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Article

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Monetary Conditions Index: New Empirical Evidence from Central and Eastern European Countries

*Anca Elena NUCU – Sorin Gabriel ANTON**

Abstract

The aim of the paper is to build a Monetary Conditions Index (MCI) for four Central and Eastern European (CEE) countries by combining changes in the short-term interest rate and in the real effective exchange rate over the period August 2005 – December 2015. Contrary to previous papers, we employ a Vector Error Correction Model to assess the relative importance of real interest rate and real exchange rate for the monetary conditions in several CEE countries. The results of the analysis provide new empirical evidence on the MCI's ability to capture the monetary policy developments. Furthermore, we employ Granger causality to infer the extent of external influences on the overall monetary conditions of analysed countries. The results highlight that monetary decisions in the Eurozone have a prominent influence on monetary conditions in CEE countries.

Keywords: *Monetary Conditions Index, Central and Eastern Europe, monetary policy, principal components, Vector Error Correction Model, interest rate, real exchange rate*

JEL Classification: E52, E44, E17

Introduction

Since the onset of the financial crisis in September 2008, the monetary authorities from Central and Eastern European (CEE) countries have adopted several measures with the purpose to safeguard financial and monetary stability, on the background of modest economic development and uncertain economic growth forecasts. The importance of the relationship between monetary policy and real economy motivates our research.

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The aim of our paper is to build a Monetary Conditions Index (MCI) for four CEE countries (Czech Republic, Hungary, Poland, and Romania) and to assess whether the monetary conditions from Euro area (EA) influence the monetary conditions from above-mentioned countries, between August 2005 and December 2015.

Emerging market economies are characterized as transitional, meaning they are in process of moving towards an open market economy and the extent of monetary tightening or ease relative to previous periods may best be gauged by looking at both principal channels of transmission, i.e., exchange rates and interest rates. The constructed MCI is important because, in the small economies, such as those analysed in our paper, the exchange rate has a greater importance for economic development and it is advisable to include this variable in the assessment of the underlying monetary conditions.

Most of the previous studies computed and interpreted MCI for one or two countries on a short period. Our paper contributes to the existing literature in several ways. Firstly, we extend the literature by proposing a monetary condition index for four CEE countries over a long time horizon which offers a comprehensive synthesis of historical perspective and illustrates the monetary movements towards loosening or tightening. This allows us to learn a lesson in mapping the narrative of monetary conditions before and after the latest global financial crisis.

Secondly, the weighted average approach is based on Vector Error Correction Model (VECM) technique, which implies the existence of long-run relationship between variables in the model. The MCIs is constructed by weighting the initial standardized variables with the impulse-response cumulated over eight quarters with variance decomposition. The proposed methodology is a nonlinear combination of main MCI components. Until now, to the best of authors' knowledge, this methodology has not been applied for the selected countries.

Thirdly, the paper came with a new research idea, by analysing the degree to which the movements of monetary policy in CEE countries are associated with the European Central Bank (ECB) decisions over the period between August 2005 and December 2015, using a Granger causality analysis. By employing this methodology, we validate the unidirectional causality coming from MCI for the Euro area to MCIs in CEE countries.

The rest of the paper is organized as follows. Section 1 briefly surveys the major contributions of the literature review. Section 2 explains our data set and the methodology used. Section 3 discusses the empirical results, while last section brings the main conclusions.

1. Literature Review

Numerous papers have investigated the construction of the MCI and also its advantages and limitations. Most of the contribution has been made by central banks, which aimed to analyse monetary policy transmission mechanisms via interest rate and exchange rate. Early papers were focused on providing a theoretical background of monetary condition index, being defined as a combination of the changes in short-term interest rates and the multilateral exchange rate compared to base period (Freedman, 1995; Batini and Turnbull, 2002). Regarding the construction of the index, the academic literature recognizes various econometric techniques used to calculate the weights of variables in MCI (Hyder and Khan, 2006): single equation of either price or output; trade elasticities approach; Vector Autoregressive (VAR) and Johansen's cointegrating models, the latest one being preferred. The first studies concerning MCI's construction were developed on the example of Canada (Duguay, 1994), where MCI has been used as a target of monetary policy, being extended to New Zealand (Nadal De-Simone, Dennis and Edward, 1996).

There are only a few studies in the literature conducted on one or more CEE countries (Korhonen, 2002; Torój, 2008; Benazic, 2012; Olteanu, 2013; Ho and Lu, 2013; Czech National Bank, 2015). Korhonen (2002) estimated the MCIs for three new European Union (EU) member countries (Czech Republic, Poland, and Slovakia) and found that MCI ratio for the Czech Republic is comparable to that of small EU countries, while Poland appears to be more sensitive to movements in the exchange rate. On the other hand, Torój (2008) estimated the weights for the MCI in Poland using four empirical strategies (Investment Savings and Phillips curve, VAR model and small structural system of equations) and found that most of the methods indicate a prevailing role of real interest rate, at the level of 2/3. Benazic (2012) constructed a MCI for Croatia using Engle-Granger co-integration method of time series and he concluded that MCI should be used more as an indicator in conducting monetary policy rather than a technical instrument. Ho and Lu (2013) applied two complementary approaches (factor analysis and vector auto-regression) in order to estimate a Financial Condition Index (FCI) for Poland, taking into account internal and external financial variables. Their conclusion is that FCI can be usefully employed as an analytical tool to inform monetary authorities, as well as near-term growth forecasting. The Czech National Bank built both a real monetary conditions index (RMCI) as the „weighted average of the deviations of domestic ex ante real interest rates and the real exchange rate from their equilibrium levels" (The Czech National Bank, 2015) and an alternative monetary conditions index, which describes larger monetary conditions, using Factor-Augmented Vector Autoregressive (FAVAR) models. Both indicators state that the domestic real monetary conditions have been very accommodative, as a response to the international economic and financial crisis.

The study of the MCI is widely debated concerning advantages and shortcomings in interpretations, highlighting the fact the MCI should not be used as operational target, because exchange rate is not a monetary policy instrument and there is a risk of losing information on individual components movements by looking at the aggregate effect (Siklos, 2002; Osborne-Kinch and Holton, 2010). The general conclusion is that there is no agreed neutral point of monetary conditions and the interpretation of the index should focus on its movements, rather than values. The Financial Condition Index (FCI) is seen as an extension of MCI, taking into account more variables. Despite the shortcomings, Us (2004) stated, on the example of the Turkish economy, that the policymakers should consider using MCI as an instrument when conducting monetary policy. The majority of academic literature shows that regardless of the chosen econometric technique, MCIs is successful in highlighting the prevalent monetary conditions' tightness/looseness at different moments and in describing their movements.

