MONETARY CONDITIONS INDEX FOR CROATIA

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Abstract

MCI is an indicator of the combined effect of short-term interest rates and exchange rates on price level and aggregate demand. In construction of the index for Croatia, Engle-Granger co-integration method of time series was used. Obtained results indicate that in the observed period monetary policy in Croatia was mainly expansive, suggesting an easing of monetary conditions. However, it is necessary to bear in mind a number of limitations in the conduct of Croatian monetary policy if it is to be based on the use of the MCI. The most important constrain, that reduces the possibility of freely determining domestic interest rates and money supply, stems from a relative freedom of international capital flows between Croatia and other countries and the necessity of maintaining a stable nominal exchange rate due to a highly euroized economy.

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1 INTRODUCTION

The aim of this paper is to show the meaning of Monetary Conditions Index (MCI) for the operations within a monetary policy and to calculate it for Croatian economy.

In conducting monetary policy central banks must take into account the final objectives of economic policy such as high level of employment and sustainable and non-inflationary growth. For these objectives central banks use a set of instruments through which they can implement monetary policy. However, the link between the instruments and main objectives is not a direct one, but it occurs indirectly, through intermediary targets such as monetary aggregates, interest rates, exchange rates etc., assuming that there is a link between intermediary targets and monetary policy instruments. Ultimately, the central bank may operate directly upon an operational target such as short-term interest rate when it changes its instrument. In last two decades, the MCI has become the operational target of many central banks.

MCI has gained great popularity during the 1990s. By monitoring the relationship between interest rates and exchange rates, some central banks (e.g. Central Bank of country-regionplaceCanada, country-regionplaceNew Zealand and country-regionplaceSweden) use MCI within their monetary policy; through a combination of the short-term interest rate and the exchange rate. The basic idea is that interest rates and exchange rates on average have offsetting impacts on price level and aggregate demand as the final objectives of monetary policy. Except the above mentioned central banks, MCIs are calculated by many authors for different countries. For example, Kesriyeli and Kocaker (1999) calculated the MCI for Turkey, Lattie (1999) for Jamaica, Batini and Turnbull (2000) for UK, Hataiseree (2000) for Thailand, HKMA (2000) for Hong Kong, Soares Esteves (2003) for Portugal, Mladenovic-Komatina, Palic and Vukicevic (2005) for Serbia, Kannan, Sanyal and Bhoi (2006) for India, Knedlik (2006) for South Africa, Hyder and Khan (2007) for Pakistan, Guangning (2009) for China, etc. Lang and Krznar (2004) have constructed the indicator of monetary policy stance for Croatia using the SVAR (structural vector autoregressive) model that included monetary and non-monetary policy variables such as exchange rate, excess liquidity, changes in real stocktickerGDP, changes in price level and the ratio of current account to stocktickerGDP. The indicator of (unanticipated) monetary policy stance is constructed by summing up a previous unanticipated monetary policy shocks. The indicator is calculated for the period 1997-2004. Finally, they constructed two indicators in order to check its robustness: one which uses excess liquidity and another which uses money market interest rate. Obtained results suggest that monetary tightening in country-regionplaceCroatia started after the banking crisis in mid-1998, reached its maximum in early 2000 and was completed by a sharp monetary easing that lasted until (end) 2002. Next tightening can be seen in the beginning of 2003 which was caused by stocktickerCNB's administrative measures to control credit growth. MCI for Croatia was also calculated by IMF (International Monetary Fund) for the period 2000-2003 using the method of calibration i.e. using estimates from other countries and adjusting them for the openness of Croatian economy (IMF, 2004). They found that MCI was in a strong correlation with interest rates within a money market. Obtained results suggest that monetary policy was more expansionary during the mid-2000 until mid-2002 when it became restrictive.

In line with these studies, this paper uses the idea of Engle-Granger co-integration method (Engle and Granger, 1987) of time series, which implies the possible existence of long-run relationship between variables in the model.

However, the use of MCI can have negative consequences that will be mentioned in this paper. Despite the above, the calculation and monitoring of the index can help central banks in decision-making and implementation of adequate monetary policy.

