THE ACADEMY OF ECONOMIC STUDIES

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DERMINANTS OF THE VELOCITY OF MONEY, THE CASE OF ROMANIAN ECONOMY

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Abstract

The paper identifies a number of real and monetary factors on the behavior of money velocity, such as output, deposit rate, exchange rate, spread of commercial banking and the credibility of national currency, during high inflation and stabilization period in Romania. The necessity of such a study emerges from the complexity induced by the instability of money velocity into disinflation efforts of monetary policy. Knowing or even controlling the mechanism that governs velocity could improve the outcome of monetary policy. The determinants of the money velocity are identified in the context of the abolition of the consumption rationalization system, the development of banking system, exchange market liberalization and the improvement of the institutional framework of monetary policy. To examine the extent to which these stylized facts affect the velocity function, the paper develops an econometric analysis on the behavior of money velocity during 1996 – 2002. The paper concludes by assessing prospects for money velocity in Romania, including the likely increases of national currency credibility.

CONTENTS

1. Introduction

The velocity of money and its determinants is a frequently debated subject in the context of monetary policy effects. Despite the numerous studies made about the determinants of the velocity of money, considerable uncertainty remains about the sources of its observed movements.

Several explanations on the behaviour of money velocity are identified with the Milton Friedman's (1956) influential version of the velocity function. He stated that besides classical determinants such as interest rate, equity yields, expected inflation and real production, velocity function also contains a catch-all taste-and-technology variable. The new communication and data process technology, sustained by modern software applications, has facilitated the reshape of the way that traditional operations were realised, and especially the innovation of new products and financial services. Anderson and Rasche (2001), observing the remarkable stability of monetary base velocity in the United States between 1919 and 1991, has assigned the velocity of M2 volatility to the development of payment system and to the diversity of saving alternatives.

Bordo and Jonung (1987, 1990) associated the behaviour of money velocity to institutional factor, which induced the substitution between monetary assets, as macroeconomic objectives required. When the liquidity of the economy increases and the substitution possibilities between different assets diversify, the public decident's confidence in the capacity of the monetary authority to accomplish its objectives plays a key role in the way that the economy develops. For instance, consider that national currency purchasing power reduces more than the targeted level of inflation. Then, the firms and the individuals become more willing to spend much quicker their revenues, buying mostly non-financial assets like consumer durable goods, real estate and jewellery. Another example could be the dolarisation phenomenon, which develops inversely to the opportunity of holding term deposits. The result is an undesirable increase in the velocity of circulation.

A different approach results from the money demand perspective. Barnett and Xu (1998) have associated the money velocity volatility to interest rates fluctuations. Moreover, empirical determination of money demand facilitates the assessment of the money velocity variability induced by its sensitivity to the changes of real production. Thus, the development of commercial trade, the improvement of cash management, the utilisation of barter as a payment instrument or the generalisation of compensatory operations between firms – as factors, which favour production growth – cause a sub-unit increase of transaction money and, consequently, the acceleration of velocity of money.

The paper identifies a number of real and monetary factors on behavior of money velocity, such as output, spread of commercial banking, deposit rate, exchange rate and the confidence in national currency, during high efforts of bringing inflation down in Romania. The study emphasises the role of money velocity in the success of monetary policy program. Here is explained the interaction between the money velocity volatility and the deviation of inflation from its targeted level. The determinants of the velocity of money are identified in the context of the abolition of the consumption rationalization system, the development of banking system, exchange market liberalization and the improvement of the institutional framework of monetary policy.

The rest of the study is organized as follows. The second part discusses the methodological issues. The delimitation of the real causes from the monetary factors and the quantification of the extent of each determinant's influence on the variability of the transaction velocity are realized using the Johansen's cointegration procedure. The analysis is then extended to the level of saving behavior using a dynamic equation for the velocity of circulation. The third part presents the data problems and the econometric estimations. The most important aspects dealt with are pointing out the long-run relationship, the variance decomposition of the transaction velocity and the stability test performed for the coefficients of the exogenous variables included in the velocity of circulation function[1]. The conclusions are specified in the fourth part.

[1]transaction velocity is synonim to velocity of M1, while velocity of circulation is synonim to velocity of M2

2. Methodological Issues

This study identifies a number of real and monetary factors on the behavior of money velocity, such as output, spread of commercial banking, interest rates on deposits, exchange rate and the credibility of national currency, during high efforts of bringing inflation down in Romania. The result of disinflation efforts has been strongly affected by the velocity of circulation volatility, during january 1996 and march 2002.

The delimitation of the real causes from the monetary factors and the quantification of the extent of each determinant's influence on the variability of the transaction velocity the starting point for the analysis of its controllability using monetary instruments. Besides output and technical characteristics of payment system, the development of commercial trade and the accumulation of arrears are real factors of the transaction mechanism. Monetary determinants like deposit and exchange rates models the opportunity of holding money for transactions reasons.

The issue of the velocity of circulation determinants become more complex when we extend the analysis to the saving behavior. The opportunity of holding term deposits and the spread of commercial banking represents the main exogenous monetary variables. A special case is the modification of inflation deviation from its targeted level. This factor could be associated both to monetary and real determinants.

If we assimilate the inflation deviation to the inflation targeting error, then it will be the case of monetary determinants. On the other hand, if we accept the hypothesis that inflation deviation is a leading indicator for inflation expectations, then it will be the case of real factors.

2.1 The role of money velocity in the success of monetary policy program

The dinamic model of inflation deviation from its targeted level is given by the following equation:

$$\begin{aligned} \inf\_deviation\_month_{t,i} = \phi * \inf\_deviation\_month_{t-1,i} + \varphi * velocity\_month_{t,i} + \\ + \gamma * wages_{t-1,i} + \eta * ex\_rate\_month_{t-1,i} + \\ + \lambda * d\_12 + \theta * d97 + c + \varepsilon_{t,i} \end{aligned} \quad (1)$$

Where $inf\_deviation\_month_{t,i}$, $velocity\_month_{t,i}$, $wages_{t,i}$, $ex\_rate\_month_{t,i}$ represents the logarithm of the monthly changes index of inflation deviation, velocity of circulation, average wages and exchange rate during *t* month within year *i*. $\phi, \varphi, \gamma, \eta$ express the elasticities of the inflation deviation changes to the previews variables. The introduction of a dummy variable d_12 is justified by the growth of monetary aggregates in december; *d97* is also a dummy variable, which reflects the prices liberalization in january 1997, and *c* is a constant which express the trend of inflation deviation changes.

The deviation of inflation from its targeted level is equal to the difference between inflation average value for the first *t* month of year *i* on annual basis and the inflation target.

$$inf\_deviation_{t,i} = inf\_annual\_average_{t,i} - target_i$$

Inflation average value for the first *t* month of year *i* on annual basis is computed as follows:

$$inf\_annual\_average_{t,i} = \frac{12}{t} * \sum_{j=1}^{t} (\inf lation_j)$$

where $inflation_j$ represents logarithm value of inflation for *j* month from the first *t* month of the year *i*.

Velocity of circulation estimation as a fix base index is made by adding its monthly logarithm changes, begining with january 1996:

$$velocity\_bf_{t,i} = velocity\_bf_{t-1,i} + velocity\_month_{t,i}$$

Where $velocity\_month_{t,i}$ represent the changes in velocity of circulation for the month *t* of year *i*.

The calculation of the monthly changes of money velocity is performed using the following identity:

$$\ln(\frac{M_t}{M_{t-1}}) + velocity\_month_t = \ln(\frac{P_t}{P_{t-1}}) + \ln(\frac{Y_t}{Y_{t-1}})$$

$$velocity\_month_t = \ln(\frac{P_t}{P_{t-1}}) + \ln(\frac{Y_t}{Y_{t-1}}) - \ln(\frac{M_t}{M_{t-1}})$$

Where:

$Ln(M_t/M_{t-1})$ – express the logarithm value of the money growth;

$Ln(P_t/P_{t-1})$ – represents the logarithm of prices growth into (t-1, t) period;

$Ln(Y_t/Y_{t-1})$ – represents the logarithm of real output growth into (t-1, t) period.

The inclusion of the monthly changes of inflation deviation for the previews period among explainatory variables is justified through the concept of the pesistence of inflation.

Besides the wages dinamics and nominal depreciation, monthly changes of the velocity of circulation represents a significant element of the inflation spillovers. Due to the fact that the most part of the wage from the previews month is spent during the current month, the wage changes are acounted for changes in inflation deviation with one lag. The hypothesis seems to be valid if we keep in sight the low level of the average wage in the economy and the wages payment calendar in Romania. The changes in velocity of circulation influence the inflation deviation changes within the same period. The justification results from the determination between the velocity of circulation acceleration and the transaction growth. In general transaction growth leads to higher inflation. Thus, average

inflation estimated on annual basis increases. As long as the inflation target is not grown, the acceleration of the velocity of circulation causes the inflation deviation growth from its targeted level. Due to high weight of imports in GDP (38,8% - 2000) and to the characteristics of commerce activity the exchange rate changes induce changes in inflation deviation with one month delay.