2. Data and Methodology

2.1. Data

Our empirical research sample is formed from CEE countries in which central banks have as main objective price stability and the monetary policy strategy adopted is direct inflation targeting. Thus, the sample comprises four countries from the region: Czech Republic, Hungary, Poland, and Romania. These countries have adjusted their monetary policy instruments depending on structural adjustments, using generally the same instruments as the ECB, but with certain features, depending on the characteristics of each economy. The sample was constructed taking into account the similarities of monetary policy strategy of mentioned countries. Since the monetary policy in Croatia and Bulgaria is based on the exchange rate anchor, these countries are out of scope in our study. For Baltic countries, we consider that the presented model does not apply, due to their exchange rate arrangements (the currency board of Lithuania and the participation of Latvia to Exchange Rate Mechanism II, prior to the entry into the Euro area). The MCI construction is based on monthly data series ranging from August 2005 to December 2015. The base period is considered August 2005, when National Bank of Romania decided to adopt direct inflation targeting as a monetary policy strategy. Although other countries adopted this strategy earlier

(Czech Republic – 1998; Hungary – 2001; Poland – 1999), we analyse the period 2005M08 – 2015M12 for comparability purpose. The common features of these countries motivate their selection for the current study, other CEE countries being too different in terms of exchange rate regime in order to validate the current modelling setup. The proposed sample is of great interest because the conclusions and lessons can be transferred to other developing countries.

T a b l e 1

Defines the Variables Used in the Econometric Estimations

Variable	**Proxy/calculation**	**Data source**	**Data specification**
Interest rate	Money market interest rates – 3-month rates	Eurostat	In level
Exchange rate	Real Effective Exchange Rate (deflator: consumer price indices – 42 trading partners)	Eurostat	Logarithmic
Output	Industrial production (output of industrial establishments; covers sectors such as mining, manufacturing and public utilities; measured as an index based on a reference period)	OECD	Logarithmic
Stock index	The reference index for the capital market.	Bloomberg	Logarithmic
Loan to deposit ratio	Total loans/ Total deposits for the banking system	Central banks' official websites	In level

Source: Own representation based on the literature review.

We employ a set of variables commonly used in the extant literature (Batini and Turnbull, 2002; Kodra, 2011; Trinh and Kim, 2014) as proxies for real sector and different components of the financial system. All the variables relevant in the transmission process in the economy are included in order to estimate the weights of MCI components.

Industrial production is employed as a proxy variable for the real sector, the monthly frequency of industrial production being preferred instead of GDP reported quarterly. The effect of monetary policy decisions is captured by the 3-month interbank interest rate.

We employ the loans to deposit ratio for the banking system in our models given the importance of the banking sector in financing economic activity. A boom in the credit market not accompanied by an increase in deposits level (which reflects the confidence in the national currency) may indicate a potential imbalance in the financial system because the private sector indebtedness can reach unsustainable levels. Bank credit to the private sector is found to have a negative and highly significant impact on the soundness of banks in CEE countries, as demonstrated by Mirzaei, Moore and Liu (2013). A significant and rapid increase in the value of this variable can signify excessive risk-taking by banks and thus the deterioration of their' financial soundness. Therefore, we expect a positive monetary policy shock to cause a drop in the loan/deposit ratio.

As a proxy for the capital market we used the most representative stock index for each country in the region, respectively PX for Prague Stock Exchange, BUX for Budapest Stock Exchange, WIG for Warsaw Stock Exchange, and BET for Bucharest Stock Exchange. From the central bank's perspective, an unexpected rise in key interest rates should lead to a fall in asset prices. Bubbles in asset prices could degenerate into a financial crisis.

The exchange rate measured as the local currency versus the Euro is used as a proxy for the foreign exchange market. The exchange rate stability plays an important role in the development of foreign investments and reducing the currency risk. Reverse evolution between the policy rate and the exchange rate is desirable under the impact of a monetary policy shock. An unexpected exogenous increase in interest rates by the central bank, which does not lead to an appreciation of the local currency denotes a potential imbalance in the financial system.

2.2. Methodology

According to the extant literature (e.g., Abdul Majid, 2012), our analysis is based on two assets model, namely short-term interest rate (IR) and real effective exchange rate (REER). Let's consider the weighted sum of the changes in exchange rate and interest rate in the selected base year, based on the following formula:

$$MCI_t = w_{ir}(IR_t - IR_b) + w_{er}[\log(ER_t) - \log(ER_b)] \quad (1)$$

where IR_t and ER_t represent the three-month interest rate and respectively, the real effective exchange rate (deflator: consumer price indices – 42 trading partners) at time t, the best proxy for the exchange rate, according to Freedman (1994). IR_b and ER_b are the interest rate and real effective exchange rate in the selected base year (2005). The real effective exchange rate is expressed in logarithms, in order to stabilize the variance, whereas the interest rate is in levels. We have selected the effective exchange rate due to its strong relationship to economic activity (net export). The most important items from the equation are the value of weights (w_s), because these numbers highlight the significance of exchange rate and interest rate as channels of monetary policy transmission mechanism. Each MCI is scaled such that its weights sum to unity (i.e., $w_{ir} + w_{er} = 1$).

By construction, a rise in the interest rate increases the MCIs and is interpreted as a tightening of monetary conditions. A decline in the interest rate increases aggregate demand and lowers the MCI, so a fall in the index is interpreted as a loosening of monetary conditions. The academic literature points out that no independent significance is to be ascribed to the absolute values of MCIs (Deutsche Bundesbank, 1999; Trinh and Kim, 2014), the ongoing development only indicating whether the underlying monetary conditions have eased (decline in the MCI) or become tighter (increase in the MCI). According to the extant literature on MCIs, the index can serve as an operational target, as an indicator, or as a monetary policy rule. The MCIs have never been used by central banks in the form of a rule, but have been used as operating targets by the Central Banks of Canada and New Zealand.

Regarding the MCI's utility in practice, Trinh and Kim (2014) state that the indicator has two main features of a supporting index for short-term monetary policy management, including quick reaction to monetary policy changes and close nexus with the policy objective. We recommend to look at the MCI as a broad reference and interpret it with caution because there is no unanimous way to compute econometrically the weights of the components and the results could be slightly biased of different measuring methods.

