Money demand stability, monetary overhang and inflation forecasting in CEE countries

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Abstract

This paper tests the money demand stability in Central and Eastern European (CEE) countries, comparing two competing models, namely the Cagan's (1956) closed-economy money demand model, and the Albulescu et al.'s (2017) open-economy model adapted for the CEE countries. The purpose is to see if the money demand is more stable in a generalized, open-economy model, which considers a currency substitution effect. Further, we check to what extent the monetary overhang represents a good predictor of inflation in the Czech Republic, Hungary and Poland. We discover that in the long run, the open-economy specification of the money demand model gives more consistent results than the closed-economy version, except for the Czech Republic, where no significant differences appear. Finally, we discover that money may improve the forecasts of inflation vis-à-vis a benchmark model only in the long run and only if we consider the currency substitution between the domestic currency and the euro. This result is however consistent only for Poland.

Keywords: money demand stability; monetary overhang; inflation forecasts; currency substitution; CEE countries

JEL codes: E41, E47, E52, F41

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1. Introduction

For a long time economists investigated the causes of high-inflation episodes, and one of the possible explanations is provided by the demand for money (Eckstein and Leiderman, 1992). A stable money demand function is associated with a long run positive correlation between the money in circulation and the level of inflation, showing that money can predict inflation, and that the monetary policy strategy should be built around the monetary aggregates.

The Cagan's (1956) constant semi-interest elasticity model served as starting point for many empirical works on money demand, which focus on the interest rate role and investigate the stability of money demand functions. However, during the '80, several elements, as financial innovations and deregulation process, put into question the money demand stability (Lucas and Nicolini, 2015). Starting with Friedman and Kuttner (1992) who report a break in the cointegration relationship around 1980 for the United States (US), a new instability literature emerged, characterized by the consideration within the money-demand function of substitutes for money. Further, the focus on monetary policy rules (Taylor, 1999) has introduced the perception of policy irrelevance of money demand theory (Cziráky and Gillman, 2006), although Alvarez et al. (2001) underline the ongoing role of money for the equivalence between interest rate rules and money supply rules.

The evaluation of money demand stability remains a subject of interest for developing nations, as the Central and Eastern European (CEE) countries, because their monetary policy tends to be oriented toward discretion rather than rules (Cziráky and Gillman, 2006). After a successful disinflation process recorded by these countries, their Euro Area accession became a subject of interest in the context of a new European Union (EU) framework and developing strategy. From the perspective of the Euro Area enlargement, stable money demand function creates good pre-condition for the euro adoption (Fidrmuc, 2009).

To test the stability of money demand in the CEE, our paper adopts an alternative approach as compared to the existing empirical literature. Previous works (i.e. Dreger et al., 2007; Fidrmuc, 2009) resort to a general formulation of the money demand function as in Leventakis (1993). Different from these works, we test the stability of money demand comparing two competing money demand models, namely the classic Cagan's (1956) closed-economy model (CEM), and the Albulescu et al.'s (2017) open-economy model (OEM). The latter model is a micro-founded model that responds to the Bordo and Choudri's (1982) criticism addressed to Miles's (1978), regarding the general format of the money demand function, which omits the existence of a scale variable. Moreover, this model is compatible with both currency substitution and currency complementarity effects and is well adapted for the CEE countries, as it makes the assumption that euro offers liquidity services to the domestic representative agent, while the reverse is supposed not to be true (for details, please refer to Albulescu et al., 2017). We resort to the Hansen's parameter instability test (Hansen, 1992) to assess the cointegrating relationship, and we estimate the long run money demand parameters with the Fully Modified Ordinary Least Squares (FMOLS) method of Phillips and Hansen (1990).

Another contribution of our paper to the existing literature resides in the identification of the monetary overhang, starting from these two OEM and CEM long run equations.[1] The purpose is to see to what extent the monetary overhang represents a good predictor of inflation in the Czech Republic, Hungary and Poland, over the period 1999 to 2016 (monthly data). Our focus is on these advanced CEE countries for two reasons. On the one hand, we are constrained by the data availability. As Cziráky and Gillman (2006) notice, evaluating the stability of money demand in CEE countries is problematic, because the lack of confidence in data quality. In order to overcome this issue, we resort to international statistics for harmonization purpose, without considering national databases as most of previous studies do. On the other hand, the selected countries have in place floating exchange rate regimes and their degree of integration with the Euro Area is considered to be higher compared to other candidate countries (i.e. Bulgaria, Croatia or Romania).

We discover that in the long run, the open-economy specification of the money demand model gives more consistent results than the closed-economy version. In addition, using the Stock and Watson's (1999) inflation forecasting equation (out-of-sample and combined forecasting approach), we show that money improves the forecast of inflation vis-à-vis a benchmark model only if we consider the currency substitution between domestic currency and the euro. However, this result is evident only for Poland, while for Hungary we find mixed evidence.

The rest of the paper is as follows. Section 2 presents the money stabilization literature. Section 3 is dedicated to the analysis of the demand for money stability, comparing the performance of a closed- and an open-economy money demand model. Section 4 addresses the monetary overhang and the inflation forecasting in the selected CEE countries. The last section concludes and presents the policy implications of our findings.