2.2 The determinants of the velocity of M1

It is considered the following money demand equation:

$$(m_t - p_t) = (m_t^d - p_t) = a + b * y_t - d * dep\_rate_t - g * ex\_rate\_bf_t + u_t \qquad (2)$$

Where *a* is a constant and *m, p, y* and *ex_rate_bf* represents the logarithm value index of transaction money, price level, output and exchange rate; *dep_rate* represents the logarithm of the monthly fructification obtained for 1 unit ROL deposit and *u* is the error term.

Equation (4) shows that transaction money depends positevely of real output and negatively on two opportunity costs of holding money for transactions like exchange and deposit rate. Due to underdeveloped capital market in Romania term deposits and foreign currency are considered alternative portfolio choices.

Equation (5) it can be written as transaction velocity function:

$$vel\_bf_t = (y_t + p_t - m_t) = -a + (1-b)y_t + d * dep\_rate_t + g * ex\_rate\_bf_t + w_t \qquad (3)$$

Where the variables are those of equation (4) and *w* denotes the error term. If transaction money sensitivity to real output is equal to one than the transaction velocity dynamic will depend only of changes in exchange rate and deposit rate.

Johansen's cointegration methodology is used in order to study the long-run evolution of transaction velocity. The analysis goes on with the test for weak exogenity and variance decomposition of transaction velocity.

3.3 The determinants of the velocity of M2

The velocity of circulation is inversely correlated to the confidence in the national currency. The opportunity of holding national currency, the way that the monetary authority achieves its goals and its relevance to the behavior of the economic subjects represent the base of the causality between the instability of the confidence in the national currency and the variability of the velocity of circulation. If there is an inflation target (*target*) and the economic subjects are aware of it, than the monetary credibility is at its highest level when the deviation of the average inflation on annual basis (*inf_annual_average*) from the targeted level is minimum. Moreover, the confidence in the national currency grows as the opportunity cost of holding ROL ($ex\_rate\_month_{t\text{-}1,i} - dep\_rate_{t\text{-}1,i}$) decreases. Due to the negative impact of credit on money demand and to the stimulating effect of deposit rate over the same variable, the spread of the commercial banking affects the dynamics of the velocity of circulation positively.

The dynamic of the velocity of circulation is:

$$velocity\_bf_{t,i} = \alpha * velocity\_bf_{t-1,i} + \beta * \inf\_deviation\_month_{t-2,i} + \delta * oportunity\_cost_{t-1,i} + \mu * spread + \vartheta * d\_12 + \varepsilon_{t,i} \qquad (4)$$

where *velocity_bf, inf_deviation_month, oportunity_cost and spread* represents the logarithm of the velocity of circulation index, monthly changes of inflation deviation, national currency holding opportunity, wages and commrcial banking spread during *t* month within year *i*. $\alpha, \beta, \delta, \mu$ express the elasticites of the inflation deviation changes to the precedent variables. The introduction of a dummy variable d_12 is justified by the growth of monetary aggregates in december.

The velocity of circulation dinamics is characterised by the adaptive behavior of the economic subjects. Due to the fact that the public decident models his expectations with respect to previews observations, the volatility of the velocity of money is influenced by the moment when the public decident percieves the relevant information and by the necessary time to implement his decision.

Changes of inflation deviation determine velocity of circulation dynamics with a lag of two months due to the technical possibilities used to estimate the monthly inflation and to the frequency of revenues payments (at most two times a month). The technical possibilities delays inflation's publication more than a month.

The velocity of circulation evolution is influenced by the opportunity cost of making deposits with a lag of one month. The justification lies on the fact that non-financial agents used to keep one-month deposits and the liquidating cost is not covered by the depreciation.

3. Data and Empirical estimations

3.1 Data issue

The data sample covers the period 1996:01 – 2002:03. The sources of the time series used in estimation are the publications of the National Bank of Romania.

The reason I chose to start with January 1996 is a tradeoff I made between a length samples as long as possible and a quality of information as good as possible provided by the data series. The fact that inflation reached in 1995 the lowest level ever-accomplished in Romanian transition period has played an important role in this decision. This outcome seems to reveal best the highest level of monetary policy credibility. From this point on it will be analyzed the correlation between the velocity of circulation dynamic and the evolution of the confidence in national currency.

Necessary data availability and its quality affect the accuracy of the empirical estimations. There are short data series and problems with the unconvincing information provided by them. Due to transition process there are several structural breaks, which affect the stable relationships between macroeconomic variables.

Another problem arises from using "proxy" variables to replace missing data. There is no data available about money velocity with monthly frequency. To estimate the money velocity index I used industrial output index as a proxy for GDP. Missing information about the structure of currency deposits and interest paid on these deposits was replaced with the hypothesis of USD representatives. Thus, the exchange rate ROL/USD was considered as proxy for the opportunity of holding foreign currencies.

There are no data available about average interest paid on term deposits, as for demand deposits average interest paid is available starting with January 2000. However, demand deposits represent less than 10% of M2. Thus, average interest paid on deposits was considered as opportunity cost for transaction money.

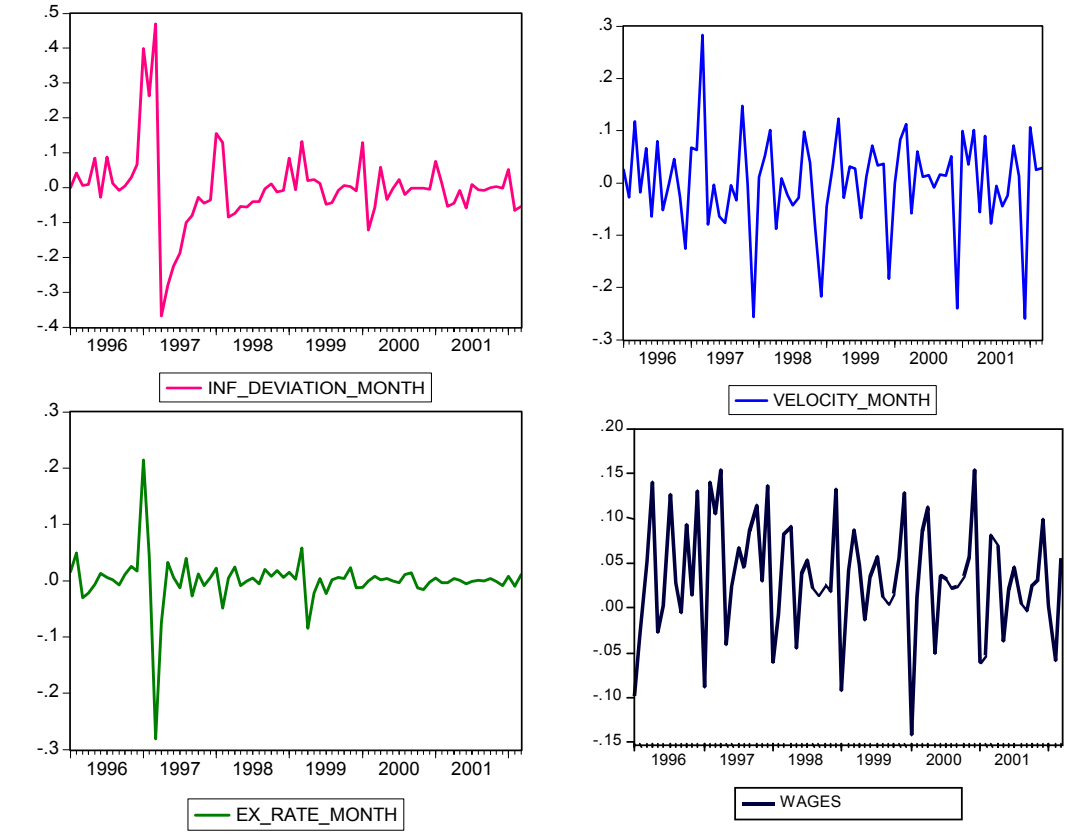
Moreover, average interest rate paid on deposits is used to measure the opportunity of saving money through term deposits versus holding USD.

Comments on results will be made with caution due to data limitation.

2.2 Empirical estimations

3.2.1. In the first part of the econometric analysis I estimate the coefficients of equation (1) in order to test the hypothesis that velocity of circulation affects the success of monetary policy program. The relevant determinants are the monthly changes of the following variables:

Simbol	Denumirea variabilei
inf_deviation	Deviation of inflation from its targeted level
velocity_bf	Velocity of circulation index (base dec.1995)
Wages_bf	Average wages index (base dec.1995)
ex_rate_bf	Exchange rate index ROL/USD (base dec.1995)
D_12	dummy variable due to growths of monetary aggregates in december
D97	dummy variable due to prices liberalization in january 1997



Before testing the regression we need to see which the properties of the regression variables are. For this purpose we will perform unit-root tests to determine the integration order of the series. We will use the Augmented Dickey-Fuller and Phillips-Perron (annex 1).