The academic literature highlights different approaches related to this subject: the estimation of a large-scale macro-econometric model, the estimation of an equation system consisting of reduced form aggregate demand and aggregate supply functions, and the analysis of impulse response functions obtained through VAR model estimation.

In order to estimate the MCI's weights, we followed impulse response functions and variance decomposition derived from a VECM estimation of order p with the following standard representation:

$$\Delta Y_t = \alpha\beta' Y_{t-1} + \Gamma_1 \Delta Y_{t-1} + ... + \Gamma_{p-1}\Delta Y_{t-p+1} + u_t \tag{2}$$

where

Y_t – a K-dimensional vector of observable variables,
α – a $(K \times r)$ matrix of loading coefficients,
β' – the $(K \times r)$ cointegration matrix, with r cointegration rank,
Γ_j – a $(K \times K)$ short-run coefficient matrix for $j = 1, p - 1$ (p = VECM order),
u_t – a white noise error vector with $u_t \sim (0, \Sigma_u)$,
K – the number of time series variables.

We tested the number of cointegration relationships (r) envolved in VECM estimation, using the Johansen Cointegration test, based on testing the null hypothesis sequence:

$$H_0: rk(\Pi) = 0, H_0: rk(\Pi) = 1, \ldots, H_0: rk(\Pi) = K - 1 \tag{3}$$

The test ends when the null hypothesis cannot be rejected for the first time. If Johansen trace test rejects $r = 0$, the data series are cointegrated.

For our purpose, we will consider the VECM form in which the deterministic trend is dropped and all observable stochastic variables fall into the model as endogenous variables:

$$A\,\Delta y_t = \Pi^* y_{t-1} + \Gamma_1^* \Delta y_{t-1} + \ldots + \Gamma_{p-1}^* \Delta y_{t-p+1} + \varepsilon_t \text{ – structural form} \quad (4)$$

Multiplying the structural form with A^{-1}, the result is reduced form:

$$Y_t = \prod Y_{t-1} + \Gamma_1 \Delta Y_{t-1} + \ \ldots \ + \Gamma_{p-1} \Delta Y_{t-p+1} + A^{-1}\varepsilon_t \quad (5)$$

where

$$\Pi = A^{-1}\Pi^*,\ \Gamma j = A^{-1}\Gamma_j^* cuj = 1,\ \ldots,\ p-1$$

The nexus between the vector of structural shocks and ε_t and VECM innovation vector u_t is:

$$u_t = B^* \varepsilon_t \quad (6)$$

with the following structure:

$$\begin{bmatrix} u_{ip} \\ u_{irs} \\ u_{ldr} \\ u_{sp} \\ u_{er} \end{bmatrix} = \begin{bmatrix} b_{11} & 0 & 0 & 0 & 0 \\ b_{21} & b_{22} & 0 & 0 & 0 \\ b_{31} & b_{32} & b_{33} & 0 & 0 \\ b_{41} & b_{42} & b_{43} & b_{44} & 0 \\ b_{51} & b_{52} & b_{53} & b_{54} & b_{55} \end{bmatrix} * \begin{bmatrix} \varepsilon_{ip} \\ \varepsilon_{irs} \\ \varepsilon_{ldr} \\ \varepsilon_{sp} \\ \varepsilon_{er} \end{bmatrix} \quad (7)$$

where B is a lower triangular matrix obtained from a Cholesky decomposition of the covariance matrix Σu, such that $BB' = \Sigma u$ (Pesaran and Shin, 1998).

In order to capture monetary policy reaction function, for each country from the sample we defined a VECM model of order 5, taking into account more (macro) economic variables, as following: logarithmic series of industrial production index for the real sector (*ip*); 3 month interbank interest rate (*irs*); the loans to deposit ratio for the banking system (*ldr*); logarithmic series of stock index for capital market (*sp*); logarithmic series of exchange rate measured as local currency versus the Euro (*er*).

The order of variables is important for optimal results. Within the empirical analysis, a recursive scheme is considered under the following two assumptions: (1) industrial production does not immediately respond to a monetary policy shock; (2) a monetary policy shock has a contemporary impact on the stock index, on the exchange rate, and on the level of loans and deposits. The first assumption is standard in literature dedicated to such models, considering that prices and output respond with a lag (delay) to a monetary policy shock (Balabanova and

Brüggemann, 2012). The second assumption also assumes the standard scheme of contemporary response for the exchange rate. Identification systems, which do not allow the exchange rate to respond immediately, and conversely, tend to produce the „price puzzle“, i.e. a positive initial response of prices to monetary policy tightening (Jarocinsky, 2010). In addition, we considered that stock index responds contemporary respond to a shock of the monetary authorities since market players are the first to react to unanticipated actions or rumors.

The orthogonal shocks are given by the relationship below:

$$\varepsilon_t = B^{-1} * u_t \tag{8}$$

Given the fact the effects of shocks are visible in terms of moving average

$$Y_t = \Phi_0 u_t + \Phi_1 u_{t-1} + \Phi_2 u_{t-2} + ... \tag{9}$$

we get the following form:

$$Y_t = \omega_0 \varepsilon_t + \omega_1 \varepsilon_{t-1} + ... \tag{10}$$

where $\omega_i = \Phi_i B,\ \omega_0 = B$. $\Phi_i * B$ are the matrices of impulse response function. Based on the two mentioned hypotheses, the proposed ordering of VECM is considered appropriate to study the „variance decomposition” relation between the variables.

The variance decomposition is used to aid in the interpretation of VECM model once it has been fitted. The variance decomposition indicates the amount of information each variable contributes to the other variables in the autoregression. It determines how much of the forecast error variance of each of the variables can be explained by exogenous shocks to the other variables. The variance decomposition calculates the proportions of changes in a variable which is due to their innovations and innovations in other variables (in percentage). The results should be interpreted cautiously because „the total effect of a variable is assigned entirely to the variables included in the system“ (Botel, 2002).

