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THE STABILITY OF MONEY DEMAND IN CROATIA IN POSTSTABILIZATION PERIOD

Autori u članku procjenjuju funkciju potražnje za novcem u Hrvatskoj za novčane agregate M1 i M1a unutar vektorske autoregresije. Potražnja za novčanim saldom se povećala nakon uvođenja antiinflacijskog stabilizacijskog programa godine 1993. Monetarnu politiku je ograničila liberalizacija deviznog tržišta i deviznog tečaja, očekivana inflacija je bila smanjena, a kućanstva su zamijenila ukinutu deviznu štednju domaćom valutom. Rezultat toga je bio promjena u potražnji za novcem.

Introduction

Analysing demand for money in Croatia is important for several reasons:

(a) The money demand function in Croatia will be estimated for two monetary aggregates within small vector autoregression (VAR)[1]. That means that we take in account simultaneity of the included variables to ensure efficient estimation of the long-run coefficients of the model.

(b) Demand for money balances was increased after introducing anti-inflation stabilization program on October 4, 1993 by the Croatian government. Namely, monetary policy was restrictive with liberalization of foreign exchange market and exhange rate. Expected inflation was reduced (with appreciation of the nominal and real exhange rate). Housholds replaced their foreign exchange savings with domestic currency and the result was change in the money demand.

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[1]Analysing monetary aggregate M4 does not lead to sensible outcomes. Diagnostic statistics of the chosen model are very poor and not acceptable. That is why we exclude that aggregate from the analysis. We hope that longer available data series might improve the analysis.

(c) It is interesting to look in detail at the stability of the money demand function in a small country which is, and will be, mostly dependent on European monetary union. Some papers show that European money demand function has greater stability compared to most estimates on national level (see Artis et al. 1993, Hayo, 1999).

The goal of this paper is to provide estimates of real money demand over poststabilization period. This is not a complement to the previous work on estimation of the demand for real money balances in Croatia (Anušić 1994; Anušić et.al. 1995, Babić, 1998, Payne, 2000) because we undertake more advanced econometric approach i.e. cointegration methodology. This paper can be viewed as some kind of further research and a complement to the estimation transactory demand for money (Babić, 2000).

Data and Methodology

As a data base we used monthly data series from 1994(10) to 2000(8).[2]

The empirical analysis is presented in two parts. The first presents the estimation of the long-run equilibrium of the variables, the cointegratin vectors. In the second part this information is included into a model of a short run dynamics as an error correction term.

A number of alternative ways to analyse integration and cointegration of time series as well as to estimate the cointegrating vectors have been proposed, (Maddala and Kim, 1998, Harris, 1995 etc.). We employed Johansen's reduced-rank procedure, (Johansen, 1988, and Johansen and Juselius, 1990).

The dependent variable is an actual monetary aggregate. A model explaining actual money can be interpreted as a demand for money if the quantity movements on the money market are exclusively due to changes in money supply.

The money demand relationship is specified in the standard way, with a scale variable and a proxy to capture the opportunity costs of holding money. The variables employed in this study are:

M1 - cash outside banks, deposits with central bank by other banking institutions, and other domestic sectors as well as deposit money banks' demand deposit in millions of kunas;

M1a - M1 plus demand deposits of central government and funds with deposit money banks in millions of kunas;

[2] Because of the low quality of the data, the inclusion of the data before that period does not improve the analysis.

M4 - M1 plus savings and time deposits, foreign currency deposits as well as bonds and money market instruments;
CPI- retail price index, base 1998=100;
GDP- collected revenues of the economy as a whole and
INT- deposit money banks' interest rates on deposit in kunas, average.[3]

Money and income variables are in logarithms. All variables are seasonally unadjusted. In a view of the theoretical and empirical evidence we estimated the demand for real money; i.e. we imposed price homogeneity. The results of money demand studies are robust with respect to the choice of the deflator so CPI has been chosen as a deflator for the income and money variables.

Before testing for cointegration, the order of integration of the individual time-series must be determined. Tests for unit roots were performed on all of the data using ADF test (Dickey-Fuller, 1979) and KPSS test (Kwiatkowski, Phillips, Schmidt and Shin 1992). The difference between these two tests is in the formulation of the null hypothesis. ADF test has a nonstationarity as a null hypothesis i.e. the null hypothesis is that the variable under investigation has a unit root. On the other hand, in the KPSS test we assume that the variable is stationary. It has been suggested (KPSS, 1992) that the tests using stationarity as a null can be used for confirmatory analysis, i.e. to confirm our conclusion about unit root tests. If both tests fail to reject the respective nulls or both reject the respective nulls, we do have a confirmation[4]. The resultes[5] are reported in Table 1. The variables used in this study are given in the first column of Table 1. The top part of table reports tests of stationarity of the log-levels[6] of the variables and the bottom half of their first differences. Columns two and three contain test values for ADF tests with the information about use of a constant term or a deterministic trend. The strategy of adding lags to the ADF regression is based on the objective to remove any autocorrelation from the residuals, which is tested applying Lagrange Multiplier test.

[3] Collected revenues of the economy as a whole is proxy for gross domestic product on a monthly bases. Data on gross domestic product can be obtained only as a quarterly and annual estimations. Retail price index is a measure of changes in retail prices of goods and services and it is used as a measure of inflation.

[4] The situation is similar to the tests of nontested hypotheses.

[5] All empirical work was performed with RATS and CATS statistical packages of Doan (1992).

[6] Letter L denotes log-transformation.

