DOES ECONOMIC CRISIS AFFECT THE DEMAND FOR MONEY: EVIDENCE FROM CROATIA?

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Abstract

The purpose of this paper is to examine whether there are significantly different characteristics of the demand for money in Croatia in the period before and during the recession. The paper applies error correction model (ECM) and autoregressive distributed lag (ARDL) approach, estimating model 1 for the period of growth, and model 2 for the period of recession. Structural stability of these models was tested by cumulative sum and cumulative sum of square tests. Comparing the results of the models, the substantial changes in the function of the demand for money has been detected. Namely, the research shows that variables: interest rates (IR), real effective exchange rate (REER) and inflation (CPI) are significant in model 1, while the variable industrial production (IP) is not significant. In model 2 only industrial production (IP) and inflation (CPI) have been found to be statistically significant with the adequate sign.

Keywords: money demand, economic crisis, error correct model, autoregressive distributed lag, Croatia

JEL Classification: E41, G01

1. Introduction

Understanding the issues about money demand is a prerequisite for conducting adequate monetary policy. This is why the determinants of money demand have been extensively studied by both policy makers in the central banks, as well as academic researchers. The focus of interest is often directed toward questions which variables should be included in money demand function and which monetary aggregate best describes money demand. Another very important question that should be thoroughly investigated is whether the relationship between the chosen variables and the demand for money under various conditions is persistent. It could be

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expected that during the recession money demand changes its characteristics. The goal of this paper is to investigate if this is the case for Croatia.

Namely, at the end of 2008 Croatia has entered into the long-lasting deep recession with very high negative GDP growth rates (-8.6% in 2009q1, -8.2% in 2009q2, etc.). Although Croatia in 2nd and 3rd quarter of 2011 recorded two positive GDP growth rates (0.2% and 0.4%, respectively), unfortunately that was not the sign of the end of the recession, because after that followed numerous quarters with negative growth rates. However, it seems that in the 4th quarter of 2014 the recession has finally ended, but according to currently available data this conclusion cannot be confirmed.

In the second half of 2008, the monetary authority noted that Croatia has entered the recession, and that is why they adjusted their monetary policy. Croatian central bank - Croatian national bank (CNB) made a series of Decisions among which the most important were these: The first Decision was announced in October 2008. That was Decision to cease the Decision of the marginal reserve requirement in order to increase the foreign currency liquidity of banks. After that, in November of the same year, the reserve requirement rate was reduced from 17% to 14% which released 8.4 billion Kuna into liquidity. In February 2010 this rate was further reduced to 13%, which freed up another 2.9 billion Kuna for financing the government and HBOR programs for encouraging bank credit activity. In January, and then again in February 2009 the CNB decided to reduce the rate of minimum coverage of foreign currency liabilities by foreign currency claims, first from 28.5% to 25% (in January) and then from 25% to 20% (in February), which gave the banking system access to a total of 18.25 billion Kuna. In March 2011 the Governor of the CNB decided on an additional easing of the rates of minimum coverage of foreign currency liabilities by foreign currency claims from 20% to 17%, which meant for bankers 6.3 billion Kuna of newly available funds. However, such growth of monetary aggregates, unfortunately, had no significant impact on economic growth (Svilokos, 2012).

Reasons for that could be because the determinants of money demand in a period of recession have changed. Namely, because of rising unemployment and fear of job loss, households demand for loans stagnated. Money demand from enterprises in periods of the recession was also lower because of lack of good investment projects and overall pessimistic expectations. In the same time, because of higher credit risk and country risk, banks increased the interest rates. Furthermore, because direct foreign investments and loans from abroad significantly dropped with the beginning of the recession, that contributed to the depreciation of domestic currency. The negative changes in the real effective exchange rate (REER) in the highly euroized economy such as Croatia could also have significant negative impact on money demand. Croatian consistent practice to use relatively stable foreign currencies in order to protect against currency risk means that in times of crisis the demand for domestic currency will decrease, and at the same time the demand for foreign currencies, primarily for the Euro and Dollar, will increase.

Because of all of the above, the focus of interest of this paper is to the changes in money demand determinants in Croatia. The goal of the research is to find out whether there are significant differences in these determinants before and after Croatia entered the recession. For conducting this research there are relatively short time series span (131 monthly observations for periods of expansion, and 76 monthly observations for period of recession), so the suitable approach is to employ Autoregressive Distributed Lag (ARDL) bound testing procedure based on an unrestricted error correction model proposed by Pesaran et. al. (2001). The ARDL model is a more reliable method to determine the cointegration relation in small samples (Ghatak and Siddiki, 2001) than standard Johansen co-integration technique that requires large data samples for validity.

