended in numerous other publications, including: Canova (2007, p. 115), Lütkepohl and Krätzig (2004, pp. 167–168) and Gospodinov *et al.* (2013).

To conclude, inasmuch as we aim in this paper deliver stylised facts on the character of short-run monetary transmission mechanisms in the non-Eurozone Visegrad Group countries, in what follows we assume that spurious regression is not too much of a danger for the credibility of the results and base our primary model on the data in levels. In this respect we follow the strategy undertaken in numerous studies concerning the monetary transmission mechanism, such as Kim and Roubini (2000), Peersman (2004), Elbourne and de Haan (2009), Anzuini and Levy (2007), Łyziak *et al.* (2008), among others. In order to strengthen the results presented below and the robustness of our analyses, we also present impulse responses coming from models in which data were detrended through the use of Hodrick-Prescott filter (with λ=129600).

5. Monetary Policy and the LabourMarket Situation in the VisegradGroup Countries in 2000–2014 – Statistical Analysis and SVAR Model Evidence

Following the description of the theoretical background and the econometric methods used in the analyses, and after carefully examining the characteristics of the available statistical data, in this section we present the results of our performed econometric analyses. The models were estimated separately for each of the analysed countries using JMulti software. The number of lags in each of the estimations was chosen so as to minimise problems with autocorrelation, including autocorrelation at seasonal frequency of 12 lags. In order to achieve that, we used models with 3 lags of endogenous variables and, respectively, 2 and 3 lags of exogenous variables in the cases of the Czech Republic and Hungary. In the case of Poland it was necessary to use models with as many as 5 and 6 endogenous lags and 5 to 4 lags of exogenous variables. A relatively large number of lags was needed in order to remove autocorrelations from the data concerning the Polish economy, which may cast some doubts on the quality of results obtained from that model. It is worth mentioning, however, that the same problems were reported e.g. by Anzuini and Levy (2007) who estimated a similar model using the data from the 1993–2002 period.

Apart from excluding autocorrelations, each of the models was also tested against heteroscedasticity (using the multivariate ARCH-LM test) and instability of parameters (using the CUSUM test). Due to the instability of the model of the Hungarian economy, which occurred towards the end of the original sample, it was necessary to re-estimate it with the use of a shorter sample covering the period of 2000:1–2010:12. As the sample period was characterised by relatively dynamic changes in the economic conditions, in some cases dummy variables were used in order to achieve normal distributions of residuals of the models. In the case of the models concerning the Czech Republic, dummies were used for singular episodes characterised by the occurrence of output or exchange rate shocks. The need for the use of dummies was definitely stronger in case of Hungary and Poland. In the model for Hungary the introduction of dummies for 6 months of 2003 was mainly a result of the changes of exchange rate regimes, which occurred twice that year. Furthermore, some dummies were also needed in order to model the 2006 Hunagrian debt crisis properly. In the case of Poland, dummies were needed at the beginning of the sample in order to model the consequences of the change of the exchange rate regime in 2001. Some dummies were also necessary in order to better explain the shocks connected with EU accession in 2004. The other dummies were used in order to model some minor demand shocks. Finally, the models were also checked for the existence of explosive roots. None of the specifications used in the further analyses were characterised by the existence of such roots.

The results of the estimations are depicted by the impulse response functions (IRFs) coming from both Cholesky identification – presented in Charts 1, 3 and 5, as well as from the MTM theory-based identification – shown in Charts 2, 4, and 6. The charts present responses of endogenous variables to the 1 percentage point positive monetary policy shock within a 48 month horizon for both, the models estimated in levels and using the Hodrick-Prescott-filtered data. In order for the pictures to remain clear we present only the 90% Hall confidence intervals obtained from 2000 bootstraps for the Hodrick-Prescott filtered data. In case of the models in levels, if not stated otherwise each of responses is statistically significant at the 10% level.