[1] The monetary overhang is associated with the residuals of the cointegration relationships. A positive monetary overhang represents a sign of inflationary pressure. If for example the money demand proves to be unstable, this will bias the inflation forecasting results (see Carstensen et al., 2009).

2. Money demand stabilization: connections with existing literature

The empirical literature on money demand stabilization usually resorts to simultaneous equations, cointegration analyses, and apply consecrates stability tests, as recursive residuals approaches (CUSUM, CUSUMSQ), or Chow tests. Most of these studies address the case of developed economies, while few empirical works are oriented towards the CEE countries.

Early studies in this area focus on the US economy and show mixed evidence. Laumas and Mehra (1977) examine the stability of the US money demand using annual data for the period 1900-1974. Their varying parameter technique, which regress money on income and interest rates, shows that the money demand is not stable. Baum and Furno (1990) report similar results for the US post-war period, resorting to an error-correction model. Opposite findings are advanced by Lin and Oh (1984), who employ switch regression techniques. The authors state that the 1974 change in the US money demand equation cannot be associated with a downward shift in the constant term, as other studies show. Their findings are confirmed by recent works on the post-war stability of money demand in the US. On the one hand, using survey data, Reynard (2004) states that previous time-series estimations of money demand in the US tend to inappropriately suggest instability. On the other hand, Arize et al. (2012) examine the long run stability of the US money demand function and use a Johansen cointegration technique for the period 1961 to 1996 (quarterly data). The authors show that the money demand function in the US has long run stability.

Estimates of the demand for money stability are familiar for developed countries[2], and become of great interest for emerging economies. In the latter case, the stability of money demand and the monetary overhang are investigated by Liew and Kawaguchi (1995) for China, by Pradhan and Subramanian (2003) for India, and by Conway (1997) and Kim (1999) for the former Soviet Union. Most of these works report a stable money demand function. Nevertheless, a significant plethora of studies addresses the case of the EU countries.

An historical perspective of money demand stability in Italy is adopted by Funke and Thornton (1999) and by Muscatelli and Spinelli (2000), in order to explain the 1920s' hyperinflation and the post-war inflation. Funke and Thornton (1999) estimate the long- and

[2] The empirical literature on money demand stability in developed countries is very extensive. Noteworthy papers in this area are those of Hoffman et al. (1995), Ewing and Payne (1999) and Bahmani-Oskooee and Chomsisengphet (2002) for OECD countries, of Maki and Kitasaka (2006) for Japan, of lovland (1982) for Norway, and the papers by Hoque and Al-Mutairi (1996) and Kumar and Webber (2013) for Australia. Different from other studies, Mark and Sul (2003) investigate the stability of money demand in a set of industrialized countries resorting to a panel framework and dynamic ordinary least squares (DOLS) estimator.

short run money demand functions over the period 1861-1980, resorting to a cointegration analysis and to an error-correction model. Their CUSUM stability test shows a fairly high degree of parameter stability in the long run relationship. Muscatelli and Spinelli (2000) use an extended data set for the period 1861-1996, and test the structural stability of money demand. Their Johansen vector error-correction model and the autoregressive distributed lag (ARDL) model show a remarkably stable demand for broad money over the analyzed period.

Recent studies on the money demand stability in the EU are oriented on the Euro Area monetary stabilization as a whole, and few of them approach the case of Euro Area individual countries. Golinelli and Pastorello (2002) show that the area-wide money demand is more stable than the single-country one, while Brand and Cassola (2003) and Coenen and Vega (2001) reaffirm the stability of money demand at aggregate level. Belke and Czudaj (2010) investigate the money demand at aggregate level comparing cointegrated VAR and single equation techniques. The authors posit that the recent financial crisis has no noticeable impact on the stability of money demand. With a focus on the same aggregate level, De Santis et al. (2013) adopt a different approach and argue that a stable broad money demand for the Euro Area can be obtained by modelling cross-border international portfolio allocation. Further, applying the Johansen's (1995) cointegration method and the Nyblom's (1989) time-invariance parameter test, the authors reports a strong co-movement between net cross-border portfolio flows and M3 velocity growth. Dreger and Wolters (2014) analyze the stability of money demand in the Euro Area and the inflation forecasting performances of a broad monetary aggregate. They state that the evolution of M3 is in line with the money demand.

Adopting a different strategy, Setzer and Wolff (2013) focus on the stability of money demand for the selected Euro Area countries, using disaggregated data. Their cointegration relationship is generated from a micro-founded money demand model and the results show that the income and the interest rate elasticity remain stable over time. Capasso and Napolitano (2012) add another piece of evidence to the stability of money demand in the Euro Area countries. With a focus on Italy over the period 1977 to 2007, and using bounds testing cointegration, the authors show that the introduction of the euro contributed to the money demand stability.

The interest for assessing the stability of money demand in the Euro Area increased after the recent global crisis outburst, but it progressively vanished with the conduct of unconventional monetary policy by the European Central Bank (ECB). However, studding the stability of money demand in the Euro Area candidate countries still remains a subject of great interest for researchers and policy makers. The bulk of empirical literature on the monetary stabilization in the CEE countries is divided in panel data and time series analyses. Given the fact that during the 1990s, the CEE transition economies registered noteworthy structural changes that make difficult the access to data for a long sample period, a first set of studies uses panel data investigations.