The remainder of the paper is structured as follows: after the Introduction part, Section 2 provides the short literature review of numerous papers related to the topic of money demand stability in periods of financial crisis and money demand in Croatia. Section 3 gives the description of methodology, theoretical framework and data. In Section 4 the main results of this research are presented followed by a conclusion in Section 5.

2. Literature review

Money demand stability during the financial crisis and under other conditions has been a very popular research topic. There are many papers of which the recent work of Dreger and Wolters (2011), Kapounek (2011), Atkins (2005), Slavova (2003) and Carstensen (2006) should be emphasised.

Dreger and Wolters (2011) explored the stability of the relation between money demand for M3 and inflation in the euro area by including the period of the financial crisis. Their results indicated that the equilibrium evolution of M3 was still in line with money demand. They concluded that the hypothesis of weak exogeneity should be rejected for real money balances and inflation, and find out that real income, real asset prices, and the term structure did not respond to deviations from the long-run equilibria.

Kapounek (2011) focused on monetary policy implementation and money demand in the euro area during the financial crisis. His empirical analysis showed money demand function instability during the financial crisis. The instability was described by a decrease in credit money creation and money velocity changes.

Atkins (2005) estimated the money demand function for Jamaica using a Structural cointegrating VAR in order to find out whether the Jamaican financial crisis compromised the stability of money demand. The author determined the adequate stability of money demand despite the serious financial crisis of the 1990's.

Slavova (2003) estimated the demand for narrow and broad money in Bulgaria over three distinct sub-periods: the period of high, variable, but not systematically accelerating inflation; the near-hyperinflationary period; and the period of stabilization. Her results confirmed that the functional econometric relationship among the variables of interest has changed. Over the first sub-period, the long-run demand for real M1 and M2 balances was affected significantly by the deposit rate and the price level. For the hyperinflationary period, author tested a Cagan-style demand for money specification and found strong evidence that the demand for both M1 and M2 was determined solely by inflation. The results for the last sub-period were indicative of a more "normally behaved" demand for money function for both M1 and M2. Both the wage rate and the Treasury Bill rate have been found as significant determinants of the demand for real M1 and M2 balances.

The article of Carstensen (2006) analysed the question whether money demand in the Euro area underwent a structural change in the end of 2001 when M3 money growth started to considerably overshoot the reference value set by the European Central Bank. It has been concluded that conventional specifications of money demand have in fact become unstable, whereas specifications that were augmented with equity returns and volatility remained stable.

Money demand determinants for Croatia have been previously studied by Anušić (1994), Babić (2000), Erjavec and Cota (2001), Payne (2002), Hsing (2007), Škrabić and Tomić-Plazibat (2009).

Anušić (1994) in his paper established econometric estimation of money demand function in Croatia for the period from January 1991 to November 1993. He concluded that the main determinants of the money demand during the period of hyperinflation were inflation, real economic activity and lagged real money, whereas interest rate did not have a significant influence on money demand. Later Babić (2000) re-examined money demand providing empirical evidence that the demand for the real monetary aggregates was a stable function of a few explanatory variables: the variable of economic activity, the opportunity cost variable and the variables of partial adjustment. The best variable of economic activity for the M0, M1 and M1a turned out to be the real monthly GDP. The best opportunity cost variable for the M0, M1 and M1a turned out to be the weighted average interest rate on the commercial banks' demand deposits in Kuna.

Erjavec and Cota (2001) analysed period from October 1994 to August 2000 and found that output was a dominant positive factor, and had a negative significant interest rate. These estimates that were based upon VEC model confirmed that money-price relationship has disappeared in the post-stabilization period.

Payne (2002) conducted the post stabilisation estimates of money demand in Croatia by estimating error correction model and bounds testing approach. He discovered that industrial production was statistically insignificant for both the Ma and M1a money demand specifications, and that interest rates, inflation and the real effective exchange rate had a negative and statistically significant impact.

Hsing (2007) investigated the impacts of currency depreciation, the foreign interest rate and functional forms on Croatia's money demand function. He concluded that the demand for real M1 in Croatia was positively influenced by real output and negatively associated with the deposit rate, the kuna/euro exchange rate, the euro interest rate, and the expected inflation rate. The results for the demand for real M2 were similar. Furthermore, he noticed that for the real M1 or M2 demand, the capital mobility effect was greater than the cost of borrowing effect, and for real M1 demand, the substitution effect was greater than the wealth effect. His results also indicated that the depreciation of the Kuna would raise output.

Škrabić and Tomić-Plazibat (2009) analysed real money demand within multivariate time-series framework. The estimated long-run money demand function indicated the slow speed of adjustment of removing the disequilibrium. Additionally, their empirical results provided the evidence that in Croatia real industrial production and exchange rate explained most variations of money demand in the long-run, while interest rate was significant only in short-run.