2 DATA, EMPIRICAL ANALYSIS AND RESULTS

As already mentioned, the main goal of this paper is to estimate a monetary conditions index for Croatian economy by using the Engle-Granger co-integration method of time series. Hence, a brief analysis of used variables is carried out in next part.

Data of four selected variables are observed on a monthly basis and Figure 1 shows their movement, i.e. the movements in consumer price index (stocktickerCPI), nominal effective exchange rate of the kuna (NEER), industrial production index (Y) and money market overnight interest rate on interbank demand deposit trading (stocktickerINT). To obtain stable coefficients, which are required for calculation of the index, data cover the after-war period in Croatia starting from January 1998 and ending with the beginning of global financial crisis, which strongly affected Croatian economy, in October 2007. All data used in the analysis were taken from the Croatian National Bank (stocktickerCNB) and the International Financial Statistics (stocktickerIFS).

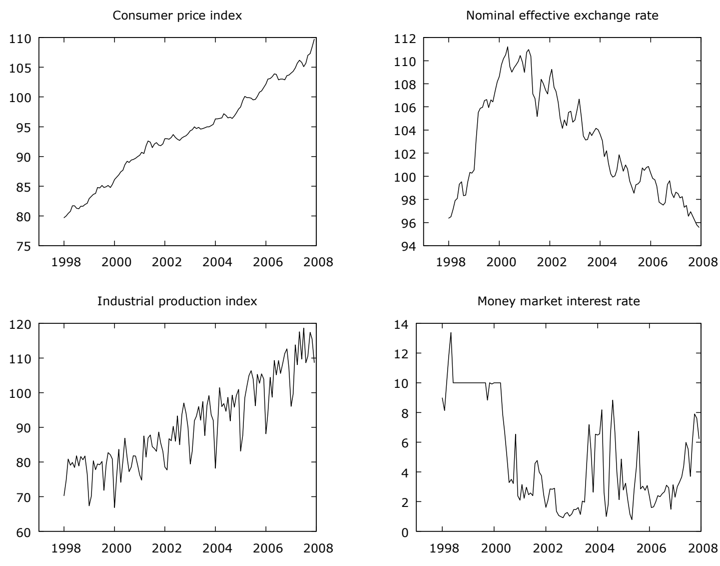

FIGURE 1 Consumer price index (2005 = 100), nominal effective exchange rate of the kuna (2005 = 100), industrial production index (2005 = 100) and

money market overnight interest rate on interbank demand deposit trading (in %)

Source: stocktickerCNB and stocktickerIFS.

Consumer price index and industrial production index in the observed period register a growing trend while the nominal effective exchange rate first depreciates and after 2000 appreciates. It is noticeable that a money market overnight interest rate on interbank demand deposit trading experienced a downward sloping trend until 2003 when suddenly began to grow.

TABLE 1 Unit root tests

					ADF				
	Level					**First difference**			
	Constant		**Constant and trend**			**Constant**		**Constant and trend**	
Variable	**t-Stat.**	**Lag**	**t-Stat.**	**Lag**	**Variable**	**t-Stat.**	**Lag**	**t-Stat.**	**Lag**
LCPI	-0,983179	0	-2,101375	0	D(LCPI)	-11,52128	0	-11,52075	0
LNEER	-0,920851	0	-4,016426	2	D(LNEER)	-9,586395	0	-10,42430	0
INT	-2,373049	0	-2,496553	0	D(INT)	-8,830536	2	-8,914227	2
LY	0,690994	4	-7,769261	0	D(LY)	-9,500443	3	-9,619941	3
					PP				
	Level					**First difference**			
	Constant		**Constant and trend**			**Constant**		**Constant and trend**	
Variable	**Adj. t-Stat.**				**Variable**	**Adj. t-Stat.**			
LCPI	-1,050301		-2,046248		D(LCPI)	-11,54016		-11,55065	
LNEER	-1,058654		-3,268988		D(LNEER)	-9,633643		-10,42462	
INT	-2,198158		-2,498056		D(INT)	-17,24626		-24,11131	
LY	-0,678125		-7,948645		D(LY)	-30,20593		-37,50969	
					KPSS				
	Level					**First difference**			
	Constant		**Constant and trend**			**Constant**		**Constant and trend**	
Variable	**LM-Stat.**				**Variable**	**LM-Stat.**			
LCPI	1,260599		0,196421		D(LCPI)	0,240506		0,177589	
LNEER	0,570319		0,238864		D(LNEER)	0,863946		0,179137	
INT	0,690844		0,227623		D(INT)	0,475718		0,315601	
LY	1,250112		0,220170		D(LY)	0,343196		0,115947	

Source: Authors' calculation.

