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Modeling the impact of money on GDP and inflation in Iran: Vector-error-correction-model (VECM) approach

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Monetary policy is one of the main instruments used by government for obtaining macro-economic goals. Increasing the level of output and employment is the main purpose of Expansionary monetary policy. In this paper, we examine the short-run and long-run effects of money (M2) on inflation and GDP in Iran with four variable vector error correction model. We use quarterly data between 1988Q1 and 2005Q4. Results of estimation indicate that in the short-run M2 has no acceptable effect on output and inflation but in long-run excess supply of money lead to inflation. Impulse response functions imply that effects of money shock remain for 2.5 years but inflation fluctuation is more than one output.

Key words: Vector-error-correction-model, money, co integration.

INTRODUCTION

Expansionary monetary policy and monetary base rising are most important factors that increase money supply in Iran. The volume of monetary base increase in two ways: first the rise of government budget deficit and second foreign assets of central bank that increase by oil price rising. Monetary base increases money supply through money multiplier. On the other hand, money supply decreases the interest rate and increases investment and aggregate demand. Excess demand raises price level, and depending on aggregate supply elasticity can increase the output.

Corrective use of these policies depends on knowing the effect of them on macroeconomic variables and particularly on aggregate output and inflation. So many researches with various methods were done for different countries in the world. Any research or policy analysis exercise in economics must be consistent with the time-series properties of observed macroeconomic data (Hoffman and Rasche, 1997). The co-integration framework has been developed rapidly over the last years. Its fast progress is to a large extent due to its usefulness for applied work. Co-integration is a concept for modeling equilibrium or long-run relations of economic variables. Many economic issues have been reanalyzed using the co-integration tool kit with partly very interesting new findings and insights (Lutkepohl, 2004). The purpose of this paper is to examine empirically the relationships among GDP, M2, and inflation in Iran using a simple vector error correction model.

The paper is structured as follows: we review the subject literature and provide some background and context for researches done until now. VECM methodology was discussed, and the framework for using information from Iran economy and applying the model was lay out in this study. We then concludes the paper.

LITERATURE REVIEW

Each economic school tries to explain the role of money in economy and its effect on inflation and output. Although they are true in some way, trusting their view

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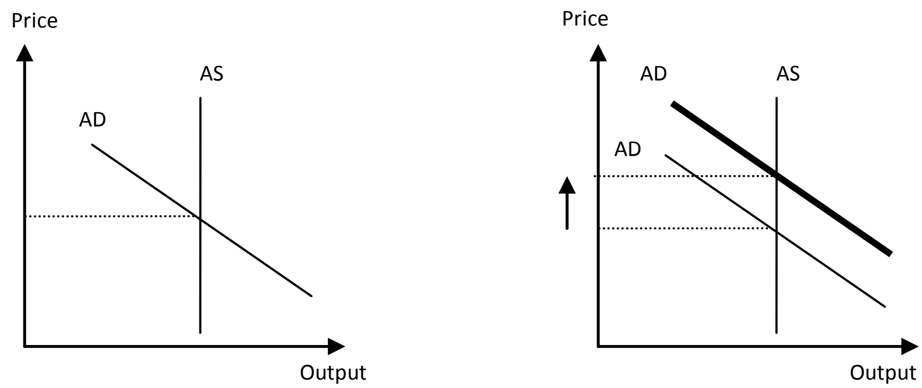

Figure 1. Effect of expansionary monetary policy on price and output in classical school.

Table 1.The relationship of money, output and inflation in economic schools.

Schools	View
Classicals	Money is neutral on output and only increase price
Keynesians	Money affect the output but there is problem like liquidity constraint
New Classicals	just unpredictable monetary policy can affect the output
Monetarists	In short-run money increase output and in long-run lead to inflation

depends on their assumptions (Solow, 1956).

