



Department of Applied Econometrics Working Papers

Warsaw School of Economics
Al. Niepodległości 164
02-554 Warszawa, Poland

Working Paper No. 6-08

Estimation of weights for the Monetary Conditions Index in Poland

Andrzej Torój
Warsaw School of Economics
and National Bank of Poland

Estimation of Weights for the Monetary Conditions Index in Poland*

Andrzej Torój[†]

June 16, 2008

Abstract

In this paper, we follow the econometric approach to assess relative importance of real interest rate and real exchange rate for the monetary conditions in Poland, quantified as weights for Monetary Conditions Index (MCI). We consider both single- and multiple-equation specifications proposed in the literature with an application to Poland. Although MCI is nowadays broadly considered a rather obsolete indicator in monetary policy conduct, we argue that the econometric framework used for this purpose could be a good departure point when modelling monetary adjustments in a monetary union, provided correct dynamic specification of the models.

Keywords: Monetary Conditions Index, MCI-ratio, IS curve, Phillips curve, VAR.

JEL Classification: C22, C32, E52, E59

*The paper has benefited from insightful comments by Ewa Marta Syczewska, Marek Gruszczyński, Leszek Kašek, Adam Kot and participants of seminars at Warsaw School of Economics.

[†]Warsaw School of Economics (Faculty of Applied Econometrics, Ph. D. student) and National Bank of Poland (Bureau for the Integration with the Euro Area); andrzej.torój@doktorant.sgh.waw.pl, andrzej.torój@mail.nbp.pl

1 Introduction

Monetary Conditions Index (MCI) is a weighted average of real interest rate and real exchange rate of a country. It has been conceived in early 1990s in the Bank of Canada as a univariate measure of how 'tight' or 'loose' monetary conditions in an economy are. Batini and Turnbull (2002) enumerate three possible applications of such an index: operating target in monetary policy, policy rule or leading indicator measuring monetary policy stance or, more generally, short to mid-term impact of monetary conditions on real economy. After a period of vivid interest of monetary policymakers in late 1990s and early 2000s, the concept of using the indicator in monetary policy conduct has been given up. This paper is not intended to address theoretical caveats, associated with problem of correct identification of macroeconomic shocks necessary for efficient monetary policy. However, the indicator can still be a useful source of macroeconomic knowledge¹, making econometric worries associated with the construction of the index worth resolving.

Early research was focused on providing a holistic definition of monetary conditions: Fischer and Orr (1994) use survey data from entrepreneurs who assessed tightness of current monetary policy on a scale of 1 to 7. Although the question was posed in absolute terms, some relationship between the share of foreign market in the own business and the variance of their evaluations was detected, as the same interest or exchange rate developments weighted differently on business agents' perspectives. Hens (1992) attempts to evaluate monetary policy stance by means of a simple indicator composed of real interest and exchange rates plus yield curve slope and money supply. He sets weights for particular components fully arbitrarily.

The concept of MCI has been developed in seminal papers by Ch. Freedman (1994, 1995). The basic formula for the MCI is:

$$MCI_t = \alpha (r_t - \bar{r}_0) + (1 - \alpha) (reer_t - r\bar{e}er_0) \quad (1)$$

with α denoting relative weight of real interest rate (r_t) and $1 - \alpha$ denoting relative weight of real exchange rate ($reer_t$). 0 is the basis period.² The author motivated the index with the necessity to take into account not only interest rate, but also exchange rate developments in a small open economy when measuring monetary policy stance.³ As Kokoszcyński (2004) reminds, this

¹In the spirit of point 3 by Batini and Turnbull (2002).

²MCI equals zero in the first period; positive or negative value means that monetary conditions are tighter or looser than in the basis period, but not tight or loose in absolute terms, whatever it should mean. Interpretation should be focused on dynamics between any two periods or trends.

³The specification above has been generalized in a number of publications to Financial Conditions Index (FCI):

$$FCI_t = \sum_{k=1}^K w_k (P_{k,t} - \bar{P}_{k,t}) \quad (2)$$

with P_k denoting price of financial asset k at time t (\bar{P}_k long-term trend or equilibrium value thereof) and w_k relative weight of asset k in the index. This specification encompasses MCI with real interest and exchange rate as specific financial assets. Gauthier et al. (2004) argue that this extension is relevant for theoretical completeness and stable, significant dynamic correlations with output gap. Rising asset prices should increase economic agents' perception of own wealth and hence consumption (Grande, 1997), while growing value of firms' assets provides them with better collateral and improves their credit capacity (balance sheet effect within credit channel, see Mayes and Viren (2001) for a detailed discussion). According to Goodhart and Hofmann (2001), aggregate demand is influenced by all asset prices and we should not skip any of them. The authors suggest housing prices, stock prices and bond risk premium. However, such a specification is problematic in practice: the choice of variable set is arbitrary, they are usually not included in models and the relationships are too vague to be able to deliver a robust specification; relevant data sets normally suffer from strong multicollinearity. For these reasons, and in line with European Commission (2006) considering the wealth effect captured within the real interest rate, we do not follow

was postulated after the collapse of Bretton Woods system. The specification assumes implicitly that both channels are perfectly substitutable and work independently ⁴. Mayes and Viren (2002) discusses this substitution on the aggregate level as a synthesis of contradictory reactions at sectoral levels (for example, importers versus exporters). Hyder and Khan (2006) see here space for significant sectoral shifts.

Much attention used to be paid to the role of MCI in monetary policy conduct. Freedman (1994, 1995) understood it as an indicator, assisting the central bank in tracing the transmission process from policy instruments, over operating targets and intermediate targets to ultimate target. Bofinger (2001) builds a model where MCI helps to minimize the loss function of the central bank subject to internal and external equilibrium conditions, which yields a unique solution for real interest and exchange rate. Stevens (1998) considers MCI as a hybrid of instrument and target of a central bank, as in a free floating regime no direct control exists over the exchange rate. Mayes and Viren (2000) stress in this context the importance of profound knowledge of empirical interactions between the interest and exchange rate. According to Frochen (1996), MCI cannot be treated as a synthetic indicator of monetary policy actions because it takes market-based variables into account; market is also pricing in its own expectations and perception. This point of view seems to have been widely accepted in subsequent literature. Siklos (2000) emphasizes in this context the role of MCI in communication, as a feedback from the financial markets towards the central bank.

Freedman (1994) did not place the problem of weighting in the central point of the analysis. He assigns a weight of $\frac{1}{4}$ to the exchange rate so as to reflect the impact of external developments on Canadian economy. In the subsequent literature, more formal methods are investigated. Some authors use an observable proxy for the degree of openness (e.g. share of imports in GDP, as World Bank (2005, 2006) does). Such treatments are subject to criticism for the following reasons: they are decoupled from full complexity of impact of both channels, the choice of time period is arbitrary (the World Bank uses e.g. average share over 2000-2005) and we are unable to calculate an index with more sophisticated dynamic specification. This is why the econometric approach is dominating in the literature.

The aim of this paper is to present and apply for Poland a set of empirical strategies for estimating weights, along with the econometric discussion of their possible disadvantages and to find the best one.. The remaining part is organized as follows: section 2 gives a brief overview of economic background behind MCI and econometric difficulties associated with correct estimation of weights. Section 3 indicates data sources and transformations performed for the Polish economic time series. Section 4 applies to Poland the single equation approach, while section 5 deals with - seemingly more correct - multi-equation specifications. Section 8 concludes and suggests directions of future research.

the FCI approach in this paper.

Ericsson et al. (1998) interpret this class of indices as a three-level aggregation: first, we select broad macroeconomic and financial categories which are expected to represent monetary or financial conditions - say, real interest rate and real exchange rate. Then we select variables to operationalize them, e.g. 3-month money market rate or long term rate, CPI- or ULC-based REER. On the third stage, we search for weights to build a single index. This paper is focused mainly on the third stage.

⁴Stevens, 1998. Further discussion of this assumption in section 2 and Bofinger (2001).

2 Economic motivation and econometric traps behind MCI

Real interest rate and real exchange rate exert demand-side pressure on the output within the open-economy IS framework. Falling real interest rate motivates households to consume today rather than in the following period(s), improves their perceived wealth by increasing the discount factors associated with their present and future endowments and provides an incentive for producers to invest by depressing the alternative cost of such investment. All this constitutes an expansionary effect, leading to increase in positive output gap or reduction of a negative one. A rise in interest rates has contractionary effects described in an analogous way. Real exchange rate depreciation improves in turn the competitive position of producers in the tradeable sector (exporters and competitors of importers) vis a vis their foreign counterparts. This also translates into a positive output gap effect.

As monetary conditions depend on both real exchange and interest rates, their relative importance has to be assessed against each other. In order to do this, a **target variable** needs to be defined; Eika et al. (1996) consider then the weights as multipliers of the target variable with respect to both rates in question.⁵ As we consider demand-driven impact of the two rates on economic activity, output gap seems to be the most appropriate choice for the target variable. In the literature related to the subject, output gap is usually measured as a percentage deviation⁶ of seasonally adjusted real GDP from its value smoothed by modified Hodrick-Prescott filter ($\lambda = 1600$, which is standard for quarterly data). However, this method is recently facing heavy criticism with regard to an application to nonstationary data (see e.g. Lada, 2007).