In looking at the impulse responses estimated for the Czech Republic. (Charts 1 and 2) we see that in the case of models in levels both identification schemes give similar results. Positive monetary policy shock causes declines of output, employment, inflation, and money supply, increases in the unemployment rate, as well as initial appreciation of the exchange rate. The model in levels does not suffer from liquidity, exchange rate, and discount bias puzzles, as the money supply decreases and the exchange rate initially appreciates following the shock, in order to fall down to previous levels after about 20 months. Under the Cholesky identification a small and statistically insignificant price puzzle is observed. It takes 9 months before the reaction of inflation rate to the changes in short-term interest rates can be observed. Under the MTM identification the price puzzle is larger – it takes at least 17 months for the inflation rate to react to monetary policy shock.

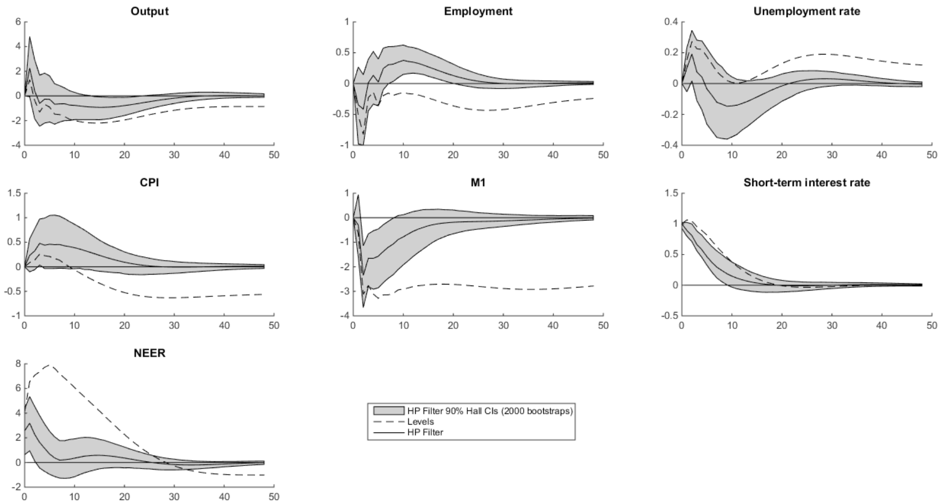

Chart 1. Responses to a positive 1 percentage point monetary policy shock – Czech Republic (Cholesky decomposition)

Source: own calculations.

In the model based on the data in levels and under the Cholesky decomposition, the maximal reaction of output (reaching its peak at –2%) is observed 14 months after an initial shock, while employment (–0.5%), the unemployment rate (+0.2 p.p.) and inflation rate (–0.6%) react maximally after about 28 months. In the case of MTM identification,[4] reported reaction times are longer and the reaction of an economy to a monetary policy shock is less pronounced. Output reacts maximally after 17 months, reaching a maximum of –1.7%. Employment and the unemployment rate react maximally after about 30 months. Their reactions reach their peaks at the levels of: –0.3% and +0.1 p.p., respectively The reactions of CPI and the M1 aggregate are insignificant under this identification.

The model based on HP-filtered data leads to unclear conclusions. In the case of the Cholesky identification it produces statistically insignificant reactions on the part of output, the unemployment rate, and CPI to an unexpected monetary policy shock. On the other hand, in case of MTM identification it produces impulse responses, which are hardly interpretable from the point of view of economic theory (i.e. negative relationship between output and employment, lack of a negative reaction of inflation to monetary tightening). Such a result may thus cast some doubts on the existence of the phenomenon of money non-neutrality in the Czech economy.

[4] In some situations (i.e. when economic variables adjust relatively quickly to changes in the economic situation) it is also possible to introduce an adverse assumption, which says that the precautionary component of labour demand adjusts contemporaneously to changes in the labour market situation, i.e. parameters a_{52} and $a_{53} \neq 0$.

