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HOUSEHOLD MONEY DEMAND IN ROMANIA. EVIDENCE FROM COINTEGRATED VAR

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Abstract. By the means of cointegrated VAR we investigated the money demand behaviour of households. Using the traditional determinants and adding variables specific for the sector we succeeded to obtain a relevant description of what influences individuals' money holdings, gradually increasing the number of variables but also restricting on the irrelevant ones.

Keywords: cointegrated VAR, households' money demand, SUR.

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JEL Classification: E4, C30, C32.

1. Introduction

This study is a continuation of previous research concerning household money holdings. The reason why sectoral money holdings are worthy to be analysed is the information gain, a greater depth into the understanding of economic influences, reasons and behaviour. Particularities attached to different money holding sectors identified through sectoral analysis allow better knowledge of the economic mechanism and influences and the way they are perceived by the money holders. The most widely used econometric method for estimating money demand is the cointegrated VAR[1], its framework allowing both long and short run analysis as well as conditioning and restricting on account of economic information.

Compared to the previous research, in this paper we use net income as a determinant factor both in the cointegrating framework and in the simultaneous equation approach. Be-

[1] VAR – Vectors Auto Regressive

sides the traditional determinants of money demand we also introduce measures of risk and uncertainty as well as specific factors. The questions we try to answers are whether household money demand can be estimated in a sound manner by the means of cointegrated VAR, what factors can be added to the traditional determinants of money demand, what influences money demand evolution and which are the particularities of Romanian household money demand, especially in the current economic context. We also try to indentify the information gain of adding another cointegration analysis, the one of consumption, to the money demand framework.

The paper is structured into this introduction, literature review, the empirical investigation with some theoretical aspects concerning the cointegrated VAR procedure and the conclusions.

2. Literature Review

Seitz and Landesberger (2010) analyse household money demand behaviour by comparing four models with different specifications; they include as variables monetary aggregates both in real and nominal terms and use both a log and a semi-log specification with respect to the various interest rate options, as well as a measure of uncertainty estimated following Greiber and Lemke (2005). The latter two authors succeed in showing that the uncertainty measure constructed by using financial market data and business and consumer survey evidence, helps explaining monetary developments both in the euro area and US. In a previous study, Landesberger (2007) demonstrated the different behaviour of money holding sectors when the same set of explanatory variables was used.

Starting from the consumer's utility function, Atta-Mensah (2004) includes in the Canadian money demand equation a measure of uncertainty derived through conditional variance. Choi and Oh (2003) use the same method for estimating uncertainty but also introduce a measure of financial innovation in the money demand equation. Also, Pétursson (2000) starts from the utility function in estimating household money demand. Lippi and Secchi (2009) show the manner in which money holdings are influenced by the technology used for money withdrawal. Starting with the same type of models, Tin (2008) shows the importance of income variability for precautionary money holdings.

The most common way of estimating money demand is through cointegrated VAR. Results are sometimes supported by SUR[2] or FM-OLS (Seitz and Landesberger 2010; Landesberger 2007). A system approach is implemented by Chrystal and Mizen (2001, 2005) who connect money and consumption to a lending equation – also by cointegrated VAR – proving their interactive evolution, the informative content of lending for both monetary developments and consumption. Thomas (1997) shows the shock absorbing capacity of money holdings as a result of unanticipated movements in income and spending. He also includes a measure of wealth in the system specification.

The inclusion of wealth in the cointegrating vector is also adopted by Seitz and Landesberger (2010), Chrystal and Mizen (2001) and also Beyer (2009). Jain and Moon (1994)

[2] SUR – Seemingly Unrelated Regression

estimate household money demand for both households and non-financial corporations (time period: 1960–1990), showing, with the help of cointegration analysis, significant differences between the two sectors, a long-term relation being identified only for households sector. Drake and Chrystal (1997) apply nonparametric techniques for investigating households' money demand. They develop their analysis on Divisia aggregate, an alternative to the traditional summing of aggregates' components, on data corresponding to the UK. A more descriptive approach to analyzing sectoral money demand is presented in articles in the European Central Bank Monthly Bulletin[3].

3. Analysing Households Money Demand – Cointegrated VAR Approach

The theoretical model of money demand most often used has the form $M^d = f(P,Y,OC)$, where M^d is nominal money demand, P represents the price level, Y a measure of real income (can as well be final consumption as derived from the utility function) and OC an opportunity cost variable.

The variables we used in the analysis are household M2 money holdings[4], nominal wage – variable significant for transaction money demand – unemployment, interest rate differential (calculated as a difference between the yield of long-term government bonds and deposits rate considered as the own rate of M2) and consumption deflator, also as opportunity cost. As identified in the previous exploratory analyses, individuals choose their money holdings also on account of factors such as uncertainty and risk. Therefore, in this analysis a measure of risk depicted by consumers' confidence indicator and a measure of uncertainty derived as in a previous study by the means of averaging conditional variance derived from GARCH models are included.