Simbol	**Levels**		**First difference**	
	ADF	PP	ADF	PP
inf_deviation	-2.73 [3] C	-2.63 C	-5.12 [2] C	-5.85 C
velocity_bf	-3.58 [1] C	-3.65 C	-8.02 [2] C	-10.21 C
wages	-1.05 [3] C T	-1.32 C T	-8.07 [2] C	-12.19 C
ex_rate_bf	-1.89 [2] C T	-1.84 C T	-9.26 [1] C	-7.84 C

PP test is realized with a lag of 3. The figures in square brackets denote the number of lagged dependent variables in the regression of ADF test. When ADF test is made using constant, critical values for 1% and 5% level of significance are –3.52 and, respectively –2.90. When ADF test is made using constant and trend, critical value for 1% level of significance is –4.08 and for 5% is –3.47.

Null hypothesis of unit-root is rejected at 1% significance level both for ADF and PP test. Consequently the series are stationary (I(0)). Thus, OLS method is a consistent esstimator for the coefficients of the equation. The estimation results are:

Dependent Variable: INF_DEVIATION_MONTH

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INF_DEVIATION_MONTH(-1)	0.318544	0.067713	4.704294	0.0000
VELOCITY_MONTH	0.533609	0.117844	4.528105	0.0000
WAGES(-1)	0.503567	0.122226	4.119976	0.0001
EX_RATE_MONTH(-1)	1.337875	0.168099	7.958866	0.0000
D_12	0.122130	0.038581	3.165591	0.0023
D97	0.284073	0.065349	4.347022	0.0000
C	-0.021380	0.008390	-2.548370	0.0131

R-squared	0.718723	Mean dependent var	-6.80E-05
Adjusted R-squared	0.693534	S.D. dependent var	0.114078
S.E. of regression	0.063153	Akaike info criterion	-2.596708
Sum squared resid	0.267213	Schwarz criterion	-2.378755
Log likelihood	103.0782	F-statistic	28.53325
Durbin-Watson stat	2.264548	Prob(F-statistic)	0.000000

The signs of the coefficients are consistent with monetary theory. All variables are statistical significant. The independent variables explain 71% of the changes of inflation deviation. Due to the presence of the lagged depended variable among the explicative variables, Durbin-Watson indicator must be treated with caution. Ljung-Box test is used in order to verify the residuals autocorrelation.

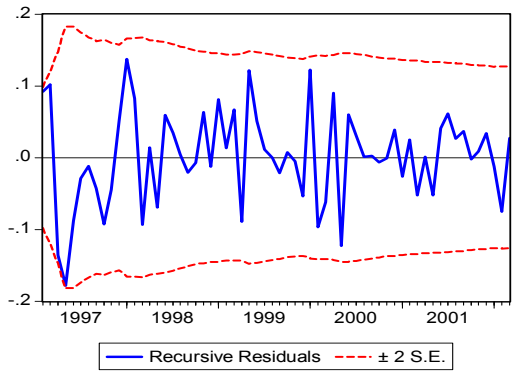
Test	Value	Distribution	Probability
Jarque-Bera	0.4534	$\chi^2(2)$	0.797
Q – statistic (6)	6.6124	$\chi^2(6)$	0.358

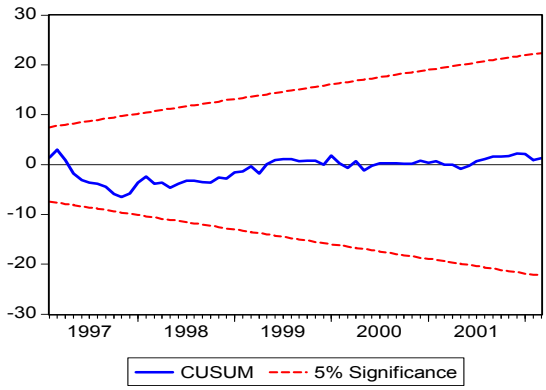
Thus, the null hypothesis of the absence of residual autocorrelation cannot be rejected. Normality test also seems to reflect the absence of any residual problems (annex 2).

The dynamic equation of the changes of inflation deviation is:

$$\begin{aligned}\inf\_deviation\_month = {} & 0.318 * \inf\_deviation\_month(-1) + 0.533 * velocity\_month + \\ & + 0.503 * \text{wages(-1)} + 1.337 * ex\_rate\_month(-1) + \\ & + 0.122 * d\_12 + 0.284 * d97 - 0.021\end{aligned}$$

The results of the coefficient stability tests are:





Wald test is performed in order to test whether changes of velocity are significant for the success of monetary policy. The result of the test shows that there is a null probability for the coefficient of the *velocity_month* (φ) to be zero.

Wald Test:
Equation: INFLATION_GAP

Null Hypothesis: C(2)=0			
F-statistic	20.50374	Probability	0.000025
Chi-square	20.50374	Probability	0.000006

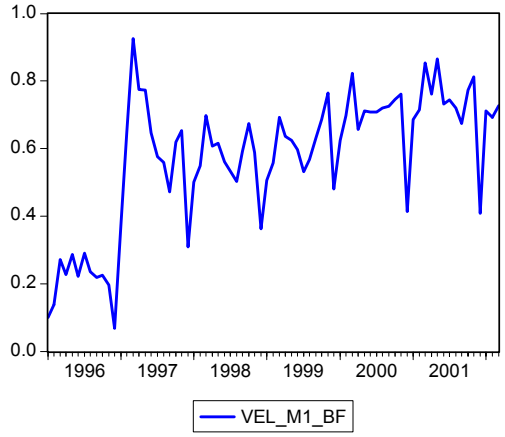
The econometric evidence points out the role of money velocity in driving inflation away from its targeted level.

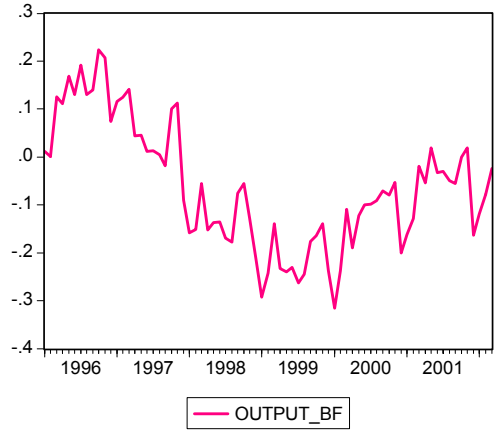
3.2.2. The second part aims to separate the real from monetary causes and to estimate the importance of each from these factors on the transaction velocity variability.

The analysis starts with the identification of the relevant variables[1] and theirs statistic characteristics.

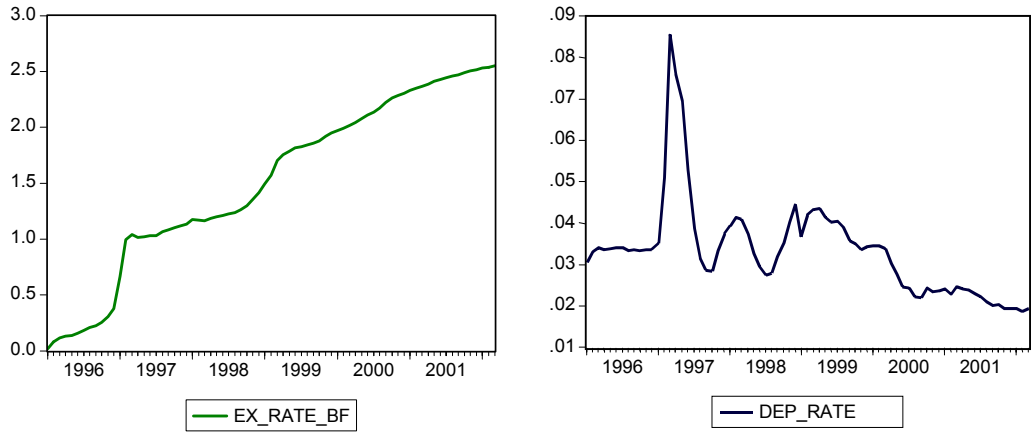
Symbol	Variables
vel_m1_bf	Transaction velocity index (base dec.95)
output_bf	Industrial output index (base dec.1995)
ex_rate_bf	Exchange rate index ROL/USD (base dec.1995)
dep_rate	Monthly fructification obtained on deposits
D_12	Dummy variable due to growths of monetary aggregates in december

* data is presented in logarithm





[1] Lee and Siklos (1992) inter alia advocate the use of seasonally unadjusted data when testing for unit roots and for cointegration, especially where there are substantial seasonal fluctuations. Only with unadjusted data can the stochastic non-stationary natur of the seasonal pattern be examined properly.