In this line, Dreger et al. (2007) employ panel cointegration methods and quarterly data for the period 1995 to 2004 and report the existence of a long runrelationship in the money demand equation. They conclude that the monetary integration of CEE countries may affect the stability of the Euro Area money demand. Without addressing the specific issue of the money demand stability, Ozturk and Acaravci (2008) examine long run determinants of money demand in ten CEE countries, in a panel framework for the period 1994-2005. The authors use a feasible generalized least squares (FGLS) model and their results show that the demand for money in the long run positively responds to the economic growth rate and negatively to inflation and exchange rate.

One of the first papers that test the stability of money demand in a panel configuration for the CEE countries is the paper by Fidrmuc (2009). The author does not find any structural breaks in the series and concludes that the money demand is stable, even if money demand is largely influenced by the Euro Area interest rates and by the exchange rate against the euro, which might represent signs of instability. Similar, Narayan (2010) uses the Pedroni's panel cointegration test to estimate the money demand function for a panel of eight transitional economies, for the period 1995:01 to 2005:03, and reports a long runrelationship. However, the Hansen's (1992) parameter stability test reveals more cases of unstable money demand functions.

Time-series money demand analyses are performed by a series of researchers in case of specific central-planned economies. For example, Charemza and Ghatak (1990) report mixed evidence when they assess the money demand in two communist economies namely Poland and Hungary. Staring with Chawluk and Cross (1997) the researchers become interested by the existence and size of a monetary overhang to predict the inflation in the CEE countries. However, the first study that investigates the stability of money demand in individual post-communist economies is that of Buch (2001). Using a cointegration and error-correction framework, and a CUSUM test for the coefficient stability, the author documents the stability of money demand in Hungary and Poland. Cziráky and Gillman (2006) estimate the money demand in Croatia using monthly data from 1994 to 2002. They find evidence for a stable money demand function, which represents the basis for inflation rate forecasting in Croatia.

Subsequent studies enlarge the group of the analyzed countries. Applying a bounds testing approach to error-correction modelling and cointegration, Bahmani and Kutan (2010) show that money demand in the case of the CEE countries is quite stable. Further, Bahmani-Oskooee et al. (2013) introduce uncertainty and monetary volatility in the money demand equation for six CEE and four other emerging economies. Their Pesaran et al.'s (2001) bounds testing approach shows that the money demand is correctly specified and stable.

Nevertheless, no previous study investigates the stability of money demand comparing different money demand functions. Moreover, no previous money demand function employed for testing the monetary stabilization in the CEE countries is specifically designed to fit the particularities of the CEE economies. To fill in this gap, we compare the stability of money demand resorting to a closed- and an open-economy money demand model. We also compare the performance of the monetary overhang obtained based on these competing models, in forecasting inflation in three CEE countries.

3. Money demand in the long run

In this section, we describe two competing long run money demand functions and present the estimated models for Hungary, Czech Republic and Poland. The monthly data period is 1999-01 to 2016-11. Details are given in the Appendix.

The first model is a standard closed-economy model which relates the real money demand to a scale variable (the real industrial production) and to a domestic interest rate. We employ the semi-log form used by Cagan (1956) and recommended by Ireland (2009), which explains the log of the real money demand by the log of the scale variable and the level of the interest rate:

$$\ln m_t = \alpha_0 + \alpha_1 \ln y_t + \alpha_2 r_t \tag{01}$$

with $\mathrm{m_t = M_t / P_t}$ and M is the M3 aggregate, r is the level of the interest rate, α_0 is a positive constant and α_2 the absolute value of the interest semi-elasticity of money demand.

The second model is a modified version of the open-economy model of Albulescu et al. (2017)[3]. In this model, the agents of CEE countries hold domestic and foreign assets (bonds and currencies). The foreign currency is the euro, which is supposed to offer liquidity services

[3] To make relevant the comparison between CEM and OEM, we consider a semi-log form of OEM whereas Albulescu et al. (2017) use a log-log specification.

to the agents of the CEE countries. Currency substitution is demonstrated to relate the money demand to the interest rate spread between the CEE countries and the Euro Area (in addition to the scale variable and to the domestic interest rate). For this reason, we include the interest rate spread in the open economy formulation of the money demand:

$$\ln m_t = \alpha_0 + \alpha_1 \ln y_t + \alpha_2 r_t + \alpha_3 \left(r_t - r_t^*\right) + \varepsilon_t \quad (02)$$

with $m_t = M_t / P_t$, where M, P, y, r and r* are defined as money (M3 aggregate), price, output (real industrial production), domestic interest rate and Euro Area interest rate.[4]

In the long run, the model is supposed to perfectly fit the data so that the error term ε_t is zero. But in the short run, money demand deviates from the long run function, giving rise to a nonzero stationary error term ε_t. The closed-economy version of the model is simply obtained with the restriction $\alpha_3 = 0$.