We adopted the uncertainty measurement implemented by Atta-Mensah (2004) and adapted it to what we considered as a greater relevance for the Romanian context and individuals' behaviour. Moreover, an equation for consumption was added to this money demand equation. We adopted a semi-log specification in all the investigations, variables entering the equations in logarithms with the exception of interest rate differential, unemployment and consumer confidence.

As money demand is usually assumed to be homogenous in the price level, of degree one, this hypothesis was tested so that real money demand could be investigated. Therefore, M2 was deflated by consumption deflator (as all were variables expressed in real terms) and household money holdings were extended backwards until 2000.

When series are non-stationary, the only way of avoiding the problems related to spurious regression is analysing them through cointegration. Moreover, not only the estimators obtained by the means of cointegration are not affected by the false relation problem induced

3 Money Demand and Uncertainty, ECB Monthly Bulletin, October 2005, 57–73 and Sectoral money holding: determinants and recent developments, ECB Monthly Bulletin August 2006, 59–72.

4 As sectoral data are available only starting from December 2004, the data was estimated backwards by taking into account households' holdings of currency (from the national financial accounts) and keeping all other holdings proportional with the share they had in December 2004.

by the trend existent in their evolution, but they have the property of being *superconsistent* (converge to their true value more rapidly, I(1) variables under these circumstances being asymptotically better than I(0) variables) (Harris 1995).

Testing long-run price homogeneity

We first estimated a cointegration equation on nominal M2, having as determinants only the traditional influences with the goal of testing price homogeneity, a hypothesis usually assumed. The traditional parsimonious equation of money demand encompassing only income and opportunity cost validates the long-run price homogeneity hypothesis, as the LR test shows (see Table 1).

Table 1. Testing price homogeneity

Cointegration Restrictions:	
B(1,1) = 1, B(1,3) = –1	
Convergence achieved after 7 iterations. Restrictions identify all cointegrating vectors LR test for binding restrictions (rank = 1): Chi-square(1)	0.014310
Probability	0.904782
Cointegrating Eq:	CointEq1
LM2NSA(–1)	1.00
LWAGEDEFL(–1)	–0.84
	(0.12)
	[–7.16]
LOG(DEFLSA(–1))	–1.00
I(–1)	0.0099
	(0.002)
	[4.97]
@TREND(00Q1)	–0.024
C	–3.28

Therefore, the extended M2 equation can be estimated in real terms.

Estimating the households' money demand by the means of cointegrated VAR

The additional variables added to the previous model are unemployment and consumer confidence indicator, while in the short run equation a measure of uncertainty is included. Uncertainty was determined by averaging the standardised conditional volatility[5] $\left(Varstd_i = \frac{Var_i - \overline{Var_i}}{Stdev(Var_i)} \right)$ of GDP, exchange rate and Robor3M rate, as we considered them to be the most relevant for extracting individuals' uncertainty (estimation results are presented in Appendix 2).

[5] Atta-Mensah (2004) used in building the uncertainty measure of the conditional volatility of a stock market index, long-term interest rate, 90-day commercial paper rate, exchange rate between Canada and US and real GDP.

The cointegrating VAR framework is very sensitive to specification errors. As most tests rely on normality, lack of autocorrelation, the system specification needs to be improved by correcting and accounting for intervention dummies, blip dummies, shift dummies. A thorough inspection of the data series in levels and first difference offers some necessary pieces of information for improving the VAR framework specification. As starting with September 2008 most variables registered a shift in their evolution, a shift dummy for the investigation interval is necessary. Whether this episode is transitory and the future evolution of the series will indicate this feature, which we consider to happen, it does not matter for the time span under analysis as the shift is visible and persistent. Moreover, some of the investigated series behave as I(2) variables when considering the whole sample 2000–2010, due to the recent developments, but as this evolution is not necessarily a quadratic trend, but more of a temporary correction we considered it was better to assume them I(1) – as they are when investigated for the interval up to 2008 Q2 (see appendix 1) – and control with the help of a shift dummy the change in their evolution. Moreover, the existence of a structural break in the data series distorts the results of the ADF test, being preferable to account by the means of an external factor for these changes. Explaining what provoked these developments can be more productive than considering a quadratic trend (Juselius 2006).

The first step in the cointegrating VAR methodology, is the estimation of an unrestricted VAR

$$y_t = \sum_{i=1}^{p} \Pi_i y_{t-1} + \psi_0 x_t + \Phi D_t + \varepsilon_t. \tag{1}$$

Errors are assumed to be NI(0,Ω), Π_i and Φ matrices of coefficients and D is a vector of determinist variables (including constants and deterministic trends), and x_t is a vector of exogenous variables. Under this framework, the best lag length is determined, so as to ensure Gaussian errors. Even though it is usually better to choose a less parsimonious specification (as cointegration rank tests are robust under over-parametrisation), when it comes to the selected number of lags, given the short sample, a high number of variables and therefore the computational problems we chose the lag length indicated by the Schwartz and LR criteria (see Table 2). Another argument in supporting this decision is the fact that if the remaining autocorrelation is due to omitted factors, a higher rank would only lead to over-parametrisation and distorted economical interpretation of results.