Denoting the *ij*th element of the orthogonalized impulse response coefficient matrix Ψ_n by $\Psi_{ij,n}$ the variance of the forecast error: $y_k, T_{+h} - y_k, T_{+h|T}$

is
$$\sigma_k^2(h) = \sum_{n=0}^{h-1} (\varphi_{k1,n}^2 + \ldots + \varphi_{kK,n}^2) = \sum_{j=1}^{K} (\varphi_{kj,0}^2 + \ldots + \varphi_{kj,h-1}^2) \tag{11}$$

The term $(\varphi_{kj,0}^2 + \ldots + \varphi_{kj,h-1}^2)$ is interpreted as the contribution of variable *j* to the *h*-step forecast error variance of variable *k*. Dividing the above terms by $\sigma_k^2(h)$ gives the percentage contribution of variable j to the *h*-step forecast error variance of variable *k*:

$$\omega_{kj}\left(h\right)=(\varphi^2_{(kj,0)}+...+\varphi^2_{(kj,h-1)})/\sigma^2_k\left(h\right) \quad (12)$$

As we mentioned in Introduction part, the paper came with a new research idea, in order to determine the degree to which the movements of monetary policy in analysed countries are associated with ECB decision. The empirical part of this paper is supported by Granger causality methodology. We use this methodology to investigate if there is any causal relationship between two selected time series, the current study testing the bidirectional causality hypothesis. Such causality assumes that a time series X_t Granger-causes another time series Y_t if Y_t can be predicted better by using the past values of X_t than by using only the historical values of Y_t. The variables considered are the MCIs calculated above for CEE countries and respectively the MCI for the Euro area. In order to test the causal relations between the two series, the following bivariate autoregression is used:

$$MCI_{Eat} = \mu_0 + \sum \mu_k MCI_{EA\ t\text{-}k} + \sum \beta_k MCI_{CEE\ t\text{-}k} + u_t \quad (13)$$

$$MCI_{CEE\ t} = \gamma_0 + \sum \gamma_k MCI_{CEE\ t-k} + \sum \theta_k MCI_{EA\ t-k} + u_t \quad (14)$$

where $\propto_0$ and γ_0 are constants, $\propto_k$, β_k, γ_k, θ_k are parameters, and u_t are uncorrelated disturbance terms with zero means and finite variances. A bi-directional causality relation exists if both $\propto_k$ and β_k coefficients are jointly different from zero.

Regarding the methodology of MCI for Euro area, we followed the output simulation of the OECD's Interlink model, which gives relative weights of 6:1 in the favour of interest rate. In the Euro area, the interest rates are controlled by the ECB, while the exchange rate is influenced by other factors, independently of monetary authority.

3. Empirical Results

The stationary analysis of time series according to Dickey-Fuller test Augmented (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) highlights that all variables from VECM system are integrated of order 1, I (1). We also run Philips-Perron test in order to confirm the results of the above-mentioned tests.

Once checked the stationarity of the time series, the estimation of a VECM model involves the specification of the cointegrating rank as well as a maximum lag order for the endogenous and exogenous variables. Zero restrictions were placed on the parameter matrices. The cointegrating rank was specified with the help of the cointegration test – Johansen Trace Tests. In the case of Poland, one lag is enough to capture the dynamics of the system, and for the rest of the sample, two lags. Johansen cointegration test highlights the existence of two steady relationships between variables in all countries. In the cointegration analysis of time series, we considered both cases (constant trend, respectively orthogonal trend) and we made the final decision taking into account the results of the bivariate system for each part, considering risk $\alpha = 0.05$ (95% confidence interval).

After the estimation of VECM for each country, the following diagnostic tests were performed: Portmanteau test for autocorrelation and respectively, LM tests for h^{th} order residual autocorrelation, h being the lag order. Chow test was used to check parameter constancy throughout the sample period. Diagnostic and stability tests of the VECM specifications indicate that estimated results are stable and significant.

Table 2 reports the variance decomposition for the Czech Republic. Our empirical results show that at six months time horizon, innovations in short-term interest rate explain 13% of the variation in the exchange rate and remain below this threshold during entire time horizon. Also, monetary shocks are an important factor in explaining industrial output, since at 18 months 24% variation of this variable is due to the short-term interest rate. The innovations in exchange rate explain 25% explain of the variation in industrial production after 8 quarters.

T a b l e 2

Variance Decomposition for the Czech Republic: Percentage of Variation for Line Variables Assigned to Column Variables

Variables	Time horizon (months)	Industrial production	3M interest rate	Loan to deposit ratio	Stock price index	Exchange rate
Industrial production	1	1.00	0.00	0.00	0.00	0.00
	6	0.80	0.09	0.09	0.02	0.01
	12	0.55	0.20	0.11	0.01	0.12
	18	0.40	0.24	0.09	0.01	0.26
	24	0.36	0.31	0.08	0.01	0.25
3M interest rate	1	0.08	0.92	0.00	0.00	0.00
	6	0.45	0.36	0.16	0.03	0.00
	12	0.44	0.12	0.29	0.14	0.00
	18	0.42	0.10	0.30	0.12	0.05
	24	0.39	0.11	0.32	0.14	0.01
Loan to deposit ratio	1	0.08	0.00	0.92	0.00	0.00
	6	0.45	0.18	0.36	0.01	0.00
	12	0.56	0.29	0.12	0.01	0.02
	18	0.52	0.32	0.10	0.00	0.05
	24	0.47	0.34	0.12	0.00	0.08
Stock price index	1	0.02	0.02	0.00	0.96	0.00
	6	0.01	0.09	0.04	0.85	0.01
	12	0.05	0.15	0.04	0.70	0.06
	18	0.20	0.12	0.02	0.55	0.10
	24	0.33	0.09	0.02	0.45	0.11
Exchange rate	1	0.04	0.07	0.02	0.06	0.82
	6	0.12	0.13	0.06	0.17	0.51
	12	0.12	0.08	0.09	0.21	0.50
	18	0.11	0.07	0.10	0.23	0.49
	24	0.10	0.05	0.12	0.25	0.48

Source: Own estimation based on JMulTi.

The variance decomposition for Hungary, as presented in Table 3, shows that innovations in short-term interest rate explain below 11% of the variation in exchange rate. Innovations in short-term interest rate and exchange rate explain below 50% and respectively 33% of industrial production after 8 quarters.