3. Methodology, theoretical framework and data

Autoregressive Distributed Lag (ARDL) model recently became recognised as a very usable tool for testing the presence of long-run relationships between economic time-series. ARDL model was firstly introduced by Pesaran et al. (2001) in order to incorporate I(0) and I(1) variables in the same estimation process. If analysed variables are stationary in levels (I(0)), then standard OLS approach is appropriate. If all variables are I(1), and if they are not cointegrated, in this case, the standard OLS can be estimated using the first differences of each series. If all variables are I(1), and econometric tests (e.g. Johansen cointegration technique; Johansen, (1988)) also strongly support the thesis that they are cointegrated, than two types of models are recommended: (a) A standard OLS regression model applied to the levels of variables that will describe the long-run relationship between them; Or (b) an error-correction model (ECM), that will show the short-run dynamics.

In practice, the things are usually more complicated than this. Sometimes the research has to be conducted based on variables of which some may be stationary (the unit root tests are inconclusive), some may be I (1), and there is also the possibility of cointegration among some of the I(1) variables (the Johansen test is inconclusive). Also, there could be a problem of availability of only the small sample sizes. In these situations using the ARDL model could be the solution. The advantages of ARDL over conventional cointegration testing is that: (a) in small samples the ARDL model is more statistically significant approach that can be used to determine the cointegration relation than conventional techniques (Ghatak and Siddiki 2001); (b) the ARDL approach does not require any assumption as to whether the time series are I(1) and/or I(0). This means that pre-testing problems associated with standard cointegration, which requires that the variables should be classified into I(1) or I(0) can be avoided (Pessaran et al, 2001); (c) using ARDL approach we can avoid the decisions about the number of endogenous and exogenous variables to be included, how to treat the deterministic elements, and the decisions about the order of VAR and the optimal number of lag (Pesaran and Smith, 1998).

ARDL form of the regression model is

$$\phi(L,p)y_t = \sum_{i=1}^{k} \beta_i(L,q_i)x_{i,t} + \delta' w_t + u_t \tag{1}$$

where: $\phi(L,p) = 1 - \phi_1 L - \phi_2 L^2 - \cdots - \phi_p L^p$,

and $\beta_i(L,q_i) = 1 - \beta_{i,1}L - \beta_{i,2}L^2 - \cdots - \beta_{i,q_i}L^{q_i}$, *i=1, 2,…, k.*

In equation (1) y_t is the dependent variable, $x_{i,t}$ is *i* dependent variables, L is a lag operator, and W_t is S×1 vector of deterministic variables. The long-run elasticity can be estimated by (Wilson and Chaudhri, 2004):

$$\hat{\Theta}_i = \frac{\hat{\beta}_{i,0} + \hat{\beta}_{i,1} + \cdots + \hat{\beta}_{q,i}}{1 - \hat{\phi}_1 - \hat{\phi}_2 - \cdots - \hat{\phi}_p},\ \forall i = 1, 2, \dots, k \tag{2}$$

The long-run cointegration relationship can be presented with equation (3)

$$y_t - \hat{\Theta}_0 - \hat{\Theta}_1 x_{1,t} - \hat{\Theta}_2 x_{2,t} - \cdots - \hat{\Theta}_k x_{k,t} = \varepsilon_t,\ \forall t = 1, 2, \dots, n \tag{3}$$

where:

$$\hat{\Theta}_0 = \frac{\hat{\beta}_0}{1 - \hat{\phi}_1 - \hat{\phi}_2 - \cdots - \hat{\phi}_p} \tag{4}$$

The Error correction model of ARDL can be obtained by rewriting the equation (1) in terms of the lagged levels and first difference of y_t, $x_{1,t}$, $x_{2,t}$,…, $x_{k,t}$ and w_t (Pahlavani et.al., 2005):

$$\Delta y_t = -\phi(1,\hat{p})EC_{t-1} + \sum_{i=1}^{k}\beta_{i,0}\Delta x_{1,t} + \delta'\Delta w_t - \sum_{j=1}^{\hat{p}-1}\varphi^* y_{t-j} - \sum_{i=1}^{k}\sum_{j=1}^{\hat{q}-1}\beta_{i,j}{}^*\Delta x_{i,t-1} + u_t \quad (5)$$

In equation (5) error correction term is defined with (6):

$$EC_t = y_t - \sum_{i=1}^{k}\hat{\Theta}_i x_{i,t} - \Psi' w_t \quad (6)$$

In equation (5) and (6) ϕ^*, δ' and $\beta_{i,j}{}^*$ are the coefficients which are related to short-run dynamics of the models' convergence to equilibrium, and $\Phi(1, \hat{p})$ is the speed of adjustment.