A battery of literature considers inflation as another target variable.⁷ Both approaches are similar, as it is the output gap that generates inflationary pressure. However, the pass-through effect of exchange rate normally leads to a direct impact of currency depreciation (appreciation) on rising (falling) prices via import prices, independently on the output gap effects. In consequence, when choosing inflation rate as target variable, higher weight for the exchange rate should be expected than with output gap in the target variable role. A practical advantage of this approach is that it allows us to use monthly data instead of quarterly, which improves statistical properties of the estimation. A serious drawback of this approach is pointed to by Stevens (1998): according to him, treating prices on the aggregate level is too general as they are determined in a different way in the tradeable sector (exchange rate pass-through, world market prices) and non-tradeable one (output gap, inflation expectations). This point of view is shared by Mayes and Viren (2000), as inflation requires much more sophisticated econometric treatment in their view. In his pioneering work, Freedman (1994) opts for an IS equation as any pass-through effect are relatively small and irrelevant for Canadian business cycle analysis; arguments of Frochen (1996) remain in line. Kokoszcyński (2004) in turn opts for weights reflecting the entire impact of real interest and exchange rate on prices, not only via output gap. In this paper, we consider both approaches to check for robustness of the results.⁸

⁵This nomenclature is rooted in a hierarchy of monetary policy concepts: Batini and Turnbull (2002) present this issue in the light of legally defined scope of central bank actions.

⁶With this definition, "multipliers" could be interpreted as elasticity, when exchange rate is expressed in logarithms or semi-elasticity, with interest rate in levels.

⁷Eika et al. (1996) see here a dynamic link between a monetary policy instrument and its ultimate target.

⁸It must be stressed here that the MCI framework considered here is too simple to fulfil a postulate of completeness; Ericsson et al. (1998) suggests admitting that MCI is reflecting only part of the complex reality and should be interpreted as no more than that.

Estimation of weights for Poland could additionally be distorted by economic transformation, which implies systematic appreciation of equilibrium REER and nonstationarity, and Balassa-Samuleson effect. With labour productivity and wages growing faster in tradeable sector, which is enforced by international competition, and wages equal across sectors due to local wage arbitrage, the nontradeable sector faces excessive wage growth with respect to productivity and generates inflation in the entire economy. This results in real exchange rate appreciation faster than equilibrium value and tightening of monetary conditions.

Last but not least, a correct identification of sources of shocks also matters for the interpretation of MCI dynamics, evolving automatically in line with real exchange and interest rate trajectories. However, it is more often than not impossible in real time. According to Kokoszcyński (2004); Stevens (1998); Freedman (1994)

- cost-push shocks (e.g. in oil prices) or change in portfolio preferences of domestic investors are generally not expected to influence domestic monetary policy actions;
- foreign inflation or policy interest rates and domestic terms-of-trade changes require careful consideration;
- exchange rate shocks associated with lack of the market's confidence in central bank's credibility need to be offset.⁹

Probably the most spectacular pitfalls in MCI-based monetary policy conduct were recorded in New Zealand. As reported by Drew (2001); Mishkin and Schmidt-Hebbel (2007); Svensson (2001), currency depreciation associated with Asian crisis in 1997 tempted Reserve Bank of New Zealand to raise interest rates in order to maintain the MCI at the level assumed earlier. This was accompanied by a draught in the summer 1997/1998 with contractionary effects for internal demand. In the aftermath of the crisis, external demand was too weak to support the expansionary effect of currency depreciation, which resulted in temporary unnecessary swings in output.

While the debate over using MCI as monetary policy rule or operating target has reached an unfavourable conclusion for the index, econometric question of estimating the best MCI-ratio for an economy remained unresolved. In the discussion, a few problems have been particularly highlighted:

Dynamic specification. A model whose parameters are used to derive weights for MCI components must reflect short- and long-term dynamic properties of the underlying process. The dynamic order of multipliers that we use depends on the desired dynamic interpretation of MCI. Batini and Turnbull (2002) suggests relaxing any arbitrary assumptions as to the horizon of monetary conditions' impact on the real economy and specifying a model with distributed lags. The parameters for lagged values could be used then in a modified index - Dynamic MCI (DMCI), including not only current, but also properly weighted past values of interest and exchange rates.

Parameter stability. Whether model parameters from which multipliers are derived can be treated as stable or not is crucial for the validity of calculations. Among potential reasons for violation of this assumption, changing share of firms' credit in foreign currency

⁹Gottschalk (2001) postulates differentiating between monetary policy shocks, for which MCI would be relevant analysis tool, from supply and demand shocks, when MCI becomes endogenous.

(Deutsche Bundesbank, 1999), structural transformation, monetary integration (Mayes and Viren, 2000) and liquidity problems (Gerlach and Smets, 2000) are the most popular in theoretical literature. Eika et al. (1996) suggest particular vulnerability of reduced-form models to violation of this assumption and criticise the assumption of superexogeneity of interest and exchange rates which is in fact associated with constant weights.

Nonstationarity. Eika et al. (1996) warns from using too few variables when building cointegrating relationships with I(1) variables, which limits the number of relationships themselves. They recommend a strategy of testing endogeneity and then excluding an equation from VAR, shifting a variable into exogenous variable set should the null not be rejected.

Exogeneity. We must not overlook the fact that the map of potential variable interdependencies presented before is incomplete. According to theoretical literature, real interest rate and real exchange rate are also linked by a relationship called uncovered interest parity (UIP): with inflation rate as a policy instrument and free-floating exchange rate, free capital flows should turn positive interest rate disparity with the rest of the world into appreciation with expectations of future depreciation. However, as noted by Frochen (1996); Chwiejczak (1999), this condition seldom holds in the short term. Nonetheless, we must bear it in mind as a potential source of multicollinearity and endogeneity problem. Gottschalk (2001) suggests that monetary conditions cannot be treated as exogenous, at least not in mid- to long term, as central bank is reacting to macroeconomic developments with its policy rate and exchange rate is part of equilibrating mechanism. According to Eika et al. (1996), rejection of hypothesis of interest or exchange rate's weak exogeneity leads to necessity of model expansion and incorrectness of indirect multipliers.¹⁰

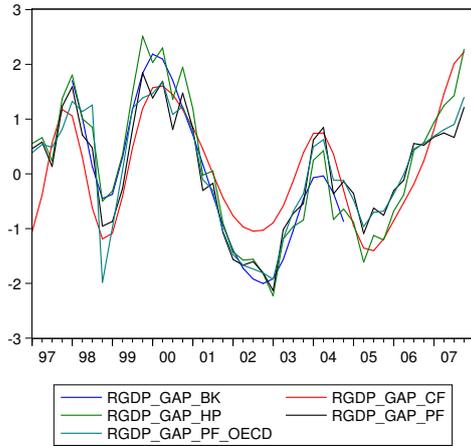
MCI-ratio precision. Although both parameters in question were estimated at very different levels across countries, their relative absolute value (which is the focus of this analysis) labelled in the literature as MCI-ratio (by custom, with parameter for the interest rate in numerator and for the exchange rate in denominator) exhibits much less dispersion. Ericsson et al. (1998) calculate confidence intervals for these ratios, using likelihood ratio-based method by Silvey (1978).¹¹ For the models analyzed, they find extremely wide MCI-ratio confidence intervals, including all positive real numbers for Norway and all real numbers for the USA.

The most sophisticated econometric approach is to use a complex macroeconomic model in order to obtain dynamic multipliers in response to unit disruption in real interest and exchange rates. However, it is often impossible for practical reasons: models contain these variables in nominal terms or there is a monetary rule that levels off part of the influence immediately (Kot, 2003a). Examples of empirical works following this strategy are Kennedy and Riet (1995); Mayes and Viren (2000) and Kokoszcyński (2004). A construction of such a model is obviously beyond the scope of this paper; in most of empirical investigations, some fragmentary specification is applied. Such a holistic view might also be inferior to more robust specifications due to data limitations and short time series at our disposal.

¹⁰Impact and long-term multipliers remain correct.

¹¹Gregory and Veall (1985) present evidence of this method's superiority over earlier approaches by Wald (1943); Fieller (1954).

Figure 1: Real GDP and output gap



Augmented Dickey-Fuller Unit Root Test on RGDP_GAP_PF

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.034227	0.0030
Test critical values:		
1% level	-3.588509	
5% level	-2.929734	
10% level	-2.603064	

*MacKinnon (1996) one-sided p-values.

Source: Eurostat, AMECO, OECD

3 Data

For the purpose of empirical evaluation of MCI weights, we use a set of Polish macroeconomic data consisting of output gap, inflation, real exchange rate and real interest rate.

We express the output gap as percentage deviation of actual real GDP (constant prices) from the potential one. One method to obtain potential GDP is HP-filtering; we could also use band-pass filters (Baxter-King, Christiano-Fitzgerald). Another way is to use annual data on potential GDP from AMECO or OECD database; for the quarterly model, linear interpolation of annual potential GDP has been performed. As presented in Figure 1, all these measures do not differ significantly and we shall use the data from AMECO.