Unit-root test are performed using ADF (Augmented Dickey Fuller) and PP (Philips Perron). The results are:

Symbol	**Levels**		**First difference**	
	ADF	PP	ADF	PP
vel_m1_bf	-2.85 [2] C	-3.44 C	-6.96 [2] C	-11.53 C
output_bf	-1.80 [2] C	-1.98 C	-7.69 [2] C	-10.03 C
ex_rate_bf	-1.89 [2] C T	-1.84 C T	-9.26 [1] C	-7.84 C
dep_rate	-3.05 [2] C	-2.51 C	-5.42 [2] C	- 5.81 C

PP test is realized with a lag of 3. The figures in square brackets denote the number of lagged dependent variables in the regression of ADF test. When ADF test is made using constant, critical values for 1% and 5% level of significance are –3.52 and, respectively –2.90. When ADF test is made using constant and trend, critical value for 1% level of significance is –4.08 and for 5% is –3.47.

The results need to be interpreted with caution, owing to low power of tests in the presence of structural breaks. Some results are contradictory. While ADF test for deposit rate seems to exhibit stationarity, PP test provides evidence of non-stationarity; the transaction velocity variable could be I(0) with trend. On balance, however, the tests justify proceeding on the assumption that all variables are I(1).

The non-stationarity of the data motivates the use of the multivariate Johansen procedure to detect the presence of long-run stationary ("cointegrating") relationship among transaction velocity, output, exchange rate and deposit rate. An advantage of the Johansen procedure is that it also allows the researcher to investigate the speed of adjustment to long-run equilibrium, and to test for weak exogenity of the explanatory variables.

The long-run equilibrium is estimated using the following relation (3):

$$vel\_m1\_bf_t = -a + (1-b)output\_bf_t + d * dep\_rate_t + g * ex\_rate\_bf_t$$

The number of lags used to perform the cointegration test and to estimate the error correction vector (VEC) is determined on the basis of the LR, FPE, AIC, SC and HQ criterion for an unrestricted VAR, which includes those four variables.

VAR Lag Order Selection Criteria
Endogenous variables: VEL_M1_BF OUTPUT_BF EX_RATE_BF DEP_RATE
Exogenous variables: C D_12

Lag	LogL	LR	FPE	AIC	SC	HQ
0	292.8811	NA	3.05E-09	-8.257422	-7.998396	-8.154658
1	598.1016	557.3593	6.98E-13	-16.64063	-15.86355	-16.33233
2	670.0360	123.0182	1.39E-13	-18.26191	-16.96678*	-17.74809
3	698.3328	45.11084	9.87E-14	-18.61834	-16.80515	-17.89899*
4	719.0827	30.67388	8.83E-14	-18.75602	-16.42478	-17.83114
5	742.2510	31.56261*	7.49E-14*	-18.96380*	-16.11450	-17.83339
6	750.5698	10.36833	9.97E-14	-18.74115	-15.37381	-17.40521

* indicates lag order selected by the criterion

The results show that the optimum lag for VAR is five. Consequently, four lags of differences were used for VEC estimation. The cointegrating test was performed using one centered seasonal dummy in order to avoid the seasonal increases of monetary aggregates in December.

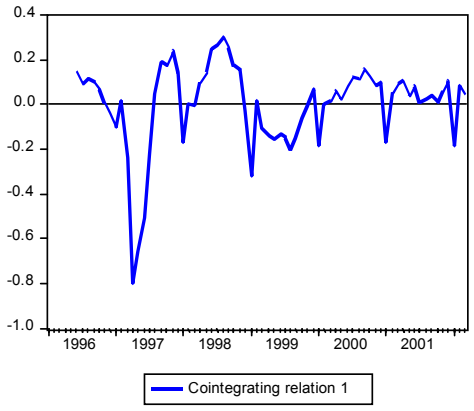
The result of testing the number of cointegrating vectors for all deterministic trend specifications is presented in the following table:

Series: VEL_M1_BF OUTPUT_BF EX_RATE_BF DEP_RATE
Exogenous series: D_12
Warning: Rank Test critical values derived assuming no exogenous series
Lags interval: 1 to 4

Data Trend:	None	None	Linear	Linear	Quadratic
Rank or No. of CEs	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Selected (5% level) Number of Cointegrating Relations by Model (columns)					
Trace	0	1	1	1	1
Max-Eig	0	1	1	1	1

Then, the cointegration test was performed without trend in CE and VAR. The hypothesis that there is no cointegrating vector is rejected at 5% level of significance. The hypothesis that exist at most one cointegrating vector is accepted at the same level of significance (annex 3).

The graph of the cointegrating relation is:



The maximum eigenvalue statistic and the trace statistic provide evidence for the existence of one cointegrating relationship across the four variables considered. I carry on estimating a vector error correction with the constraint of one cointegrating relationships to give estimates of the long-run equilibrium:

Cointegrating Eq:	CointEq1
VEL_M1_BF(-1)	1.000000
OUTPUT_BF(-1)	-0.649188 (0.19323) [-3.35967]
EX_RATE_BF(-1)	-0.426488 (0.04620) [-9.23114]
DEP_RATE(-1)	-23.67883 (4.01792) [-5.89330]
C	0.832039

The long-run equilibrium is:

$$vel\_m1\_bf = 0.6491 * output\_bf + 0.4264 * ex\_rate\_bf + 23.6788 * dep\_rate - 0.83$$

This parameters appear plausible, and shows that the model does quite a reasonable job of explaining transaction velocity (annex 3 - $R^2 = 85$). The residual tests for transaction velocity equation provide evidence that are neither first-order autocorrelation nor normality problems (annex 4). Moreover, the results are sensitive to the inclusion of the dummy variable.

Due to the logarithm expression of all variables the long-run coefficients could be interpretated as elasticities. All three variables are significant and their signs are in accordance with monetary theory.

The exclusion test provide evidence that exogenity cannot be rejected for all variables.

	Output_bf	**Ex_rate_bf**	**Dep_rate**
χ^2	11.71	15.1	18.26
Probability	0.000621	0.000102	0.000019

When output rises with 1% transaction velocity increases with 0.65%. This sensitivity is appreciated as being relatively great. The exclusion hypothesis for

output is rejected with 99% probability ($\chi^2 = 11{,}71$). Some explanations could be the development of the commercial trade and the accumulation of arrears.

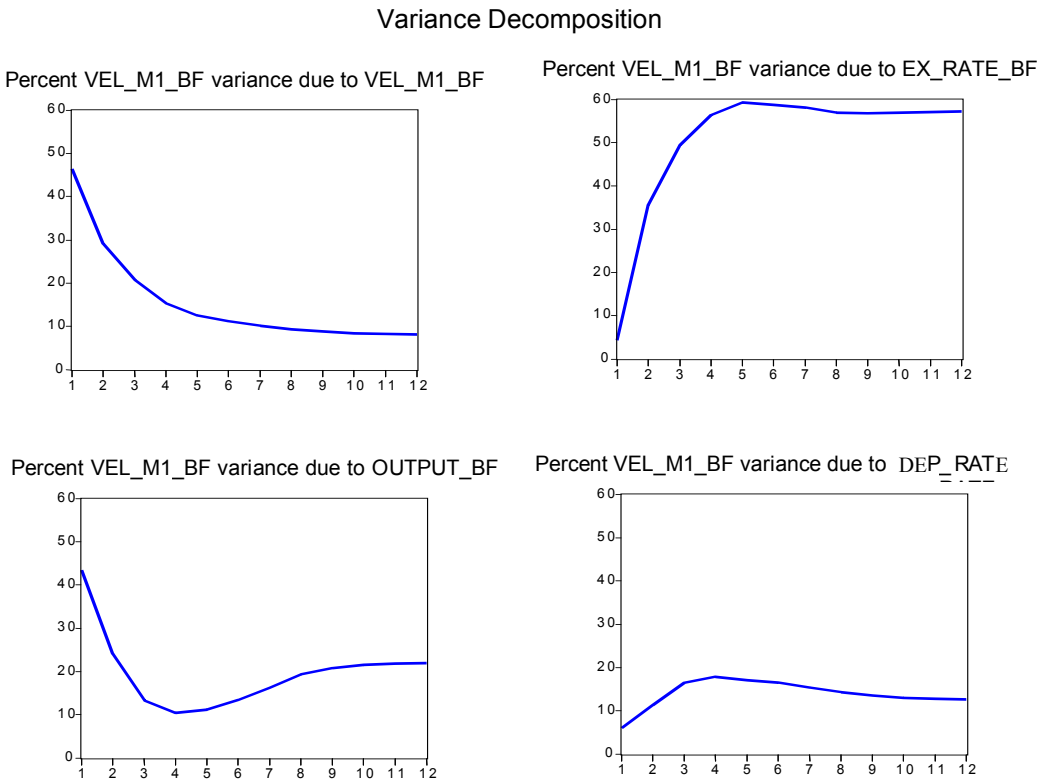
According to the next table, the velocity of adjustment of dependent variable (*vel_m1_bf*) is relatively small. The deviation of the transaction velocity from its equilibrium value is adjusted in 6 months. This result does not encourage using M1 as a monetary target.