In order to setup ARDL model for money demand determination first we have to choose the variables for the model. In previous studies of money demand for Croatia the researchers used monetary aggregate M0 (Babić, 2000), M1 or M1a (Anušić, 1994; Babić, 2000; Erjavec and Cota, 2001; Payne, 2002; Hsing, 2007; Škrabić and Tomić-Plazibat, 2009) as a dependent variable that describes money demand. Explanatory variables that were used in previously mentioned papers are: real GDP (Anušić, 1994; Babić, 2000; Erjavec and Cota, 2001; Hsing, 2007), industrial production index (Anušić, 1994; Payne, 2002; Škrabić and Tomić-Plazibat, 2009), nominal effective exchange rate (Anušić, 1994), real effective exchange rate (Payne, 2002), Kuna/Euro exchange rate (Hsing, 2007; Škrabić and Tomić-Plazibat, 2009), retail consumer price index (Erjavec and Cota, 2001; Payne, 2002; Hsing, 2007; Škrabić and Tomić-Plazibat, 2009), nominal interest rates on short-term deposits in foreign currency (Babić, 2000), foreign interest rate (Hsing, 2007), and nominal interest rates on short-term deposits in Kuna (in all previously mentioned papers).

This selection of variables is based on economic theory. The quantity theory of money developed by the classical economists in the nineteenth and early twentieth century suggests that the demand for money is purely a function of income. They argue that interest rates do not influence the demand for money (Fisher, 2006; Marshall, 1923; Pigou, 1917).

Later Keynes (1936) abandoned the classical view and developed his theory of the demand for money, which he called the liquidity preference theory that emphasized the importance of interest rates. He argues that real money balances are positively related to real income and negatively related to interest rates. This Keynes's conclusion that the demand for money is related not only to income but also to interest rates is a major departure from Fisher's views on money demand, in which interest rates have no effect on the demand for money. Further development of the Keynesian approach (Baumol, 1952; Tobin 1956) strived to give a more precise explanation of Keynes' transactions, the precautionary and speculative motive for money demand.

In 1956 Friedman (1956) developed a theory of the demand for money in which he stated that the demand for money must be influenced by the same factors that influence the demand for any asset. That is why it should be a function of the resources available to individuals (their wealth) and the expected returns on other assets relative to the expected return on money. Friedman expressed his formulation of the demand for money as follows (Mishkin, 2010):

$$\frac{M^d}{P} = f\big(\underset{+}{Y_p},\ \underset{-}{r_b - r_m},\ \underset{-}{r_e - r_m},\ \underset{-}{\pi^e - r_m}\big) \tag{7}$$

In equation (7) $\frac{M^d}{P}$ is demand for real money balances, Y_p is the present value of expected future income, r_m is expected return on money, r_b is expected return on bonds, r_e is expected return on equity, and finally, π^e is expected inflation rate. The signs below the equation (7) indicate whether the demand for money is positively or negatively related to the terms above.

In this paper the methodology and variable selection is based on work of Payne (2002) that was followed very strictly, but in contrast to that research, this paper offers two models of money demand, one for prerecession period, and one model for recession period, in order to find out whether there are significant differences in money demand determinants before and after Croatia, has entered into the phase of recession. Additionally, this research was conducted on the extended time period (from June 1994 to April 2015).

According to this, the explanatory variables of following models are:

- **Industrial production index (IP) that is used as a proxy of the level of income**. Income increase tends to be associated with the increases in the demand for currency to conduct transactions, so it should have a positive sign in subsequent models. The data resource for this variable is Croatian Bureau of Statistics;

- **Nominal interest rates on short-term deposits in Kuna (IR)**. Lower interest rates reduce the opportunity cost of holding currency and so make it relatively more attractive. It is expected that this variable has a negative sign in subsequent models. The data resource for this variable is Croatian National Bank;