Classical

Economists of this school believe that economy without intervention of government automatically reaches equilibrium. According to this school prices and wages are flexible and supply curve is vertical. So every expansionary demand policies (monetary or fiscal) only increase price and has no effect on output (Figure 1).

Keynesians

Keynes believes that supply does not create demand, so there may be disequilibrium in economy for a long time. Keynesian economists say that because of sticky prices and wages, there is no automatic process to achieve equilibrium but government should move economy to its goal with monetary and fiscal policy. In Keynesians' view money is non-neutral, at least in short-run and can affect output of economy.

Monetarists

This school has tight relationship with Classic and Keynesian schools. Monetarist originates from Fisher theorem that was stated in Classical economists' term.

$$M.V = P.Y \Rightarrow P = (V/Y).M \Rightarrow P = (k).M$$

According to quantity theory of money, when money increases, it only leads to inflation and has no effect on output. But then with understanding that money velocity is not constant, Monetarists got separated from Classical (Friedman, 1956). Monetarists believe that money is the most important factor for short-run changes in output and long-run changes in price (Table 1).

New classical

Barro, Sargent and Lucas are the most famous economists of this school. Albeit most economists believe that monetary policy in short-run can increase output, but economists of this school think differently. This school like Classicals believes that prices and wages are flexible but add rational expectation property to them. Rational expectations discuss predictability of policies versus short-run and long-run conditions. In this school money can affect output in short-run if policy be unpredictable by people and otherwise lead to inflation. We can see this fact in Lucas equation:

Here, we review the idea of economic schools briefly:

Till now, there are so many articles and researches that were done to study the relationships among money, inflation and GDP. The results are different because methods, economies and countries are different. So there is no unit prescription for all in this field. We review sum of the researches that was done in this field in Iran all over the world.

Danehkar and Khataei (1994), Naeini (1993), Afshinnia (1998) and Khashadorian (1998) with rational expectation conclude that in Iran money is neutral and inflation is a monetary phenomenon.

Although this is the first paper that uses VECM for Iran macro-economy, abroad VECM analysis is a widespread method of quantitatively analyzing macro-economic issues. In Canada and U.S. many money papers use new methods like VAR and VECM. Henry (1995), Engert (1996), Mcfail (2000), Adam (2000) and Cote and Lam (2001) use VECM to study Canada economy. Haffman and Rash (1997), Favara(1997), Andrade (2000) and Rodriguez (2000) study the effect of money on output and inflation of U.S in VECM framework. Also VECM used in other countries like Atta-Mensah (2003) for Ghana, Budina (2002) for Romany, Cheng (2002) for Malaysia, Cziraky (2004) for Croatia, Vlaar (2000) for Germany, Jonsson (2001) for South Africa, Yamak (1998) for Turkey and Khan (2006) for Pakistan.

VECM approach was adopted for the purpose of this paper because it solved the non-stationary problem and can eliminate the restrictions of economic theories. It is exactly what we want to judge without bias about economic theories. Nowadays applying this method leads to empirical evidence and basic support of economic theories (Blanchard and Watson, 1986; Bernanke, 1986).

Vector Error Correction Model (VECM)

VECM is a kind of VAR model used with co-integration restrictions. VAR system was made according to empirical rules and statistic information. Lucas (1976) and Sims (1980), critics of traditional econometrics model, developed VAR model. In VAR model all of the variables are endogenous and similar to simultaneous equation. General form of VAR model is:

$$Y_t = A_1.Y_{t-1} + A_2.Y_{t-2} + \ldots + A_p.Y_{t-p} + U_t$$

K: number of endogenous variables
Y: Vector of variables
p: number of lags

VAR model requires stationary variables; so for non-stationary variables their differences are used to avoid spurious regression.

The fact that most of the macro time series are unit roots led to the developing of non-stationary time series theorem. Engel and Granger (1987) show that linear combination of non-stationary variable can be stationary. These time series are co-integrated and the stationary combination called co-integrating equation is interpreted as the long-run relationship between two variables. If there are some non-stationary time series in the model, first of all we should test cointegration. Johansen (1988) outlined a method, which was later expanded by Johansen and Juselius (1990) that allowed for the testing of more than one cointegrating vector in the data and for the calculation of maximum-likelihood estimates of these vectors.