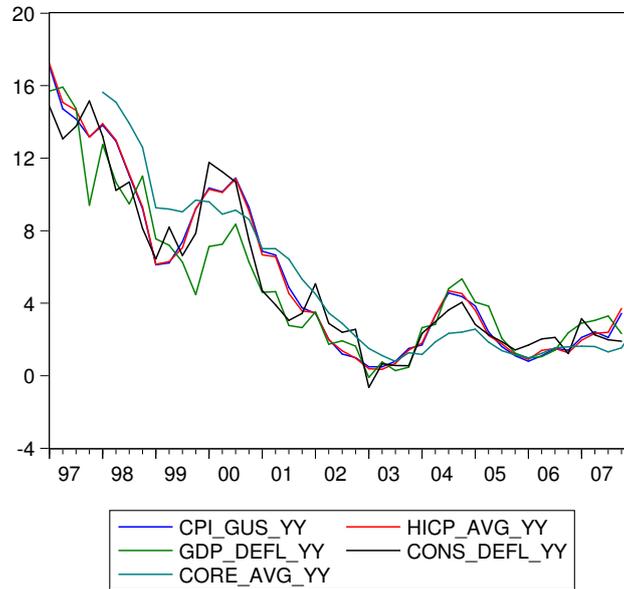
For measuring **inflation**, we use the GDP deflator in order to account for price developments in the entire economy. Figure 2 presents this inflation proxy with CPI (CSO) and HICP (Eurostat) consumer indices, core inflation (NBP) and consumption deflator (CSO) in the background; all measures behave in a similar way.

According to Freedman (1994), **real exchange rate** is best proxied by real effective exchange rate (with weights reflecting trade shares). We select REER deflated by unit labour cost index (Eurostat) - for comparison, presented with CPI-based REER in Figure 3. In the models (and the indices calculated by means of weights derived from the models), we use log-differences of the index (due to nonstationarity).¹² Thus, our REER variable is interpreted as percentage appreciation or depreciation over a quarter.¹³

¹²Kot (2003b) discards calculating percentage growth rates due to frequent distortions in the data resulting from the base effect and expresses REER as percentage deviation from equilibrium proxied by HP filter. Goodhart and Hofmann (2001) propose a simpler treatment, removing linear trend by OLS where Balassa-Samuelson effect occurs.

¹³Ericsson et al. (1998); Gottschalk (2001); Hyder and Khan (2006) choose to use nominal exchange rates - effective and EUR/USD. They motivate it with better suitability for inflation equation. In this paper, we do not follow this approach.

Figure 2: Inflation rates



Augmented Dickey-Fuller Unit Root Test on GDP_DEFL

Null Hypothesis: GDP_DEFL has a unit root Exogenous: Constant Lag Length: 4 (Fixed)		
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.538585	0.1136
Test critical values:		
1% level	-3.588509	
5% level	-2.929734	
10% level	-2.603064	

*MacKinnon (1996) one-sided p-values.

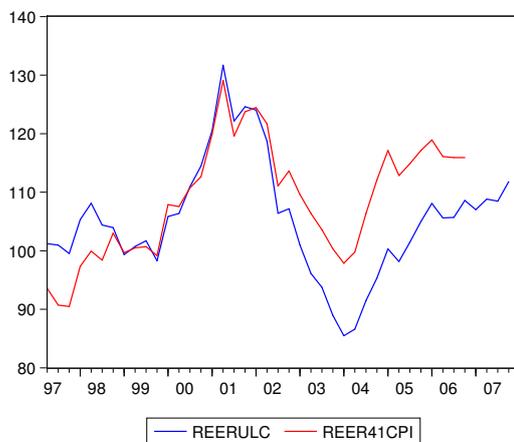
Augmented Dickey-Fuller Unit Root Test on D(GDP_DEFL)

Null Hypothesis: D(GDP_DEFL) has a unit root Exogenous: Constant Lag Length: 4 (Fixed)		
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.110566	0.0330
Test critical values:		
1% level	-3.588509	
5% level	-2.929734	
10% level	-2.603064	

*MacKinnon (1996) one-sided p-values.

Source: GUS, ECB, NBP

Figure 3: Real effective exchange rate



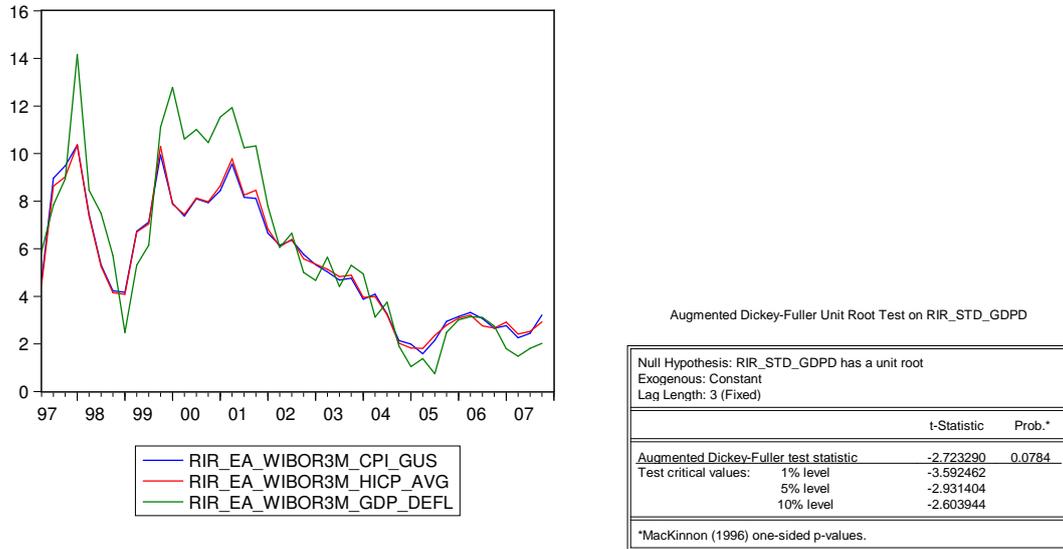
Augmented Dickey-Fuller Unit Root Test on REERULC_DLOG_STD

Null Hypothesis: REERULC_DLOG_STD has a unit root Exogenous: Constant Lag Length: 1 (Fixed)		
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.395154	0.0165
Test critical values:		
1% level	-3.588509	
5% level	-2.929734	
10% level	-2.603064	

*MacKinnon (1996) one-sided p-values.

Source: Eurostat

Figure 4: Real interest rate



Source: Eurostat

The most troublesome issue is the unobservable **real interest rate**. Ideally, a short term nominal exchange rate should be deflated by inflation expectations¹⁴. However, they are difficult to observe and possibly heterogenous across sectors or even agents. This is why we need to make assumptions: either calculate *ex post* real interest rate by means of true inflation for the same period, which is subject to criticism as economic agents do not know the deflator values at the time of taking decisions or, alternatively, deflate the nominal rate by inflation of the previous period, assuming perfectly adaptive expectations. We follow here mostly the latter approach.¹⁵ In Figure 4, we present a few real interest rates with various deflators. In this paper, we use the Polish 3-month money market borrowing rate deflated with HICP or GDP deflator.

In the following sections, real interest rate and real exchange rate variables are divided by their standard deviation across the sample period. This operation, numerically neutral for the calculations, allows us to compare directly the estimates of both parameters without a correction for different scale of variability. This makes the whole discussion and final MCI construction more transparent.

¹⁴Kokoszcyński (2004) opts here for the most representative money market rate. Kot (2003b) uses WIBOR3M, a 3-month Polish money market rate. This is also what we do in this paper. Choices in other countries vary significantly: see e.g. Hyder and Khan (2006); Gottschalk (2001). Some authors (e.g. Hyder and Khan, 2006; Frochen, 1996; Deutsche Bundesbank, 1999; Mayes and Viren, 2001) expect long-term real interest rates to significantly improve statistical properties of estimation, according to the dominating sort of financing and hence country-specific monetary transmission mechanism properties. However, bearing specific properties of Poland in mind, we share the view of Goodhart and Hofmann (2001) that such real long-term interest rate is difficult to proxy, as long-term inflation expectations would be needed. Over most of the sample period available, it would be difficult to place today's or even past inflation targets of the central bank in this role.

¹⁵For a detailed discussion of real interest rate measurement problems, see e.g. European Commission (2006).

Table 1: IS curve estimates

Dependent Variable: RGDP_GAP_PF				
Method: Least Squares				
Sample (adjusted): 1998Q1 2007Q4				
Included observations: 40 after adjustments				
	Coefficient	Std. Error	t-Statistic	Prob.
C	0.623417	0.211232	2.951342	0.0055
RGDP_GAP_PF(-1)	0.859967	0.083458	10.30418	0.0000
RIR_STD(-3)	-0.282450	0.087831	-3.215826	0.0027
REERULC_DLOG_STD(-3)	-0.154447	0.085294	-1.810768	0.0785
R-squared	0.757700	Mean dependent var	-0.026333	
Adjusted R-squared	0.737508	S.D. dependent var	1.052761	
S.E. of regression	0.539371	Akaike info criterion	1.697814	
Sum squared resid	10.47316	Schwarz criterion	1.866702	
Log likelihood	-29.95628	Hannan-Quinn criter.	1.758878	
F-statistic	37.52534	Durbin-Watson stat	2.098478	
Prob(F-statistic)	0.000000			

4 IS and Phillips curve estimates

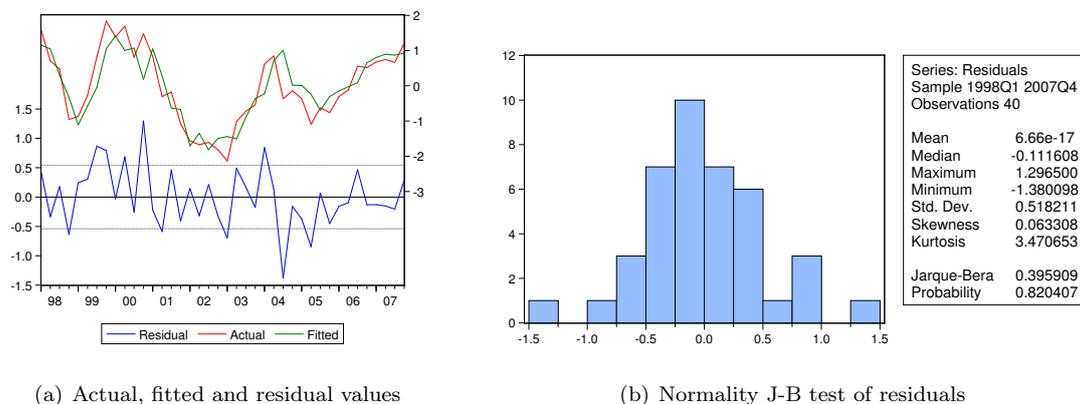
IS curves for the purpose of MCI weighting have been estimated i.a. by Mayes and Viren (2002); Korhonen (2002). For the Polish economy, an empirical investigation of both IS and Phillips curve approach for MCI-weighting was performed by Kot (2003a,b). In our IS curve, output gap is the dependent variable; on the right-hand side of the equation, lagged real interest rate based on 3-month money market nominal interest rate and real effective exchange rate deflated by unit labour costs serve the purpose of estimating the MCI-ratio. We do this by dividing the interest rate parameter by the exchange rate one. The equation also contains a constant, accounting for natural interest rate with an implicit assumption of its constancy over the sample, in the spirit of Chen (2001). Estimation output is presented in Table 1.