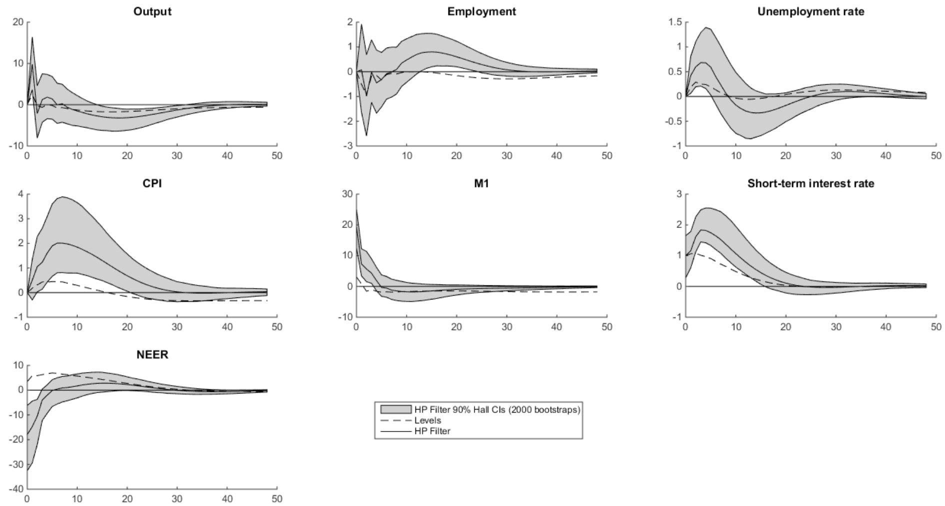

Chart 2. Responses to a positive 1 percentage point monetary policy shock – Czech Republic (MTM theory-based identification)

Source: own calculations.

Responses from the models estimated for Hungary are presented in Charts 3 and 4. Both the model based on data in levels as well as the one based on HP-filtered data show no signs of the liquidity and discount bias puzzles, whereas they suffer from price and exchange rate puzzles.

Models based on the Cholesky identification scheme, both using data in levels and HP-filtered data, show that all variables move significantly in the expected direction, however reaction times are shorter and reactions are weaker in the case of a filtered-data model. According to the model in levels, 1 p.p. tightening of monetary policy results in a decline in output which obtains its maximal value of –2.4% 30 months after an initial shock, with employment and the unemployment rate reaching their maximal responses of –0.5% and +0.2 p.p. about 22 months after the shock. The price puzzle lasts for about 15 months and prices fall down through the rest of the analysed period. According to the HP-filtered model, 1 p.p. positive shock to monetary policy results in –1% decline in output 7 months after the shock, a –0.2% decline in employment, and +0.1 p.p. rise in the unemployment rate obtained 15 months after the shock.

Under MTM-based identification, the models show the same sign and similar timing of economic reactions as in the case of the Cholesky decomposition, whereas amplitudes of impulse responses are definitely higher. A one percentage point increase in short-term interest rate leads to a decline in output reaching –4.2% at its peak, a –0.9% decline in employment and 0.4 p.p. rise in the unemployment rate. The price puzzle is longer and lasts for 27 months and the decline in inflation at the end of the analysed period (i.e. 48 months after the shock) reaches –1.2%. The reactions obtained from HP-filtered data are even stronger.