For each model and each country, we estimate the long run money demand parameters with the FMOLS method of Phillips and Hansen (1990), and perform a cointegration test with the Hansen's parameter instability test (Hansen, 1992).[5] As the theoretical money demand model adds the restrictions that the output elasticity is one: $\alpha_1 = 1$, and that the interest-rate semi-elasticity is negative: $\alpha_2 < 0$, we also pay attention to these hypotheses[6].

Table 1 presents the long run estimated parameters. It appears that the open-economy model offers more consistent results than the closed-economy model. Indeed, the estimated interest semi-elasticity is always negative and significant whereas the same estimated parameter is positive in two out of three cases when the closed-economy specification is considered. Moreover, all the parameters of the open-economy model are significant, notably the interest spread between the CEE countries and the Euro Area. The estimated parameter $\hat{\alpha}_3$ is positive for the three CEE countries, which demonstrates that preference parameters are quite homogeneous among the CEE countries.

[4] The M3 aggregate is represented by the broad money index (2010=100) and comes from the OECD database (Bruggeman et al., 2003, Carstensen et al., 2009 and Dreger and Wolters, 2014 use the M3 aggregate to check the stability of money demand in the Euro Area). The level of prices (consumer price index – 2010=100) and the real industrial production index (2010=100) comes from IMF-International Financial Statistics database. The interest rate (1-month money market rate) comes from the Eurostat database. Except for the interest rate, all the other series are seasonally adjusted as in Fidrmuc (2009).

[5] Narayan (2010) used a similar approach in his panel data analysis for the stability of money demand in eight CEE countries.

[6] The parameter α_3 can be of any sign.

Table 1

Estimation results

	Hungary		Czech Republic		Poland	
	OEM	CEM	OEM	CEM	OEM	CEM
α_0	5.195***	-4.867***	-6.125***	-3.012***	-6.311***	-7.007***
	(-10.764)	(-8.824)	(-9.310)	(-5.394)	(-20.310)	(-17.099)
α_1	1.093***	1.030***	1.319***	1.129***	1.367***	1.510***
	(11.083)	(9.126)	(9.439)	(5.484)	(20.961)	(17.479)
α_2	-0.013*	0.002	-0.021*	-0.018	-0.025***	0.012***
	(-1.735)	(0.391)	(-1.737)	(-0.977)	(-2.962)	(2.649741)
α_3	0.027***		0.096***		0.041***	
	(3.012)		(6.098)		(4.742)	

Notes: (i) The t-statistics are in bracket below the estimated long run parameters; (ii) ***, **, * means significance at 1%, 5% et 10% significance level.

It appears from Table 1 that the estimated output elasticities are not too far from the unity. Table 2 presents the results of the test of the hypothesis $\alpha_1 = 1$ for each country and each model. The hypothesis of a unitary output elasticity cannot be rejected for Hungary and the Czech Republic whereas the hypothesis is rejected for Poland. Nevertheless, the estimated parameter is rather close to the unity for Poland, in particular in the case of the open-economy model.

Table 2

Tests of the hypothesis $\alpha_1 = 1$

	Hungary		Czech Republic		Poland	
	OEM	CEM	OEM	CEM	OEM	CEM
t-statistic	0.951	0.270	2.284	0.627	5.633	5.909
(probability)	(0.342)	(0.787)	(0.023)	(0.530)	(0.000)	(0.000)

Table 3 presents the results of the cointegration tests performed according to the Hansen's parameter instability test (Hansen, 1992). The hypothesis that m, y and r are cointegrated is not plausible as the probability of the cointegration test of the closed-economy model never exceeds 0.01. On the contrary, the hypothesis that m, y, r and r-r* are cointegrated is plausible, except for the Czech Republic where the assumption of stationarity of the error term ε_t is questionable.

Table 3

Results of the cointegration tests (Hansen's parameter instability tests)

	Hungary		Czech Republic		Poland	
	OEM	CEM	OEM	CEM	OEM	CEM
Lc statistic	1.035	0.698	1.198	1.372	0.637	0.882
(probability)	(0.019)	(0.010)	(< 0.01)	(< 0.01)	(0.123)	(< 0.01)

To summarize, the open-economy specification of the money demand model gives more consistent results than the closed-economy version, consistent with a long run relation between the variables for Hungary and Poland. The hypothesis of cointegration is more doubtful in the case of the Czech Republic.

Next, we define the monetary overhang for each country and each model as the residual of the long run money demand equations:

$$\hat{\varepsilon}_t = \ln m_t - \ln \hat{m}_t \qquad (03)$$

Figures 1, 2 and 3 illustrate the differences between the two measures of monetary overhang. There are noticeable differences between these measures, especially for the Czech Republic and Poland. Moreover, it can be noticed that the monetary overhang estimated from the OEM surpassed the monetary overhang estimated from the CEM for the three CEE countries during the pre-crisis period 2006-2008. We can also see that both measures of monetary overhang rocket at the beginning of the 2008 financial crisis.