All the parameters have the expected sign; worrisome is only weak significance of the real exchange rate parameter (at 10%, but not any more at 5%). Residuals pass usual tests of autocorrelation, heteroskedasticity and normality of distribution (see Figure 5). Neither does parameter stability seem to pose a problem, in the light of CUSUM test presented in Figure 6. Nonetheless, recursive estimates of both relevant parameters indicate a possibility of an evolution in the economic structure: the real interest rate parameters establishes its significance only in the last segment of the sample, while the role of interest rate parameter is gradually decreasing. This is probably due to rising openness of the economy and expansion of tradeable sector. It is also very probable, in our view, that subjective perception of real ex ante interest rate is changing as expectation formation mechanism is evolving and becomes decoupled from current inflation rate (adaptive expectations assumed here) towards inflation target of the central bank¹⁶. Thus the MCI-ratio derived from the IS curve equal 1.829, which implies weights 0.646 for the real interest rate and 0.354 for real exchange rate, needs to be interpreted with appropriate prudence.

Alternatively, a Phillips curve equation is estimated to account for both output gap effects and direct pass-through of the exchange rate to prices. We selected GDP deflator dynamics as the

¹⁶This endogeneity of expectations formation mechanism is i.a. suggested by Woodford (2006); Benati (2008).

Figure 5: IS curve residual diagnostics



Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.971263	Prob. F(4,32)	0.4368
Obs*R-squared	4.330553	Prob. Chi-Square(4)	0.3631

Heteroskedasticity Test: White			
F-statistic	1.722193	Prob. F(9,30)	0.1273
Obs*R-squared	13.62622	Prob. Chi-Square(9)	0.1363
Scaled explained SS	13.63459	Prob. Chi-Square(9)	0.1359

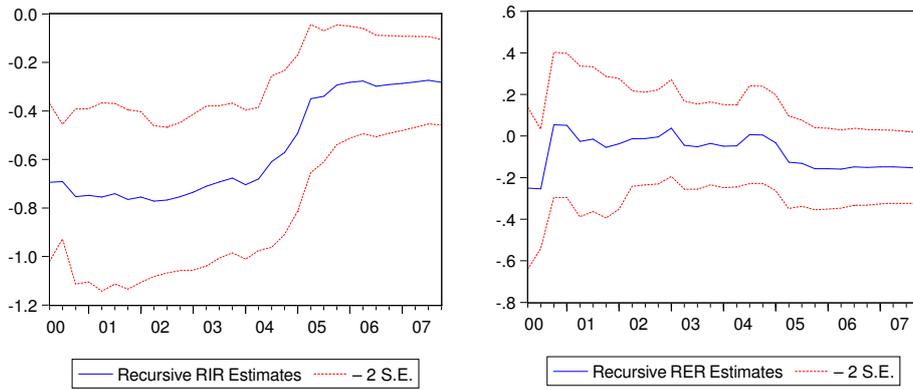
dependent variable to account for developments in the entire economy; dependent variables are: a constant (to account for the inflation target of the central bank), lagged inflation (to control for intrinsic inflation persistence) and both driving variables whose effect we intend to capture: lagged real exchange rate and real interest rate (lags are lying further behind in this specification). Due to globalisation and rising economic integration, we include euro area real interest rate and inflation rate¹⁷. The summary of estimation results is provided in Table 2.

Although both regressors are significant and exert, as expected, negative influence on domestic GDP deflator dynamics, estimates are not as good as in the case of the IS curve. Both external inflation drivers do not have the expected sign and the quality of fit seems to be insufficient. In our view, this might be due to the fact that a model for inflation requires more complicated structure, as quoted earlier from Stevens (1998) and, in this context, a separation into tradeable and nontradeable sectors. Such a split would not be easy empirically, and even if it was, e.g. by proxying with manufacturing and services respectively, there are no reliable output gap estimates for both, which would require some mechanical filtering and make the results even less reliable. However, error term sphericity and normality also pass usual tests (see Figure 7) and, as expected, a minimally higher weight than in the IS curve context is attributed to real exchange rate (0.376 versus 0.624 for the interest rate, which yields MCI ratio of 1.675). It is also worth noting that recursive estimates do not exhibit a trend towards smaller (absolute) values, in contrast with our IS-curve findings.

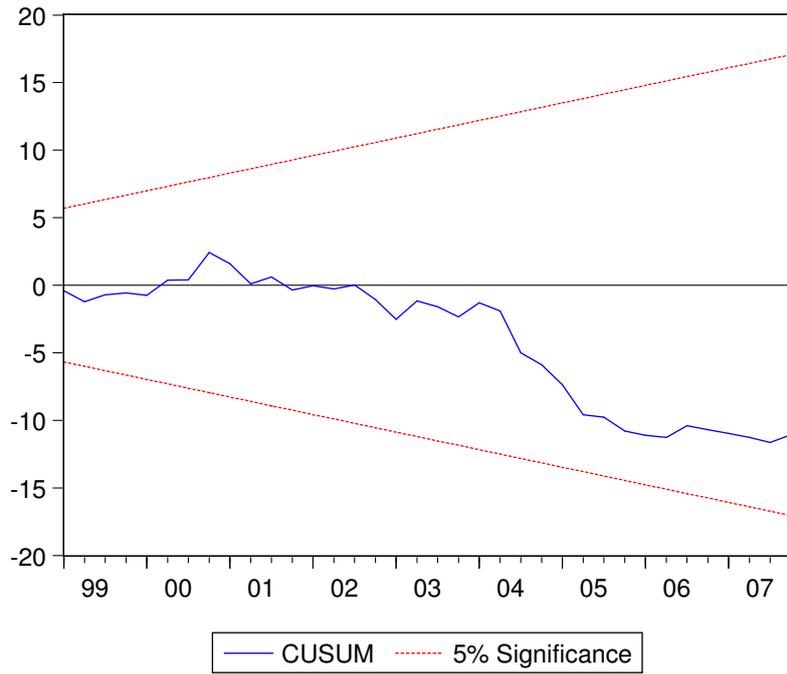
Following Eika et al. (1996), we calculate 90% confidence intervals around our MCI-ratios to check for the reliability of the results. We apply the method of Wald (1943) for statistical inference with

¹⁷Inclusion of foreign inflation rate as a regressor in domestic inflation equation takes into account rising role of international inflation drivers under globalisation, as shown i.a. by Borio and Filardo (2007). The international role of big economy's real interest rates as regressors has been described by von Hagen and Hofmann, 2004; Remsperger and Hofmann, 2005 in the IS-curve context.

Figure 6: IS curve stability diagnostics



(a) recursive estimates of parameters

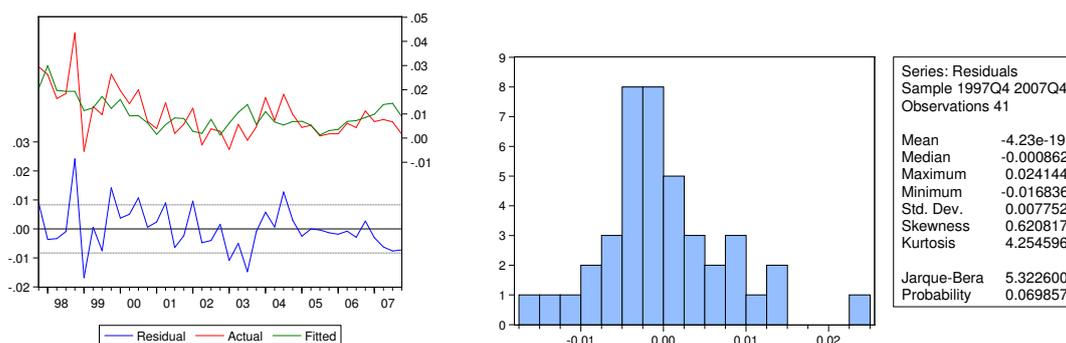


(b) CUSUM test of parameter stability

Table 2: Phillips curve estimates

Dependent Variable: DLOG(GDP_DEFL) Method: Least Squares Sample (adjusted): 1997Q4 2007Q4 Included observations: 41 after adjustments				
	Coefficient	Std. Error	t-Statistic	Prob.
C	0.009868	0.009330	1.057647	0.2975
DLOG(GDP_DEFL(-1))	0.119982	0.145641	0.823820	0.4156
RIR_STD_GDPD(-4)	-0.004140	0.001561	-2.652526	0.0119
REERULC_DLOG_STD(-4)	-0.002499	0.001363	-1.833783	0.0752
RIR_EA(-3)	0.004782	0.001914	2.498623	0.0173
LOG(HICP_EA_AVG)-LOG(HICP_EA_AVG(-4))	-0.534924	0.311145	-1.719215	0.0944
R-squared	0.388277	Mean dependent var	0.009665	
Adjusted R-squared	0.300888	S.D. dependent var	0.009911	
S.E. of regression	0.008287	Akaike info criterion	-6.613769	
Sum squared resid	0.002404	Schwarz criterion	-6.363002	
Log likelihood	141.5823	Hannan-Quinn criter.	2.140372	
F-statistic	0.003078			