Table 1

VARIABLES AND UNIT ROOT TESTS

(a) Lavels

Variable	ADF value Constant included	ADF value Constant and trend included	KPSS value H_0 stationary around a level	KPSS value H_0 trend stationary
LM1	-1,6262(13)	-2,3141(12)	0,51822*	0,16580*
LM1a	-1,5218(13)	-2,5722(13)	0,51627*	0,15585*
LGDP	-2,0451(3)	-2,3695(15)	0,79601**	0,08888
INT	-0,6199(0)	-2,0613(0)	4,01508**	0,34440**
LCPI	1,3650(0)	-2,1577(0)	7,02585**	0,96301**

(b) First Differences

First diff.	ADF value Constant included	ADF value Constant and trend included	KPPS value H_0 stationary around a level	KPPS value H_0 trend stationary
ΔLM1	-7,1740** (1)	-2,9264(4)	0,34082	0,13515
ΔLM1a	-1,0718(12)	-7,0922** (1)	0,33770	0,13385
ΔLGDP	-31,1538**(0)	-3,3002(5)	0,29234	0,13666
ΔINT	-22,2780** (0)	-21,8332** (0)	0,43038	0,16079
ΔLCPI	-932,6942** (0)	-919,9228** (0)	0,32702	0,13230

Notes: Δ is the first difference operator. One (two) asterisk(s) indicates a rejection of the Null at 5% (1%) significance level. The critical values for ADF test are taken from Hamilton (1994) and for KPSS test from KPSS (1992).

The appropriate number of lagged differences is determined by adding lags until a LM test fails to reject no serial correlation of order 12 at 5% level. In square brackets after the test values, the length of included lags is given. In the fourth column the KPSS test values, testing stationarity around level are given and in the fifth KPSS test values testing trend stationarity of the variables.

As can be seen from Table 1, variables appear to be integrated of order one, i.e. being I(1), although some of the results are sensitive to the number of included lags. Generally the resultes of KPSS tests confirm the resultes of ADF tests. So in the remainder of this study all variables are treated as being I(1).

In this paper we analysed a simple model of a demand for money. The general theoretical long-run relationship is specified as (Hayo, 2000):

$$\left(\frac{M}{P}\right)_t = \left(\frac{GDP}{P}\right)_t^{\beta 11} \exp(\beta_{12} INT_t) \qquad (1)$$

Including variable ΔLCPI, i.e. inflation rate, as additional opportunity cost variable into the cointegrating vector did not lead to sensible outcomes. It is obvious because of relatively stable price level over the post-stabilization period. But it does appear to play a role in the short-run dynamics of M1a. Since we use real variables in the model, inflation should not affect money demand in a perfect world. However rigidities in the real world means that the inflation rate may help us to explain money growth.[7]

Because our primar interest was to study short- and long- term stability of the money demand function we did not include additional variables in the model, like other interest rates.[8]

The empirical estimates for the monetary aggregates are given in the next section. First we analyse the money demand function for M1.

Modeling the Demand for M1

The cointegration analysis starts with the following unrestricted VAR model:

$$\Delta Z_t = \sum_{i=1}^{k-1} \Gamma_i \Delta Z_{t-1} + \alpha\beta' Z_{t-1} + \Psi D_t + u_t \qquad (2)$$

where: $Z_t = (LM1, LGDP, INT)'$, Ψ and Γ_i are matrices of parameters. β is 3 by r matrix of cointegration vectors, α is 3 by r matrix of the respective loadings of cointegrating vectors. r is a number of cointegrating vectors of the system, D_t is a vector of non-stochastic variables: seasonals, constant and dummy variables. u_t is a vector of residuals of the system and k is a lag length of the VAR model.

A descriptive analysis of the variable INT shows that there is a shift in the series taken place from 1996(6) to 1996(12). This property can be explained by rehabilitation of the two largest regional banks (Riječka banka and Splitska ban-

[7] Inflation may be a proxy for the yield of real assets. So changes in real assets will influence the decision to hold money if real assets are important in investor's portfolios. M1a contains money components that are more subject to portfolio decision.

[8] If we were interested to maximize the fit of the model, we should have included additional variables.

ka) so we included a step dummy variable D6a12y96 in the system[9]. During analysed period there were also some events that might affect the relationship between real money and real income in the Republic of Croatia. Introducing the Value Added Taxes (VAT) at the beginning of 1998 and police and military actions during the war appear to have caused structural breaks in the series. So we additionaly added dummy variables PDV, TB and "Oluja" to neutralise those effects[10].

In Table 2 we present the results of estimating and testing for the number of cointegrating vectors using a VAR containing four lags of the variable in lavels.

For the Johansen procedure, there are two test statististics for the number of cointegrating vectors: the trace (λ_{trace}) and the maximum value statististics, (λ_{max}). In the trace test, the null hypothesis is that the number of cointegrating vectors is less than or equal to r, where $r = 0$ to 3. In each case the null hypothesisis is tested againest the general alternative. The maximum eigenvalue test is similar, except that alternative hypothesis is explicit. The null hypotheisis r=0 is tested against the alternative that r=1, r=1 againest r=2 etc.

Table 2

ESTIMATING AND TESTING THE COINTEGRATING VECTORS FOR LM1

H_0: r =	p-r	λ_{max}	λ_{trace}	λ
0	3	36,14**	49,34**	0,4169
1	2	12,92	13,20	0,1753
2	1	0,28	0,28	0,0042

BETA (transposed)

LM1	LGDP	INT	CONSTANT
1.000	-0.792	0.009	-5.981

Loading of $\hat{\alpha}_{11}$ = -0,129

Note: '**' Indicates a rejection of the Null at 1% and '*' at 5 % significance level. The critical values are taken from Osterwald-Lenum, (1992) and are only indicative because of the dummy variables.

[9] D6a12y96=1 if 1996 (6) ≤ t ≤ 1996 (12), 0 otherwise.

[10] PDV is a dummy variable defined: PDV=1 for t ≤ 1998 (1) and 0 otherwise, which is introduced to neutralize the permenant effects of introducing the VAT in Croatia at the beginning of 1998. TB is a pulse function defined TB=1 if t=1998(1), 0 otherwise added to the system to neutralize the transitory effects of introducing a VAT. "Oluja" is a dummy variable defined OLUJA=1 if 1995 (5) ≤ t ≤ 1995 (8), 0 otherwise to neutralize the effects of police and military actions "Bljesak" and "Oluja".

From the resultes in Table 2 we can conclude that there exists one significant cointegrating vector, $\hat{\beta}_1$. The relevant adjustement parameter of the loading vector $\hat{\alpha}_{11}$ is not small, (-0.129). This implies that a deviation from the long-run equilibrium exert pressure on money growth. The diagnostic statistics of this estimate do not indicate any statistical problems. Residual analysis of the whole system as well as of the each variable included in the system is also acceptable[11].