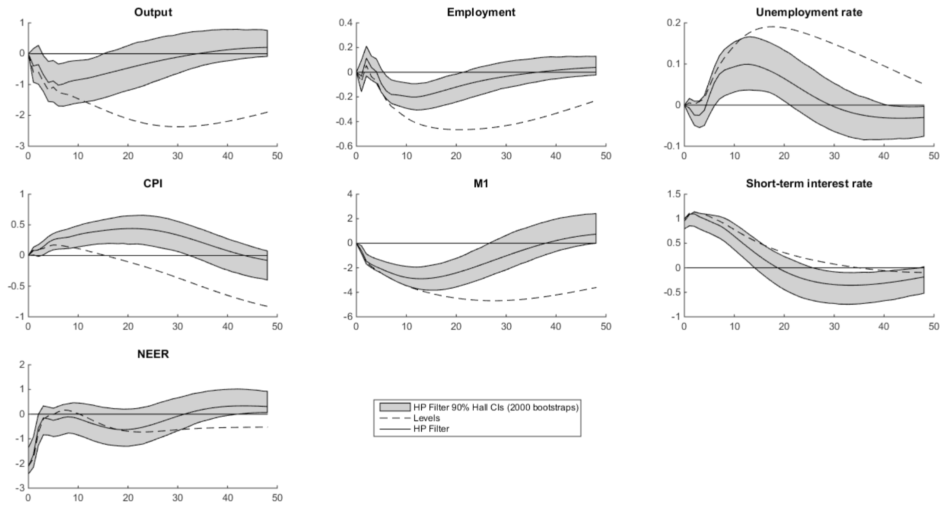

Chart 3. Responses to a positive 1 percentage point monetary policy shock – Hungary (Cholesky decomposition)

Source: own calculations.

The last group of estimations concerned the Polish economy (Charts 5 and 6). In that case neither the model in levels nor one using filtered data suffer from either the liquidity or discount bias puzzle, while at the same time they point towards a relatively large price puzzle. Additionally, under the Cholesky identification, both of them suffer from an exchange rate puzzle.

Looking at the IRFs obtained using Cholesky decomposition we observe that both models show that all of the variables except for the exchange rates move significantly in the directions that are presumed by the economic theory. The model in levels shows that 1 p.p. unexpected increase in the short-term is followed by decline in output, which reaches –2.8% at its peak 30 months after an initial shock. These changes are followed by a decline in employment and rise of the unemployment rate reaching their maximal values equal to, respectively: –1.6% and +1.8 p.p., 40 and 30 months after the primary impulse. The price puzzle lasts for 30 months after the impact of a monetary policy shock. The price level declines for the rest of an analysed period.

According to impulse responses obtained from the HP-filtered model for the Polish economy under the Cholesky identification, the impact of monetary policy on the economy is much shorter and weaker. In that case the declines in output, employment and the unemployment rate reach their maximal value about 20 months after an initial shock and are equal to, respectively: –0.7%, –0.4% and +0.4 p.p. The price puzzle lasts for the first 25 months and the maximal negative reaction of the CPI level is reached 10 months later, at the level of –0.25%.

Under the non-recursive (MTM) identification, the model in levels show very similar timing properties to those obtained under the Cholesky decomposition, whereas the magnitude of responses is much weaker. The decline in output reaches the maximum of –3% only 5 months after an initial shock, employment falls by the maximum of –0.8%, and unemployment rises by +0.9 p.p. The price puzzle lasts for 25 periods and the price level declines by –0.7% on the 48th month after an initial shock.

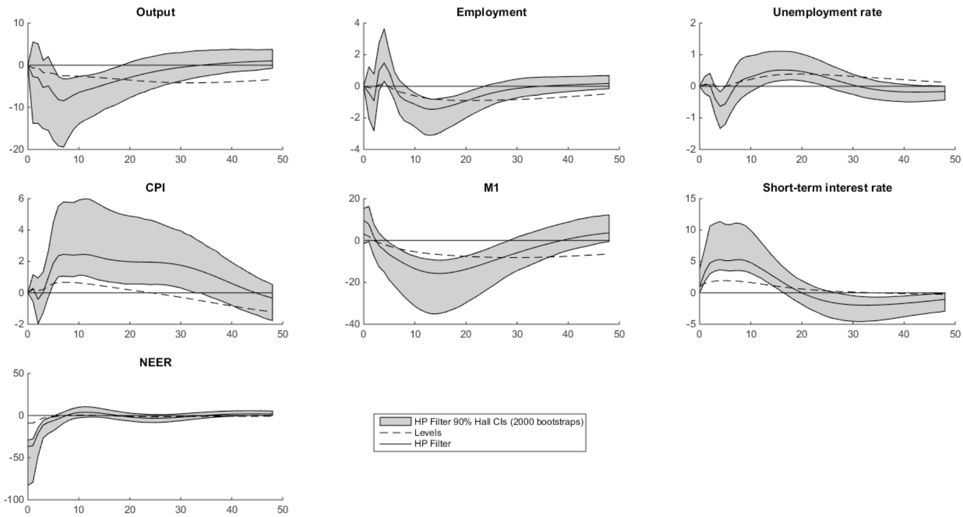

Chart 4. Responses to a positive 1 percentage point monetary policy shock – Hungary (MTM theory-based identification)

Source: own calculations.