The Johansen-Juselius (JJ) technique decomposes the matrix Π to discover information about the long-run relationships between the variables in Y.

Johansen and Juselius design a maximum-likelihood estimator to obtain estimates of α and β. This procedure also yields two test statistics of the number of statistically significant cointegrating vectors. One test is called the λ-max statistic and compares the null of H0(r) with an alternative of H1(r+1). The second is the trace test, which examines the same null of H0(r) versus an alternative of H1 (Hendry, 1995).

Cointegration is the fundamental of VECM approach. VECM is a kind of VAR where restrictions of cointegration are determined in it, and so called RVAR.

VECM contains both long-run and short-run relations among variables set in vector Y. General form of VECM is:

$$\Delta Y_t = B_1.\Delta Y_{t-1} + \ldots + B_{p-1}.\Delta Y_{t-p+1} + \Pi.Y_{t-p} + U_t$$

$\Pi = \alpha . \beta'$

Bi is the matrix of parameters; Π contains long-run information. The matrix α is the matrix of error correction coefficients. The α parameters measure the speed at which the variables adjust to restore a long-run equilibrium. Matrix β is long-run coefficients. The error correction terms, β′Yt-1, are the mean reverting weighted sums of cointegrating vectors and data dated t-1.

One of the VECM properties and generally VAR model is the ability to study effects of shocks on endogenous variables. Sims (1980) suggests impulse response functions for studying of unpredictable policy shocks on macro variables. IRF shows the reaction of one variable to stochastic element in time. In VAR model with setting all of variable in one side of equation and other side stochastic elements we can exceed IRFs.

$$\begin{bmatrix} M_t \\ P_t \end{bmatrix} = \begin{bmatrix} \alpha_1 & \beta_1 \\ \alpha_2 & \beta_2 \end{bmatrix} . \begin{bmatrix} M_{t-1} \\ P_{t-1} \end{bmatrix} + \begin{bmatrix} u_{1,t} \\ u_{2,t} \end{bmatrix} \Rightarrow$$

$$\begin{bmatrix} M_t \\ P_t \end{bmatrix} = \begin{bmatrix} 1-\alpha_1 L & -\beta_1 L \\ -\alpha_2 L & 1-\beta_2 L \end{bmatrix}^{-1} . \begin{bmatrix} u_{1,t} \\ u_{2,t} \end{bmatrix}$$

As opposed to the traditional VAR literature, the computation of the impulse response functions is based on the VECM representation where the estimated long-run restrictions are taken into account. This allows us to examine the effect of a variable-specific shock on the individual variables as well as on the estimated cointegrating relationships (Pesaran and Shin, 1996).

Table 2. Augmented Dickey-Fuller tests.

Variables		LER	LM2	LGDP	LCPI
Level	T-statistics Level	------	-1. 9318	-2. 6271	-0. 58717
Difference	(Critical values 95% = -3.4779)	-8.0218	-14. 3935	-10. 2064	-12.0006

Table 3. Cointegration tests.

H_0	H_1	Form 2	Form 3	Form 4
λ_{tarce}				
r = 0	r>= 1	132.0508	109.8615	131.3872
r<= 1	r>= 2	57.2045	35.1561	45.1191
r<= 2	r>= 3	23.9109	**10. 2127**	19.1289
r<= 3	r>= 4	8.7436	.23021	8.5480
λ_{max}				
r = 0	r = 1	74.8463	74.7055	86.2681
r<= 1	r = 2	33.2936	24.9434	25.9902
r<= 2	r = 3	15.1673	**9. 9824**	10.5809
r<= 3	r = 4	8.7436	0.23021	8.5480

EMPIRICAL RESULTS

We want to examine the effect of M2 on inflation and GDP using four variables VECM framework. The variables that we use in this paper in logarithm form are: Gross domestic production (GDP), Inflation (CPI), Exchange rate (ER) and abroad money (M2). Data are quarterly period of 1988Q1- 2005Q4. Data are taken from IFS base and Central Bank accounts of Iran.