The income elasticity of money demand as estimated by $\hat{\beta}_1$ vector is nearly one. On the other hand, the interest rate enters the cointegration relationship with a theoreticaly consistent sign and its apsolute effect is small. Using our findings of one cointegrating vector, we computed an appropriate LR- test for testing the restriction that the income elastisity is unity and the interest rate semi-elasticity is zero. The obtained resultes are presented in Table 3.

Table 3

TESTING RESTRICTIONS ON COINTEGRATING AND ADJUSTMENT VECTORS FOR LM1

Restrictions on $\hat{\beta}_1$'	$\hat{\beta}_1' = (1,-1,0)$	$\hat{\beta}_1'=(1,-1,0)$	$\hat{\beta}_1'=(1,-1,0)$	$\hat{\beta}_1'=(1,-1,0)$
Restrictions on $\hat{\alpha}$	$\hat{\alpha}_1$ unrestricted	$\hat{\alpha}_1 =(u,0,0)$	$\hat{\alpha}_1 =(u,u,0)$	$\hat{\alpha}_1 =(u,0,u)$
Test statistics	$\chi^2 (2) = 0,34$	$\chi^2 (4) = 1,34$	$\chi^2 (3) = 0,54$	$\chi^2 (3) = 0,98$
p-value	0,84	0,86	0,91	0,81

The resulting restricted estimate of the long-run relationship can be called a classical version of money demand, as it is computed with constraints $\beta_{11} = 1$ and β_{12} imposed on the equation (1). Moreover, additional tests (not included here) show that dummy variables included in the cointegration space are not significant. We continue by keeping these restriction on the cointegrating vector and test for weak exogeneity of the adjusting parameters associated with the income and interest rate variable.

[11] We reject the hypothesis of the autocorrelation of residuals, for each variable and for a whole system, but there is a violation of the assumption of normality. We believe that it is due to INT variable. Following Johansen and Juselius (1992), non-normality in the individual variable is not such a problem, because if that variable prove to be weakly exogenous, in further analysis we can condition on it (although it remains in a long-run model) and therefore improve the stochastic properties of the model. This agrees with our results further on.

Performing likelihood ratio tests of the adjustment parameters involving the eigenvalues of the system, we accept the null of weak exogeneity for both GDP and INT jointly (column 3) as well as testing them independently (columns 4 and 5). Accordingly, further on we do not analyse a money demand in a system contest, but through single equation model.

We continue the analysis with imposed restrictions on the weak exogenety of income and interest rate variables with the corresponding error correction term ECMLM1 which is now calculated as:

$$ECMLM1=LM1 - LGDP - 4,990. \quad (3)$$

The next step is to estimate the dynamic error correction model. The money demand equation consists of the first differences of the variable LM1, LGDP, INT and LCPI, cointegrating vector as a lagged error correction term, seasonal dummies and dummy variables[12]. Diagnostic statistics of the model are given in Table 4.

Table 4

RESIDUAL ANALYSIS[13] OF THE FINAL MODEL FOR LM1

TEST FOR AUTOCORRELATION			TEST FOR NORMALITY
L-B(16),	CHISQ(12)=23,035,	p-val = 0.03	CHISQ(2) = 5,168, p-val = 0.08
LM(1),	CHISQ(1)=0.162,	p-val = 0.69	
LM(4),	CHISQ(1)=0.002,	p-val = 0.97	ARCH(4) = 1.924

As it can be seen, the test statistics indicate model adequacy and we can conclude that the final model is statisticaly acceptable. In Table 5 actual estimates of the ΔLM1 equation is pressented which can be interpreted as a dynamic money demand function. As we can see the error correction term has a significant and

[12] Variables LGDP and INT are weakly exogenous and are included in the cointegration space as well as in the short-run dynamics. Variable LCPI is weakly exogenous included in the short-run dynamics but is excluded from the cointegration space. Dummy variables TB and "Oluja" were not significant and were excluded from the further analysis.

[13] L-B is Ljung-Box test for residual autocorrelation based on the estimated auto- and crosscorrelation on the first (T/4) lags, (Ljung and Box, 1978). LM(1) and LM(4) are LM- type tests for the first and the fourth order autocorrelation (Godfrey, 1988). The test for normality is Shenton-Bowman test, (Doornik and Hansen, 1994). ARCH is a test for AutoRegressive Conditional Heteroscedasticity, (Engle, 1982).

negative influence on the growth of real money. Thus we can conclude that it not only has a statistically significant influence but, judging from the parameter size, it is also significant from the economic point of view. The parameter on the error corection term indicates an overall impact of 10,9% adjustment every month.

Table 5

ESTIMATION OF ΔLM1 EQUATION

Variable	Coefficient	"t-value"
$\Delta LM1_{t-2}$	-0,308	-2,658
$\Delta LM1_{t-3}$	-0,297	-2,932
$\Delta LGDP_{t}$	0,097	3,087
ΔINT_{t}	-0,031	-2,669
ΔINT_{t-1}	-0,055	-4,320
ΔINT_{t-3}	-0,064	-4,495
$ECMLM1_{t-1}$	-0,109	-6,264
D6a12y96	-0,040	-3,400
PDV	-0,020	-4,358

The income variable has a positive influence on money growth, which is in accordance with economic theory. While we found that in the long-run money demand appears to be of a classical type in the error correction model there exists a significant negative effect of interest rate changes, in the actual period and with one and three months lag, on money growth. The influence is more pronounced in the period three lags apart from the actual value, almost doubled in size. This shows the importance of opportunity cost effects for the demand for narrow money in the short-run. Apart from some money growth lags we find that dummy variables D6a12y96 and PDV are significant. Because the series are not seasonally adjusted, some seasonal dummies are significant, too.

To check the stability of the final one-equation model and constancy of β we performed a sequence of statistical tests. We chose a sub-sample from 1995(1) to 1999(1) as a base period. When testing the constancy of β, the parameter $\hat{\beta}$ is first calculated for the base period. The constancy of the cointegrating space is then tested using a sequence of tests of the "known vector" β, where the known vector is represented by chosen $\hat{\beta}$, sub-sample estimate have β.