Note: "D" indicates first difference, while "L" indicates logarithm of the variable. For the implementation of ADF test the Schwarz information criterion has been implemented. ADF test critical values (MacKinnon, 1996); constant: 1% level (-3,49), 5% level (-2,89), 10% level (-2,58); constant and trend: 1% level (-4,04), 5% level (-3,45), 10% level (-3,15). PP test critical values (MacKinnon, 1996): constant: 1% level (-3,49), 5% level (-2,89), 10% level (-2,58); constant and trend: 1% level (-4,04), 5% level (-3,45), 10% level (-3,15). KPSS asymptotic critical values (Kwiatkowski-Phillips-Schmidt-Shin, 1992); constant: 1% level (0,739), 5% level (0,463), 10% level (0,347); constant and trend: 1% level (0,216), 5% level (0,146), 10% level (0,119).

The main idea of Engle-Granger co-integration method is that if each element of a vector of time series first achieves stationarity after differencing, but a linear combination is already stationary, the time series are said to be co-integrated with co-integrating vector (Engle and Granger, 1987). So, the first step in the Engle-Granger co-integration method requires test of the properties of time series, i.e. the degree of integration. To do so and to be sure about the degree of integration, the augmented Dickey-Fuller ADF test (Dickey and Fuller, 1979), Phillips and Perron PP test (Phillips and Perron, 1988) and KPSS test (Kwiatkowski, Phillips, Schmidt and Shin, 1992) are executed. The difference between ADF (and PP test) and KPSS test is in the formulation of the null hypothesis. ADF test has a nonstationarity as a null hypothesis i.e. the null hypothesis is that the variable under investigation has a unit root, while in the KPSS test we assume that the variable is stationary.

To eliminate the influence of seasonal factors all series were seasonally adjusted using the Arima X12 method. Furthermore, all variables are expressed in logarithms except interest rate. Results of unit root test are showed in Table 1[1].

Although ADF and PP tests indicate a possible stationarity of the industrial production and the exchange rate in levels (both with constant and trend), KPSS test rejects this possibility. Therefore, for the purposes of this analysis it can be concluded that all the series are integrated of order I(1), i.e. they are stationary in their first differences.

[1] In the analysis Gretl and EViews econometric software were used.

The MCI is calculated as a weighted sum of changes in the interest rates expressed as a percentage and a percentage change in exchange rate in relation to the base period.

$$MCI_t = w_i(i_t - i_0) + w_e(e_t - e_0) + 100,\ w_i + w_e = 1 \tag{1}$$

where w_i and w_e measure the impact of interest rate (i) and exchange rate (e) on price level. The values in parentheses represent relative changes in interest rates and exchange rate. MCI can also be constructed by calculating the weights based on the impact of exchange rate and interest rates on aggregate demand. However, based on the fact that the primary objective of Croatian National Bank is to maintain price stability, we decided to construct the MCI calculating the weights based on the impact of exchange rate and interest rate on price level. Index value above 100 indicates a restrictive monetary policy in relation to the base period, while value below 100 indicates an expansive monetary policy in relation to the base period.