At first we test the stationary of variables. Stationary tests are correlogram, Ljung-Box, Ljung-pierse, DF, ADF (Dickey and Fuller, 1979) and Philips-Perron.

Correlogram test shows that all of variables are non-stationary (Figure 1: Appendix). For more examination we use ADF test. ADF results show that all variables are non-stationary but their difference is stationary (Table 2). LER has break in its diagram and disturbs ADF so we use Philips-Perron test and conclude it is non-stationary.

All variables have unit root so it is time to test the cointegration with Johansen test (Table 3). Before testing we should determine general form as optimal lag, dummy variable, constant and time trend. In order to determine optimal lag in experimental research, each of the equations was estimated by OLS method and maximum acceptable lag was chosen as optimal lag. Lag 3 was accepted as optimal lag for GDP, ER and for model generally. With this lag, VECM form of this study is:

$$\Delta Y_t = B_1.\Delta Y_{t-1} + B_2.\Delta Y_{t-2} + \Pi.Y_{t-3} + U_t$$

$$\Delta Y_t = \begin{bmatrix} \Delta M2_t \\ \Delta ER_t \\ \Delta CPI_t \\ \Delta GDP_t \end{bmatrix}$$

There is some break in some variables. We make dummy variables and study their meaning with chow test. Figure 2 of Appendix shows the result of chow test. DUM72 is accepted and intercepts the model. Generally a VECM model can include intercept and trend in both short-run and long-run. So generally there are five forms:

1. No intercept and no trend : $\mu 2 = \delta 2 = \mu 1 = \delta 1 = 0$
2. Restricted intercepts and no trends : $\mu 2 = \delta 2 = \delta 1 = 0$
3. Unrestricted intercepts and no trends: $\delta 2 = \delta 1 = 0$
4. Unrestricted intercepts and restricted trends: $\delta 2 = 0$
5. Unrestricted intercepts and trends

First and last forms are exception, so we test other forms with Microfit software. Microfit determines both form of model and number of cointegrating vector simultaneously.

The hypothesis of one vector is accepted in all forms but two vectors were accepted in form 3. Johansen with two statistic test (Max and Trace) exceeded two cointegrating vectors. The result of Trace test is shown in Appendix Table 1. According to max test, there are two cointegrating vectors. So we can make four variable vector error correction model.

VECM formed with two cointegrating vectors and 3 optimal lag is like:

$$\begin{bmatrix} \Delta M2t \\ \Delta ER t \\ \Delta CPI\ t \\ \Delta GDP t \end{bmatrix} = B_1 \cdot \begin{bmatrix} \Delta M2\ t-1 \\ \Delta ER\ t-1 \\ \Delta CPI\ t-1 \\ \Delta GDP\ t-1 \end{bmatrix} + B2 \cdot \begin{bmatrix} \Delta M2\ t-2 \\ \Delta ER\ t-2 \\ \Delta CPI\ t-2 \\ \Delta GDP\ t-2 \end{bmatrix} + \begin{bmatrix} \alpha 11 & \alpha 12 \\ \alpha 21 & \alpha 22 \\ \alpha 31 & \alpha 32 \\ \alpha 41 & \alpha 42 \end{bmatrix} \cdot \begin{bmatrix} \beta 11 & \beta 21 & \beta 31 & \beta 41 \\ \beta 12 & \beta 22 & \beta 32 & \beta 42 \end{bmatrix} \cdot \begin{bmatrix} M2t-3 \\ ERt-3 \\ CPI\ t-3 \\ GDP t-3 \end{bmatrix} + \begin{bmatrix} u_{1t} \\ u2_t \\ u3_t \\ u4_t \end{bmatrix}$$

Table 4. Unrestricted cointegrationvectors.