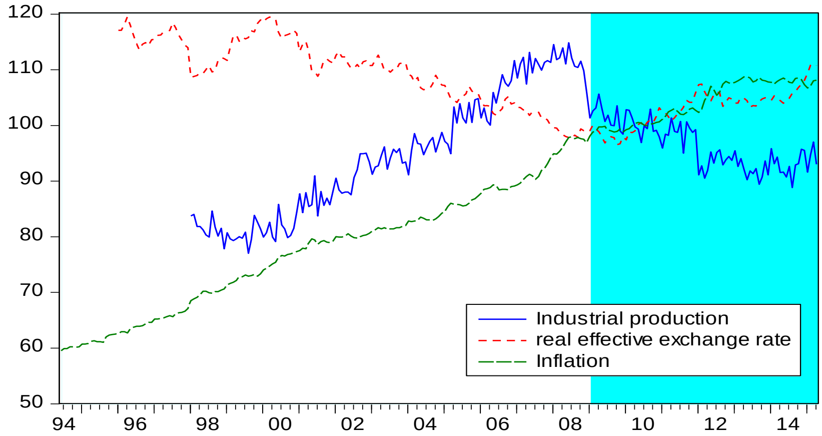
- **Real effective interest rate (REER)**. Namely, the exchange rate could be an important determinant of the demand for money in a small highly euroized economy. If the domestic currency depreciates and there are also general expectations of further depreciation, this could trigger the substitution of domestic currency with a foreign one, and vice-versa. This is why models include (REER) defined as the ratio of the Croatian Kuna relative to foreign currencies. The increase in REER means depreciation of Kuna, and therefore, this variable should have a negative sign. The data resource for this variable is Croatian National Bank;

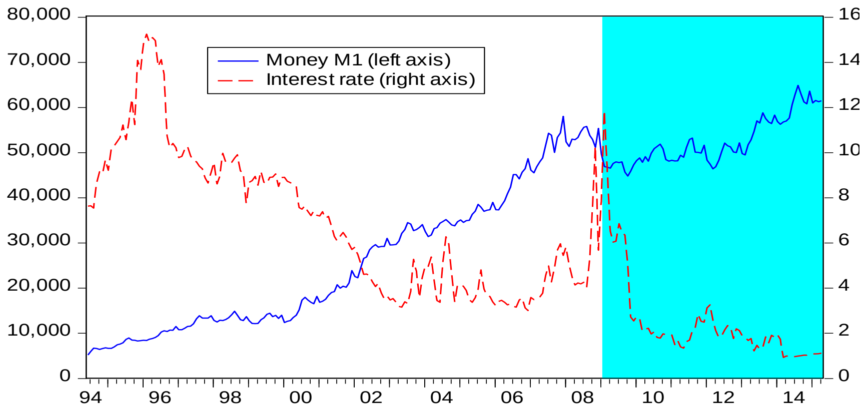
- **Consumer price index (CPI) as a proxy for inflation**. Inflation should have a negative impact on money demand because it also represents the opportunity cost of holding money. This means that theory predicts the negative sign for this variable. The data resource for this variable is Croatian Bureau of Statistics.

Figure 1 shows the movement of chosen variables in levels for the period from June 1994 to April 2015. Shaded area represents the period of recession in Croatia.

Figure 1

Movement of Industrial production, Real effective exchange rate, Inflation, Money M1, Interest rates





4. Empirical results

Following Pesaran et al. (2001) and Bahmani-Oskooee (2004), the error correction representation of the ARDL model is:

$$\Delta L\_M_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1,i} \Delta L\_M_{t-i} + \sum_{i=1}^{n} \alpha_{2,i} \Delta L\_IP_{t-i} + \sum_{i=1}^{n} \alpha_{3,i} \Delta L\_IR_{t-i} + \sum_{i=1}^{n} \alpha_{4,i} \Delta L\_REER_{t-i} + \sum_{i=1}^{n} \alpha_{5,i} \Delta L\_CPI_{t-i} + \delta_1 L\_M_{t-1} + \delta_2 L\_IP_{t-1} + \delta_3 L\_IR_{t-1} + \delta_4 L\_REER_{t-1} + \delta_5 L\_CPI_{t-1} \quad (8)$$

In equation (8) Δ is the first-difference operator, and L_ denotes the natural logarithm. All variables represent monthly values that are seasonally adjusted. Money demand (M) is presented by money aggregate M1. Other variables (Industrial production (IP), Interest rates (IP), Real effective exchange rate (REER) and Inflation (CPI)) were explained and discussed previously.

The parameters δ_j, j=1,…,5 are the long-run multipliers, while the parameters $\alpha_{i,j}$, i=1…n, j=1,…,5 are the short-run dynamic coefficients of the underlying ARDL model. First we need to estimate (8) to conduct the usual F-statistic for testing the null hypothesis (of no cointegration) defined by H0: $\delta_1= \delta_2= \delta_3= \delta_4= \delta_5=0$. The calculated F-statistic is compared with the critical value proposed by Pesaran et al. (2001) which are calculated for different regressors under the condition of an intercept and/or a trend. According to Bahmani-Oskooee (2004), these critical values include an upper and a lower bound, covering all possible classifications of the variable into I(1), I(0) or even fractionally integrated. If the F-statistic is above an upper bound, the null hypothesis of no long-run relationship can be rejected. If the computed F-statistic is below the lower bound, then the null hypothesis cannot be rejected. However, if it falls in between the lower and upper critical values, the result is inconclusive.