Figure 7: Phillips curve residual diagnostics



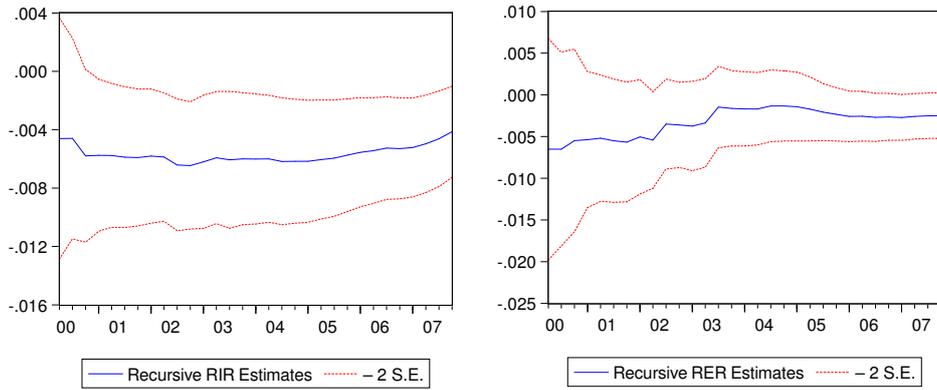
(a) Actual, fitted and residual values

(b) Normality J-B test of residuals

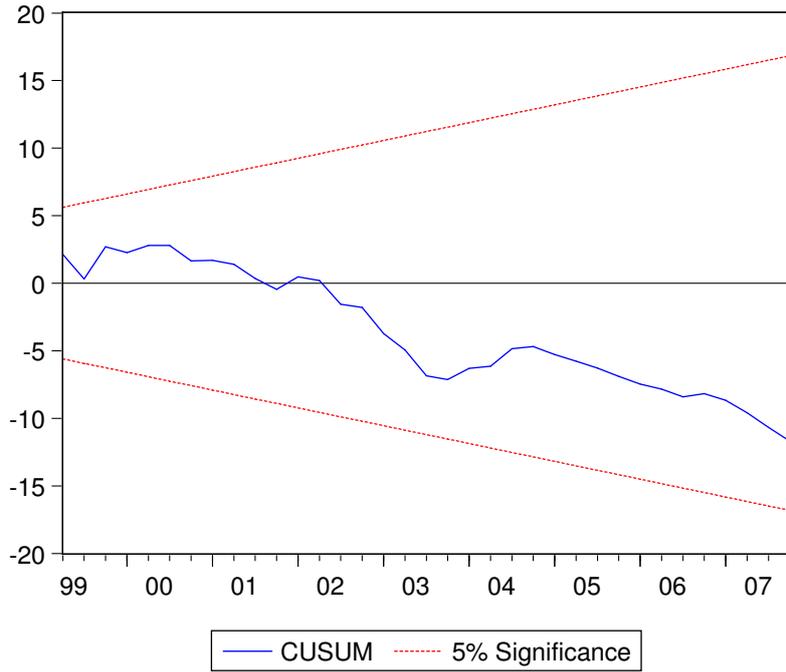
Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.469674	Prob. F(4,31)	0.7575
Obs*R-squared	2.342750	Prob. Chi-Square(4)	0.6730

Heteroskedasticity Test: White			
F-statistic	1.301937	Prob. F(20,20)	0.2803
Obs*R-squared	23.18891	Prob. Chi-Square(20)	0.2796
Scaled explained SS	27.49883	Prob. Chi-Square(20)	0.1218

Figure 8: Phillips curve stability diagnostics

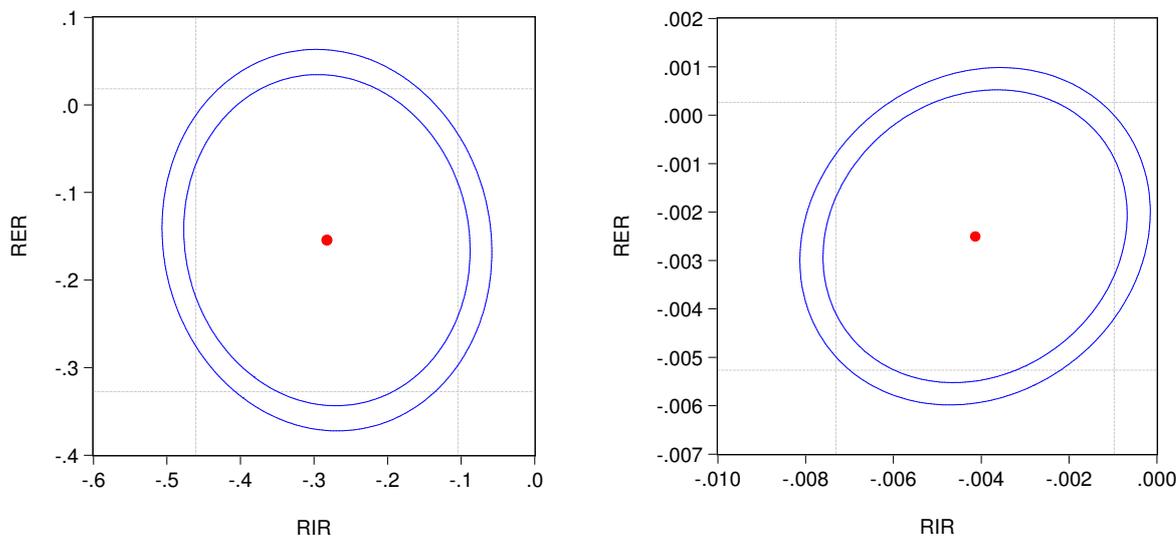


(a) recursive estimates of parameters



(b) CUSUM test of parameter stability

Figure 9: MCI-ratio estimation: 90 and 95% confidence ellipses



functions of parameters. Although all parameters in question are statistically significant (at least at 10% level), confidence intervals' width is absolutely unsatisfactory (intervals are presented in Table 6). However, this outcome is still acceptable given the summary of empirical results in the literature quoted by Eika et al. (1996). To convey an idea of MCI ratio's precision of estimation, confidence ellipses are presented as Figure 9.

5 VAR estimates

Given all the drawbacks of single equation framework, above all the problem of endogeneity of monetary conditions and interactions between real exchange and interest rates, a number of authors find a VAR model preferable for the derivation of MCI weights. For example, Eika et al. (1996) discuss theoretical aspects of estimation in the VAR framework. Jacobson et al. (1999) estimate a VAR model and Hyder and Khan (2006) search for cointegrating relationships. An SVAR model has been estimated by Cespedes et al. (2005). A widely accepted approach in this strand of the literature is to use impulse-response functions of GDP (gap) with respect to real interest and exchange rate to calculate weights for the MCI. Some authors suggest accumulated IRF over some period, defined as the MCI horizon. Others apply different lags of IRF separately to weight a few recent lags of real interest and exchange rate, in the spirit of DMCI by Batini and Turnbull (2002).

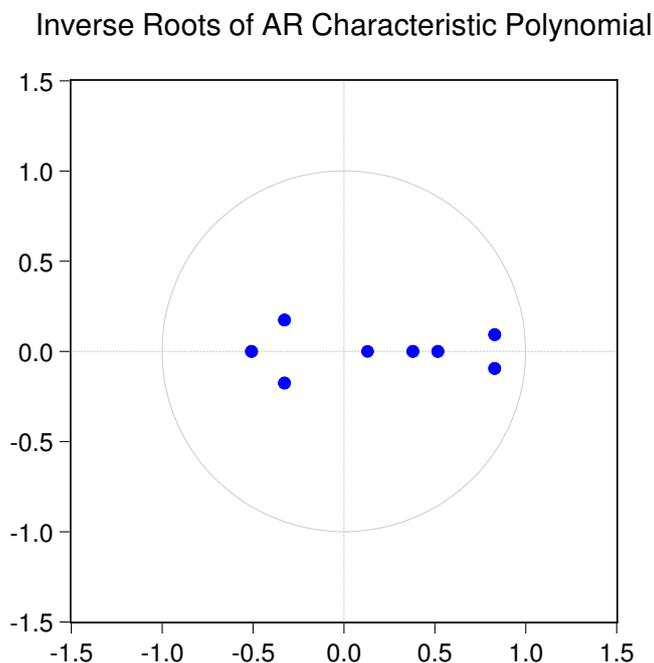
The coefficients and basic diagnostics of the model are reported in Table 3. All inverse roots of the characteristic polynomial are situated inside the unit circle (Figure 10), so the model is stable.