Variable	Vector 1	Vector 2
LM2	-1.518	0.1822
LER	0.307	-0.008
LCPI	1.3273	-0.606
LGDP	1.1483	0.7113

Table 5. Estimates of short-run coefficients.

Equations/Variable	LGDP	LCPI
Intercept	0.7502 -2.733	-1. 3257 (-2.9392)
ΔLM2(-1)	0.0667 -0.438	0.1041 -0.416
ΔLER(-1)	0.0089 -0.727	0.0082 -0.403
ΔLCPI(-1)	0.0989 -1.282	-0. 46429 (-3.6586)
ΔLGDP(-1)	-0. 2935 (-2.0272)	-0.465 (-1.9566)
ΔLM2(-2)	-0.03 (-0.1982)	0.3553 -1.42
ΔLER(-2)	-0.002 (-0.1799)	-0.033 (-1.6458)
ΔLCPI(-2)	0. 3305 -4.018	-0. 32587 (-2.4108)
ΔLGDP(-2)	-0.19 (-1.355)	0.1464 -0.636
ecm1(-1)	0.0099 -0.203	-0.141 (-1.7585)
ecm2(-1)	-0. 0947 (-2.0937)	0.0974 -1.309
DUM72	-0.04 (-1.05)	0.1276 -2.055

Cointegrating vectors (rows of matrix β) estimated by maximum-likelihood is seen in Table 4.

It should be known that whether these vectors are unique or not, their economic interpretation is important. Understanding the long-run effect of money, we impose some restrictions to vectors coefficient like equalization to zero. Imposed restrictions to first and second vector are:

Vector 1: a3=1,a4=0
Vector 2: b3=0,b4=1

Result of these restriction is in Appendix Table 4. According to this result, money affects inflation with 0.78 coefficient and affects GDP with 0.41 coefficient in second vector. It means that one unit increase in M2 increases CPI to about 0.78 unit. It emphasizes the fact that inflation in long-run is a monetary phenomenon. We can write the long-run inflation and GDP function as:

LCPI = -0.139*LER + 0.785*LM2
LGDP = -0.106*LER + 0.413*LM2

VECM also enables us to study the short-run relationship among variables. Microfit estimates short-run coefficients by OLS method (Table 5).

According to the result, in short-run money (M2) has no meaningful effect on GDP and CPI. But both of these variables were extremely affected by lag.

The role of monetary shocks

One of our purposes in this research is examining the monetary shocks on macro variables. Monetary shocks happen when monetary base increases (because of increasing oil income or Gov budget deficit). Monetary base increases M2 through money multiplier. So, monetary policy is different from monetary shocks. A monetary shock can make changes in variables that often remain for long time. So studying shock effects is important for monetary authorities to choose suitable policy. We examine the responses of the inflation and GDP to money supply shocks (impulse response analysis). Microfit yields IRF and shows the effect of one standard deviation shock of log of M2 on macro variables (Table 7 in Appendix). The results indicate that fluctuations in CPI are stronger than GDP but both of these shocks remain for 10 quarter (two and half year).

Figure 2 shows diagram of GDP response to money shock. Fluctuations are reduced and eliminated with time. Response of inflation shows that money shock creates stronger fluctuation in this variable. But like GDP after 10 quarter it disappears (Figure 3).