Based on the results of Akaike information criterion and Schwarz (Bayes) criterion (SC) and taking the care not to over-select the number of lags and paying the attention to the significance of the coefficients in the model, one lag was chosen for the model (8).

The Wald test coefficient restrictions, i.e. H0: $\delta_1= \delta_2= \delta_3= \delta_4= \delta_5=0$, was conducted using whole sample, and for each period separately. The results of F tests are presented in Table 1.

Table 1

Wald test coefficient restrictions

Period	F-statistic	Critical value 5%		Critical value 10%	
Whole sample	4.296**	2.62	3.79	2.26	3.35
1994m6-2008m12	3.572*	2.62	3.79	2.26	3.35
2009m1-2015m4 (recession)	4.112**	2.62	3.79	2.26	3.35

*Notes: Critical values were obtained from Table CI(iii) Case III: unrestricted intercept and no trend for k=5 (Pesaran et al. 2001, p 300); * - denotes significance at the 10% level; ** - denotes significance at the 5% level*
Source: Authors' calculation

The results show that the hypothesis of no long-run relationship can be rejected regardless if the test has been conducted for the pre-recession period, or for the recession period, or if it has been conducted using whole available data, with the significance level of 10%. Based on 5% significance level, this conclusion stands only for a test of the whole sample, and for the recession period. For the pre-recession period, according to Pesaran et al. (2001) the result test is inconclusive (F statistic falls between the lower and upper critical value).

Based on the obtained results it can be concluded that there is the long-run relationship between the variables. This is according to the results of Payne (2001) and this means that we can proceed to the next step of the estimation process.

Two parsimonious ARDL-ECM models for two separate sample periods are set up with lag selection based on the Akaike information criterion (AIC) and Swartz criterion (SC). The estimation results are presented in Table 2:

Model 1 for sample period from 1994m6 to 2008m12

$$\Delta L\_M_t = \beta_0 + \beta_1 \Delta L\_IP_t + \beta_2 \Delta L\_IR_t + \beta_3 \Delta L\_IR_{t-1} + \beta_4 \Delta L\_REER_t + \beta_5 \Delta L\_CPI_t + \beta_6 EC_{t-1} + e_t \quad (9)$$

Model 2 for sample period from 2009m1 to 2015m4

$$\Delta L\_M_t = \beta_0 + \beta_1 \Delta L\_IP_t + \beta_2 \Delta L\_IP_{t-1} + +\beta_3 \Delta L\_IR_t + \beta_4 \Delta L\_REER_t + \beta_5 \Delta L\_CPI_t + \beta_6 EC_{t-1} + e_t \quad (10)$$

Table 2

Error correction models for period from June 1994 to December 2008 (Model 1) and for period from January 2009 to April 2015 (Model 2)

Variable	Model 1 (1994m6-2008m12) Dependent variable ΔL_M	Model 2 (2009m1-2015m4) Dependent variable ΔL_M
C	0.010749*** (4.204749)	0.005677** (2.085527)
$\Delta(L\_IP)_t$	-0.017485 (-0.231463)	0.214059** (2.287853)
$\Delta(L\_IP)_{t-1}$		0.162529* (1.741397)
$\Delta(L\_IR)_t$	-0.047271** (-2.566837)	-0.010584 (-0.714458)
$\Delta(L\_IR)_{t-1}$	-0.041300** (-1.996941)	
$\Delta(L\_REER)_t$	-0.883990*** (-3.033984)	-0.598140 (-1.576784)
$\Delta(L\_CPI)_t$	-0.382107* (-0.656333)	-1.615434** (-2.209771)
EC_{t-1}	-0.084377*** (-2.957999)	-0.119272*** (-2.843108)
Observations	131	76
Adjusted R-squared	0.2532	0.3547
Serial correlation LM test (lag 2)	F=0,135; Prob. F(2,67)=0,874	F=0,149; Prob. F(2,122)=0,700
Heteroskedasticity test: White	F=0,516; Prob. F(27,103)=0,975	F=1,003; Prob. F(27,48)=0,4834

*Notes: * denotes significance at the level of 10%; ** denotes significance at the level of 5%; *** denotes significance at the level of 1%; t statistics are in parentheses*
Source: Authors' calculation

For these models, several validity tests were conducted. Serial correlation LM test suggests that we cannot reject the null of no serial correlation. White's heteroskedasticity test (White, 1980) tests a null hypothesis of no heteroskedasticity against heteroskedasticity of unknown general form. The test results suggest that we cannot reject the null hypothesis. In order to test whether these models have stability, the CUSUM and CUSUM of squares were performed.