First we perform the Trace test. When analysing the Trace statistic, Figure 1, one would expect the time path of Trace statistic to be upward sloping for $j \leq r$, and constant for $j \leq r$. Since our conditional model has rank 1, we expect the time path of Trace statistic to be upward sloping. Although it seems to be some changes by the end of the series, the general impression is that the time path is indeed upward sloping.

The maximised log-likelihood function, which consists of two factors, is given in Figure 2. The paths of two components look non-constant, but it is mainly due to scaling of the graphs. The path for the log-likelihood value is well inside the 95% confidence bounds for the full sample.

Figure 3 shows tests of the hypothesis that the full sample estimate of β with the over-identifying restrictions imposed is in the space spanned by β in each subsample. The hypothesis is accepted. This supports the hypothesis of parameter constancy for the analysed period.

Figure 4 gives plot of the time path of the non-zero eigenvalue together with the asymptotic 95% error bounds for a sub-sample. As can be seen from Figure 4, the plot does not indicate non-constancy in our model.

Figure 5 presents various plots associated with diagnostic testing of the residuals. There are some evidence to suggest that there is a problem around 2000:6. It is not surprising because central government repayed loans to private sector and deposit money increased. This results with some temporary fluctuations, but not with a permanent structural break.

At the end, we can conclude that the final model is generally satisfactory, being a well interpretable and statistically acceptable money demand function.

Modeling the Demand for M1a

The same modelling procedure is applied to the monetary aggregate M1a. The resultes of the cointegration analysis in a VAR with four lags are given in Table 6.

Table 6.

ESTIMATING AND TESTING THE COINTEGRATING VECTORS FOR LM1a

H_0: r =	p-r	λ_{max}	λ_{trace}	λ
0	3	30,70**	44,47**	0,3676
1	2	13,49	13,77	0,1824
2	1	0,28	0,28	0,0042

BETA (transposed)

LM1	LGDP	INT	CONSTANT
1.000	-0.785	0.002	-5.970

Loading of $\hat{\alpha}_{11}$ = -0.130

Note: '**' indicates a rejection of the Null at 1% and '*' at 5 % significance level. The critical values are taken from Osterwald-Lenum, (1992) and are only indicative because of the dummy variables.

As in the case with money aggregate M1 only one significant vector is found. Compared to narrow money, the estimates of the long-run equilibrium are almost the same. Again the diagnostic tests are acceptable and do not indicate any model non-adequancy. Testing the restrictions on the adjustment and cointegrating vector we obtained the results in Table 7.

Table 7

TESTING RESTRICTIONS ON COINTEGRATING AND ADJUSTMENT VECTORS FOR LM1a

Restrictions on $\hat{\beta}_1$'	$\hat{\beta}_1$' = (1,-1,0)	$\hat{\beta}_1$'=(1,-1,0)	$\hat{\beta}_1$'=(1,-1,0)	$\hat{\beta}_1$'=(1,-1,0)
Restrictions on $\hat{\alpha}_1$	$\hat{\alpha}_1$ unrestricted	$\hat{\alpha}_1 = (u,0,0)$	$\hat{\alpha}_1 = (u,u,0)$	$\hat{\alpha}_1 = (u,0,u)$
Test statistics	χ^2 (2) = 0,46	χ^2 (4) = 1,67	χ^2 (3) = 0,63	χ^2 (3) = 1,31
p-value	0,80	0,80	089	0,73

Because of the weak exogeneity of both GDP and INT we have to specify one-equation model. Moreover, the unity restriction on the income elasticity of money demand as well as interest rate semi-elasticity are accepted again. The followin error correction term will be included in the model when analysing LM1a.

$$ECMLM1a=LM1a - LGDP - 4,946 \quad (4)$$

None of the test statistics, Table 8, indicates a problem and the final model is statistically acceptable.

Table 8

RESIDUAL ANALYSIS OF THE FINAL MODEL FOR LM1a

TEST FOR AUTOCORRELATION			TEST FOR NORMALITY
L-B(16),	CHISQ(12)=17,132,	p-val = 0.14	CHISQ(2) = 1.078, p-val = 0.56
LM(1),	CHISQ(1)=0.028,	p-val = 0.87	
LM(4),	CHISQ(1)=0.098,	p-val = 0.76	ARCH(4) = 6.570

The actual estimates of the ΔLM1a equation is presented in Table 9. Again it can be seen that the income variable has a positive influence on money growth and that influence is a little bit stronger compared to the case of ΔLM1. The interest rate effects are negative and the values are very simmilar to the case of ΔLM1 money aggregate. Error correction term has the expected negative size and is statisticaly significant. The size of the adjustment parameter is now a little bit bigger then in the case of narrow money, so a long-run disequilibrium influence the short-run behaviour of money growth more. Inflation is not present in the model with positive impact on the money. It is represented by ΔLCPI variable. The same dummy variables are significant and their influence, the values of the parameters, are almost the same as in the case of narrow money. Some of the seasonals are significant, too.

Table 9

ESTIMATION OF ΔLM1a EQUATION

Variable	Coefficient	"t-value"
$\Delta LM1a_{t-1}$	-0,237	-2,155
$\Delta LM1a_{t-2}$	-0,423	-3,371
$\Delta LM1a_{t-3}$	-0,267	-2,313
$\Delta LGDP_{t}$	0,115	3,474
ΔINT_{t}	-0,027	-2,176
ΔINT_{t-1}	-0,063	-4,700
ΔINT_{t-3}	-0,062	-4,216
$\Delta LCPI_{t}$	-1,916	-2,413
$ECMLM1_{t-1}$	-0,128	-5,824
D6a12y96	-0,047	-3,778
PDV	-0,024	-4,357

The parameters constancy is tested through the recursive estimation.

Although it seems to be some changes by the end of the series, as in the case of narrow money, the general impression is that time path is upward sloping and within the critical region.

The path of the log-likelihood value is well inside the 95% confidence bounds for the full sample, Figure 7. The test for constancy of the cointegration space, Figure 8, supports the hypothesis of parameter constancy for the analysed period.