The second step in the analysis is reformulating the UVAR into a VECM:

$$\Delta y_t = \Pi_1 y_{t-1} + \sum_{i=1}^{l-1} \Gamma_i \Delta y_{t-i} + \psi_0 x_t + \Phi D_t + \varepsilon_t \tag{2}$$

and testing the rank of Π_1, where $\Pi_1 = \alpha\beta$, α and β being *pxr* matrices.

As errors need to be stationary, $\Pi_1 y_{t-1}$ should also be a stationary combination.

Rank determination is done through a likelihood based procedure which is able to identify the large enough eigenvalues λ_i which correspond to stationary $\beta' y_{t-1}$. The number of cointegration equations is therefore determined by the use of trace test and maximum eigenvalue test. The LR test also called the trace test or the Johansen (1991) test, calculated as

$$LR(H_r/H_p) = -T \ln\left[(1-\lambda_{r+1})\ldots(1-\lambda_p)\right] = -T \sum_{i=r+1}^{p} (1-\lambda_i), \tag{3}$$

where H_p: rank = p(full rank)

Table 2. Lag length determination

VAR Lag Order Selection Criteria
Endogenous variables: LM2DEFL LWAGEDEFL I UNEMPLOYMENT DDEFL CONS_CONF
Exogenous variables: C DUMM08 UNCERTANTY
Sample: 2000Q1 2010Q3
Included observations: 34

Lag	LogL	LR	FPE	AIC	SC	HQ
0	–92.91	NA	2.75e-05	6.52	7.33	6.80
1	97.17	**279.55***	3.43e-09	–2.53	**–0.11***	–1.71
2	137.98	45.60	3.54e-09	–2.82	1.21	–1.44
3	199.86	47.31	1.81e-09*	–4.34*	1.31	–2.41*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

H_r: rank = $r < p$ is very sensitive in small samples, having a low power, therefore the results need to be validated from the point of view of economic interpretation and validity. The asymptotic distribution of the test depends on the cointegrating VAR specification regarding the inclusion of constant and trend.

The other statistical measure, the maximum eigenvalue completes the trace statistic, by testing the hypothesis of r cointegrating relations against the alternative of $r + 1$[6].

$$\lambda_{\max} = -T \log(1 - \lambda_{r+1}). \tag{4}$$

Restricting the VECM is done in accordance with economic theory, these hypotheses being tested by the likelihood ratio statistics. As the restrictions in the VECM framework can be put both on α and β and their validity tested, we analysed whether unit elasticity with respect to wage can be assumed.

At this leg length (1), a specification with trend both in the cointegration equation and in the VAR is suggested. This is not surprising the series' evolution after the default of Lehman Brothers. For controlling of the period starting with 2008Q3 reason the shift dummy *dumm08* is included as exogenous in the cointegrated VAR specification. At the same time, the inclusion of a deterministic trend in both the cointegrating and short-run adjustment systems is justified by the M2, wage and unemployment series. When analysed up to 2008, the series behaves as I(1) under the trend inclusion assumption in the ADF test. Therefore, a deterministic trend is present in the data. For economic interpretability, we restricted the cointegrating rank to 1.

Estimation offers somewhat economically sound results (see Table 3). The estimated cointegration equation allows the possibility of restricting the coefficient of real wage to 1; therefore, the unit elasticity of household money holdings to wage can be considered further on.

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[6] As mentioned in Harris (1995) it is not uncommon that the two statistics offer different results, especially in the case of small samples. Anyway, between the two the trace statistics is more robust to residuals' lack of normality.

Unemployment evolution seems to be a determinant of money holdings, which can only be interpreted in terms of increasing precautionary demand for money. Surprisingly, consumer confidence does not seem to be very relevant for households' behaviour, very small coefficient and a sign change after imposing the restriction on wages.

The interest rate differential was validated as an opportunity cost, but a different thing happened with quarterly inflation measured through the consumption deflator. It seems that periods of high inflation do not have the effect of dragging individuals out of the money holdings. This coefficient could perhaps be also attached to the period of high inflation and increase in monetary aggregates or it might be explained partly also by the differences in computation between the consumption deflator and inflation.