The CUSUM test (Brown, et al., 1975) is based on the cumulative sum of the recursive residuals. This option plots the cumulative sum together with the 5% critical lines. The test finds parameter instability if the cumulative sum goes outside the area between the two critical lines. The CUSUM test is based on the statistic:

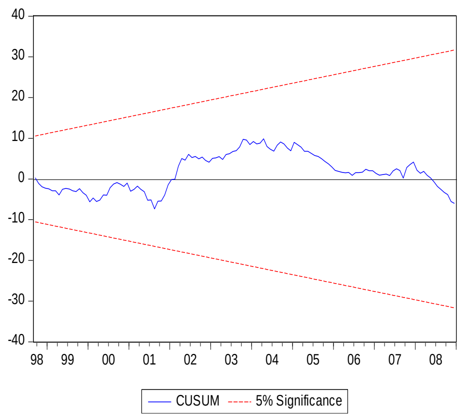
$$W_t = \sum_{r=k+1}^{t} \frac{w_r}{s} \tag{11}$$

for t=k+1,…,T, where *w* is the recursive residual, and *s* is the standard deviation of the recursive residuals w_t. If the β vector remains constant from period to period, $E(W_t)=0$, but if β changes, W_t will tend to diverge from the zero mean value line. The significance of any departure from the zero line is assessed by reference to a pair of 5% significance lines, the distance between which increases with t. Movement of outside the critical lines is suggestive of coefficient instability. The CUSUM test results are given below:

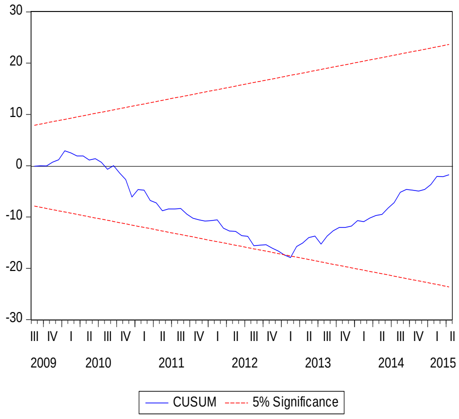
Figure 2

CUSUM tests

CUSUM test for model 1



CUSUM test for model 2



Source: Authors' calculation

The CUSUM test for model 1 clearly indicates stability in the equation during the whole sample period, while the CUSUM test for model 2 shows adequate stability in the equation. This test reveals stability during the whole sample period except for 2013M02.

The CUSUM of squares test (Brown, et.al, 1975) is based on the test statistic:

$$S_t = \frac{\sum_{r=k+1}^{t} w_r^2}{\sum_{r=k+1}^{T} w_r^2} \tag{12}$$

The expected value of S_t under the hypothesis of parameter constancy is:

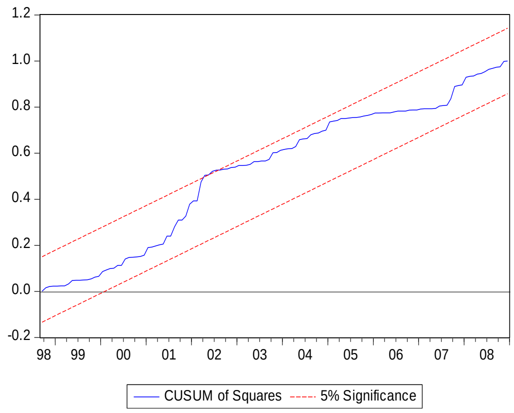
$$E(S_t) = \frac{(t-k)}{(T-k)} \tag{13}$$

which goes from zero at t=k to unity at t=T. The significance of the departure of S from its expected value is assessed by reference to a pair of parallel straight lines around the expected value. The CUSUM of squares test provides a plot of S_t against t, and the pair of 5 percent critical lines. As with the CUSUM test, movement outside the critical lines is suggestive of the parameter or variance instability. Now follows the results of CUSUM of squares test for both models:

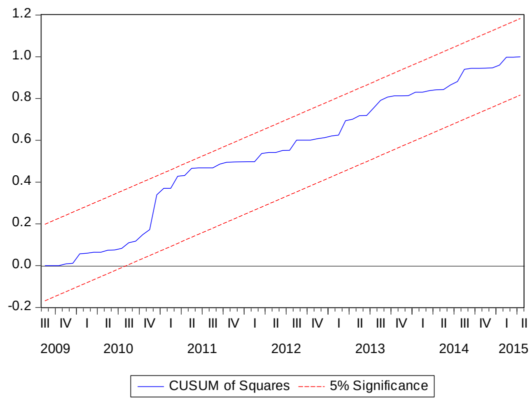
Figure 3

CUSUM of squares tests

CUSUM of squares tests for model 1



CUSUM of squares tests for model 2



Source: Authors' calculation

The cumulative sum of squares for model 1 is generally within the 5% significance lines, except for short period 2002m4-2002m6 suggesting that the residual variance is relatively stable. The cumulative sum of squares for model 2 indicates the residual variance stability for a whole sample period. After these tests, we can draw a general conclusion that the both models are stable and statistically adequate.