Table 3

Variance Decomposition for Hungary: Percentage of Variation for Line Variables Assigned to Column Variables

Variables	Time horizon (months)	Industrial production	3M interest rate	Loan to deposit ratio	Stock price index	Exchange rate
Industrial production	1	1.00	0.00	0.00	0.00	0.00
	6	0.65	0.18	0.03	0.07	0.08
	12	0.27	0.40	0.03	0.08	0.23
	18	0.13	0.47	0.03	0.08	0.30
	24	0.08	0.50	0.03	0.07	0.33
3M interest rate	1	0.02	0.98	0.00	0.00	0.00
	6	0.18	0.61	0.08	0.14	0.00
	12	0.25	0.31	0.13	0.30	0.01
	18	0.27	0.22	0.14	0.36	0.01
	24	0.28	0.18	0.14	0.39	0.01
Loan to deposit ratio	1	0.00	0.20	0.80	0.00	0.00
	6	0.02	0.07	0.88	0.00	0.03
	12	0.05	0.05	0.78	0.00	0.11
	18	0.08	0.05	0.63	0.01	0.23
	24	0.11	0.05	0.49	0.01	0.34
Stock price index	1	0.00	0.12	0.05	0.82	0.00
	6	0.01	0.10	0.32	0.54	0.03
	12	0.02	0.08	0.40	0.41	0.09
	18	0.02	0.08	0.44	0.34	0.13
	24	0.02	0.07	0.46	0.29	0.16
Exchange rate	1	0.00	0.11	0.05	0.24	0.60
	6	0.00	0.02	0.14	0.30	0.54
	12	0.00	0.01	0.20	0.31	0.48
	18	0.00	0.01	0.25	0.31	0.43
	24	0.00	0.02	0.30	0.30	0.38

Source: Own estimation based on JMulTi.

Table 4 summarizes the variance decomposition for Poland and shows that short-term interest rate represents an important factor in explaining exchange rate and industrial production, after 24 months, 19% and respectively roughly 70% of the variation of the aforementioned variable is due to the interest rate.

The variance decomposition for Romania, as illustrated in Table 5, shows that innovations in short-term interest rate explain around 55% of the variation in the exchange rate at a time horizon of 24 months. The innovations in short-term interest rate explain roughly 33% of industrial production after 8 quarters, while the exchange rate is a modest factor in influencing the aforementioned variable.

Table 6 summarizes MCIs weights for the analysed countries, the weights being computed as the cumulative impulse response of growth attached to the variables in building the MCI.

T a b l e 4

Variance Decomposition for Poland: Percentage of Variation for Line Variables Assigned to Column Variables

Variables	Time horizon (months)	Industrial production	3M interest rate	Loan to deposit ratio	Stock price index	Exchange rate
Industrial production	1	1.00	0.00	0.00	0.00	0.00
	6	0.81	0.15	0.01	0.01	0.02
	12	0.39	0.53	0.02	0.05	0.02
	18	0.24	0.66	0.03	0.07	0.01
	24	0.20	0.69	0.03	0.07	0.01
3M interest rate	1	0.03	0.97	0.00	0.00	0.00
	6	0.12	0.85	0.01	0.01	0.02
	12	0.16	0.78	0.02	0.03	0.01
	18	0.17	0.75	0.02	0.05	0.02
	24	0.17	0.73	0.02	0.06	0.02
Loan to deposit ratio	1	0.00	0.03	0.97	0.00	0.00
	6	0.08	0.09	0.73	0.09	0.01
	12	0.09	0.18	0.55	0.14	0.05
	18	0.08	0.22	0.49	0.15	0.07
	24	0.07	0.24	0.47	0.15	0.07
Stock price index	1	0.01	0.02	0.01	0.96	0.00
	6	0.03	0.39	0.03	0.54	0.02
	12	0.09	0.64	0.01	0.20	0.06
	18	0.14	0.66	0.01	0.13	0.06
	24	0.17	0.66	0.01	0.12	0.05
Exchange rate	1	0.00	0.00	0.05	0.22	0.72
	6	0.08	0.01	0.07	0.11	0.72
	12	0.10	0.05	0.08	0.08	0.69
	18	0.08	0.13	0.08	0.07	0.64
	24	0.06	0.19	0.08	0.07	0.59

Source: Own estimation based on JMulTi.

T a b l e 5

Variance Decomposition for Romania: Percentage of Variation for Line Variables Assigned to Column Variables

Variables	Time horizon (months)	Industrial production	3M interest rate	Loan to deposit ratio	Stock price index	Exchange rate
Industrial production	1	1.00	0.00	0.00	0.00	0.00
	6	0.68	0.20	0.01	0.05	0.06
	12	0.58	0.26	0.02	0.08	0.05
	18	0.54	0.30	0.03	0.09	0.05
	24	0.49	0.33	0.03	0.10	0.04
3M interest rate	1	0.01	0.99	0.00	0.00	0.00
	6	0.07	0.60	0.04	0.10	0.19
	12	0.08	0.52	0.03	0.11	0.26
	18	0.09	0.49	0.03	0.11	0.28
	24	0.11	0.46	0.03	0.11	0.30
Loan to deposit ratio	1	0.00	0.10	0.90	0.00	0.00
	6	0.05	0.20	0.67	0.01	0.08
	12	0.11	0.13	0.58	0.04	0.15
	18	0.14	0.21	0.38	0.11	0.16
	24	0.14	0.32	0.22	0.17	0.15
Stock price index	1	0.00	0.21	0.00	0.79	0.00
	6	0.02	0.38	0.02	0.58	0.01
	12	0.02	0.45	0.03	0.49	0.01
	18	0.02	0.47	0.03	0.48	0.01
	24	0.02	0.48	0.04	0.46	0.00
Exchange rate	1	0.00	0.13	0.02	0.05	0.80
	6	0.02	0.27	0.00	0.09	0.62
	12	0.02	0.48	0.00	0.10	0.39
	18	0.02	0.52	0.01	0.11	0.34
	24	0.02	0.55	0.01	0.12	0.31

Source: Own estimation based on JMulTi.