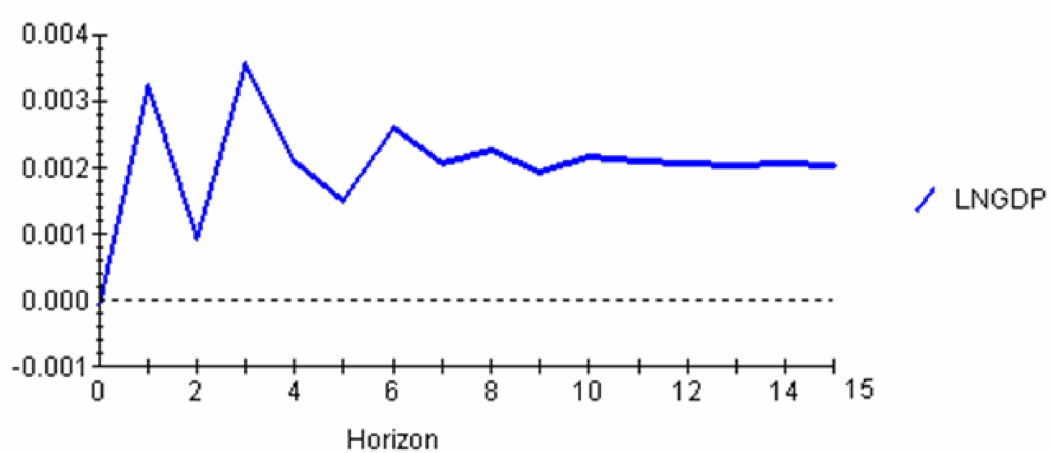

Figure 2. Generalized Impulse Response(s) to one S.E. shock in LGDP equation for LM2.

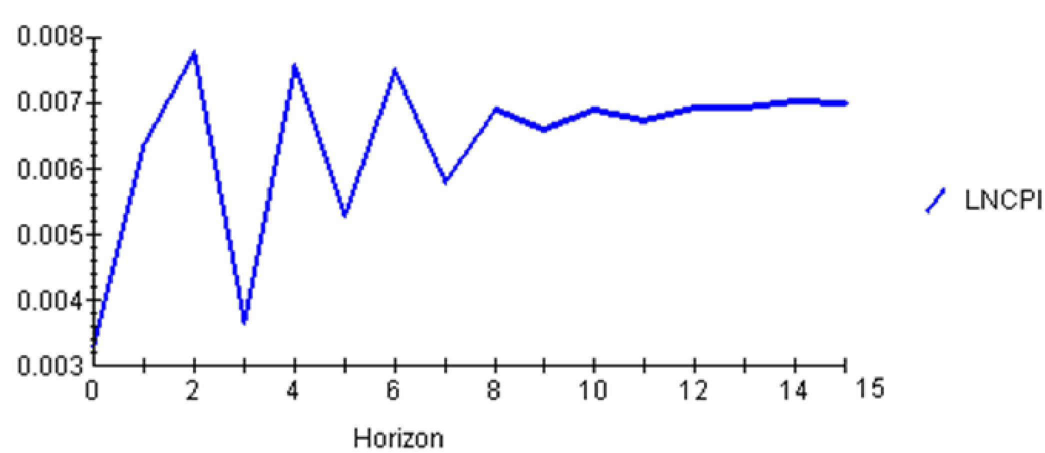

Figure 3. Generalized Impulse Response(s) to one S.E. shock in LCPI equation for LM2.

The time length of money shock suggests that government must attend to monetary shocks and try to keep out shocks from economy.

Conclusion

The effect of money on inflation and GDP in Iran is the main purpose of this study. First of all it is proved that all variables are non-stationary. Next two cointegrating vectors are derived from Johansen-Juselius test. According to obtained long-run equations, abroad money (M2) affects inflation with 0.74 coefficient. In short-run the estimate results of VECM show that money has no meaningful effect on these variables. On the other hand, both of them were affected by lag quantity themselves. It is concluded that in Iran, in the long run, excess creation of money is bound to lead to inflation but in the short run the links may not be as tight. Other tight monetary policies are suggested for controlling inflation.

Because of the powerful effect of money base on moving M2, something must be done to neutralize the effects of monetary base components particularly oil income and budget deficit increase. So managing budget and decreasing the government volume can stop money shocks. Impulse response functions showed that money shocks make fluctuations in GDP and inflation to remain for 10 quarters. So it is necessary for monetary authorities to look at the future.