Table 3. Household money demand

Vector Error Correction Estimates Sample (adjusted): 2001Q4 2010Q2 Included observations: 35 after adjustments Standard errors in ( ) & t-statistics in [ ]		Cointegration Restrictions: B(1,1) = 1, B(1,2) = −1 Convergence achieved after 168 iterations. Restrictions identify all cointegrating Vectors LR test for binding restrictions (rank = 1):	
		Chi-square(1) Probability	2.69 0.10
Cointegrating Eq:	CointEq1	Cointegrating Eq:	CointEq1
LM2DEFL(−1)	1.00	LM2DEFL(−1)	1.00
LWAGEDEFL(−1)	−1.28	LWAGEDEFL(−1)	−1.00
	(0.12)	I(−1)	0.009
	[−10.35]		[5.85]
I(−1)	0.012		
	(0.002)	UNEMPLOYMENT(−1)	−0.02
	[5.62]		(0.004)
UNEMPLOYMENT (−1)	−0.019		[−4.56]
	(0.004)		
	[−4.34]	DDEFL(−1)	−1.48
DDEFL(-1)	−1.85		(0.38)
	(0.38)		[−3.94]
	[−4.82]	CONS_CONF(−1)	−0.002
CONS_CONF(−1)	0.0007		(0.0008)
	(0.001)		[−2.71]
	[0.67]		
@TREND(00Q1)	−0.025	@TREND(00Q1)	−0.029
	(0.003)		(0.001)
	[−8.99]		[−19.95]
C	3.73	C	−0.52

The obtained cointegration equation even though acceptably adequate from the perspective of residual tests (normally skewed, no signs of autocorrelation nor of heteroskedasticity), can be improved by adding another cointegrating equation, the one for consumption.

Therefore, we repeated the whole procedure previously described and restricted for a rank of 2 (trace and eigenvalue tests suggested a number of 3 cointegating equations).

Re-estimating the cointegrated var system leads to the results presented in Table 4 (restrictions imposed and no signs of rejection):

Table 4. Household money demand and consumption

Vector Error Correction Estimates Sample (adjusted): 2001Q4 2010Q2 Included observations: 35 after adjustments Standard errors in ( ) & t-statistics in [ ]		
Cointegration Restrictions: B(1,1) = 1, B(1,2) = 0, B(1,3) = −1, B(2,1) = 0,B(2,2) = 1, B(2,4) = 0 A(1,2) = 0, A(2,1) = 0 Convergence achieved after 227 iterations. Restrictions identify all cointegrating vectors LR test for binding restrictions (rank = 2):		
Chi-square(4) Probability	2.064692 0.723861	
Cointegrating Eq:	CointEq1	CointEq2
LM2DEFL(−1) LCONS(−1) LWAGEDEFL(−1)	1.00 0.00 −1.00	0.00 1.00 −0.57 (0.07) [−7.76]
I(−1)	0.0079 (0.001) [5.84]	0.00
UNEMPLOYMENT (−1)	−0.016 (0.006) [−2.74]	0.003 (0.005) [0.57]
DDEFL(−1)	−3.54 (0.50) [−7.09]	1.16 (0.44) [2.65]
CONS_CONF(−1)	−0.003 (0.001)	0.0016 (0.001)
@TREND(00Q1)	[−2.97]	[1.44]
C	−0.026 −0.61	−0.004 −1.31

The equation for consuwmption has the ability of making the households money demand behaviour clearer. The unemployment measure, previously positively correlated to money demand has the opposite impact on consumption, being a hint to the formerly stated precautionary reason. Furthermore, including consumption leads to a better fit of short term movements (measured by the increase in adjusted R-square, a lower standard error and better AIC and SIC information criteria values).

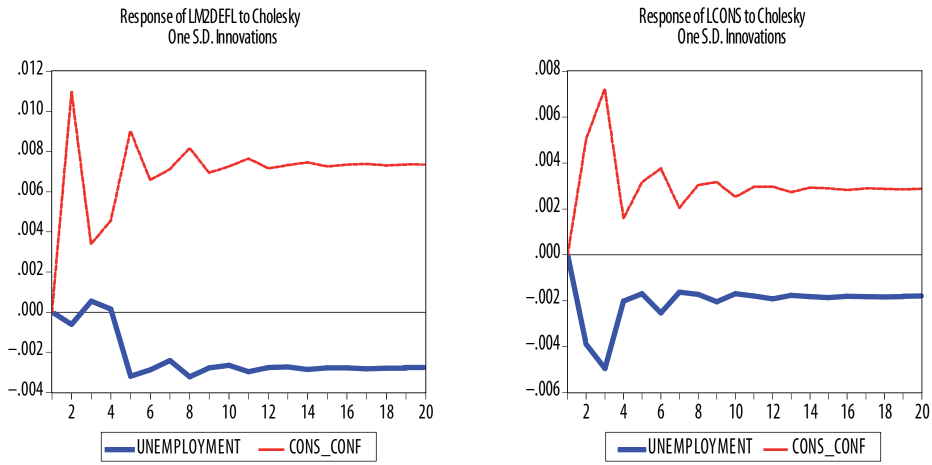

Fig. 1. Impulse responses

The short-term evolution draws its importance from money holders' behaviour that are considered to establish certain targets and thresholds regarding the quantity of money they hold and who will react for adjusting their holdings when one of the self imposed limits is hit (Smith 1986).

The impulse response analysis (Fig. 1) shows that a shock in unemployment will in the long run also have a downward impact on money demand. The effect is opposite for consumption. The biggest downward impact on consumption happens in the first quarters after the shock has taken place. On the other hand, a shock in consumer confidence has the maximum positive impact at 2–3 quarters after the shock happened.