T a b l e 6

The Estimated Weights of MCI

	Output (weights expressed as a %)	
	Ratio (Interest rate/exchange rate)	Exchange rate
Czech Republic	3.0	25
Hungary	2.0	33
Poland	2.2	31
Romania	1.5	40

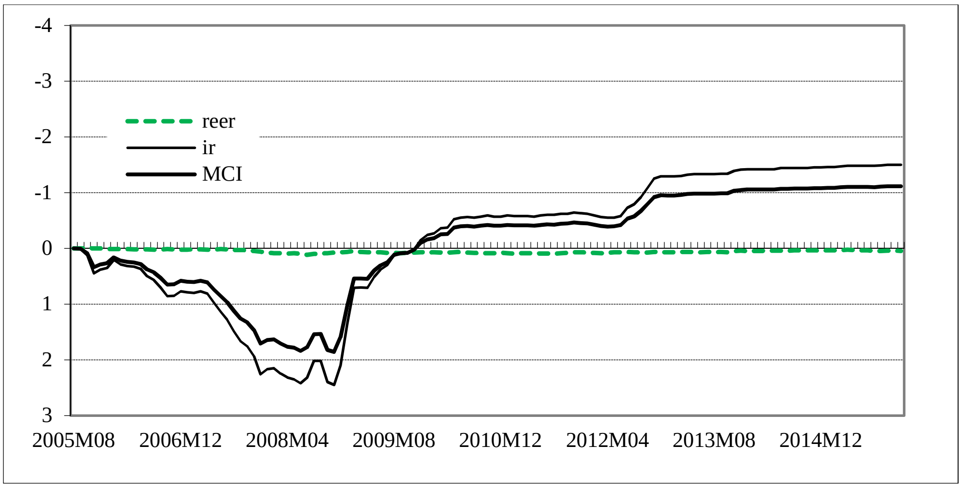
Source: Author's calculation.

During the analysed period, for CEE countries, the weight ratio w_{ir}/w_{er} is higher than one, standing around 2, in favour of interest rate. For Poland, our results are in line with Toroj (2008), the relative weights of the interest rate and the exchange rate component are 2.22:1. The occurrence of an increase in MCI signals that there is a tightening in monetary policy and a decrease in MCI signals a loosening of monetary policy.

Figure 1 plots the evolution of MCI for the Czech Republic over the period between August 2005 and December 2015. The evolution of index indicates an easing of the monetary conditions in 2005 – 2007 followed by tightening due to the sharp appreciation of the national currency and an increase in interest rates due to pressures on inflation expectations. As a response to the global financial and economic crisis, MCI's evolution marks a rapid easing of the monetary conditions. The end of the year 2013 highlights a further easing of the monetary conditions through the direct effect of the weakening of the koruna on the real exchange rate and, as a response, to an increase in inflation expectations.

F i g u r e 1

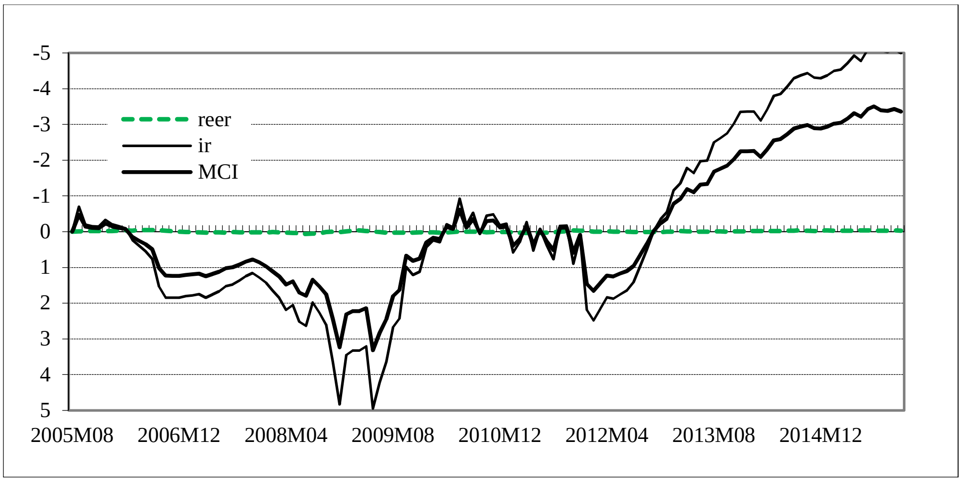
The Evolution of MCI and Its Contributors for Czech Republic (inverted scale)



Source: Own estimation.

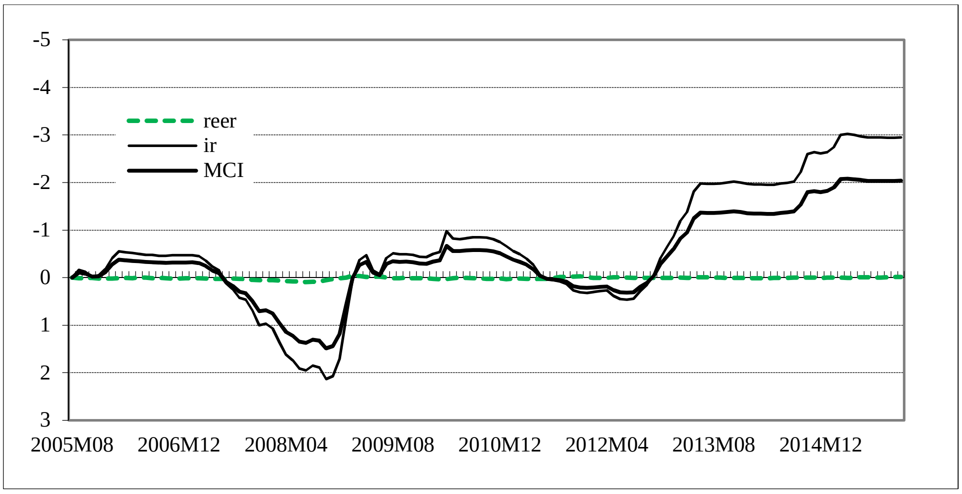
Figure 2 captures the evolution of MCI for Hungary. The MCI signals accentuate loosening in monetary policy compared with the Czech Republic, starting at mid-2013, marked by gradual phasing-out of the two-week central bank deposit facility and the upward trend in central bank interest rate swaps. The MCI follows the extended rate-cutting cycle, which started in July 2012 when the monetary policy interest rate was 7.0% and ended at the current record-low of 0.9%, according to historical data reported for July 2016.

F i g u r e 2
The Evolution of MCI and Its Contributors for Hungary (inverted scale)



Source: Own estimation.