Figure 1. Monetary overhang of Hungary

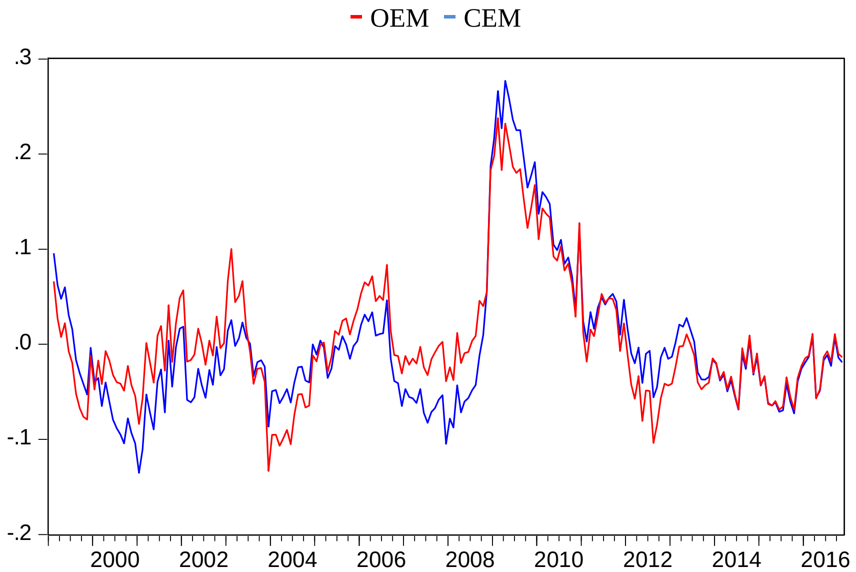


Figure 2. Monetary overhang of the Czech Republic

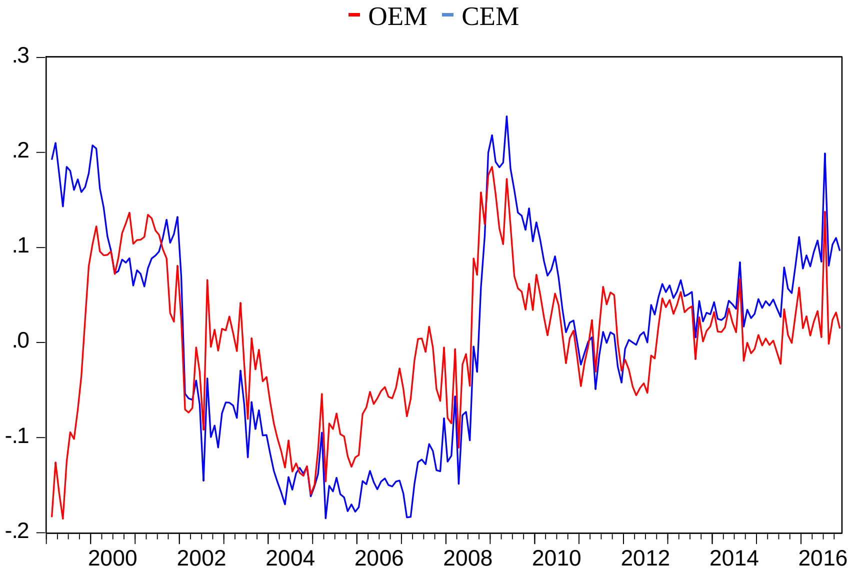
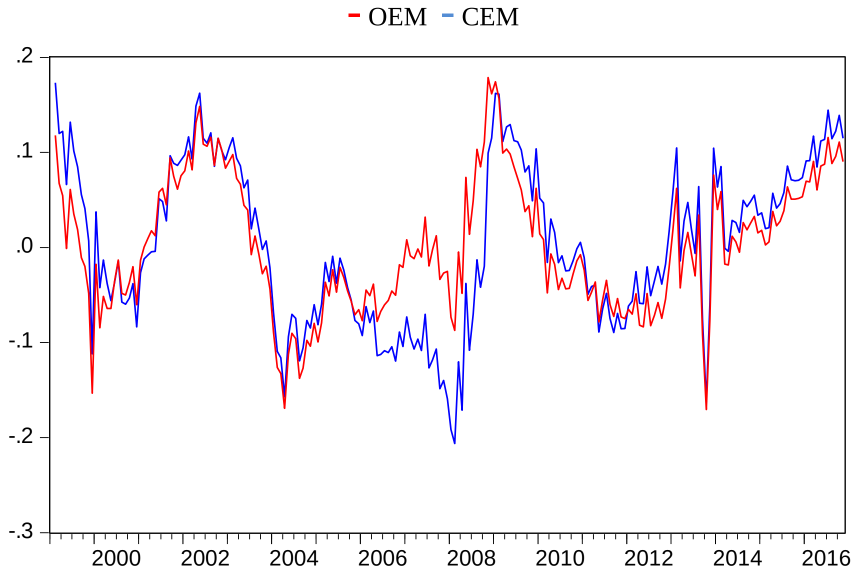


Figure 3. Monetary overhang of Poland



4. Monetary overhang and inflation forecasting in the CEE countries

It is generally accepted that the existence of a long run money demand function implies that the monetary overhang is a good leading indicator of inflation. Thus, we study and compare the inflation forecasting properties of the two measures of monetary overhang. For this purpose, we consider inflation forecasting for different forecast horizons h: a month (h = 1), a quarter (h = 4), a year (h = 12) and two years (h = 24). We follow Stock and Watson (1999) to specify the inflation forecasting equation:

$$\pi^h_{t+h} - \pi_t = \beta + \beta_\pi(L)\Delta\pi_t + \beta_{\hat{\varepsilon}}(L)\hat{\varepsilon}_t + \eta_{t+h} \qquad (04)$$

where $\pi_t = 12 \times \ln(P_t / P_{t-1})$ is the annualized monthly inflation rate in the price level P_t, $\pi^h_{t+h} = (12/h) \times \ln(P_{t+h}/P_t)$ is the annualized h-period inflation rate, $\hat{\varepsilon}_t$ is one of the two measures of monetary overhang, Δ is the difference operator, $\beta_\pi(L)$ and $\beta_{\hat{\varepsilon}}(L)$ are lag polynomials, and η_{t+h} is an error term.