The measure of uncertainty which we have computed following Atta-Mensah (2004) did not prove relevant for the short term movements. Still, the coefficients are in accordance with expectations, positive impact on M2 money holdings on account of increasing precautionary demand in times of uncertainty and a negative impact for consumption. Given the narrow portfolio options, a small impact from uncertainty on money demand is acceptable – especially as we analysed the behaviour of M2 money holding which comprise both transaction and precautionary money demand. Therefore, the change in structure is not visible; an increase in precautionary money demand being accompanied by a decrease in transaction holdings; therefore, there is a shift inside the M2 which the analysis cannot reveal. But, to a certain extent, this is revealed by the consumption equation.

There are still some specification problems (residual tests presented in the appendix 3). The multiple normality hypothesis is rejected due to kurtosis values. Anyway, VAR specifications are more sensitive to deviations from normality due to skewness rather than to kurtosis (Juselius 2006). Neither signs of residual correlation are left, nor of heteroskedasticity.

Results of the VECM estimation are enforced by estimating the system of short run influences by seemingly unrelated regression[7] (see appendix 4). Moreover, results of the SUR

[7] SUR allows estimating the equations of the system by accounting for the residuals' correlation (coming from different common influences and perceived shocks).

estimation provide similar coefficient values, under better model specification. Results point to a relatively low speed of adjustment –0.10 in the VECM framework and –0.12 in the SUR estimation; therefore, an adjustment happens in about 8 to 10 quarters. A low speed of adjustment is nevertheless typical for studies regarding money demand (Seitz, Landesberger 2010).

4. Conclusions

Even though facing the problem of a small sample and of significant structural break, the estimated cointegrated VAR offers some insight into the mechanism of household money demand. Besides the traditional factors, (income and opportunity cost) we introduced unemployment as decision important variable and measures of risk and uncertainty which did not prove to be as significant as expected. Because M2 also includes the precautionary component of money holding, we considered the introduction of a consumption function which helped in making the mechanism even clearer appropriate.

Therefore, the whole mechanism could be synthesized as follows: households' money holdings are (i) directly influenced by the level of income (a unit coefficient being validated); (ii) inversely by the opportunity cost measured by the interest rate differential but not registering a similar response to variations in the consumption deflator, (iii) has a positive response to unemployment – which gradually turns negative – due to the precautionary component (fact enforced by the negative reaction of households' consumption to unemployment evolution suggesting the repositioning from transactions holdings to precautionary); (iv) uncertainty has no influence on the short run, but consumer confidence in the long-run equation has the ability of positively influencing money holdings.

The estimated cointegrated VAR is acceptably adequate except for the errors' kurtosis, but after restricting and re-estimating the short run component this problem is no longer present in the SUR estimation. Moreover, the short-run adjustment is slowly producing.

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Appendix 1. ADF Unit root test

Variable	Exogenous	t-statistic	Prob
LM2DEFL	Constant, Linear Trend	0.52	1.00
D(LM2DEFL)	Constant, Linear Trend	–5.30	0.00
LWAGEDEFL	Constant, Linear Trend	–0.58	0.97
D(LWAGEDEFL)	Constant, Linear Trend	–5.75	0.00
DDEFL	Constant	–2.69	0.09
D(DDEFL)	Constant	–8.73	0.00
I	Constant	–1.77	0.39
D(I)	Constant	–7.22	0.00
UNEMPLOYMENT	Constant, Linear Trend	–2.98	0.16
D(UNEMPLOYMENT)	Constant, Linear Trend	–6.74	0.00
CONS_CONF	Constant	–1.45	0.54
D(CONS_CONF)	Constant	–4.45	0.00

Appendix 2. GARCH estimation of uncertainty components

Dependent Variable: ROBOR3M
Method: ML - ARCH
Date: 01/22/11 Time: 20:52
Sample (adjusted): 2000Q3 2010Q3
Included observations: 41 after adjustments
Convergence achieved after 38 iterations
MA Backcast: 2000Q2
Presample variance: backcast (parameter = 0.7)
GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
AR(1)	1.108711	0.012411	89.33066	0.0000
AR(2)	-0.136726	0.019465	-7.024359	0.0000
MA(1)	0.552007	0.114910	4.803806	0.0000
Variance Equation				
C	12.47880	4.855348	2.570115	0.0102
RESID(-1)^2	-0.121537	0.123151	-0.986895	0.3237
GARCH(-1)	-0.871016	0.095439	-9.126435	0.0000

R-squared	0.968740	Mean dependent var	18.69122
Adjusted R-squared	0.964274	S.D. dependent var	13.30652
S.E. of regression	2.515108	Akaike info criterion	4.858618
Sum squared resid	221.4019	Schwarz criterion	5.109385
Log likelihood	-93.60167	Hannan-Quinn criter.	4.949933
Durbin-Watson stat	2.219551		