To calculate the weights w_i and w_e the OLS (Ordinary Least Squares) regression is estimated, but before that we tested for the existence of the long-run co-integration relationship using Engle-Granger test assuming the existence of a single co-integrating vector (Hansen, 1992, Phillips and Hansen, 1990). Engle-Granger test is a unit root tests applied to the residuals obtained from SOLS (Static OLS) estimation of the following co-integrating equation which represents $n+1$ dimensional time series vector process$(y_t, X_t{}')$:

$$y_t = X_t'\beta + D_{1t}'\gamma_1 + u_{1t} \tag{2}$$

where $D_t = (D_{1t}', D_{2t}{}')'$ are deterministic trend regressors and the n stochastic regressors X_t are governed by the system of equations:

$$X_t = \Gamma_{21}{}'D_{1t} + \Gamma_{22}{}'D_{2t} + e_{2t}, \Delta e_{2t} = u_{2t} \tag{3}$$

The assumption is that the innovations $u_t = (u_{1t}, u_{2t}{}')'$are stationary and ergodic with zero mean, contemporaneous covariance matrix Σ, one-sided long-run covariance matrix Λ, and nonsingular long-run covariance matrix Ω, each of which we partition conformably with u_t (Hansen, 1992):

$$\Sigma = E(u_t u_t{}') = \begin{bmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{21} & \Sigma_{22} \end{bmatrix} \tag{4}$$

$$\Lambda = \sum_{j=0}^{\infty} E(u_t u_{t-j}{}') = \begin{bmatrix} \lambda_{11} & \lambda_{12} \\ \lambda_{21} & \Lambda_{22} \end{bmatrix} \tag{5}$$

$$\Omega = \sum_{j=-\infty}^{\infty} E(u_t u_{t-j}{}') = \begin{bmatrix} \omega_{11} & \omega_{12} \\ \omega_{21} & \Omega_{22} \end{bmatrix} = \Lambda + \Lambda' - \Sigma \tag{6}$$

The assumptions imply that the elements of y_t and X_t are I(1) and co-integrated but exclude both co-integration amongst the elements of X_t and multicointegration.

If the series are not co-integrated, all linear combinations of$(y_t, X_t{}')$in the Equation 2, including the residuals from SOLS, are non-stationary. Therefore, a test of the null hypothesis of no co-integration against the alternative of co-integration corresponds to a unit root test of the null of non-stationarity against the alternative of stationarity. For this purpose, the Engle-Granger test based on parametric augmented Dickey-Fuller (ADF) approach is used. The Engle-Granger test estimates a p-lag augmented regression of the form

$$\Delta \widehat{u}_{1t} = (\rho - 1)\widehat{u}_{1t-1} + \sum_{j=1}^{p} \delta_j \Delta \widehat{u}_{1t-j} + v_t \tag{7}$$

where ρ and δ are parameters to be estimated and v_t are residuals.

The ADF test statistics are based on the t-statistic for testing the null hypothesis of non-stationarity and on the normalized autocorrelation coefficient$(\widehat{\rho} - 1)$:

$$\widehat{\tau} = \frac{\widehat{\rho} - 1}{se(\widehat{\rho})}, \widehat{z} = \frac{T(\widehat{\rho} - 1)}{(1 - \sum_j \widehat{\delta}_j)} \tag{8}$$

where T is the sample size and$se(\widehat{\rho})$is the usual OLS estimator of the standard error of the estimated $\widehat{\rho}$(Hayashi, 2000):

$$se(\widehat{\rho}) = \widehat{s}_v (\sum_t \widehat{u}_{1t-1}^2)^{-1/2} \tag{9}$$

where $\widehat{s}_v$ represents degrees of freedom corrected estimated standard error.

The results of estimated co-integrating equation that includes only a constant are summarized in the following table.

TABLE 2 The Engle-Granger co-integration test

Dependent	tau-statistic	Prob.	z-statistic	Prob.
LCPI	-8,790254	0,0000	-91,83938	0,0000
Intermediate Results				
Rho – 1		-0,784952		
Rho S.E.		0,089298		
Residual variance		0,000373		
Long-run residual variance		0,000373		
Number of lags		0		
Number of stochastic trends		4		

Source: Author's calculation.

Note: MacKinnon (1996) p-values.

From the intermediate results it can be seen that the number of lags based on Schwartz criterion is zero. Residual and long-run variances are used to obtain the denominator of the z-statistic while the number of stochastic trends used to obtain the p-values is four (it corresponds to the number of co-integrating variables in the system). Both test statistics (tau-statistic and z-statistic) reject the null hypothesis of no co-integration with the residual from the LCPI at the 1% level. Therefore, obtained results clearly show the existence of long-run co-integration relationship. This conclusion enables us to take the next step in calculating the weights for the MCI.