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Appendix

Table 1. Johansen test (Trace statistics)

Cointegration with unrestricted intercepts and no trends in the VAR				
Cointegration LR Test Based on Trace of the Stochastic Matrix				
***				
69 observations from 1367Q4 to 1384Q4. Order of VAR = 3.				
List of variables included in the cointegrating vector:				
LNM2	LNER	LNCPI	LNGDP	
List of I(0) variables included in the VAR:				
DUM72				
List of eigenvalues in descending order:				
.66132	.30337	.13469	.0033308	
***				
Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	109.8615	48.8800	45.7000
r<= 1	r>= 2	35.1561	31.5400	28.7800
r<= 2	r>= 3	10.2127	17.8600	15.7500
r<= 3	r = 4	0.23021	8.0700	6.5000
***				
Use the above table to determine r (the number of cointegrating vectors).				

Table 2. Estimate matrix Π.

Variables	LGDP	LCPI	LER	LM2
LM2	0.06225	-0.03885	0.00123	0.00481
LER	-2.247	-2.698	-0.61481	3.0486
LCPI	0.09739	-0.14128	-0.00925	0.07078
LGDP	-0.0947	0.0099	-0.0087	0.03136

Table 3. Estimated cointegrated vectors in Johansen estimation.

```
     Cointegration with unrestricted intercepts and no trends in the VAR
*****************************************************************************
 69 observations from 1367Q4 to 1384Q4. Order of VAR = 3, chosen r =2.
 List of variables included in the cointegrating vector:
 LNM2            LNER            LNCPI           LNGDP
 List of I(0) variables included in the VAR:
 DUM72
*****************************************************************************
                  Vector  1      Vector  2
 LNM2                -1.5175         .18221
                  (  -1.0000)    (  -1.0000)

 LNER                 .30702      -.0083405
                  (   .20233)    (  .045775)

 LNCPI                1.3273        -.60582
                  (   .87471)    (   3.3249)

 LNGDP                1.1483         .71133
                  (   .75672)    (  -3.9040)

*****************************************************************************
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Table 4. ML estimates subject to exactly identifying restrictions.

```
      Estimates of Restricted Cointegrating Relations (SE's in Brackets)
                     Converged after 2 iterations
      Cointegration with unrestricted intercepts and no trends in the VAR
*****************************************************************************
 69 observations from 1367Q4 to 1384Q4. Order of VAR = 3, chosen r =2.
 List of variables included in the cointegrating vector:
 LNM2             LNER             LNCPI            LNGDP
 List of I(0) variables included in the VAR:
 DUM72
*****************************************************************************
 List of imposed restriction(s) on cointegrating vectors:
 a3=1; a4=0; b3=0; b4=1
*****************************************************************************
                   Vector  1      Vector  2
 LNM2                 -.78584        -.41313
                   (   .11744)    (   .13397)

 LNER                  .13902         .10668
                   (  .085095)    (  .097055)

 LNCPI                 1.0000           0.00
                   (   *NONE*)    (   *NONE*)

 LNGDP                   0.00         1.0000
                   (   *NONE*)    (   *NONE*)