The impulse-response functions are reported in Figure 11. We are interested in output gap's reaction to Cholesky one s.d. innovations to real interest and exchange rates. An expected negative influence over a period of 4-14 quarters is observed in both cases. Tables with values of IRF (both each period's and accumulated) are provided below the IRF figures. From these IRF, we construct both a usual MCI-ratio of 0.734 (proportion of accumulated weights after 8 periods) and two vectors

Table 3: VAR estimates

Sample (adjusted): 1997Q1 2007Q4 Included observations: 44 after adjustments Standard errors in () & t-statistics in []				
	RGDP_GAP_	REERULC_	DLRIR_STD_GD	DLOG(GDP_
RGDP_GAP_PF(-1)	0.559925 (0.14000) [3.99950]	0.206771 (0.18539) [1.11531]	0.368662 (0.09165) [4.02270]	0.005022 (0.00167) [3.01232]
RGDP_GAP_PF(-2)	0.073326 (0.17341) [0.42284]	0.274070 (0.22964) [1.19347]	-0.381660 (0.11352) [-3.36209]	-0.001559 (0.00207) [-0.75471]
REERULC_DLOG_STD(-	-0.017743 (0.12384) [-0.14327]	-0.094667 (0.16400) [-0.57724]	-0.012238 (0.08107) [-0.15096]	-0.002015 (0.00147) [-1.36644]
REERULC_DLOG_STD(-	-0.031851 (0.11780) [-0.27038]	0.048247 (0.15599) [0.30929]	0.121809 (0.07711) [1.57962]	0.000709 (0.00140) [0.50550]
RIR_STD_GDPD(-1)	0.018683 (0.23193) [0.08055]	0.084361 (0.30713) [0.27467]	1.034080 (0.15183) [6.81096]	0.004311 (0.00276) [1.56079]
RIR_STD_GDPD(-2)	-0.247802 (0.22379) [-1.10730]	-0.348456 (0.29635) [-1.17582]	-0.136402 (0.14650) [-0.93110]	-0.004268 (0.00267) [-1.60146]
DLOG(GDP_DEFL(-1))	21.29790 (12.1708) [1.74992]	2.542227 (16.1172) [0.15773]	-10.92298 (7.96719) [-1.37099]	0.015074 (0.14494) [0.10401]
DLOG(GDP_DEFL(-2))	15.10673 (11.3743) [1.32814]	18.98872 (15.0624) [1.26067]	11.55959 (7.44581) [1.55250]	0.358824 (0.13545) [2.64908]
C	0.006046 (0.25953) [0.02330]	0.283237 (0.34368) [0.82414]	0.118080 (0.16989) [0.69504]	0.006021 (0.00309) [1.94803]
R-squared	0.620157	0.302047	0.849399	0.524136
Adj. R-squared	0.533336	0.142515	0.814976	0.415367
Sum sq. resids	17.20254	30.16686	7.371643	0.002440
S.E. equation	0.701071	0.928391	0.458932	0.008349
F-statistic	7.142928	1.893331	24.67524	4.818803
Log likelihood	-41.77238	-54.12949	-23.12922	153.1693
Akaike AIC	2.307836	2.869522	1.460419	-6.553151
Schwarz SC	2.672783	3.234470	1.825367	-6.188203
Mean dependent	0.030623	0.086236	1.551974	0.010379
S.D. dependent	1.026267	1.002577	1.066925	0.010919
Determinant resid covariance (dof adj.)	4.93E-06			
Determinant resid covariance	1.98E-06			
Log likelihood	39.23285			
Akaike information criterion	-0.146948			
Schwarz criterion	1.312844			

Figure 10: VAR model stability diagnostics



of 6 DMCI weights (3 to 8 periods ahead), with all 12 weights summing up to 1. In the light of above IRF values, DMCI approach seems to be best suited to describe the process: in the single equation framework it was rather unavailable, due to multicollinearity of lags and lack of sufficient number of degrees of freedom), but it is still necessary to take persistence of influences in time into account. This conclusion also remains in line with the suggestion that adjustments in a monetary union via competitiveness channel are more prolonged.¹⁸

As suggested by Eika et al. (1996), we conclude the VAR analysis by exogeneity testing. Our findings are supportive of the authors' doubts with respect to feedback problem in the single equation methods. All variables are confirmed as endogenous at 10% significance level (except the real exchange rate dynamics, which is endogenous only at 1%). However, reaction functions of GDP gap are much weaker than other variables'. This result seriously undermines the applicability of a single-equation approach of the MCI analysis in general, supporting the Eika et al. critique also for the Polish case.

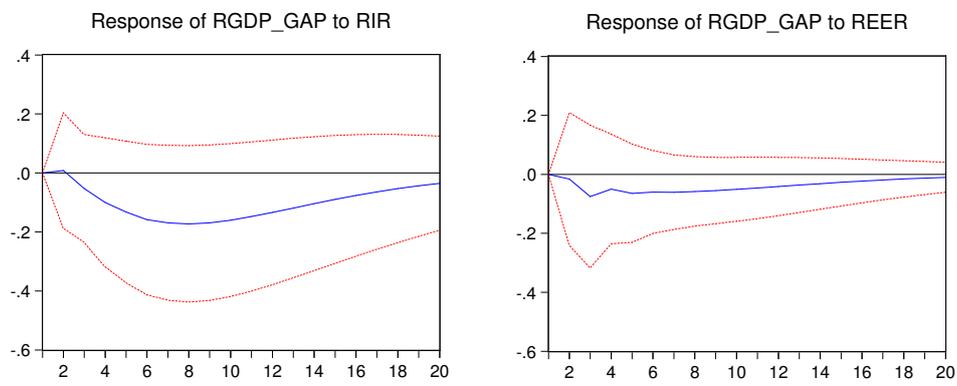
6 Equation system estimates

With regard to serious feedback problems, described theoretically in section 2, encountered in single-equation framework in section 4 and formally confirmed in section 5, we decided to test one more model specification: a small structural model containing all the variables described above and all the interactions needed. The model remains in the spirit of Batini and Turnbull (2002)

¹⁸See e.g. European Commission (2006)

Figure 11: Impulse-response functions

Response to Cholesky One S.D. Innovations – 2 S.E.



Response of RGDP_GAP_PF to Cholesky (d.f. adjusted) One S.D. Innovations

Period	RIR_STD_GDPD	REERULC_DLOG_STD
1	0.000000	0.000000
2	0.008168	-0.016099
3	-0.052704	-0.075542
4	-0.100157	-0.050183
5	-0.132621	-0.064336
6	-0.158338	-0.059917
7	-0.169235	-0.060649
8	-0.173073	-0.058126
9	-0.168855	-0.055037
10	-0.160144	-0.050912

cumulated Response of RGDP_GAP_PF to Cholesky (d.f. adjusted) One S.D. Innovations

Period	RIR_STD_GDPD	REERULC_DLOG_STD
1	0.000000	0.000000
2	0.008168	-0.016099
3	-0.044536	-0.091641
4	-0.144693	-0.141824
5	-0.277314	-0.206160
6	-0.435653	-0.266077
7	-0.604888	-0.326726
8	-0.777961	-0.384852
9	-0.946816	-0.439889
10	-1.106960	-0.490801

Table 4: Block exogeneity tests

Sample: 1997Q1 2008Q1 Included observations: 44			
Dependent variable: RGDP_GAP_PF			
Excluded	Chi-sq	df	Prob.
DLOG(GDP_DEFL)	13.62448	2	0.0011
RIR_STD_GDPD	3.657147	2	0.1606
REERULC_DLOG_STD	0.090857	2	0.9556
All	16.88278	6	0.0097
Dependent variable: DLOG(GDP_DEFL)			
Excluded	Chi-sq	df	Prob.
RGDP_GAP_PF	10.64419	2	0.0049
RIR_STD_GDPD	2.723991	2	0.2561
REERULC_DLOG_STD	2.177511	2	0.3366
All	25.37403	6	0.0003
Dependent variable: RIR_STD_GDPD			
Excluded	Chi-sq	df	Prob.
RGDP_GAP_PF	17.70790	2	0.0001
DLOG(GDP_DEFL)	2.635677	2	0.2677
REERULC_DLOG_STD	2.539414	2	0.2809
All	62.59993	6	0.0000
Dependent variable: REERULC_DLOG_STD			
Excluded	Chi-sq	df	Prob.
RGDP_GAP_PF	6.458998	2	0.0396
DLOG(GDP_DEFL)	3.250091	2	0.1969
RIR_STD_GDPD	3.093657	2	0.2129
All	11.97962	6	0.0624

estimation for DMCI construction; here, we focus explicitly on 3-quarter-lead MCI as proposed earlier in the case of IS and Phillips curves.

$$rgdp_gap_t = c_1 + c_2 \cdot rgdp_gap_{t-1} + c_3 \cdot r_{t-5} + c_4 \cdot dlog(reer_ulc)_{t-3} + \varepsilon_{1t} \quad (3)$$

$$wibor3M_t = c_5 + c_6 \cdot rgdp_gap_{t-1} + c_7 \cdot gdp_defl_yy_{t-1} + \varepsilon_{2t} \quad (4)$$

$$gdp_defl_yy_t = c_8 + c_9 \cdot gdp_defl_yy_{t-1} + c_{10} \cdot rgdp_gap_{t-4} + c_{11} \cdot dlog(hicp_ea)_{t-1} + \varepsilon_{3t} \quad (5)$$

$$r_t = wibor3M_t - gdp_defl_yy_t \quad (6)$$

Equation (3) is the IS curve as estimated earlier in single-equation framework. Its parameters will be crucial for our estimation, as α_2/α_3 is expected to be our MCI-ratio. Equation (4) is a Taylor rule, necessary to control for nominal rate (central bank's) reaction to current macroeconomic environment.¹⁹ Equation (5) describes inflation dynamics due to demand pressure. Equation (6) is Fisher identity, providing the system with real interest rate definition. This allows us to split real interest rate dynamics into separate endogenous nominal interest rate and inflation developments. In our VAR model, pre-calculated real interest rate was one of the endogenous variables with its own, unique shocks. Estimation results are reported in Table 5. We estimate the parameters jointly using the full information maximum likelihood method.²⁰

¹⁹However extremely simplified, such rules provide in practice a very accurate approximation of nominal rate behaviour; see e.g. Deutsche Bundesbank (1999). An assumption of perfect money market reaction to central bank's rates motivates such a specification; hence, we abstract here from such anomalies as e.g. money market liquidity crisis during the 2007 credit market turbulence.