We follow Carstensen et al. (2009) and fix the lag order of the polynomials $\beta_\pi(L)$ and $\beta_{\hat{\varepsilon}}(L)$ to 12 since the data are monthly.[7] In Table 4, we report for each country and each measure the F-statistic and the probability of the hypothesis that the monetary overhang measure can be excluded from the equation (the parameters of the lag polynomial $\beta_{\hat{\varepsilon}}(L)$ are all zero).

Table 4

Tests of exclusion of the monetary overhang (MO) measures in the forecasting regressions

	Hungary	Czech Republic	Poland
h = 1			
MO based on OEM	1.195	0.723	0.611
	(0.285)	(0.738)	(0.842)
MO based on CEM	1.234	0.620	0.399
	(0.258)	(0.835)	(0.968)
h = 3			
MO based on OEM	1.818	0.261	1.085
	(0.043)	(0.995)	(0.374)
MO based on CEM	1.681	0.263	0.744
	(0.068)	(0.995)	(0.717)
h = 12			
MO based on OEM	3.183	0.898	1.590
	(0.000)	(0.556)	(0.092)
MO based on CEM	1.816	1.105	1.026
	(0.044)	(0.358)	(0.428)
h = 24			
MO based on OEM	4.027	1.409	2.077
	(0.000)	(0.160)	(0.018)
MO based on CEM	1.908	2.146	1.302
	(0.033)	(0.014)	(0.217)

Notes: Probability of the hypothesis of nullity of the parameters of $\beta_{\hat{\varepsilon}}(L)$ is reported in brackets.

[7] Carstensen et al. (2009) set the lag order to four since their data are quarterly.

First, the results of the tests that monetary overhang can be excluded from the forecasting models are globally consistent with the results of the cointegration tests. For the Czech Republic, monetary overhang measures are bad predictors of future inflation, whatever is the forecasting horizon (except for the monetary overhang based on the CEM which predicts inflation at a horizon of two years). This result is not surprising as we have showed that the hypothesis of stationarity of monetary overhang is doubtful in the case of the Czech Republic. For Hungary and Poland, the monetary overhang based on OEM gives a better prediction of future inflation at all horizons than the monetary overhang based on CEM (in the sense that the probabilities are lower). Inflation seems to be unpredictable at a very short horizon (one month). At a horizon of one quarter, monetary overhang shows a significant ability to predict inflation in the case of Hungary. Further, at a horizon of one and two years, it cannot be excluded from the forecasting regression for Hungary and Poland, especially when the monetary overhang measure based on OEM is used. The monetary overhang measure using CEM is a significant predictor of inflation in the case of Hungary, but not in the case of Poland.

To gain further insights in the forecasting ability of monetary overhang measures, we follow Stock and Watson (1999) and perform forecasting comparisons using an out-of-sample methodology for the last five years of the sample (from 2012-01 to 2016-11), using the forecasting equation (04) re-estimated with data from 1999-01 to 2011-12. We estimate three versions of the forecasting equation and compare their forecasting performance: a benchmark model (BM) which excludes the monetary overhang from the forecasting equation ($\beta_{\hat{\varepsilon}}(L) = 0$), a forecasting model with a monetary overhang obtained from the OEM, and a forecasting model with monetary overhang based on the CEM. For each model, the prediction error at horizon h, given a forecast carried out at date t, is:

$$e_{t,h} = \pi^{h}_{t+h} - \pi^{h}_{t+h/t}, \qquad (05)$$

where $\pi^{h}_{t+h/t}$ is the forecast based on equation (04) estimated with data prior to 2012-01. The root mean-squared prediction errors (RMSPE) at horizon h are defined as:

$$\mathrm{RMSPE}(h) = \sqrt{\frac{\sum_{t=1}^{N}\left(e_{t,h}\right)^2}{N}} \qquad (06)$$

The number N of predictions is not a constant and is a function of h, as it is lower when h is higher. As the sample used for prediction ends in 2016-11, we cannot for example evaluate the prediction error of the forecasts carried out in 2016-01 for horizons h = 12 and h = 24. Table 5 displays the RMSPE for the three models, for each country, and for h = 1, 3, 12 and 24.