The long run parameters that measure the impact of interest rate (i) and exchange rate (e) on price level are obtained by the following OLS regression:

$$LCPI_t = \beta_0 + \beta_1 LNEER_t + \beta_2 TN_t + \beta_3 LY_t + u_t \qquad (10)$$

where $\beta_0,\ldots,\beta_3$ are the regression coefficients and u_t is the error term.

Table 3 and 4 summarize the results of the estimated OLS regression with consumer price index (LCPI) as dependent variable.

TABLE 3 OLS regression model results (dependent variable: LCPI)

	Coefficient	Std. Error	t-ratio	p-value
Constant	-0,525811	0,437783	-1,2011	0,23221
LNEER	0,443815	0,0703298	6,3105	0,00001
TN	-0,308127	0,0847449	-3,6359	0,00042
LY	0,671558	0,0292853	22,9316	0,00001

Source: Author's calculation.

TABLE 4 OLS model statistics and tests

Mean dependent var	4,537150	S.D. dependent var	0,080346
Sum squared residuals	0,047323	S.E. of regression	0,020374
R-squared	0,937345	Adjusted R-squared	0,935697
F(4, 115)	568,4994	P-value(F)	2,22e-68
Log-likelihood	294,0306	Akaike criterion	-580,0612
Schwarz criterion	-568,9785	Hannan-Quinn	-575,5613
rho	0,215048	Durbin-Watson	1,522089
Portmanteau test for autocorrelation up to order 12: Chi-square (12) = 18,965, p-value = 0,0894		LM test for autocorrelation up to order 12: LMF = 1,55275, p-value = 0,117783	
Test for normality of residual: Chi-square(2) = 0,372615, p-value = 0,830018		Test for ARCH of order 12: LM = 7,93212, p-value = 0,790412	
White's test for heteroskedasticity: LM = 10,1248, p-value = 0,340478		White's test for heteroskedasticity (squares only): LM = 9,26203, p-value = 0,159369	
Breusch-Pagan test for heteroskedasticity: LM = 0,780479, p-value = 0,85413		Breusch-Pagan test for heteroskedasticity (robust variant): LM = 0,765373, p-value = 0,85773	

Source: Author's calculation.

Conducted tests show no signs of autocorrelation (up to order 12), non-normality, ARCH effects (up to order 12) or heteroskedasticity in residuals. Based on the above model statistics we can conclude that the model is well estimated and results are statistically acceptable.

According to Table 3 it is obvious that industrial production has the strongest impact on price level and that the effect of exchange rate on price level is higher than the effect of interest rate. Furthermore, depreciation and industrial production have positive impact on price level while interest rate has negative impact on price level. Weights w_i and w_e calculated from the OLS regression estimates are presented in the following table.

TABLE 5 Calculated weights w_e and w_i from OLS regression model

e	0,443163	w_e	0,590708
i	0,30706	w_i	0,409292
		$w_e + w_i$	1

Source: Author's calculation.

Note: "e" and "i" are taken from the Table 4 and represent the impact of exchange rate and interest rate on price level.

January 1998 is taken as the base period for calculating the MCI. The reason for that is that there has been a change in methodology of calculating the price index. Until then, Croatian Bureau of Statistics calculated the retail prices index. Based on the Equation 1, constructed MCI for Croatia is revealed in the following figure.