The empirical results show that the variable IP in model 1 has a negative sign which is not according to the theoretical expectations. However, in this model this variable is not statistically significant. In model 2, IP variable has a positive sign, and it is significant (at 5% level) as well as its lag 1 (at 10% level). A positive sign means that a higher level of economic activity increases the level of demand for money.

Variable IR has a negative sign in both models, and it is significant in model 1 with a significance level of 5%, while in the model 2 it has been shown as not significant. The negative sign is according to the theory because interest rate could be considered as an opportunity cost of holding money. During financial crisis, it seems that the public holds this cost as no more important.

Regarding the REER, the negative sign of this variable is in line with theoretical expectations with a significance level of 1% in the first model, and in the second model this variable is not significant. The result of model 1 is in line with Payne (2002), and the result of model 2 suggests that the statistical linkages between REER and money demand for the period of crises were broken.

In both models the CPI variable is significant (at 1% level) and has a negative sign, which means that a higher level of inflation has a negative impact on the demand for money. This is also consistent with the theory.

Finally, residual EC has a negative sign and is highly significant in both models indicating the existence of a long-run relationship. This variable also presents the speed of adjustment to long-run equilibrium. The whole system comes back to long-run equilibrium at the speed of 8.44% within one month in the period from 1994m4 to 2008m12 and in the period from 2009m1 to 2015m4 the whole system comes back to long-run equilibrium at the speed of 11.93% within one month.

If we compare the results of model 1 with the results that are presented in Payne (2002), the similarity of the signs and the significance of the parameters can be noticed. However, if we compare the results of model 1 with the results of model 2 it can be concluded that there is a substantial difference in the determinants of money demand in a period of recession compared with the period of growth. In the interval before the recession, IP is not a significant determinant of demand for money, and in the interval of the recession it becomes significant. Variables such as interest rate and real effective exchange rate ceased to be statistically significant in a period of recession. These results could be useful for monetary authorities in a process of decision making because their policies should take into the consideration the changes in the determinants of money demand under the various conditions.

5. Conclusions

This study provides additional evidence of changes in money demand function as a consequence of different economic circumstances. There are many papers that try to capture this phenomenon (Dreger and Wolters (2011), Kapounek (2011), Atkins (2005), Slavova (2003) and Carstensen (2006), etc.), but none of them were conducted in the case of Croatia. Unfortunately, since January 2009 Croatia has experienced a long lasting period of recession, but exactly that made it very suitable for this research. Money demand determinants for Croatia have been previously studied by Anušić (1994), Babić (2000), Erjavec and Cota (2001), Payne (2002), Hsing (2007), Škrabić and Tomić-Plazibat (2009), and all of these researches were conducted using the pre-recession data.

The goal of this paper was to establish two models, one model for a period of growth (1994m6-2008m12) and one model for a period of recession (2009m1-2015m4) in order to compare the results of the first model with the results of previous researches, and to compare the models between them. This paper was based on error correction model (ECM) and autoregressive distributed lag (ARDL) methodology proposed by Pesaran et al. (2001), while the variables selection was based on work of Payne (2002). The chosen methodology has advantages over conventional cointegration testing because it is more statistically significant in small samples, it can be applied whether the regressors are I(1) and/or I(0), and the decision about the number of endogenous and exogenous variables that are to be included, how to treat the deterministic elements, and the decision about the optimal number of lag is not so crucial.

The bounds testing reveal that there is the long-run relationship among the chosen variables. Furthermore, variables interest rates (IP), real effective exchange rate (REER) and inflation (CPI) have the same sign as the theory suggests, and they are significant in model 1. Variable industrial production (IP) in model 1 is not significant which is in line with results presented in Payne (2002). In model 2 only industrial production (IP) and inflation (CPI) have been found statistically significant with the adequate sign. In both models, the constant term (C), as well as error correction term (EC) have been also found significant. The whole system comes back to long-run equilibrium at the speed of 8.44% within one month in the period from 1994m4 to 2008m12, and in the period from 2009m1 to 2015m4 the whole system comes back to long-run equilibrium at the speed of 11.93% within one month.

The comparison of the results of model 1 with the results of model 2 reveals the substantial differences in the determinants of money demand. There may be areas for further research. Using the same data sets based on different methodology or different variables, other models could be estimated. The additional comparison of the empirical results could be useful in order to draw the stronger scientific conclusions about the money demand determination under different economic circumstances.

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