Table 5

Root mean-squared prediction errors

	Hungary	Czech Republic	Poland
h = 1			
BM	0.0404	0.0300	0.0188
OEM	0.0395	0.0312	0.0258
CEM	0.0405	0.0311	0.0248
h = 3			
BM	0.0302	0.0179	0.0157
OEM	0.0271	0.0183	0.0218
CEM	0.0285	0.0186	0.0215
h = 12			
BM	0.0220	0.0121	0.0130
OEM	0.0180	0.0130	0.0135
CEM	0.0210	0.0116	0.0148
h = 24			
BM	0.0276	0.0133	0.0163
OEM	0.0220	0.0138	0.0154
CEM	0.0267	0.0109	0.0195

First, we notice for all countries that the RMSPE is a decreasing function of h up to a horizon h = 12 and then decreases when h increases from 12 to 24. The best predictions of inflation are obtained with a horizon of a year. Secondly, when comparing the OEM and the CEM with the BM at a horizon of one month, it appears that the BM gives almost always the best predictions, confirming the results of the tests of exclusion of the monetary overhang measures in the forecasting regressions (Table 4). With specific respect to the comparison of OEM and BM, money does not improve the forecasts vis-à-vis the benchmark model when considering the Czech Republic and Poland. It confirms the previous results on the Czech Republic, but it contradicts those on Poland (see Table 4) except for a horizon of two years. Regarding Hungary, money (based on OEM) does improve the forecasts of inflation at horizons of one quarter, one and two years. Finally, when considering the comparison of CEM and BM, money does not generally improve the forecasts as compared to the benchmark model. In the case of Poland, the BM always offers better predictions than the CEM. For Hungary, the CEM gives slightly better predictions than the BM. For the Czech Republic, the CEM does not generally improve the forecast, except for a horizon of two years. These results about the CEM are consistent with those of Table 4. Finally, it seems that money may improve the forecast of inflation vis-à-vis a benchmark model if currency substitution between the local money and the euro is taken into account.

Following Stock and Watson (1999), in order to detect a significant improvement of the forecasting, we implement a forecast combination regression:

$$\pi^{h}_{t+h} - \pi_t = \lambda f^{x}_{t} + (1-\lambda) f^{u}_{t} + \eta_{t+h} \qquad (07)$$

where f_t^u and f_t^x are two competing forecasts, with u and x chosen among BM, CEM and OEM.

Using the forecasts we get at the previous stage, we estimate equation (07) on the sample used for the out-of-sample prediction exercise (2012-01 to 2016-11). Then we test the hypothesis $\lambda = 0$ (the forecast f_t^x adds nothing to the forecast f_t^u) and the hypothesis $\lambda = 1$ (the forecast f_t^u adds nothing to the forecast f_t^x). Tables 6, 7 and 8 present the estimates of λ and the probabilities of the tests of $\lambda = 0$ and $\lambda = 1$ for all the pairs of f_t^u and f_t^x, for each forecasting horizon, for the three countries.

Table 6

Results of the forecast combination regression for Hungary

Hungary	u = BM, x = CEM	u = BM, x = OEM	u = CEM, x = OEM
h = 1			
λ	-0.414	-0.598	0.767
Probability ($\lambda = 0$)	0.563	0.456	0.692
Probability ($\lambda = 1$)	0.052	0.049	0.904
h = 3			
λ	0.780	0.803	0.637
Probability ($\lambda = 0$)	0.417	0.386	0.700
Probability ($\lambda = 1$)	0.819	0.831	0.826
h = 12			
λ	1.271	1.077	1.319
Probability ($\lambda = 0$)	0.355	0.192	0.334
Probability ($\lambda = 1$)	0.842	0.924	0.814
h = 24			
λ	2.257	2.280	3.260
Probability ($\lambda = 0$)	0.403	0.048	0.039
Probability ($\lambda = 1$)	0.640	0.259	0.147

Tables 6, 7 and 8 confirm the previous results. For the Czech Republic (Table 7), all the probabilities are high, indicating that the competing forecasts cannot be ranked. Therefore, monetary overhang (resulted from CEM or OEM) does not improve the inflation forecast compared to the BM. For Hungary, it is not clearly visible that the forecasts based on the CEM are better than those based on the BM, although the probabilities associated to the test of the hypothesis $\lambda = 0$ are lower than those associated to the test of the hypothesis $\lambda = 1$ (for h = 3, 12 and 24). Comparing the forecasts based on the CEM with those based on the BM, the results are in favor of the CEM (for h = 3, 12 or 24), especially for longer horizons. For long horizons (h = 12 and 24), the forecasts based on the OEM are also better than those based on the CEM. For Poland, we see clearly that money (based on the OEM) improves the forecast of inflation, especially for long horizons (h = 12 and 24). For long horizons, forecasts based on the OEM are better than those based on CEM, which themselves are not better than those based on the BM.