Inverted AR Roots	.97	.14
Inverted MA Roots	-.55	

Dependent Variable: RON_EURO
Method: ML - ARCH
Date: 01/22/11 Time: 20:57
Sample (adjusted): 2000Q3 2010Q3
Included observations: 41 after adjustments
Failure to improve Likelihood after 75 iterations
MA Backcast: 2000Q2
Presample variance: backcast (parameter = 0.7)
GARCH = C(5) + C(6)*RESID(-1)^2 + C(7)*GARCH(-1) + C(8)*GARCH(-2)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	4.288198	0.225843	18.98750	0.0000
AR(1)	1.044210	0.154584	6.754955	0.0000
AR(2)	-0.121760	0.129136	-0.942884	0.3457
MA(1)	0.273654	0.096669	2.830831	0.0046
Variance Equation				
C	0.029790	0.008498	3.505482	0.0005
RESID(-1)^2	0.293561	0.138166	2.124697	0.0336
GARCH(-1)	-0.573473	0.056896	-10.07937	0.0000
GARCH(-2)	-0.794663	0.129439	-6.139278	0.0000

R-squared	0.950022	Mean dependent var	3.525443
Adjusted R-squared	0.939420	S.D. dependent var	0.578731
S.E. of regression	0.142443	Akaike info criterion	-1.259576
Sum squared resid	0.669569	Schwarz criterion	-0.925220
Log likelihood	33.82130	Hannan-Quinn criter.	-1.137822
F-statistic	89.61238	Durbin-Watson stat	2.188370
Prob(F-statistic)	0.000000		

Inverted AR Roots	.91	.13
Inverted MA Roots	-.27	

Dependent Variable: LOG(GDP)
Method: ML - ARCH
Date: 01/22/11 Time: 20:46
Sample (adjusted): 2000Q4 2010Q3
Included observations: 40 after adjustments
Convergence achieved after 33 iterations
MA Backcast: 2000Q3
Presample variance: backcast (parameter = 0.7)
GARCH = C(6) + C(7)*RESID(-1)^2 + C(8)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	10.33794	0.045117	229.1338	0.0000
AR(1)	0.850295	0.105893	8.029778	0.0000
AR(2)	0.384255	0.216614	1.773912	0.0761
AR(3)	-0.279792	0.116119	-2.409533	0.0160
MA(1)	0.952859	0.038619	24.67317	0.0000
Variance Equation				
C	0.000142	4.47E-05	3.168943	0.0015
RESID(-1)^2	0.400307	0.202284	1.978935	0.0478
GARCH(-1)	-0.714095	0.205735	-3.470941	0.0005

R-squared	0.994834	Mean dependent var	10.19163
Adjusted R-squared	0.993704	S.D. dependent var	0.146255
S.E. of regression	0.011605	Akaike info criterion	-6.183587
Sum squared resid	0.004310	Schwarz criterion	-5.845811
Log likelihood	131.6717	Hannan-Quinn criter.	-6.061458
F-statistic	880.3570	Durbin-Watson stat	2.043904
Prob(F-statistic)	0.000000		

Inverted AR Roots	.94	.50	-.59
Inverted MA Roots	-.95		

Appendix 3. Residuals tests

Component	Skewness	Chi-sq	df	Prob.
1	0.058488	0.019955	1	0.8877
2	-0.003843	8.61E-05	1	0.9926
3	0.321833	0.604195	1	0.4370
4	-0.280511	0.459004	1	0.4981
5	0.503331	1.477830	1	0.2241
6	0.114352	0.076279	1	0.7824
7	-0.049295	0.014175	1	0.9052
Joint		2.651525	7	0.9153

Component	Kurtosis	Chi-sq	df	Prob.
1	1.029359	5.663328	1	0.0173
2	0.803028	7.038915	1	0.0080
3	1.267000	4.379794	1	0.0364
4	1.481195	3.364039	1	0.0666
5	3.267515	0.104364	1	0.7467
6	1.092453	5.306487	1	0.0212
7	1.245397	4.489670	1	0.0341
Joint		30.34660	7	0.0001

Component	Jarque-Bera	df	Prob.
1	5.683283	2	0.0583
2	7.039001	2	0.0296
3	4.983989	2	0.0827
4	3.823043	2	0.1479
5	1.582195	2	0.4533
6	5.382766	2	0.0678
7	4.503845	2	0.1052
Joint	32.99812	14	0.0029

VEC Residual Serial Correlation LM Test

Lags	LM-Stat	Prob
1	55.03908	0.2568
2	57.33946	0.1934
3	45.95098	0.5975
4	49.55999	0.4508
5	56.53094	0.2143
6	44.93818	0.6385

Probs from chi-square with 49 df.