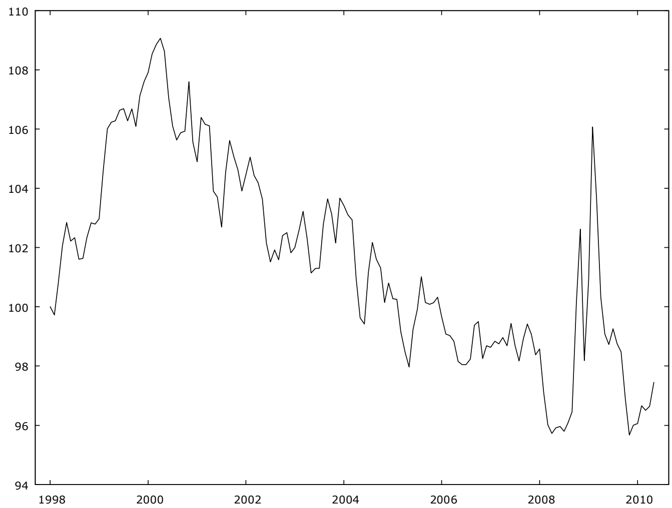

FIGURE 2 Monetary Conditions Index for Croatia (January 1998 = 100)
Source: Author's calculation.

The movement of MCI indicates the restrictiveness of the Croatian monetary policy in the period from 1998 to 2000 while after that it indicates the opposite trend. Significant fluctuations in the index can be seen during 2009. The main reason is the spill-over effect of the global financial crisis on the Croatian economy. Namely, during 2009 money market interest rate significantly increased, while exchange rate in the same time depreciated.

Correlation in the movement of the MCI, interest rate and the exchange rate is clearly visible at the following figure.

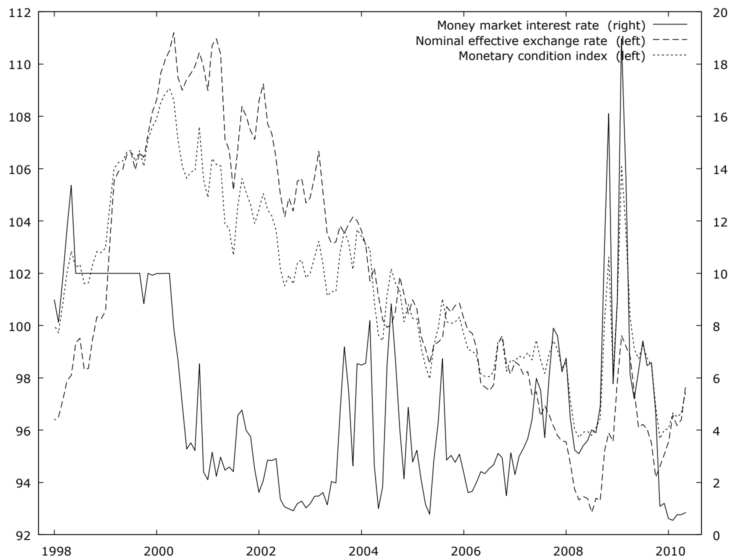

FIGURE 3 Monetary Conditions Index for Croatia (January 1998 = 100), Nominal effective exchange rate of the kuna (2005 = 100) and Money market interest rate (in %)

Source: Author's calculation.

Figure 4 shows the movement of the MCI and inflation. Monitoring of their movements can help in achieving the objectives of monetary policy.

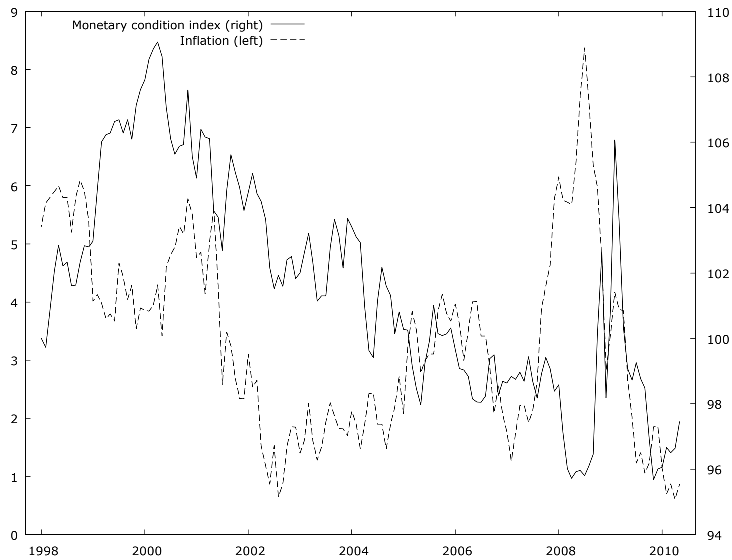

FIGURE 4 Monetary Conditions Index for Croatia (January 1998 = 100) and Inflation (in %)

Source: Author's calculation.