F i g u r e 3
The Evolution of MCI and Its Contributors for Poland (inverted scale)

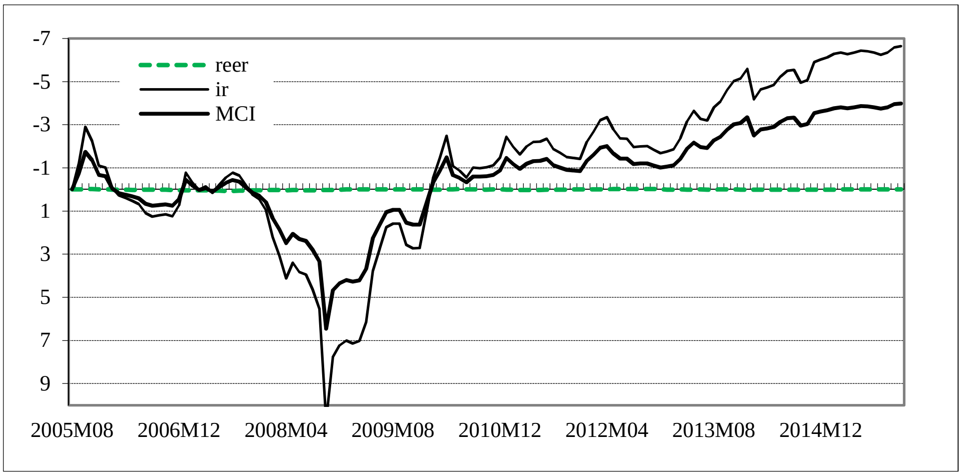


Source: Own estimation.

The backdrop of monetary easing in the region is highlighted by the evolution of MCI in Poland (see Figure 3), motivated by slowdown growth in emerging economies. Between the end of 2008 and early 2010, the monetary policy rate was gradually decreased since the global financial crisis affected the economic activity, determined a credit freeze and suppressed global commodity prices. Around mid-2012, the evolution of MCI shows another wave of policy rate cuts as inflationary pressures throughout the region eased.

The evolution of MCI in Romania marks a rapid easing of the monetary conditions, as a response to the global financial and economic crisis (see Figure 4). The National Bank of Romania (NBR) followed a prudent downward cycle of policy rate pursuing price stability on medium-term according to a stationary inflation target of 2.5% ± 1%, in a manner to support economic growth, including reviving lending process.

Figure 4
The Evolution of MCI and Its Contributors for Romania (inverted scale)



Source: Own estimation.

The pace and extent to which monetary policy rates were lowered after the intensification of the crisis were different in countries that pursue inflation targeting strategy. In the Czech Republic and Poland, central banks have resorted to a sharp drop in key interest rates shortly after September 2008 and pronounced depreciation of the currency has provided additional support for the two economies. Unlike the aforementioned countries, in October 2008, during the initial phase of the crisis, Hungary raised the key policy rate by 300 basis points as part of sustained efforts of the EU and IMF to stop capital outflows and to stabilize the exchange rate after a substantial depreciation of the Hungarian forint. Monetary policy continued to consider the constraints on financial stability and the key interest rate was reduced gradually, given that it was necessary to maintain a differential to minimize the risk of sudden currency depreciation.

The actions and the approaches of central banks from CEE focused on continuous harmonizing of some features of monetary policy instruments with the standards and practices of the ECB. We use Granger causality methodology to investigate if there is any causal relationship between the MCIs calculated above for CEE countries and respectively the MCI for the Euro area. The current study tests the bidirectional causality hypothesis. In order to employ a Granger-causality test data series must be stationary, therefore we perform the Augmented Dickey-Fuller (ADF) tests on the transformed series. For making them stationary a first difference was applied for both series. Table 7 displays the results for Granger-causality test.

T a b l e 7

Granger Causality Results between MCI Indicators in CEE Countries and Euro Area (EA)

Causality hypothesis	Test value	P-value
Czech Republic		
H0: „MCI_EA“ do not Granger-cause „MCI_CZ“	3.4862	0.0166
H0: „MCI_CZ“ do not Granger-cause „MCI_EA“	0.0819	0.9698
Hungary		
H0: „MCI_EA“ do not Granger-cause „MCI_HU“	3.4942	0.0628
H0: „MCI_HU“ do not Granger-cause „MCI_EA“	0.0042	0.9486
Poland		
H0: „MCI_EA“ do not Granger-cause „MCI_PL“	1.5391	0.2052
H0: „MCI_PL“ do not Granger-cause „MCI_EA“	0.4500	0.8842
Romania		
H0: „MCI_EA“ do not Granger-cause „MCI_RO“	0.8844	0.5639
H0: „MCI_RO“ do not Granger-cause „MCI_EA“	0.4194	0.9797

Source: Own estimation.

In each case, a rejection of the null implies there is Granger causality. As results emphasize, we validate the unidirectional causality coming from MCI for the Euro area to MCI in CEE countries. The results highlight that monetary decisions in the Eurozone have a prominent influence on monetary conditions in CEE countries and respectively, the fact that economic climate from these countries is not ready to ensure the bi-directional nexus.

Conclusions

Following the impulse response functions and variance decomposition derived from a VECM estimation, we built a MCI for four CEE countries (Czech Republic, Hungary, Poland, and Romania), as a weighted average of the real short-term interest rate and the real effective exchange rate relative to their value in a base period. The analysis was conducted over the period between August 2005 and December 2015. Regarding variance decomposition, a horizon of 1 – 8 quarters was selected for robustness. The purpose of constructed indices is to give information about monetary conditions, by considering both channels: interest rate and exchange rate.

Our empirical analysis shows that MCI is an instrument capable to capture the monetary policy developments, whether the underlying monetary conditions have eased (decline in the MCI) or become tighter (increase in the MCI). The evolution of MCI in the Czech Republic indicates an easing of the monetary conditions in 2005 – 2007 followed by tightening due to the sharp appreciation of the national currency and an increase in interest rates due to pressures on inflation expectations. As a response to the global financial and economic crisis, MCI's evolution marks a rapid easing of the monetary conditions of the Czech Republic. The constructed index for Hungary signals accentuates loosening in monetary policy compared with the Czech Republic, starting at mid-2013, marked by gradual phasing-out of the two-week central bank deposit facility and the upward trend in central bank interest rate swaps. The backdrop of monetary easing in the region is highlighted by the evolution of MCIs in Poland and also Romania, motivated by slowdown growth in emerging economies. As a result of a fall in financial market inflation expectations, 2013 marks a rapid easing of the monetary conditions, in order to support economic growth, including reviving lending process.

The MCIs constructed for CEE countries offer powerful predictive information of monetary policy developments towards loosening or tightening, very useful in understanding the actions and the approach of central banks from CEE countries.