Table 7

Results of the forecast combination regression for the Czech Republic

Czech Republic	u = BM, x = CEM	u = BM, x = OEM	u = CEM, x = OEM
h = 1			
λ	0.434	0.381	-0.109
Probability ($\lambda = 0$)	0.576	0.632	0.968
Probability ($\lambda = 1$)	0.468	0.438	0.691
h = 3			
λ	0.411	-0.887	-0.979
Probability ($\lambda = 0$)	0.838	0.724	0.720
Probability ($\lambda = 1$)	0.770	0.454	0.470
h = 12			
λ	0.702	-0.383	-0.376
Probability ($\lambda = 0$)	0.655	0.850	0.826
Probability ($\lambda = 1$)	0.850	0.496	0.424
h = 24			
λ	1.189	-0.398	-0.641
Probability ($\lambda = 0$)	0.471	0.911	0.732
Probability ($\lambda = 1$)	0.908	0.697	0.383

Table 8

Results of the forecast combination regression for Poland

Poland	u = BM, x = CEM	u = BM, x = OEM	u = CEM, x = OEM
h = 1			
λ	-0.0709	0.030	-0.272
Probability ($\lambda = 0$)	0.808	0.902	0.785
Probability ($\lambda = 1$)	0.000	0.000	0.206
h = 3			
λ	0.165	0.202	0.252
Probability ($\lambda = 0$)	0.540	0.408	0.762
Probability ($\lambda = 1$)	0.003	0.001	0.372
h = 12			
λ	0.512	0.790	1.320
Probability ($\lambda = 0$)	0.217	0.064	0.072
Probability ($\lambda = 1$)	0.240	0.619	0.658
h = 24			
λ	0.434	0.990	1.876
Probability ($\lambda = 0$)	0.228	0.027	0.005
Probability ($\lambda = 1$)	0.119	0.981	0.176

Conclusions and policy implications

The white paper on the future of Europe released by the European Commission in March 2017, after the Brexit decision, designs several scenarios for the EU27 until 2025. Given the new commitments for a stronger EU and the election results in the old EU members with a strong Euroscepticism current (i.e. France and Netherlands), the last scenario, namely "Doing much more together" seems to be plausible. This means that new member states are encouraged to join the Euro Area while a stronger fiscal coordination is necessary. In this context, understanding the determinants of money demand for the CEE countries is crucial. A stable money demand function shows to what extent these countries may use monetary aggregates to conduct monetary policy (Dreger et al, 2007). Moreover, a stable money demand shows that a monetary targeted regime is feasible to meet the Maastricht criteria (Bahmani and Kutan, 2010). Further, a stable money demand allows seeing if the monetary overhang is a good predictor of future inflation.

To provide additional insights to the money demand stability in selected CEE countries, we compare two money demand functions, resulted from a closed and an open, micro-founded money demand model. This specification allows us to see if the consideration of a currency substitution effect makes the money demand more stable in the long run. Using monthly data for the Czech Republic, Hungary and Poland for the period 1999-2016, our results can be summarized as follows.

First, considering the interest rate differential (OEM) we obtain consistent results for the money demand stability, although to a smaller extent for the Czech Republic. This result might be explained by the fact that the structure of money in circulation in the Czech Republic (approximated through the structure of bank deposits), shows a higher proportion of domestic currency denominated deposits as compared to Hungary and Poland (around 90% of deposits in the Czech Republic compared to 80% in the other two countries). The policy implications of these findings show that in countries where the confidence in domestic currency is higher, the effect of currency substitution for the monetary stabilization diminishes.

Second, we discover that the monetary overhang generated from the OEM surpassed the monetary overhang estimated from the CEM in the pre-crisis period. On the one hand, this observation point in the favor of a soft monetary stance before the crisis. On the other hand, this evidence raises questions about the forecasting capacity of the monetary overhang. Given the structural break that appears in the monetary overhang in 2008 for all the countries retained into the analysis, we admit that our forecast exercises have some limits. However, our F-test confirms the cointegration results and states that the monetary overhang is a good predictor of inflation only for Hungary and Poland.

Third, the results of the forecasting exercises are mixed. On the one hand, we have performed out-of-sample inflation forecasts. These results show that prediction errors decrease with the time horizon, until 12 months, for all three countries. Nevertheless, the consideration of the monetary overhang in forecasting the inflation is recommend this time only for Poland. Poland, as the other countries in our sample, has in place an inflation targeting monetary strategy and a floating exchange rate regime. As compared to the Czech Republic and Hungary that have a trade openness over 160% of GDP according to the World Bank statistics in 2014, the trade openness in Poland is about 90% of its GDP. This evidence partially contradicts the important role of international factors in explaining the money demand in Poland. However, the central bank of Poland announced an accommodating inflation targeting policy, in order to sustain economic growth and to achieve financial stability. Therefore, money becomes more important in predicting inflation if monetary policy becomes less restrictive, but helps to predict inflation only in the long run. The findings obtained from a forecast combination regression are similar, showing that for the Czech Republic the role of monetary overhang in predicting inflation cannot be assessed. At the same time, for Hungary we find mixed evidence, the importance of monetary overhang being noticed only in the long run, when the OEM outperforms the CEM. However, for Poland, there is a clear evidence about the importance of the monetary overhang generated from an OEM in forecasting inflation.

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Appendix - Data description

Variables	Database	Explanations
m = M/P (real money)	OECD IFS (IMF)	M - Broad Money (M3) Index (2010=100), seasonally adjusted. P - Consumer Prices Index (2010=100).
y (output)	IFS (IMF)	Industrial Production Index (2010=100), seasonally adjusted.
r (domestic interest rate)	Eurostat	1-month Money Market Rate for the Czech Republic, Hungary and Poland.
r* (Euro Area interest rate)	Eurostat	1-month Money Market Rate for the Euro Area.