Previous figure evidently suggests the opposite movement of the MCI and the inflation. It can be seen that in the period of inflation Croatian monetary policy is expansive while during the period of deflation Croatian monetary policy is restrictive. This can especially be seen in the period 1999-2001 and 2007-2009. Namely, this supports the thesis that monetary policy in Croatia is pro-cyclical, which is the general characteristic of the exchange rate targeting monetary regimes (Lang and Krznar, 2004).

Therefore, it is clear that MCI can be used as an indicator in predicting the future effects of monetary policy concerning the future inflation.

3 MONETARY CONDITIONS INDEX AND ITS LIMITATIONS

Usage, as well as interpretation of the MCI as an indicator considers a number of limitations. First, MCI is based on estimates which are exposed to changes in time. Another limitation within a small-open economy such as Croatia is a high degree of euroisation which reduces the possibility of freely determining domestic interest rates. Therefore, money supply stems from the relative freedom of international capital flows between the Croatia and other countries and the necessity of maintaining a stable nominal exchange rate due to a highly euroised economy.

Ultimately, the exchange rate and interest rates are not the only factors that influence price level movements. Also, some other exogenous variables that affect price level movements should be taken into account in the case of Croatia (Krznar and Kunovac, 2010).

Another limitation of this analysis is relatively short period of observation. To obtain stable model coefficients without stronger structural brakes we made a "trade-off" between stability and number of observations by taking into account stable after-war period which starts in 1998 and ends with the beginning of global financial crisis in 2007.

Throughout history, there are several cases in which reliance on the MCI has led to significant errors within monetary policy aiming at the price stability, for example New Zealand and Chile (Mishkin, 2001). As mentioned before, the basic idea is that interest rates and exchange rates on average have offsetting impacts on inflation. Exchange rate falls normally lead to a higher inflation in the future, so interest rates need to rise in order to offset this pressure. Mishkin stresses that the offsetting effects of interest rates and exchange rates on inflation depend on the nature of the shocks within exchange rates. If the exchange rate depreciation arises from the portfolio considerations, then it does lead to a higher inflation and the optimal response is an interest rate rise. However, if the reason for the exchange rate depreciation is a real shock such as negative terms of trade shock which decreases the demand for a country's exports and reduces aggregate demand and is thus likely to be deflationary. The correct interest rate response is then a decline in interest rates, not a rise as the MCI suggests. Taking all mentioned into account, the MCI should be used more as an indicator in conducting monetary policy and not as a technical instrument by which monetary policy should make its decisions.

4 CONCLUSION

In this paper the Monetary Conditions Index (MCI) for Croatia was constructed using Engle-Granger co-integration method of time series which implies the existence of long-run relationship between variables in the model. MCI is an indicator of the combined effect of short-term interest rates and exchange rates on price level and aggregate demand as the final objectives of monetary policy and can be used as an indicator of expansiveness or restrictiveness of monetary policy of some country. The main idea is that interest rates and exchange rates on average have offsetting impacts on price level and aggregate demand as the final objectives of monetary policy.

Calculated MCI for Croatia indicates that Croatian monetary policy was restrictive in the period 1998-2000 while after it indicates easing of monetary conditions. Some fluctuations in the index can be seen during the 2009 and the main reason for that can be found in the spill-over effect of the global financial crisis on Croatian economy. Furthermore, MCI and inflation show opposite movements what supports the thesis that Croatian monetary policy is pro-cyclical, which is the general characteristic of the exchange rate targeting monetary regimes. However, it is necessary to bear in mind some limitations while calculating MCI for Croatian monetary policy such as relatively short estimated time period and high degree of euroisation which reduces the possibility of freely determining domestic interest rates and imposes a need of maintaining a stable nominal exchange rate.

Thus, it can be concluded that MCI should be used more as an indicator in conducting Croatian monetary policy and not as a technical instrument by which monetary policy should make its decisions.

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