Moreover, employing Granger causality methodology, we validate the unidirectional causality coming from MCI for the Euro area to MCI in CEE countries. The results highlight that monetary decisions in the Eurozone have a prominent influence on monetary conditions in CEE countries and respectively, the fact that economic climate from these countries is not ready to ensure the bi-directional nexus. In terms of policy implications, the causality between MCIs in CEE countries and the Euro area is important because it has consequences on the best monetary policy strategy for ensuring price stability, in particular, of economies in transition. The unidirectional Granger causality from EA to CEE would provide policymakers with important knowledge regarding the plausible prospects for convergence with the Euro area.

Our methodology for constructing and interpreting the MCIs has two important limits. Firstly, the weights used for constructing MCIs are held constant, based on econometric estimates, which are highly dependent on the model used.

Secondly, the interpretation of the index should focus on its movements, rather than values. A given direction of the MCI may have different implications in terms of central bank's objective, varying on the factors underlying modifications in the components. Therefore, an automatic activism of monetary policy based on MCI should be avoided (Grande, 1997).

The Monetary Condition Indicators are dependent on the stability of the nexus between real and financial variables and of the estimated weights – therefore, given changing economic environment the indexes need to be periodically reassessed to incorporate the most relevant information in time. Also, as potential directions for further research, a financial condition index can be constructed, by considering the categories of indicators representative of the domestic economy, as well as for the external environment.

References

ABDUL MAJID, M. Z. (2012): Measuring Monetary Conditions in a Small Open Economy: The Case of Malaysia. Journal of Financial Economic Policy, *4*, No. 3, pp. 218 – 231.

BATINI, N. – TURNBULL, K. (2002): A Dynamic Monetary Condition Index for the UK. Journal of Policy Modelling, *24*, No. 3, pp. 257 – 281.

BENAZIC, M. (2012): Monetary Conditions Index for Croatia. Economic Research-Ekonomska Istrazivanja, *25*, No. 1, pp. 47 – 64.

BOŢEL, C. (2002): The Causes of Inflation in Romania, June 1997 – August 2001. Analysis Based on VAR. [NBR Occasional Papers.] București: NBR.

BALABANOVA, Z. – BRÜGGEMANN, R. (2012): External Information and Monetary Policy Transmission in New EU Member States: Results from FAVAR Models. [Working Paper.] Konstanz: Department of Economics, University of Konstanz.

CZECH NATIONAL BANK (2015): Inflation Report/ II. [Online.] [Cit. 20 October 2016.] Available from: <https://www.cnb.cz/en/monetary_policy/inflation_reports /2015/2015_II/>.

DEUTSCHE BUNDESBANK (1999): Taylor Interest Rate and Monetary Conditions Index. Monthly Report April, pp. 47 – 63. [Online.] [Cit. 25 October 2016.] Available from: <https://web.stanford.edu/~johntayl/PolRulLinkpapers/Taylor_Interest_Rate_and_Monetary_Conditions_Index-Bundesbank-April-1999.pdf>.

DUGUAY, P. (1994): Empirical Evidence on the Strength of the Monetary Transmission Mechanism in Canada: An Aggregate Approach. Journal of Monetary Economics, *33*, No. 1, pp. 39 – 61.

FREEDMAN, C. (1994): The Use of Indicators and of the Monetary Conditions Index in Canada. In: BALIÑO, T. J. T. and COTTARELLI, C. (eds): Frameworks for Monetary Stability: Policy Issues and Country Experiences. Washington, DC: International Monetary Fund.

FREEDMAN, C. (1995): The Role of Monetary Conditions and the Monetary Conditions Index in the Conduct of Policy. Ottawa: Bank of Canada Review.

GRANDE, G. (1997): Properties of the Monetary Conditions Index. [Economic Working Papers, Vol. 324.] Rome: Banca d'Italia.

HO, G. – LU, Y. (2013): A Financial Conditions Index for Poland. [IMF Working Paper, No. 13/252.] Washington, DC: International Monetary Fund.

HYDER, Z. – KHAN, M. M. (2006): Monetary Conditions Index for Pakistan. [Working Paper, No. 11/06, May.] Karachi: State Bank of Pakistan.

JAROCINSKI, M. (2010): Responses to Monetary Policy Shocks in the East and the West of Europe: A Comparison. Journal of Applied Econometrics, *25*, No. 5, pp. 833 – 868.

KODRA, O. (2011): Estimation of Weights for the Monetary Conditions Index in Albania. [Special Conference Paper.] Athens: Bank of Greece.

KORHONEN, L. (2002): Selected Aspects of Monetary Integration. Helsinki: Bank of Finland Institute for Economies in Transition, BOFIT.

MIRZAEI, A. – MOORE, T. – LIU, G. (2013): Does Market Structure Matter on Banks' Profitability and Stability? Emerging vs. Advanced Economies. Journal of Banking & Finance, *37*, No. 8, pp. 2920 – 2937.

NADAL De SIMONE, F. – DENNIS, R. – EDWARD, P. (1996): A Monetary Conditions Index for New Zealand. [Discussion Paper Series, No. G96/2, July.] Wellington: Reserve Bank of New Zealand.

OLTEANU, D. C. (2013): Monetary Conditions and GDP Evolution in Romania. București: The National Institute of Economic Research.

OSBORNE-KINCH, J. – HOLTON, S. (2010): A Discussion of the Monetary Condition Index. Quarterly Bulletin 01, January.

PESARAN, H. – SHIN, Y. (1998): Generalized Impulse Response Analysis in Linear Multivariate Models. Economics Letters, *58*, No. 1, pp. 17 – 29.

SIKLOS, P. L. (2002): Is the MCI a Useful Signal of Monetary Policy Conditions? An Empirical Investigation. International Finance, *3*, No. 3, pp. 413 – 437.

TORÓJ, A. (2008): Estimation of Weights for the Monetary Conditions Index in Poland. [Working Paper, No. 6-08.] Warsaw: Department of Applied Econometrics Working Papers.

TRINH, P. T. T. – KIM, N. T. (2014): Broad Monetary Condition Index: An Indicator for Short-Run Monetary Management in Vietnam. In: HUYNH, V. N., KREINOVICH, V., SRIBOONCHITTA, S. and SURIYA, K. (eds): Econometrics of Risk. Studies in Computational Intelligence. Vol. 583. Cham: Springer, pp. 391 – 413.

US, V. (2004): Monetary Transmission Mechanism in Turkey under the Monetary Conditions Index: An Alternative Policy Rule. Applied Economics, *36*, No. 9, pp. 967 – 976.