VEC Residual Heteroskedasticity Test: No Cross Terms

Joint test:

Chi-sq	df	Prob.
655.8883	644	0.3640

Appendix 4. Comparison

Table 1. VECM Estimation

Error Correction:	D(LM2DEFL)	D(LCONS)	D(LWAGED...	D(I)	D(UNEMPL...	D(DDEFL)	D(CONS_C...
CointEq1	-0.103076	0.000000	0.017821	-61.57049	0.022020	0.375480	27.77164
	(0.06332)	(0.00000)	(0.09621)	(11.7232)	(10.5696)	(0.09563)	(44.5788)
	[-1.62778]	[NA]	[0.18523]	[-5.25201]	[0.00208]	[3.92655]	[0.62298]
CointEq2	0.000000	-0.064970	0.267020	-72.21280	0.886855	0.048392	-9.207311
	(0.00000)	(0.06318)	(0.10125)	(12.1694)	(10.9372)	(0.10508)	(47.5178)
	[NA]	[-1.02826]	[2.63715]	[-5.93395]	[0.08109]	[0.46054]	[-0.19377]
D(LM2DEFL(-1))	-0.125614	0.098325	-0.135983	-14.61858	19.07274	-0.201523	82.13107
	(0.24274)	(0.22577)	(0.21358)	(26.2246)	(23.7853)	(0.26002)	(97.0051)
	[-0.51749]	[0.43551]	[-0.63668]	[-0.55744]	[0.80187]	[-0.77502]	[0.84667]
D(LCONS(-1))	-0.664994	-0.061170	-0.626886	101.1497	18.38704	0.513076	16.48161
	(0.29616)	(0.27545)	(0.26058)	(31.9956)	(29.0196)	(0.31724)	(118.352)
	[-2.24542]	[-0.22207]	[-2.40571]	[3.16136]	[0.63361]	[1.61730]	[0.13926]
D(LWAGEDEFL(-1))	-0.223605	-0.412432	-0.106909	8.002039	-6.578214	0.897377	-30.38368
	(0.24657)	(0.22933)	(0.21695)	(26.6386)	(24.1608)	(0.26413)	(98.5362)
	[-0.90686]	[-1.79841]	[-0.49277]	[0.30039]	[-0.27227]	[3.39753]	[-0.30835]
D(I(-1))	-0.004071	-0.000292	-0.002353	-0.009148	0.136539	0.000310	-0.869247
	(0.00151)	(0.00141)	(0.00133)	(0.16336)	(0.14816)	(0.00162)	(0.60427)
	[-2.69233]	[-0.20728]	[-1.76862]	[-0.05600]	[0.92154]	[0.19137]	[-1.43852]
D(UNEMPLOYMENT(-1))	-0.000921	-0.003543	0.000515	-0.596637	-0.201970	0.004504	-0.681324
	(0.00260)	(0.00242)	(0.00229)	(0.28129)	(0.25513)	(0.00279)	(1.04050)
	[-0.35356]	[-1.46317]	[0.22484]	[-2.12107]	[-0.79165]	[1.61497]	[-0.65481]
D(DDEFL(-1))	-0.509366	-0.415252	-0.307959	-57.64663	6.730301	0.419241	-4.399033
	(0.19190)	(0.17848)	(0.16885)	(20.7322)	(18.8038)	(0.20556)	(76.6886)
	[-2.65433]	[-2.32656]	[-1.82387]	[-2.78053]	[0.35792]	[2.03947]	[-0.05736]
D(CONS_CONF(-1))	0.001908	0.001143	0.001400	-0.010047	-0.055386	-0.001076	-0.053253
	(0.00062)	(0.00058)	(0.00055)	(0.06700)	(0.06077)	(0.00066)	(0.24782)
	[3.07676]	[1.98182]	[2.56645]	[-0.14996]	[-0.91148]	[-1.61991]	[-0.21488]

End of Table 1

Error Correction:	D(LM2DEFL)	D(LCONS)	D(LWAGED...	D(I)	D(UNEMPL...	D(DDEFL)	D(CONS_C...
C	0.003563	0.002672	0.017117	-5.960194	0.063742	-0.012045	-4.202535
	(0.01227)	(0.01141)	(0.01080)	(1.32552)	(1.20223)	(0.01314)	(4.90312)
	[0.29044]	[0.23415]	[1.58557]	[-4.49648]	[0.05302]	[-0.91645]	[-0.85711]
@TREND(00Q1)	0.003365	0.001550	0.001496	0.228697	-0.068630	-0.000761	0.079822
	(0.00069)	(0.00064)	(0.00061)	(0.07484)	(0.06788)	(0.00074)	(0.27685)
	[4.85734]	[2.40622]	[2.45344]	[3.05561]	[-1.01100]	[-1.02542]	[0.28832]
DUMM08	-0.112136	-0.082189	-0.074419	-2.987085	2.732458	0.046210	-7.758463
	(0.02088)	(0.01942)	(0.01837)	(2.25593)	(2.04609)	(0.02237)	(8.34469)
	[-5.37020]	[-4.23188]	[-4.05045]	[-1.32410]	[1.33545]	[2.06590]	[-0.92975]
UNCERTANTY	-0.003607	0.004051	-0.005562	0.690240	0.111794	0.009454	-0.368151
	(0.00507)	(0.00472)	(0.00446)	(0.54821)	(0.49722)	(0.00544)	(2.02783)
	[-0.71085]	[0.85838]	[-1.24568]	[1.25908]	[0.22484]	[1.73936]	[-0.18155]
R-squared	0.777811	0.791333	0.843541	0.655372	0.144658	0.862412	0.477793
Adj. R-squared	0.656617	0.677514	0.758200	0.467393	-0.321891	0.787363	0.192954
Sum sq. resids	0.004296	0.003717	0.003326	50.14568	41.25092	0.004930	686.1251
S.E. equation	0.013974	0.012997	0.012296	1.509751	1.369322	0.014969	5.584577
F-statistic	6.417891	6.952585	9.884359	3.486407	0.310060	11.49143	1.677410
Log likelihood	107.9309	110.4676	112.4097	-55.95557	-52.53854	105.5235	-101.7378
Akaike AIC	-5.424622	-5.569576	-5.680554	3.940318	3.745060	-5.287058	6.556446
Schwarz SC	-4.846922	-4.991875	-5.102853	4.518019	4.322760	-4.709357	7.134147
Mean dependent	0.037871	0.015822	0.017737	0.149571	-0.008571	-0.001693	-1.180000
S.D. dependent	0.023848	0.022888	0.025005	2.068720	1.190989	0.032463	6.216430