²⁰For a detailed discussion of the advantages of using FIML in this context, see Clausen and Hayo (2006). The authors estimate similar, 3-equation systems for Germany, Italy and France in order to assess the asymmetries in monetary transmission mechanisms on the eve of EMU.

Table 5: System estimates

Sample: 1997Q2 2007Q4 Included observations: 43 Total system (balanced) observations 129 Convergence achieved after 1 iteration				
	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	0.505669	0.393294	1.285727	0.1985
C(2)	0.820130	0.148742	5.513776	0.0000
C(3)	-0.068426	0.046117	-1.483741	0.1379
C(4)	-0.177073	0.098569	-1.796429	0.0724
C(5)	4.953106	1.259441	3.932783	0.0001
C(6)	1.205827	0.772735	1.560466	0.1186
C(7)	1.267088	0.261527	4.844963	0.0000
C(8)	0.379005	0.991169	0.382382	0.7022
C(9)	0.874597	0.080112	10.91721	0.0000
C(10)	0.074138	0.217613	0.340689	0.7333
C(11)	-7.554772	90.27868	-0.083683	0.9333
Log likelihood	-222.9974	Schwarz criterion	11.33414	
Avg. log likelihood	-1.728662	Hannan-Quinn criter.	11.04974	
Akaike info criterion	10.88360			
Determinant residual covariance	6.413077			
Equation: $RGDP_GAP_PF = C(1)+C(2)*RGDP_GAP_PF(-1)+C(3)*WIBOR3M(-5)-C(3)*GDP_DEFL_YY(-5) +C(4)*REERULC_DLOG_S(-3)$				
Observations: 43				
R-squared	0.678785	Mean dependent var	0.020643	
Adjusted R-squared	0.654076	S.D. dependent var	1.036250	
S.E. of regression	0.609474	Sum squared resid	14.48687	
Prob(F-statistic)	2.030262			
Equation: $WIBOR3M = C(5) + C(6)*RGDP_GAP_PF(-1) + C(7)*GDP_DEFL_YY(-1)$				
Observations: 43				
R-squared	0.764436	Mean dependent var	11.46698	
Adjusted R-squared	0.752658	S.D. dependent var	7.002612	
S.E. of regression	3.482646	Sum squared resid	485.1528	
Prob(F-statistic)	0.374683			
Equation: $GDP_DEFL_YY = C(8)+C(9)*GDP_DEFL_YY(-1)+C(10)*RGDP_GAP_PF(-4)+C(11)*HICP_EA_DLOG(-1)$				
Observations: 43				
R-squared	0.863151	Mean dependent var	4.826750	
Adjusted R-squared	0.852624	S.D. dependent var	3.942278	
S.E. of regression	1.513424	Sum squared resid	89.32758	
Prob(F-statistic)	2.500877			

We derive the MCI ratio from the IS curve in the system. The result is somewhat puzzling, as both parameters imply a ratio of 0.386, equivalent to a weight of 0.279 for the real interest rate and 0.721 for real exchange rate. However, due to insignificance of one of the parameters in question, a Wald-based confidence interval for the ratio exceeds the zero bound.

7 MCI-ratio inference and confidence intervals

Table 6 summarizes our findings from sections 4, 5 and 6 in terms of MCI weights and confidence intervals around the MCI-ratio.

Table 6: MCI weights from different methods

method	RIR weight (1)	RER weight (2)	MCI-ratio (1/2)	90% conf. int.
IS curve	0.646	0.354	1.829	(0.8; 20.8)
Phillips curve	0.624	0.376	1.657	(0.6; 15.0)
VAR	.046 .087 .115 .137 .147 .150 (0.669 cumulated after 8q)	.065 .043 .056 .052 .053 .050 (0.331 cumulated after 8q)	2.021 (after 8q)	-
FIML system	0.279	0.721	0.386	(-0.04; 4.6)

We apply all our weights to calculate MCI in five variants, according to formula 1. We are using both standardised real interest and exchange rate variables applied in the models in previous sections and treat 1997q2 as the base period. Results are presented in Figure 12.

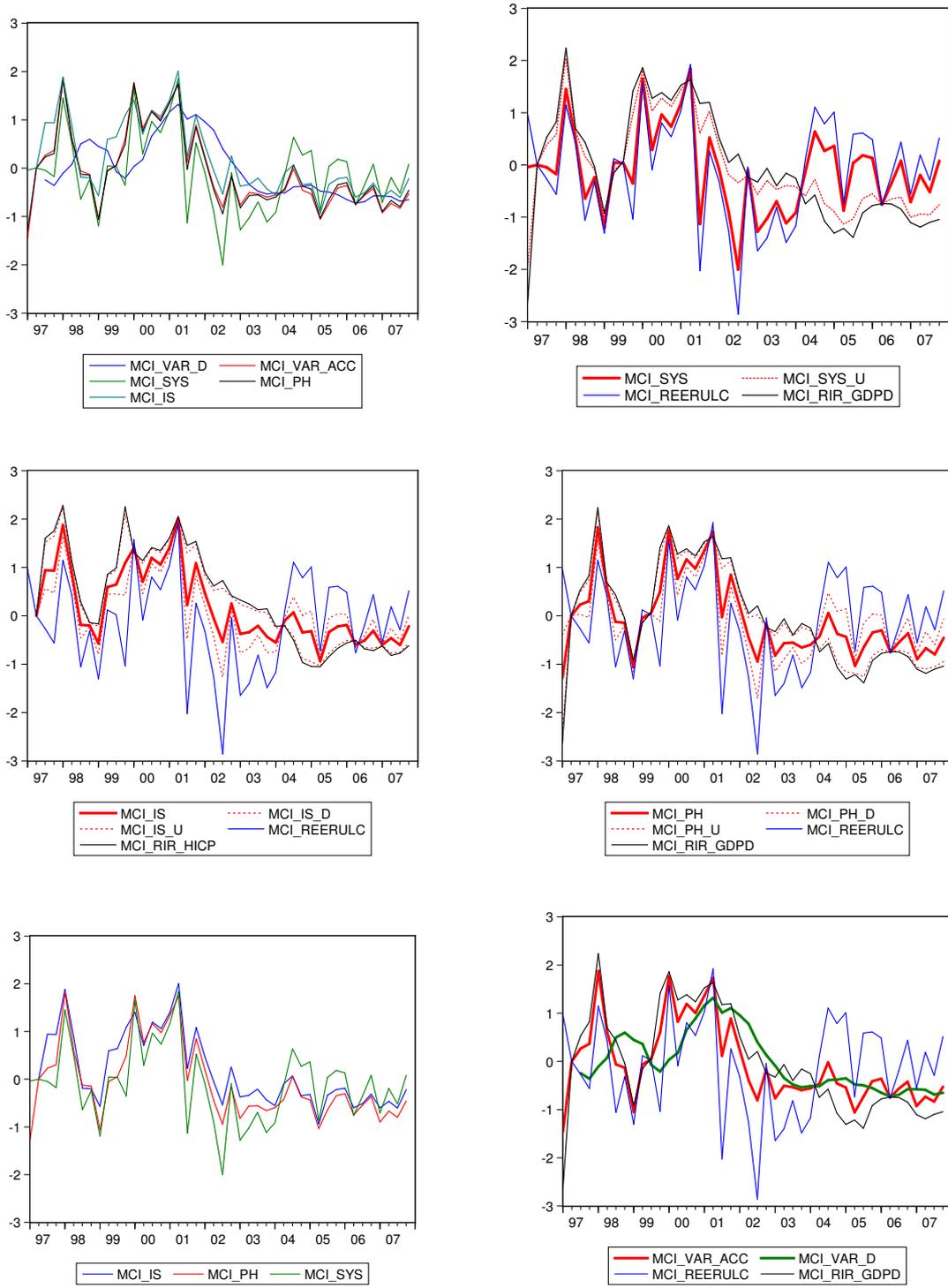
In the upper-left panel, all 5 MCIs are presented. Upper-right and middle-row panels present MCIs calculated with weights from equation system, IS and Phillips curve respectively. The thick red line represents MCI itself, black line standardized real interest rate and blue line - standardized real exchange rate, two variables between which MCI is spanned. Red dotted lines are confidence intervals, representing MCI calculated with weights implied by lower and upper bound of the MCI-ratio confidence interval. As the confidence interval for equation system based MCI ratio begins slightly below zero, only one dotted line is presented in the upper-right panel. The lower-right panel presents MCIs not based on VAR estimates; in the lower-right panel, both MCI and DMCI from VAR-model are shown, along with real interest rate and real exchange rate.