Error Correction:	D(VEL_M1_BF)	D(OUTPUT_BF)	D(EX_RATE_BF)	D(DEP_RATE)
CointEq1	**-0.184516** (0.09545) [-1.93308]	-0.012017 (0.06705) [-0.17922]	-0.040708 (0.05520) [-0.73744]	-0.013226 (0.00413) [-3.20090]
	A(1,1)	A(2,1)	A(3,1)	A(4,1)

The hypothesis A (1,1) = 0 is rejected with a 94% probability. Moreover, I imposed restrictions on A (2,1) and/or A (3,1) in order to perform weak exogenity tests for output and exchange rate. The weak exogenity hypothesis for output is accepted with an 85.78% probability ($\chi^2 = 0.03$). The same test provides evidence that exchange rate does not adjusts to shocks to the rest of the system (P=45.88%, $\chi^2 = 0.54$).

Variance decomposition has been performed from the estimated VEC. Variance decomposition give the proportion of the h-period ahead forecast error variance of transaction velocity that can be attributed to output, exchange and deposit rates. These decompositions are related to the concept of Granger causality since if innovations in one variable, say exchange rate cause unexpected fluctuations in velocity, then the information on exchange rate would be useful in predicting velocity.

The Choleski decompositions are examined for our model. The variables are ordered in the following sequence: output, exchange rate, deposit rate and income velocity of M1. The rationale for this ordering is the prior belief that changes in the other variables precedes those in velocity. The result is:



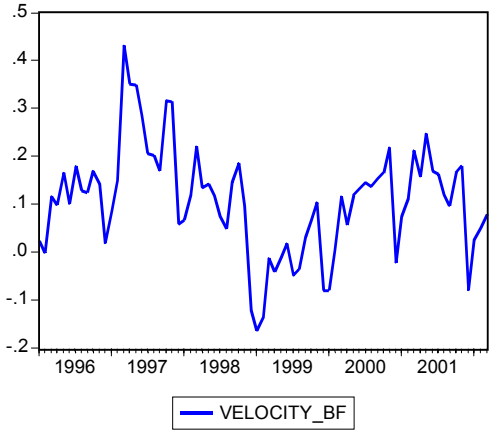
The previews graphs shows that for the period 1996:01 – 2002:03, 22% of the error variance in transaction velocity is explained by innovations in output at a forecast of 12 months. At the same forecast horizon, innovations in exchange rate explain 57%, while those in deposit rate 12%. The percentage of variation that can be attributed to its own shocks is rather small (9%). Taking the analysis a step further, we can compare the weights of monetary (exchange and deposit rates) and real (output) variables. The monetary variables together explain the greatest proportion (69%) of the forecast error variance of transaction velocity.

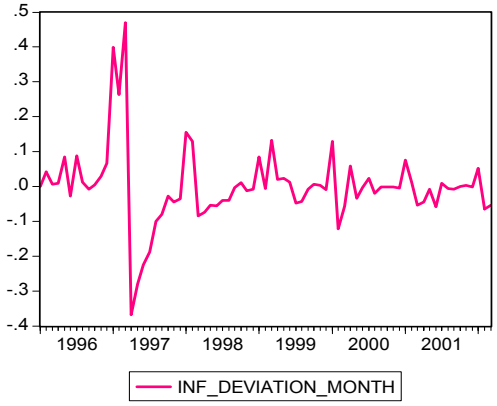
The following conclusions can therefore be derived from the present analysis of the variance decomposition. First, exchange rate is the most important determinant of income velocity of M1. Second, both real and monetary factors are important in explaining movements in velocity.

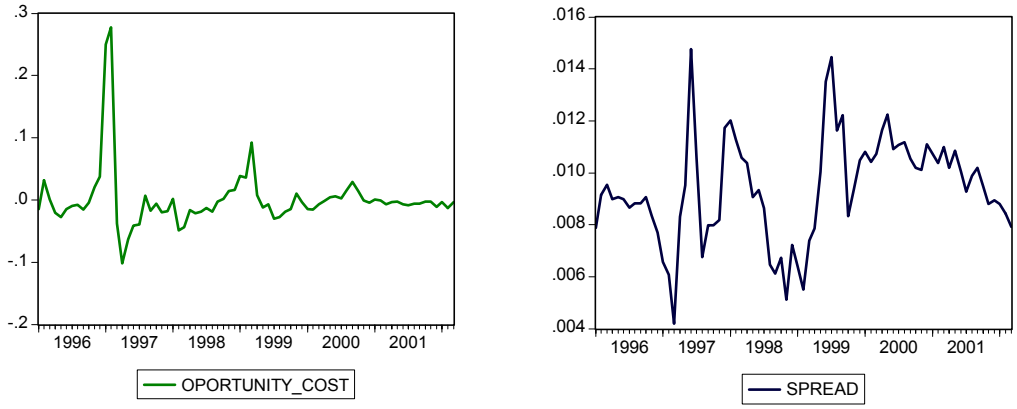
3.2.3. *Third part of the study aims to measure and to test the stability of the sensitivity of income velocity of M2 to changes of confidence in national currency. Moreover, it will be analised the role of commercial banking in explaining movements in velocity of circulation.*

The sensitivity measurement provide information about the economic subjects behavior accounted to the opportunity of holding national currency and to the way that the monetary authority achieves its goals. Banks are also a key element of the confidence in national curency. Commercial banking performance, measured here by spread, affects both the money demand for transactions and portfolio choices. A high level of credit rate will force economic agents to use substitutes for money, like commercial trade or even forms of refusals to pay, while the lack of credibility of banks drives households to hold foreign currency. Thus, changes in velocity of circulation are considered to be the result of the agents' expectations about the alternative portfolio choices and to the utilization of money substitutes in order to perform transactions.

Symbol	Variables
velocity_bf	Velocity of circulation index (base dec.1995)
inf_deviation_month	Monthly changes of inflation deviation from its targeted level
oportunity_cost	Opportunity cost of holding deposits
spread	Commercial banking spread
D_12	Dummy variable







Before testing the regression we need to see which the properties of the regression variables are. For this purpose we will perform unit-root tests to determine the integration order of the series. We will use the Augmented Dickey-Fuller and Phillips-Perron.

Simbol	**Levels**	
	ADF	PP
inf_deviation_month	-5.12 [2] C	-5.85 C
velocity_bf	-3.58 [1] C	-3.65 C
oportunity_cost	-4.34 [2] C	-4.68 C
spread	-3.36 [2] C	-3.26 C

PP test is realized with a lag of 3. The figures in square brackets denote the number of lagged dependent variables in the regression of ADF test. When ADF test is made using constant, critical values for 1% and 5% level of significance are –3.52 and, respectively –2.90.

The results of the stationarity tests provide evidence that null hypothesis of unit-root is rejected at 1% significance level for the velocity of circulation, changes in inflation deviation and opportunity cost, as for spread at 5%. Consequently the series are stationary (I(0)). Thus, OLS method is a consistent esstimator for the coefficients of the equation. The estimation results are:

Dependent Variable: VELOCITY_BF

Variable	Coefficient	Std. Error	t-Statistic	Prob.
VELOCITY_BF(-1)	0.811824	0.057932	14.01343	0.0000
INF_DEVIATION_MONTH(-2)	0.142039	0.058918	2.410789	0.0186
OPORTUNITY_COST(-1)	0.419717	0.133810	3.136670	0.0025
SPREAD	2.125056	0.930298	2.284275	0.0255
D_12	-0.221451	0.023879	-9.273985	0.0000

R-squared	0.778071	Mean dependent var	0.109539
Adjusted R-squared	0.765016	S.D. dependent var	0.113755
S.E. of regression	0.055143	Akaike info criterion	-2.891746
Sum squared resid	0.206770	Schwarz criterion	-2.734865
Log likelihood	110.5487	Durbin-Watson stat	2.408385

The signs of the coefficients are consistent with monetary theory. All variables are statistical significant. The independent variables explain 77% of the movements of the velocity of M2. Due to the presence of the lagged depended variable among the explicative variables, Durbin-Watson indicator must be treated with caution. Ljung-Box test is used in order to verify the residuals autocorrelation.