The time path of the non-zero eigenvalue is well inside the asymptotic 95% error bounds for a sub-sample, which indicates constancy of the parameters in the partial model.

Apart from the autocorrelation at lag=12, the diagnostic tests of the residuals seem to be generally satisfactory.

Conclusion

The demand for money is treated as demand for real balances. That means that the function is homogenous of degree one in the level of prices. Monetary aggregates M1 and M1a show very similar behaviour during the analysed period.

We found, in accordance with economic theory, stable long-run and short--run money demand functions. Money demand appears to be of a classical type in the long run; dominated by economic transactions. The estimated long-run interest rate elasticity for M1 and M1a is zero and income elasticity is unity.

The corresponding error-correction term is an important explanatory variable in the short-run M1 and M1a demand functions. Therefore a disequlibrium in the long-run relationship makes pressure on real money growth. That lies in a fact that the demand for money is transaction one. In the error correction model there exists a significant and negative effect of interest rate changes on money growth (with one and three months lags). That shows the importance of opportunity cost effects for the demand for narow money and M1a in the short run.

Considering the statistical properties of the estimated models, apart from some outliers located at the end of the series, we found no serious evidence of misspecification. There is the evidence that the D6a12y96 and introducing the Value Added Taxes (VAT) at the beginning of 1998 have statistically significant influence on the short-run money demand functions, although their influence, according to parameter size, is not large. Police and military actions during the war appear not to have any effects.

On the basis of the presented results we can not conclude that monetary policy instruments cause money demand to shift (the parameter values of the corresponding variables are not large), so our opinion is that those instruments have become more market oriented.

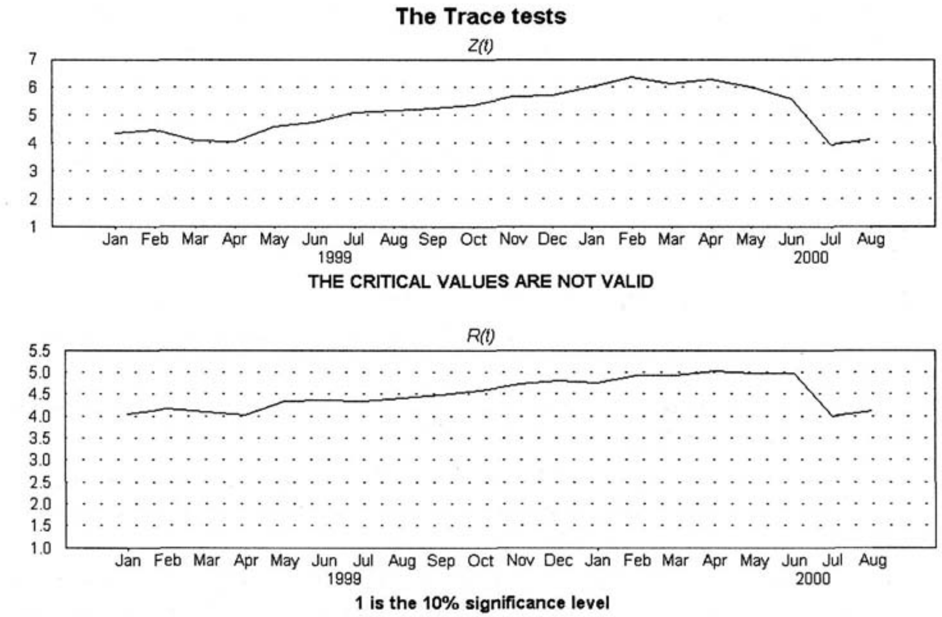
LITERATURA:

1. *Anušić, Z.:* "The Determinants of Money Demand in Croatia and Simulation of Post - Stabilization Period", Croatian Economic Survey, Insitute of Economics, Zagreb and National Bank of Croatia, 1995.
2. *Anušić, Z., Z. Rohatinski and V. Šonje* (eds.): "A Road to Low Inflation: Croatia 1993-1994", The Government of the Republic of Croatia.
3. *Artis, M. J., R. C. Bladen-Hovell and W. Zhang:* "A European Money Demand Function", in P. R. Masson and M. P. Taylor (eds.), "Policy Issues in the Operation of Currency Unions", Cambridge: Cambridge University Press, 1993., str. 240-263.
4. *Babić, A.:* "Stopping Hyperinflation in Croatia 1993-1994", Zagreb Journal of Economics 2(2), 1998., str. 71-114.
5. *Babić, A.:* "The monthly Transaction Money Demand in Croatia", Working Papers, W-5, Croatian National Bank, 2000.
6. Bulletin National Bank of Croatia, various numbers.

7. *Dickey, D. A. and W. A. and Fuller:* "Distributions of the estimators for autoregressive time series with unit root", Journal of the American Statistical Association, 74, 1979., str. 427-431.
8. *Doan, A. T.:* "User's Manual: RATS", Version 4.2., 1992.
9. *Doornik, J. A. and Hansen, H.:* "An omnibus test for univariate and multivariate normality", Working paper, Nuffield Collage, Oxford, 1994.
10. *Engle, R.:* "Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation", Econometrica, 38, 1982., str. 507-516.
11. *Godfrey, L. G.:* "Misspecification tests in econometrics. The Lagrange Multiplier principle and other approaches", Cambridge University Press, 1988.
12. *Hayo, B.:* "The Demand for money in Austria", Empirical Economics, Vol 25 (4), 2000., str. 581-603.
13. *Hayo, B.:* "Estimating a European Demand for Money", Scottish Journal of Political Economy, 46(3), 1999., str. 221-244.
14. *Harris, R. I. D.:* "Using Cointegration Analysis in Econometric Modeling", Prentice Hall, London, 1995.
15. *Hamilton, J. D.:* "Time series analysis, Princeton, 1994.
16. *Ljung and Box, G.:* "On a measure of Lack of Fit in Time Series Models", Biometrika, 65, 1978., str. 297-303.
17. *Johansen, S.:* "Statistical Analysis of Cointegration Vectors, Journal of Economic Dynamics and Control, Vol. 12, 1988., str. 231-54.
18. *Johansen, S. and K. Juselius:* "Maximum likelihood Estimation and Inference on Cointegration - with Application to the Demand for Money", Oxford Bulletin of Economics and Statistic, 52, 1990., str. 211-244.
19. *Kwiatkowski D. , P.C.B. Phillips, P. Schmidt and Y. Shin:* "Testing the Null Hypothesis of Stationary against the Alternative of a Unit Root", Journal of Econometrics, 54, 1992., str. 159-178.
20. *Maddala G. S. and In-Moo Kim:* "Unit Roots, Cointegration and Structural Change", Cambridge University Press, Cambridge, 1998.
21. *Osterwald-Lenum, M.:* "A Not with Fractiles of the Asymptotic Distribution of the Maximum Likelihood Cointegration Rank Test Statistic, Oxford Bulletin of Economics and Statistic, 54, 1992., str. 461-472.
22. *Payne, J. E.:* "Post Stabilization Estimates of Money Demand in Croatia: The role of the Exchange rate and Currency Substitution", Ekonomski pregled, 11-12, 2000., str. 1352-1368.