All calculated MCIs suggest periods of monetary conditions easing between 1998 and mid-1999, associated with a mild decline in real interest rates and, to a lesser extent, real exchange rate. Another period of monetary easing seems to have taken place from 2001 to 2003, where both components were contributing to economic stimulation, whereby the REER was much more volatile and stable real interest rates damped this volatility in terms of aggregate monetary conditions. The period from mid-1999 to 2000 was, in turn, associated with a sharp tightening, mainly due to real exchange rate developments which outweighed a gradual decline in real interest rate. In the recent years, real interest rates were kept at a relatively stable level; real exchange rate was more volatile, but the MCI remained relatively flat. In the second half of 2007, both factors contribute to gradual monetary tightening.

8 Conclusions

In this paper, we apply four empirical strategies (IS and Phillips curve, VAR model and small structural system of equations) to evaluate relative importance of real interest rate and real exchange rate for the dynamics of output gap, which allows us to build a monetary conditions index (MCI). Weights for the real interest rate vary from 0.279 to 0.669, whereby most of the methods indicate at a prevailing role of real interest rate, at the level of 2/3.

Figure 12: MCI for Poland - different methods



Profound knowledge of monetary conditions' influence on the real economy is helpful on the eve of joining a monetary union, a commitment that Poland is obliged to fulfill. This will virtually exogenize nominal interest rate and, to a large extent²¹, lock nominal exchange rate at a constant level, leaving real interest rate dependent on domestic inflation expectations and real exchange rate - on domestic and foreign inflation. Countries with advanced cyclical position and high inflation rate experience low (ex post) real interest rates, which poses a risk of further overheating (reverse mechanism could be at work for overcooled economies). On the other hand, above-average inflation deteriorates the competitiveness of domestic tradeable sector (European Commission, 2006). The latter mechanism is generally considered to be at work in mid- to long term, while the former one - within 3-4 years. Good econometric insight into the both channels and their interplay allows to assess ex ante a country's adaptability to asymmetric developments inside a monetary union.

In this context, a higher weight attributed to real interest rate in most outcomes could suggest a risk of a macroeconomic overheating or overcooling in the case of a cyclical divergence between Poland and the rest of EMU in a currency union. It must be stressed, however, that this finding is just indicative as an ex ante signal: endogenous effects of monetary union membership could change the way that macroeconomic mechanisms work and real exchange rate channel is widely considered to be at work in the long run.

References

- Batini N., Turnbull K. (2002):** *A Dynamic Monetary Conditions Index for the UK*, Journal of Policy Modeling.
- Benati L. (2008):** *Investigating inflation persistence across monetary regimes*, ECB Working Paper Series.
- Bofinger P. (2001):** *Monetary Policy. Goals, Institutions, Strategies and Instruments*, Oxford University Press.
- Borio C., Filardo A. (2007):** *Globalisation and inflation: New cross-country evidence on the global determinants of domestic inflation*, BIS Working Papers.
- Cespedes B.J.V., Lima E.C.R., Maka A., Mendonca M.J.C. (2005):** *Measuring monetary policy stance in Brazil*, Texto para discussão, Instituto de Pesquisa Econômica Aplicada.
- Chen L.H. (2001):** *A model for ex ante real interest rates*, Applied Economics Letters.
- Chwiejczak P. (1999):** *Indeks restrykcyjności polityki monetarnej (MCI)*, Rynek Terminowy, 5.
- Clausen V., Hayo B. (2006):** *Asymmetric monetary policy effects in EMU*, Applied Economics.
- Deutsche Bundesbank (1999):** *Taylor-Zins und Monetary Conditions Index*, Deutsche Bundesbank Monatsbericht.
- Drew A. (2001):** *Lessons from inflation targeting in New Zealand*, Central Bank of Chile Working Papers, 113.

²¹According to preliminary CSO data for 2007, trade with EMU account for 52.2% of Polish exports and 48.4% of imports plus 9.9 and 10.7 p.p. respectively with EU New Member States also obliged to join EMU.

- Eika K., Ericsson N., Nymoen R. (1996):** *Hazards in implementing a Monetary Conditions Index*, Oxford Bulletin of Economics and Statistics.
- Ericsson N., Jansen E., Kerbeshian N., Nymoen R. (1998):** *Interpreting a Monetary Conditions Index in economic policy*, BIS conference papers: Topics in monetary policy modelling.
- European Commission (2006):** *The EU economy: 2006 review. Adjustment dynamics in the euro area - Experiences and challenges*.
- Fieller E.C. (1954):** *Some Problems in Interval Estimation*, Journal of the Royal Statistical Society, 16(2), 175–185.
- Fischer A., Orr A. (1994):** *The determinants and properties of monetary conditions: direct survey evidence from New Zealand*, OECD Economics Department Working Papers.
- Freedman C. (1994):** *Frameworks for Monetary Stability*, chapter The use of indicators and of the Monetary Conditions Index in Canada, IMF.
- Freedman C. (1995):** *The role of monetary conditions and the Monetary Conditions Index in the conduct of policy*, Bank of Canada Review.
- Frochen P. (1996):** *Les indicateurs des conditions monétaires*, Bulletin de la Banque de France, 30.
- Gauthier C., Graham C., Liu Y. (2004):** *Financial conditions indexes for Canada*, Bank of Canada Working Paper.
- Gerlach S., Smets F. (2000):** *MCIs and monetary policy*, European Economic Review.
- Goodhart C., Hofmann B. (2001):** *Asset prices, financial conditions, and the transmission of monetary policy*, paper presented at the conference "Exchange Rates and Monetary Policy", Stanford.
- Gottschalk J. (2001):** *Monetary conditions in the euro area: Useful indicators of aggregate demand conditions?*, Kiel Institute of World Economics Working Paper, 1037.
- Grande G. (1997):** *Properties of the monetary conditions index*, Banca d'Italia Temi di Discussione.
- Gregory A.W., Veall M.R. (1985):** *Formulating Wald Tests of Nonlinear Restrictions*, Econometrica, 53(6), 1465–1468.
- Hens L. (1992):** *A multicriteria indicator of monetary policy*, International Symposium on Economic Modelling, University of Göteborg.
- Hyder Z., Khan M. (2006):** *Monetary Conditions Index for Pakistan*, State Bank of Pakistan Working Papers.
- Jacobson T., Jansson P., Vredin A., Warne A. (1999):** *Monetary policy analysis and inflation targeting in a small open economy: a VAR approach*, Journal of Applied Econometrics.
- Kennedy N., Riet A.V. (1995):** *A Monetary Conditions Index for the Major EU Countries: A Preliminary Investigation*, European Monetary Institute.

- Kokoszcyński R. (2004):** *Współczesna polityka pieniężna w Polsce*, PWN, Warszawa.
- Korhonen I. (2002):** *Selected aspects of monetary integration*, Bank of Finland Institute for Economies in Transition.
- Kot A. (2003a):** *Metody kwantyfikacji restrykcyjności monetarnej, fiskalnej oraz policy mix w krajach akcesyjnych*, Bank i Kredyt, June.
- Kot A. (2003b):** *Restrykcyjność monetarna, fiskalna oraz policy mix w Polsce, Czechach i na Węgrzech*, Bank i Kredyt, July.
- Lada K. (2007):** *Usuwanie trendu metodą filtru Hodricka-Prescotta: konsekwencje dla metody najmniejszych kwadratów*, *Studia Ekonomiczne*, 1-2, pp. 113–121.
- Mayes D., Viren M. (2000):** *The exchange rate and monetary conditions in the euro area*, *Review of World Economics*.
- Mayes D., Viren M. (2001):** *Financial conditions indexes*, Bank of Finland Discussion Papers.
- Mayes D., Viren M. (2002):** *Asymmetry and the problem of aggregation in the euro area*, *Empirica*.
- Mishkin F., Schmidt-Hebbel K. (2007):** *One decade of inflation targeting in the world: what do we know and what do we need to know?*, *Monetary Policy Strategy*, 8397.
- Remsperger H., Hofmann B. (2005):** *Inflation differentials among the euro area countries: potential causes and consequences*, *Journal of Asian Economics*.
- Siklos P. (2000):** *Is the MCI a useful signal of monetary policy conditions? An empirical investigation*, *International Finance*, 3(3), 413–437.
- Silvey S.D. (1978):** *Wnioskowanie statystyczne*, PWN, Warszawa.
- Stevens G. (1998):** *Pitfalls in the use of Monetary Conditions Indexes*, Reserve Bank of Australia Bulletin.
- Svensson L. (2001):** *Independent review of the operation of monetary policy in New Zealand*, www.princeton.edu/svensson/.
- von Hagen J., Hofmann B. (2004):** *Macroeconomic implications of low inflation in the euro area*, *North American Journal of Economics and Finance*.
- Wald A. (1943):** *Tests of Statistical Hypotheses Concerning Several Parameters When the Number of Observations Is Large*, *Transactions of the American Mathematical Society*, 54 (3), 426–82.
- Woodford M. (2006):** *Interpreting Inflation Persistence: Comments on the Conference on "Quantitative Evidence on Price Determination"*, *Journal of Money, Credit and Banking*.
- World Bank (2005):** *World Bank EU8 Quarterly Economic Report*, October.
- World Bank (2006):** *World Bank EU8 Quarterly Economic Report*, May.