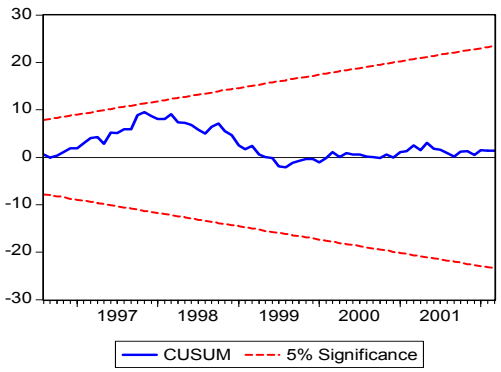
Test	Value	Distribution	Probability
Jarque-Bera	0.94	$\chi^2(2)$	0.62
Q – statistic (6)	8.07	$\chi^2(6)$	23.33

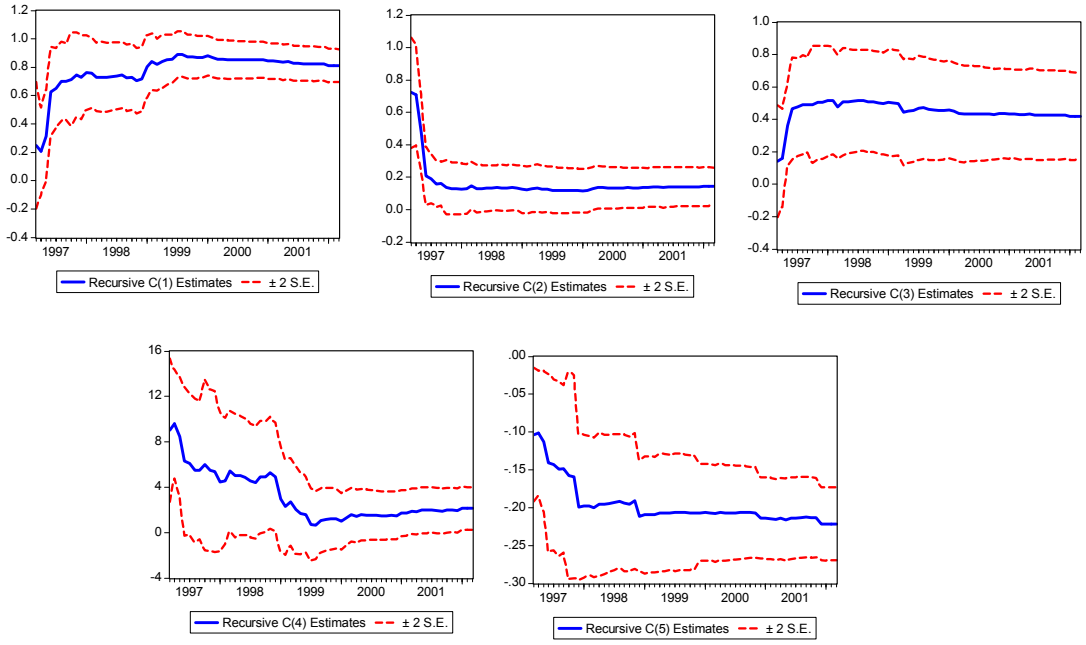
Thus, the null hypothesis of the absence of residual autocorrelation cannot be rejected up to lag 6. Normality test also seems to reflect the absence of any residual problems (annex 5).

The dynamic equation of the velocity of circulation is:

$$velocity\_bf = 0.81 * velocity\_bf(-1) + 0.14 * \inf\_deviation\_month(-2) + \\ + 0.42 * oportunity\_cost(-1) + 2.12 * spread - 0.22 * d\_12$$

The results of the coefficient stability tests are:





Since the liberalization of the exchange market in March 1997, the coefficients of *inf_dev_month* and *opportunity_cost* have been stabilized at 0.14 and 0.42 respectively. In fact, the deregulation procces facilitated housholds and firms the full acces of to exchange market. Thus, it has been removed a major obstacle in making portofolio choices. The sensitivity of velocity to the dinamic of the opportunity cost increased from 0.18 to 0.42, while its sensitivity to the changes in inflation deviation decreased from 0.7 to a steady level of 0.14.

Since June 1999, the soundness of Romanian's banking system has improved significantly, owing to the restructuring of state-owned banks. This efforts were inforced by the stricter loan loss provisioning and bank supervision so that banks could contribute to the recovery of confidence in the national currency. Thus, the elasticity of velocity of circulation to the spread of commercial banking become relatively stable at 2.12 starting with the second half of 1999.

The following conclusions can therefore be derived from the present analysis of the equation (6) estimates. First, the confidence in the national currency is the most important determinant of income velocity of M2. Second, the sensitivity of velocity of circulation to the confidence in national currency is quite stable.

4. Conclusions

The paper identifies a number of real and monetary factors on the behavior of money velocity, such as output, exchange rate, deposit rate, spread of commercial banking and the confidence in national currency, during high efforts of bringing inflation down in Romania. The role of velocity of M2 in driving inflation away from its targeted level is confirmed by empirical results. Therefore, the following concluding remarks could have positive implications for the success of monetary policy.

First of all, it was described the behavior of the transaction velocity in order to get more insight of the function of M2 velocity. The VEC estimates does quite a reasonable job of explaining transaction velocity ($R^2 = 85$) . Empirical results show that exchange rate is the most important determinant of income velocity of M1. However, both real and monetary factors are important in explaining movements in velocity.

The VEC estimates, however, must be interpreted with caution. It is true that adding various structural factors in the way Bordo and Jonung (1987) suggest (e.g. including the development of treasury bills secondary market, life insurance products and other deepening variables) would affect the variance decomposition of the velocity of M1. However, as long as this financial variables are stationary, they are unlikly to alter the cointegration relationship.

The improvement of economic subjects' judgment about theirs alternative portfolio choices and the mechanism that forms theirs expectations about the monetary policy success play an important role for velocity of M2 dynamic. The equation (4) explains quite well the velocity evolution ($R^2 = 77$) . Empirical results show that when exchange market was deregulated (march 1997) the velocity function was affected. In fact, the deregulation procces removed a major obstacle in making portofolio choices. The full acces of housholds and firms on exchange market produced a shift in the way economic subjects responded to changes of confidence in national currency. Consequently, the sensitivity of velocity to the

dinamic of the opportunity of holding deposit increased “asymptoticaly” from 0.18 to 0.42, while its sensitivity to the changes in inflation deviation decreased from 0.7 to a steady level of 0.14.

The improvement of Romanian’s banking system soundness reduced their contribution to velocity instability. Since june 1999 the elasticity of velocity to the spread of commercial banking has been relatively stable at 2.12.

The main finding of the paper is that velocity fluctuations are less influenced by output variability and governed by the exchange rate, deposit rate and expectations about the outcome of monetary policy, in a sound banking environment. This result represents the first step for a future analysis about the controllability of the velocity instability using monetary instruments.

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ANNEX 1.

Stationarity test of Inf_deviation:

ADF Test Statistic	-2.739274	1% Critical Value*	-3.5239
		5% Critical Value	-2.9023
3 lags		10% Critical Value	-2.5882
PP Test Statistic	-2.632993	1% Critical Value*	-3.5200
		5% Critical Value	-2.9006
		10% Critical Value	-2.5874
ADF Test Statistic	-5.122430	1% Critical Value*	-3.5239
First difference		5% Critical Value	-2.9023
2 lags		10% Critical Value	-2.5882
PP Test Statistic	-5.850561	1% Critical Value*	-3.5213
First difference		5% Critical Value	-2.9012
		10% Critical Value	-2.5876

Stationarity test of Velocity_bf:

ADF Test Statistic	-3.588591	1% Critical Value*	-3.5213
		5% Critical Value	-2.9012
1 lag		10% Critical Value	-2.5876
PP Test Statistic	-3.657101	1% Critical Value*	-3.5200
		5% Critical Value	-2.9006
		10% Critical Value	-2.5874

Stationarity test of Ex_rate_bf:

ADF Test Statistic	-1.893770	1% Critical Value*	-4.0890
		5% Critical Value	-3.4721
2 lags		10% Critical Value	-3.1629
PP Test Statistic	-1.842505	1% Critical Value*	-4.0853
		5% Critical Value	-3.4704
		10% Critical Value	-3.1620
ADF Test Statistic	-5.778120	1% Critical Value*	-4.0890
First difference		5% Critical Value	-3.4721
1 lag		10% Critical Value	-3.1629
PP Test Statistic	-4.382596	1% Critical Value*	-4.0871
First difference		5% Critical Value	-3.4713
		10% Critical Value	-3.1624

Stationarity test of Wages:

ADF Test Statistic	-1.059997	1% Critical Value*	-4.0909
		5% Critical Value	-3.4730
3 lags		10% Critical Value	-3.1635
PP Test Statistic	-1.328314	1% Critical Value*	-4.0853
		5% Critical Value	-3.4704
		10% Critical Value	-3.1620
ADF Test Statistic	-8.753773	1% Critical Value*	-4.0909
First difference		5% Critical Value	-3.4730
2 lags		10% Critical Value	-3.1635
PP Test Statistic	-14.12522	1% Critical Value*	-4.0871
First difference		5% Critical Value	-3.4713
		10% Critical Value	-3.1624

Stationarity test of Vel_M1_bf:

ADF Test Statistic	-2.855873	1% Critical Value*	-3.5226
		5% Critical Value	-2.9017
2 lags		10% Critical Value	-2.5879
PP Test Statistic	-3.442304	1% Critical Value*	-3.5200
		5% Critical Value	-2.9006
		10% Critical Value	-2.5874
ADF Test Statistic	-6.967052	1% Critical Value*	-3.5239
First difference		5% Critical Value	-2.9023
2 lags		10% Critical Value	-2.5882
PP Test Statistic	-11.53814	1% Critical Value*	-3.5213
First difference		5% Critical Value	-2.9012
		10% Critical Value	-2.5876

Stationarity test of Output_bf:

ADF Test Statistic	-1.801668	1% Critical Value*	-3.5226
		5% Critical Value	-2.9017
2 lags		10% Critical Value	-2.5879
PP Test Statistic	-1.982751	1% Critical Value*	-3.5200
		5% Critical Value	-2.9006
		10% Critical Value	-2.5874
ADF Test Statistic	-7.696885	1% Critical Value*	-3.5239
First difference		5% Critical Value	-2.9023
2 lags		10% Critical Value	-2.5882

PP Test Statistic	-10.00518	1% Critical Value*	-3.5213
First difference		5% Critical Value	-2.9012
		10% Critical Value	-2.5876

Stationarity test of Dep_rate:

ADF Test Statistic	-3.054517	1% Critical Value*	-3.5226
		5% Critical Value	-2.9017
2 lags		10% Critical Value	-2.5879

PP Test Statistic	-2.517284	1% Critical Value*	-3.5200
		5% Critical Value	-2.9006
		10% Critical Value	-2.5874

ADF Test Statistic	-5.421398	1% Critical Value*	-3.5239
First difference		5% Critical Value	-2.9023
2 lags		10% Critical Value	-2.5882

PP Test Statistic	-5.818774	1% Critical Value*	-3.5213
First difference		5% Critical Value	-2.9012
		10% Critical Value	-2.5876

Stationarity test of Opportunity_cost:

ADF Test Statistic	-4.341756	1% Critical Value*	-3.5226
		5% Critical Value	-2.9017
		10% Critical Value	-2.5879

PP Test Statistic	-4.685689	1% Critical Value*	-3.5200
		5% Critical Value	-2.9006
		10% Critical Value	-2.5874

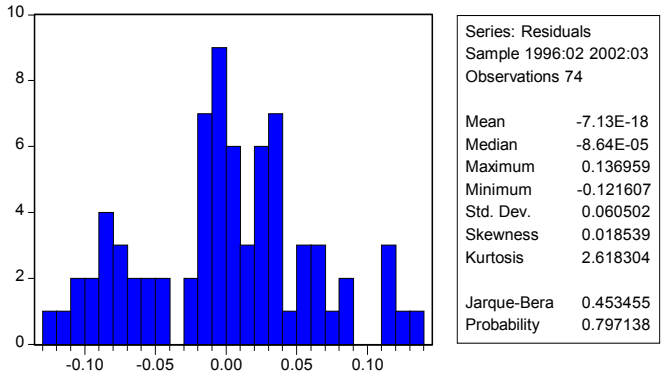
Stationarity test of Spread:

ADF Test Statistic	-3.636636	1% Critical Value*	-3.5226
		5% Critical Value	-2.9017
		10% Critical Value	-2.5879

PP Test Statistic	-3.684859	1% Critical Value*	-3.5200
		5% Critical Value	-2.9006
		10% Critical Value	-2.5874

ANNEX 2

Normality test for the reziduals of the equation (1):



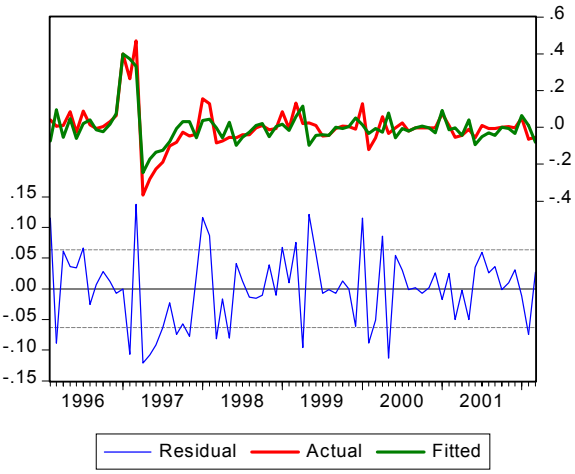
Autocorrelation test for the reziduals of the equation (1):

Correlogram of Residuals

Date: 06/26/99 Time: 22:19
Sample: 1996:02 2002:03
Included observations: 74

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.158	-0.158	1.9334	0.164
		2	0.118	0.096	3.0248	0.220
		3	0.058	0.093	3.2915	0.349
		4	-0.044	-0.035	3.4465	0.486
		5	0.197	0.175	6.5953	0.253
		6	0.014	0.077	6.6124	0.358
		7	-0.103	-0.137	7.5005	0.379
		8	-0.017	-0.095	7.5261	0.481
		9	-0.162	-0.160	9.7975	0.367
		10	0.055	-0.003	10.063	0.435
		11	0.143	0.200	11.886	0.372

Actual, Fitted and Residual Graph of the equation (1):



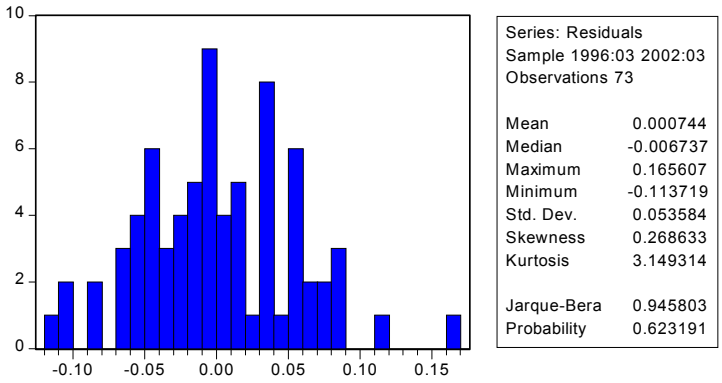
ANNEX 3

Error Correction:	D(VEL_M1_BF)	D(OUTPUT_BF)	D(EX_RATE_BF)	D(DEP_RATE)
CointEq1	-0.184516	-0.012017	-0.040708	-0.013226
	(0.09545)	(0.06705)	(0.05520)	(0.00413)
	[-1.93308]	[- 0.17922]	[-0.73744]	[-3.20090]
D(VEL_M1_BF(-1))	-0.304767	0.077722	-0.015879	0.000923
	(0.16026)	(0.11258)	(0.09268)	(0.00694)
	[-1.90169]	[0.69039]	[-0.17133]	[0.13303]
D(VEL_M1_BF(-2))	0.041273	0.135477	-0.078919	0.003111
	(0.15907)	(0.11174)	(0.09199)	(0.00689)
	[0.25947]	[1.21243]	[-0.85789]	[0.45185]
D(VEL_M1_BF(-3))	-0.422460	-0.329547	-0.268912	-0.011856
	(0.14860)	(0.10439)	(0.08594)	(0.00643)
	[-2.84286]	[-3.15692]	[-3.12907]	[-1.84309]
D(VEL_M1_BF(-4))	-0.035051	0.076998	-0.116987	-0.011566
	(0.14482)	(0.10173)	(0.08375)	(0.00627)
	[-0.24204]	[0.75690]	[-1.39686]	[-1.84509]
D(OUTPUT_BF(-1))	-0.342044	-0.199553	-0.041222	-0.012987
	(0.25645)	(0.18014)	(0.14831)	(0.01110)
	[-1.33379]	[-1.10775]	[-0.27795]	[-1.16990]
D(OUTPUT_BF(-2))	-0.455150	-0.340738	0.164329	-0.003468
	(0.23727)	(0.16668)	(0.13722)	(0.01027)
	[-1.91826]	[-2.04432]	[1.19757]	[-0.33765]
D(OUTPUT_BF(-3))	0.271269	0.357832	0.398935	0.008345
	(0.23178)	(0.16281)	(0.13404)	(0.01003)
	[1.17039]	[2.19779]	[2.97624]	[0.83176]
D(OUTPUT_BF(-4))	-0.247354	-0.219988	-0.018086	0.010976
	(0.23813)	(0.16728)	(0.13772)	(0.01031)
	[-1.03873]	[-1.31510]	[-0.13133]	[1.06482]
D(EX_RATE_BF(-1))	1.395420	0.008068	1.024537	0.076933
	(0.24733)	(0.17374)	(0.14304)	(0.01071)
	[5.64189]	[0.04644]	[7.16279]	[7.18577]
D(EX_RATE_BF(-2))	-0.924088	-0.185282	-0.816558	0.017584
	(0.45662)	(0.32076)	(0.26407)	(0.01977)
	[-2.02378]	[-0.57764]	[-3.09223]	[0.88962]
D(EX_RATE_BF(-3))	-0.234310	0.024904	0.781947	-0.029110
	(0.45448)	(0.31926)	(0.26284)	(0.01967)
	[-0.51555]	[0.07801]	[2.97504]	[-1.47970]
D(EX_RATE_BF(-4))	-0.388978	0.060933	-0.396947	0.023772
	(0.37132)	(0.26084)	(0.21474)	(0.01607)
	[-1.04757]	[0.23361]	[-1.84852]	[1.47897]