Under the MTM-based identification the model using HP-filtered data yields almost exactly the same results as the one which uses the Cholesky decomposition. The only difference concerns the reaction of prices. Under non-recursive identification the price puzzle ends after 25 months and the maximum level of the decline in CPI is obtained 37 months and equates –0.3%.

The performed analyses lead us to the conclusion that models based on data in levels give relatively stable results, which are mostly in line with existing economic theories, thus we will base our conclusions regarding the time structure and magnitude of reaction of non-eurozone Visegrad Group countries only on the results coming from this type of model. The results coming from the models using HP-filtered data are more disputable, especially when we analyse the magnitudes of impulse responses. Thus, we treat them mostly as a qualitative check on the robustness of the results obtained using models in levels to the exclusion of a long-term relationships from the data.

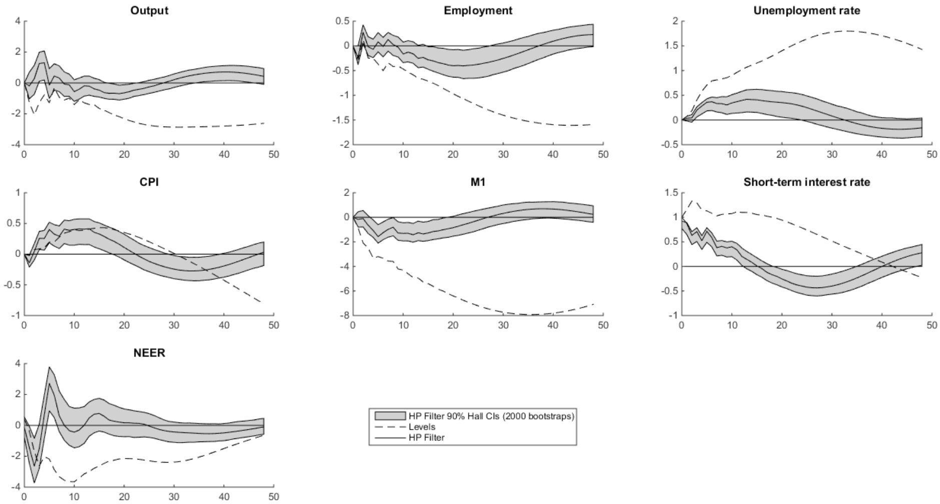

Chart 5. Responses to a positive 1 percentage point monetary policy shock – Poland (Cholesky decomposition)

Source: own calculations.

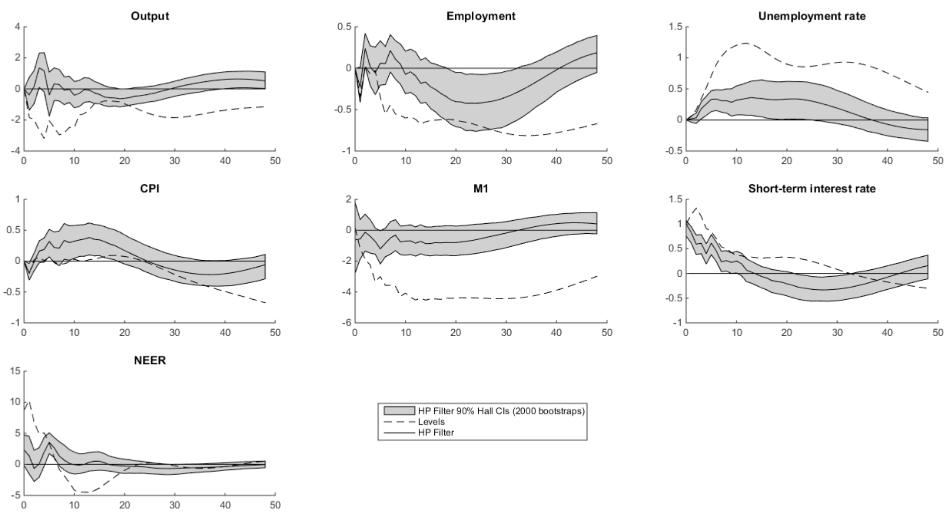

Chart 6. Responses to a positive 1 percentage point monetary policy shock – Poland (MTM theory-based identification)

Source: own calculations.