Determinant resid covariance (dof adj.)	2.80E-14
Determinant resid covariance	1.08E-15
Log likelihood	254.9106
Akaike information criterion	-8.566321
Schwarz criterion	-3.900277

Table 2. SUR Estimation

System: ECM
Estimation Method: Seemingly Unrelated Regression
Date: 02/07/11 Time: 23:36
Sample: 2001Q4 2010Q3
Included observations: 36
Total system (balanced) observations 72
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.125341	0.043533	-2.879231	0.0055
C(4)	-0.624267	0.157446	-3.964970	0.0002
C(5)	-0.333510	0.143432	-2.325210	0.0235
C(6)	-0.003570	0.001001	-3.564900	0.0007
C(8)	-0.529071	0.125895	-4.202478	0.0001
C(9)	0.001923	0.000388	4.957960	0.0000
C(11)	0.003320	0.000274	12.11959	0.0000
C(12)	-0.109624	0.012486	-8.779920	0.0000
C(15)	-0.139366	0.039806	-3.501128	0.0009
C(21)	-0.164317	0.066441	-2.473124	0.0163
C(22)	0.000938	0.000355	2.642886	0.0105
C(24)	0.001320	0.000110	11.97677	0.0000
C(25)	-0.068197	0.006574	-10.37390	0.0000
Determinant residual covariance		1.61E-08		

Equation: D(LM2DEFL) = C(1)*(LM2DEFL(-1) - 1*LWAGEDEFL(-1) + 0.00796646679368*I(-1) - 0.0159963560363*UNEMPLOYMENT(-1) - 3.53717390802*DDEFL(-1) - 0.00337694953936*CONS_CONF(-1) - 0.0263811686179*@TREND(00Q1) - 0.606935610289) + C(4) *D(LCONS(-1)) + C(5)*D(LWAGEDEFL(-1)) + C(6)*D(I(-1)) + C(8) *D(DDEFL(-1)) + C(9)*D(CONS_CONF(-1)) + C(11)*@TREND(00Q1) + C(12)*DUMM08

End of Table 2

Observations: 36

R-squared	0.792023	Mean dependent var	0.036282
Adjusted R-squared	0.740029	S.D. dependent var	0.025364
S.E. of regression	0.012932	Sum squared resid	0.004683
Durbin-Watson stat	2.343617		

Equation: D(LCONS) = C(15)*(LCONS(-1) - 0.568627985797 *LWAGEDEFL(-1) + 0.00300197162086*UNEMPLOYMENT(-1) + 1.16289832827*DDEFL(-1) + 0.00157610382946*CONS_CONF(-1) - 0.0035720980905*@TREND(00Q1) - 1.31484284684) + C(21) *D(DDEFL(-1)) + C(22)*D(CONS_CONF(-1)) + C(24)*@TREND(00Q1) + C(25)*DUMM08

Observations: 36

R-squared	0.748195	Mean dependent var	0.015114
Adjusted R-squared	0.715704	S.D. dependent var	0.022954
S.E. of regression	0.012239	Sum squared resid	0.004644
Durbin-Watson stat	2.401081		

PINIGŲ POREIKIO RUMUNIJOS NAMŲ ŪKIUOSE TYRIMAS NAUDOJANT KOINTEGRUOTUS AUTOREGRESINIUS VEKTORIUS

G. Ruxanda, A. Muraru

Santrauka. Autoriai, naudodami kointegruotus autoregresinius vektorius, tyrė pinigų poreikio pokyčius namų ūkiuose. Tyrimuose buvo naudojami tiek tradiciniai, tiek šiam sektoriui būdingi veiksniai. Nustatyti veiksniai, kurie turi didžiausią įtaką namų ūkiams, taip pat identifikuoti nereikšmingi.

Reikšminiai žodžiai: kointegruoti autoregresiniai vektoriai, pinigų poreikis namų ūkiuose, atvirkštinė priklausomybė.

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