D(INT_RATE_LIAB(-1))	3.086400	-0.640440	0.141122	0.050783
	(2.71377)	(1.90632)	(1.56942)	(0.11747)
	[1.13731]	[-0.33596]	[0.08992]	[0.43230]
D(INT_RATE_LIAB(-2))	4.063862	0.092619	-1.330333	0.347949
	(2.54339)	(1.78664)	(1.47088)	(0.11010)
	[1.59781]	[0.05184]	[-0.90444]	[3.16042]
D(INT_RATE_LIAB(-3))	1.615666	0.050465	3.069424	0.041801
	(2.45766)	(1.72642)	(1.42131)	(0.10638)
	[0.65740]	[0.02923]	[2.15958]	[0.39292]
D(INT_RATE_LIAB(-4))	-4.243483	-1.138970	1.132855	-0.183752
	(1.87365)	(1.31617)	(1.08356)	(0.08110)
	[-2.26482]	[-0.86537]	[1.04549]	[-2.26562]
C	0.016008	-0.001326	0.019181	-0.003115
	(0.01801)	(0.01265)	(0.01042)	(0.00078)
	[0.88876]	[-0.10479]	[1.84145]	[-3.99525]
D_12	-0.334498	-0.158503	-0.015099	-0.000146
	(0.02999)	(0.02107)	(0.01735)	(0.00130)
	[-11.1527]	[-7.52314]	[-0.87052]	[-0.11275]
R-squared	0.851017	0.694297	0.642180	0.844914
Adj. R-squared	0.798435	0.586401	0.515890	0.790178
Sum sq. resids	0.201577	0.099469	0.067417	0.000378
S.E. equation	0.062869	0.044163	0.036358	0.002721
F-statistic	16.18454	6.434908	5.084978	15.43609
Log likelihood	105.4270	130.1484	143.7614	325.2202
Akaike AIC	-2.469343	-3.175669	-3.564612	-8.749148
Schwarz SC	-1.859037	-2.565363	-2.954306	-8.138842
Mean dependent	0.006270	-0.002746	0.034489	-0.000205
S.D. dependent	0.140032	0.068670	0.052255	0.005941
Determinant Residual Covariance		2.74E-14		
Log Likelihood		739.9572		
Log Likelihood (d.f. adjusted)		695.6234		
Akaike Information Criteria		-17.58924		
Schwarz Criteria		-15.01953		

ANNEX 5

Normality test for the reziduals of the equation (4):



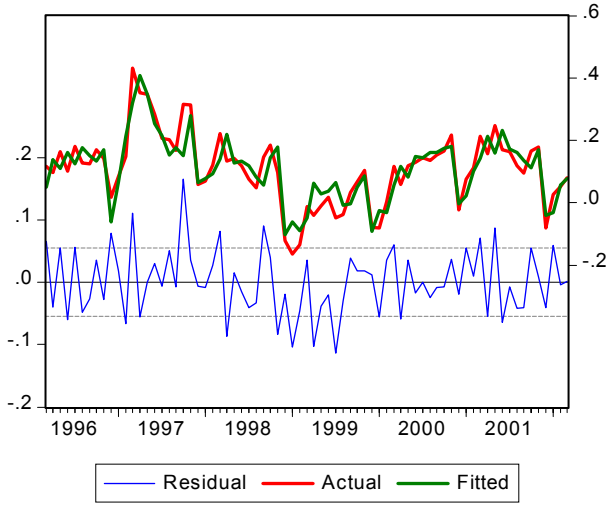
Autocorrelation test for the reziduals of the equation (4):

Correlogram of Residuals

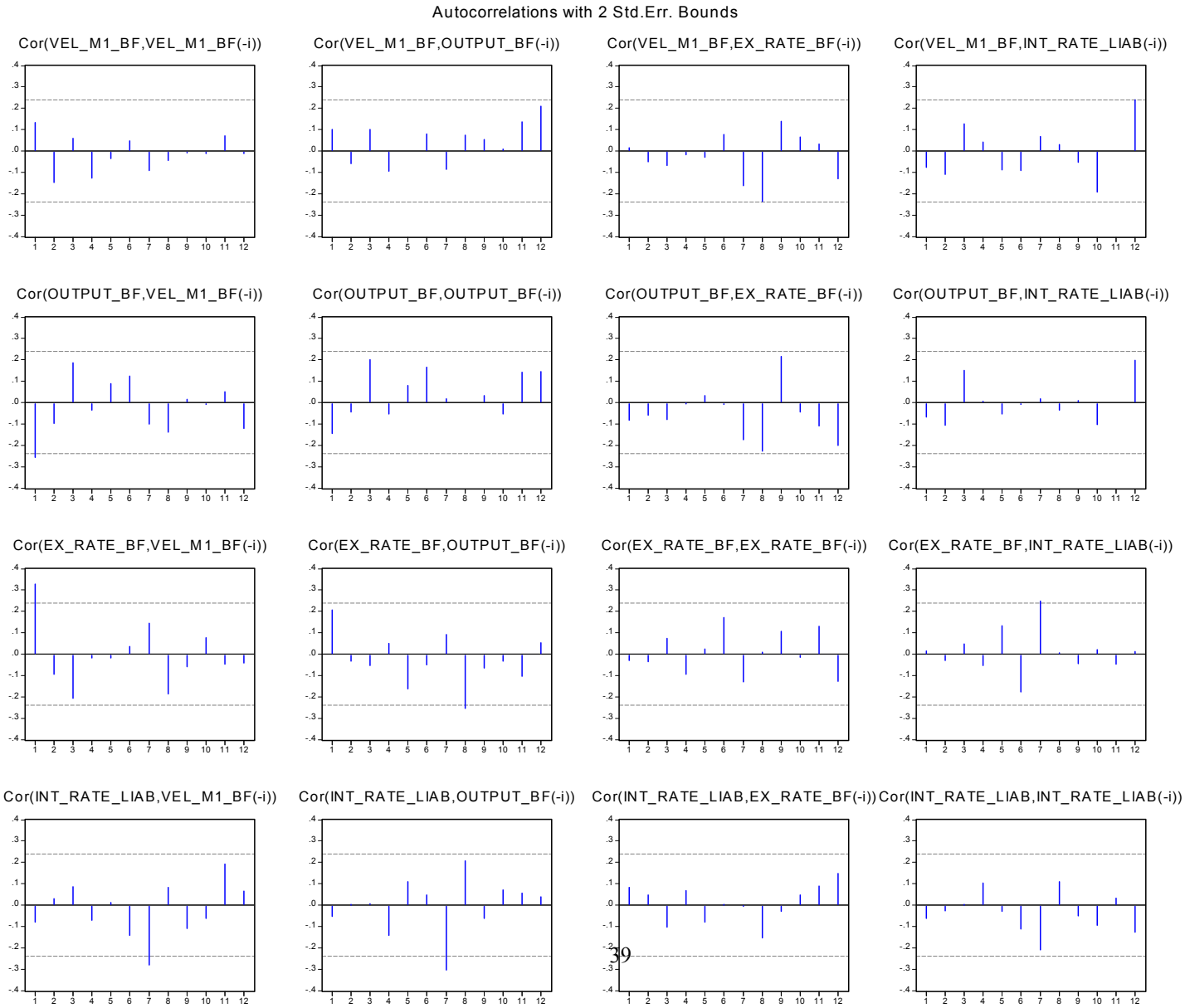
Date: 06/26/99 Time: 22:29
Sample: 1996:03 2002:03
Included observations: 73

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.214	-0.214	3.4973	0.061
		2	0.134	0.093	4.8892	0.087
		3	0.130	0.186	6.2127	0.102
		4	-0.081	-0.034	6.7343	0.151
		5	0.128	0.068	8.0473	0.154
		6	-0.018	0.014	8.0736	0.233
		7	0.045	0.040	8.2436	0.312
		8	0.031	0.017	8.3250	0.402
		9	-0.076	-0.075	8.8211	0.454
		10	-0.004	-0.067	8.8226	0.549
		11	-0.058	-0.062	9.1192	0.611

Actual, Fitted and Residual Graph of the equation (4):



ANNEX 4


Autocorrelations with 2 Std.Err. Bounds
Cor(VEL_M1_BF,VEL_M1_BF(-i))
Cor(VEL_M1_BF,OUTPUT_BF(-i))
Cor(VEL_M1_BF,EX_RATE_BF(-i))
Cor(VEL_M1_BF,INT_RATE_LIAB(-i))
Cor(OUTPUT_BF,VEL_M1_BF(-i))
Cor(OUTPUT_BF,OUTPUT_BF(-i))
Cor(OUTPUT_BF,EX_RATE_BF(-i))
Cor(OUTPUT_BF,INT_RATE_LIAB(-i))
Cor(EX_RATE_BF,VEL_M1_BF(-i))
Cor(EX_RATE_BF,OUTPUT_BF(-i))
Cor(EX_RATE_BF,EX_RATE_BF(-i))
Cor(EX_RATE_BF,INT_RATE_LIAB(-i))
Cor(INT_RATE_LIAB,VEL_M1_BF(-i))
Cor(INT_RATE_LIAB,OUTPUT_BF(-i))
Cor(INT_RATE_LIAB,EX_RATE_BF(-i))
Cor(INT_RATE_LIAB,INT_RATE_LIAB(-i))