6. Conclusions

The performed analyses were aimed at establishing the stylised facts describing the character of the monetary transmission mechanism in the non-eurozone Visegrad Group countries. The obtained results are consistent with the Keynesian/monetarist view on monetary theory, which acknowledges the existence of a short-run nexus between the character of the monetary policy undertaken and the situation in the labour market. The main findings are summarized below.

The economies of all of the analysed countries are characterised by the non-neutrality of money, which results in the existence of a relationship between the nature of the monetary policy undertaken, reflected in the levels of nominal variables such as short-term interest rates, monetary aggregates, or price level and the levels of real economic variables such as output, employment and the unemployment rate. The impact of nominal variables on real economic activity takes place with some lag, which is usually no longer than 10 months. Changes of employment and in the unemployment rate follow the changes of output with some additional lag, which is close to 10 months. They are also weaker than the corresponding changes of output, due to the existence of adjustment processes in an economy. A 1 p.p. increase in the short-term interest rate in the non-eurozone Visegrad group countries leads on average to a maximum –2.68% decrease in output, a –0.71% decrease in employment, a +0,53 p.p. increase in the unemployment rate, and a decline of the price level by –0.7% at the end of a 48 month horizon.

According to the obtained results, the economies of each of the analysed countries are characterised by the existence of irreducible price puzzle, which ranges from 10 to even 30 months. This phenomenon might result from the relative instability of economic processes in the analysed period. As the sample covers periods of both good prosperity and crisis, it might be susceptible to regime and/or volatility changes, which may, at least partially, contribute to the existence and scale of the puzzles. This observation marks the possible direction of an extension of the proposed research framework, which might be obtained through the use of VAR models with varying parameters, such as Markov Switching VAR (MS-VAR) or Time-Varying Parameters VAR (TVP-VAR). These issues will be subjected to further analysis in forthcoming publications.

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Streszczenie

TRANSMISJA POLITYKI PIENIĘŻNEJ A RYNEK PRACY W KRAJACH GRUPY WYSZEHRADZKIEJ NIEBĘDĄCYCH CZŁONKAMI STREFY EURO W LATACH 2000–2014. WYNIKI ANALIZ Z WYKORZYSTANIEM MODELI SVAR

Celem prezentowanego artykułu jest wypełnienie luki w istniejącej literaturze ekonomicznej poprzez dostarczenie nowych dowodów na istnienie zależności pomiędzy rozmiarami podaży pieniądza a poziomami zatrudnienia i bezrobocia obserwowanymi w krajach Grupy Wyszehradzkiej niebędących członkami strefy euro (Czechach, Węgrzech i Polsce). Analizy wykorzystują strukturalne modele wektorowej autoregresji (SVAR), które estymowano w oparciu o dane miesięczne z okresu 2000:1–2014:2. W celu uzyskania oszacowań funkcji odpowiedzi na impuls wykorzystano zbiór restrykcji krótkookresowych wyprowadzonych z teorii transmisji polityki pieniężnej. Zaproponowano dwie różne identyfikacje modelu.

Wyniki potwierdzają istnienie zależności pomiędzy polityką pieniężną, zatrudnieniem i bezrobociem. Zgodnie z uzyskanymi oszacowaniami szoki polityki pieniężnej powodują opóźnioną reakcję produkcji, zatrudnienia i stopy bezrobocia w analizowanych krajach.

***Słowa kluczowe**: polityka pieniężna, produkcja, zatrudnienie, bezrobocie, Grupa Wyszechradzka, strukturalne model wektorowej autoregresji, SVAR.*