Figure 1:

Plot of the Trace Statistic[14]



[14] The Trace statistic is scaled by the 90% quantile of the trace distribution derived for a model without exogenous variables or dummies. Asymptotic distribution is different if we are not analysing a standard model, which is the case here, so the lines of critical values are not valid. But our primary interest is in the time path of the statistic and the visual inspection of it is not affected by scaling.

Figure 2:

THE LOG- LIKELIHOOD VALUE

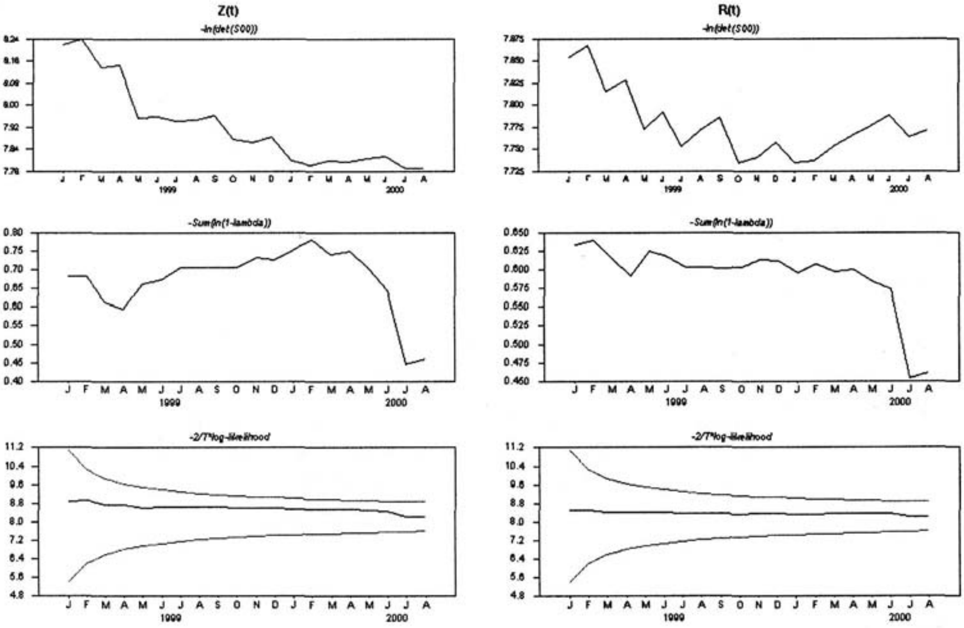


Figure 3:

TEST OF CONSTANCY OF $\hat{\beta}$

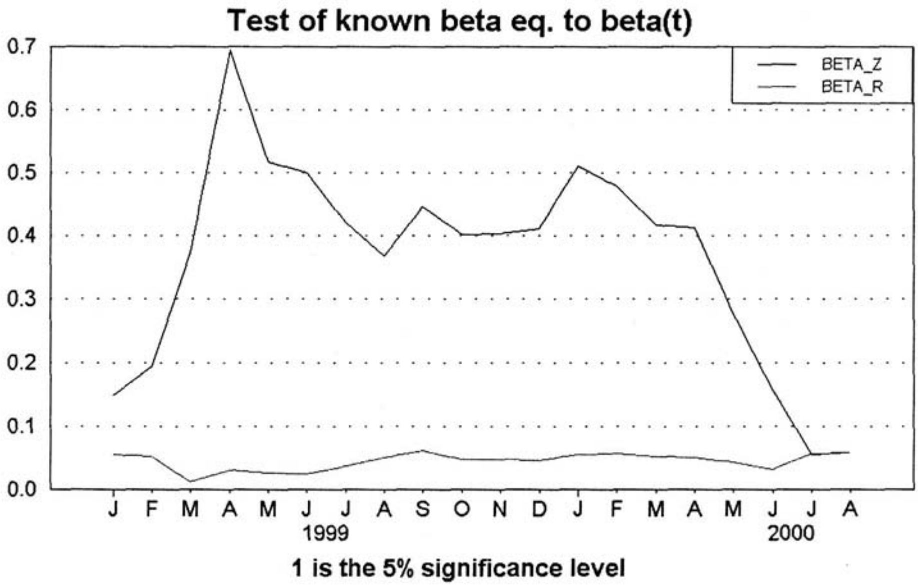


Figure 4:

THE NON-ZERO EIGENVALUE

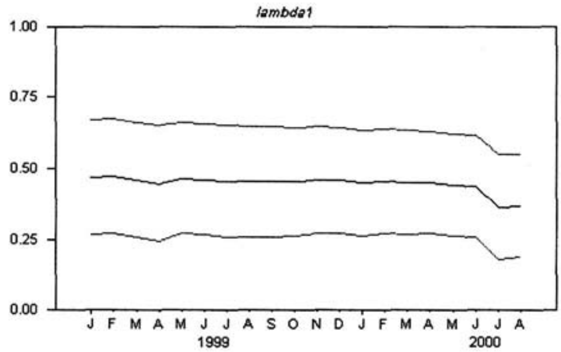


Figure 5:

RESIDUAL ANALYSIS FOR LM1

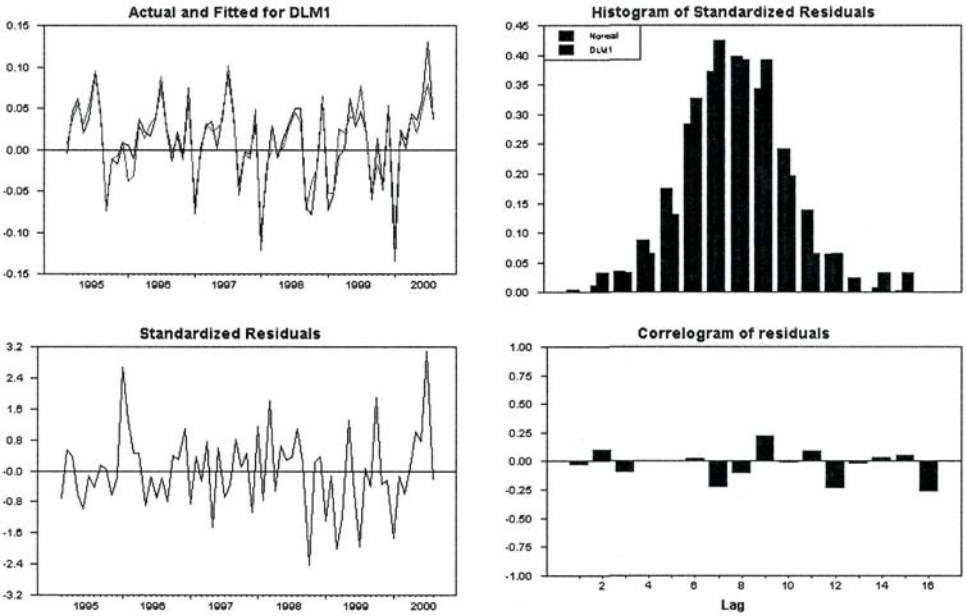
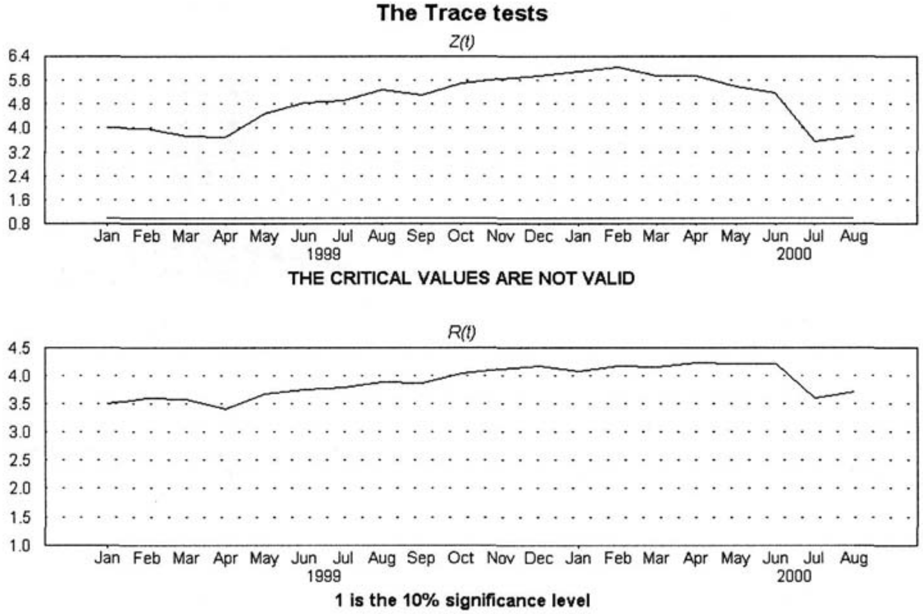


Figure 6:

PLOT OF THE TRACE STATISTIC[15]



[15] The lines of critical values are not valid, because of the dummies included in the model.

Figure 7:

THE LOG- LIKELIHOOD VALUE

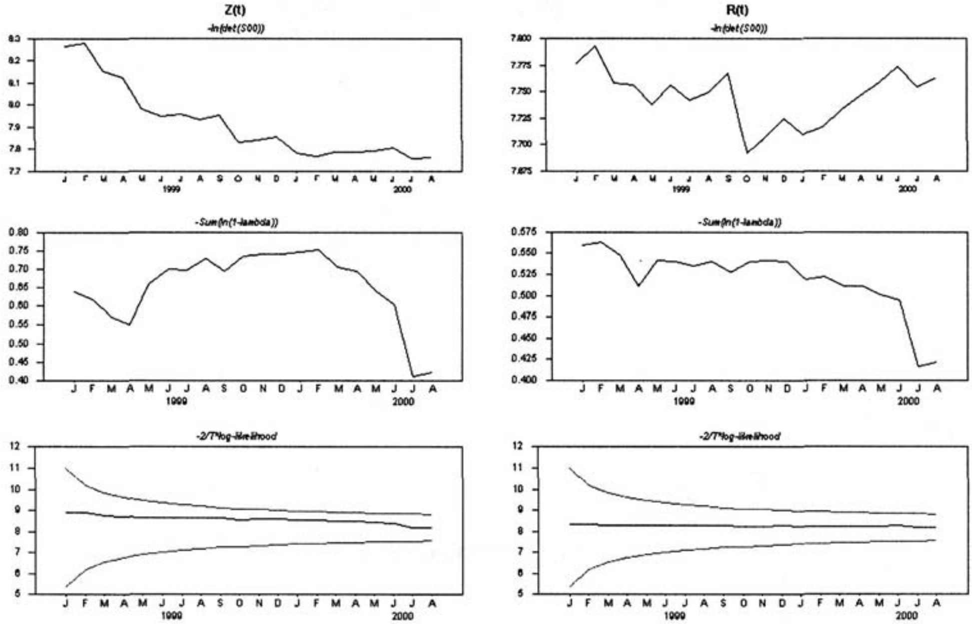


Figure 8:

TEST OF CONSTANCY OF β

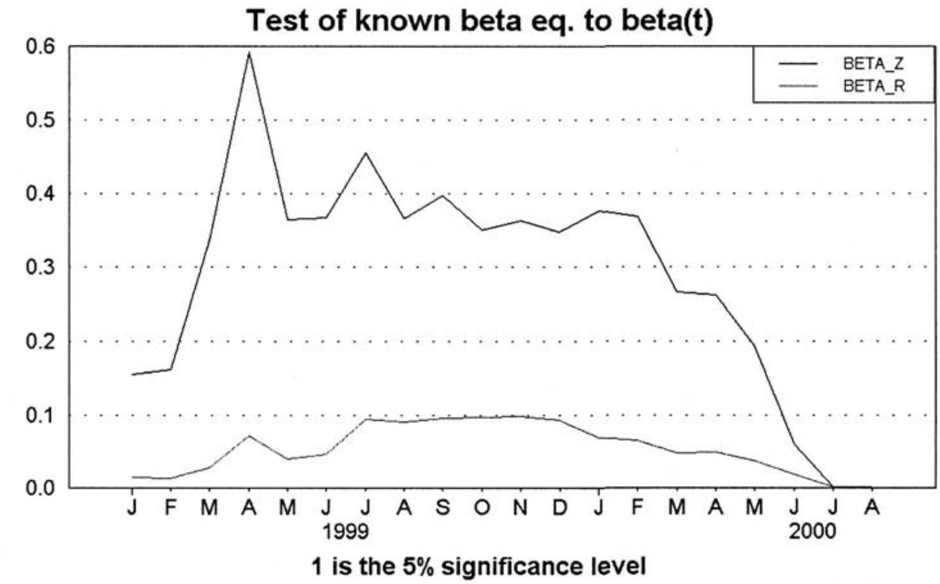


Figure 9:

THE NON-ZERO EIGENVALUE

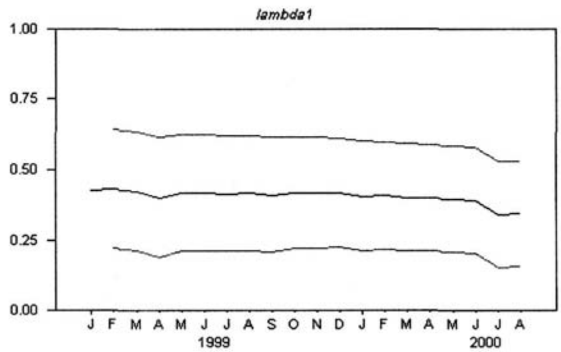
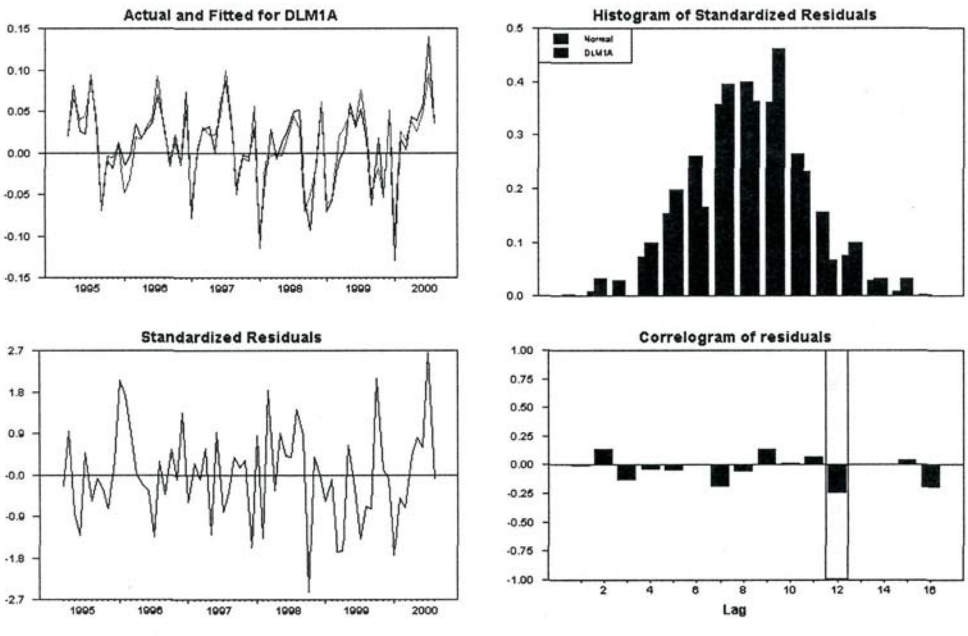


Figure 10:

RESIDUAL ANALYSIS FOR LM1a



STABILNOST POTRAŽNJE ZA NOVCEM U HRVATSKOJ U POSTSTABILIZACIJSKOM RAZDOBLJU

Sažetak

Članak procjenjuje funkciju potražnje za novcem u Hrvatskoj za novčane agregate M1 i Mla unutar vektorske autoregresije. Potražnja za novčanim saldom se povećala nakon uvođenja antiinflacijskog stabilizacijskog programa 4. listopada 1993. Monetarnu politiku je ograničila liberalizacija deviznog tržišta i deviznog tečaja, očekivana inflacija je bila smanjena, a kućanstva su zamijenila ukinutu deviznu štednju domaćom valutom. Rezultat je bio promjena u potražnji za novcem. Monetarni agregati M1 i Mla su slični u analiziranom periodu. Našli smo dugoročne i kratkoročne funkcije potražnje za novcem. Potražnja za novcem se dugoročno pojavljuje u klasičnom obliku u kojem prevladavaju ekonomske transakcije. Procijenjena dugoročna elastičnost kamatne stope za M1 i Mla je nula a elastičnost dobiti je jedinstvenost.

Odgovarajući izraz ispravke greške je važna objasnidbena varijabla u kratkoročnim M1 i Mla funkcijama potražnje. Zbog toga neravnoteža u dugoročnom odnosu stvara pritisak na rast kovanog novca. U modelu ispravke greške postoji značajan i negativan učinak promjena kamatne stope na rast novca. To podrazumijeva važnost učinaka oportunitetnog troška u potražnji ograničenog novca i M1 u kratkom roku.