*****************************************************************************
 LL subject to exactly identifying restrictions= 429.2503
*****************************************************************************
```

Table 5. Short-run CPI equation.

ECM for variable LNCPI estimated by OLS based on cointegratingVAR(3)			
**			
Dependent variable is dLNCPI			
69 observations used for estimation from 1367Q4 to 1384Q4			
**			
Regressor	Coefficient	Standard Error	T-Ratio[Prob]
Intercept	-1.3257	.45103	-2.9392[.005]
dLNM21	.10405	.25038	.41554[.679]
dLNER1	.0081771	.020306	.40270[.689]
dLNCPI1	-.46429	.12690	-3.6586[.001]
dLNGDP1	-.46548	.23790	-1.9566[.055]
dLNM22	.35529	.25020	1.4200[.161]
dLNER2	-.032528	.019765	-1.6458[.105]
dLNCPI2	-.32587	.13517	-2.4108[.019]
dLNGDP2	.14643	.23035	.63569[.528]
ecm1(-1)	-.14128	.080340	-1.7585[.084]
ecm2(-1)	.097394	.074378	1.3094[.196]
DUM72	.12757	.062070	2.0553[.044]
**			
R-Squared	.40728	R-Bar-Squared	.29290
S.E. of Regression	.055064	F-stat.F(11, 57)	3.5607[.001]
Mean of Dependent Variable	.044632	S.D. of Dependent Variable	.065482
Residual Sum of Squares	.17282	Equation Log-likelihood	108.7341
Akaike Info. Criterion	96.7341	Schwarz Bayesian Criterion	83.3295
DW-statistic	2.0397	System Log-likelihood	429.2503
**			

Table 6. Short-run GDP equation.

ECM for variable LNGDP estimated by OLS based on cointegratingVAR(3)					
***					
Dependent variable is dLNGDP					
69 observations used for estimation from 1367Q4 to 1384Q4					
***					
Regressor	Coefficient	Standard Error	T-Ratio[Prob]		
Intercept	.75023	.27451	2.7330[.008]		
dLNM21	.066722	.15239	.43784[.663]		
dLNER1	.0089840	.012359	.72694[.470]		
dLNCPI1	.098978	.077235	1.2815[.205]		
dLNGDP1	-.29352	.14479	-2.0272[.047]		
dLNM22	-.030183	.15228	-.19821[.844]		
dLNER2	-.0021643	.012029	-.17992[.858]		
dLNCPI2	.33058	.082267	4.0184[.000]		
dLNGDP2	-.19003	.14019	-1.3555[.181]		
ecm1(-1)	.0099159	.048897	.20279[.840]		
ecm2(-1)	-.094777	.045268	-2.0937[.041]		
DUM72	-.039696	.037777	-1.0508[.298]		
***					
R-Squared		.37757	R-Bar-Squared	.	25745
S.E. of Regression		.033513	F-stat.F(11, 57)		3.1433[.002]
Mean of Dependent Variable		.012113	S.D. of Dependent Variable		.038891
Residual Sum of Squares		.064017	Equation Log-likelihood		142.9970
Akaike Info. Criterion		130.9970	Schwarz Bayesian Criterion		117.5923
DW-statistic		2.1538	System Log-likelihood		429.2503

Table 7. Impulse response functions.

Generalized Impulse Response(s) to one S.E. shock in the equation for LNM2 Cointegration with unrestricted intercepts and no trends in the VAR				
***				
69 observations from 1367Q4 to 1384Q4. Order of VAR = 3, chosen r =2.				
List of variables included in the cointegrating vector:				
LNM2	LNER	LNCPI	LNGDP	
List of I(0) variables included in the VAR:				
DUM72				
***				
List of imposed restrictions:				
a3=1;a4=0;b3=0;b4=1				
***				
Horizon	LNM2	LNER	LNCPI	LNGDP
0	.029330	.087509	.0033184	-.3879E-4
1	.013114	.072890	.0063570	.0032365
2	.024698	.063519	.0077733	.9235E-3
3	.016721	.080984	.0036770	.0035439
4	.022335	.063741	.0075521	.0020902
5	.018862	.062296	.0053169	.0014917
6	.021241	.068233	.0074930	.0025855
7	.019627	.064118	.0057890	.0020743
8	.020824	.066524	.0069000	.0022543
9	.020111	.062936	.0065885	.0019314
10	.020633	.065399	.0068900	.0021707
11	.020309	.064385	.0067242	.0021137
12	.020588	.064342	.0069259	.0020574
13	.020449	.063992	.0069345	.0020377
14	.020577	.064172	.0070233	.0020592
15	.020524	.064013	.0070145	.0020428
***				

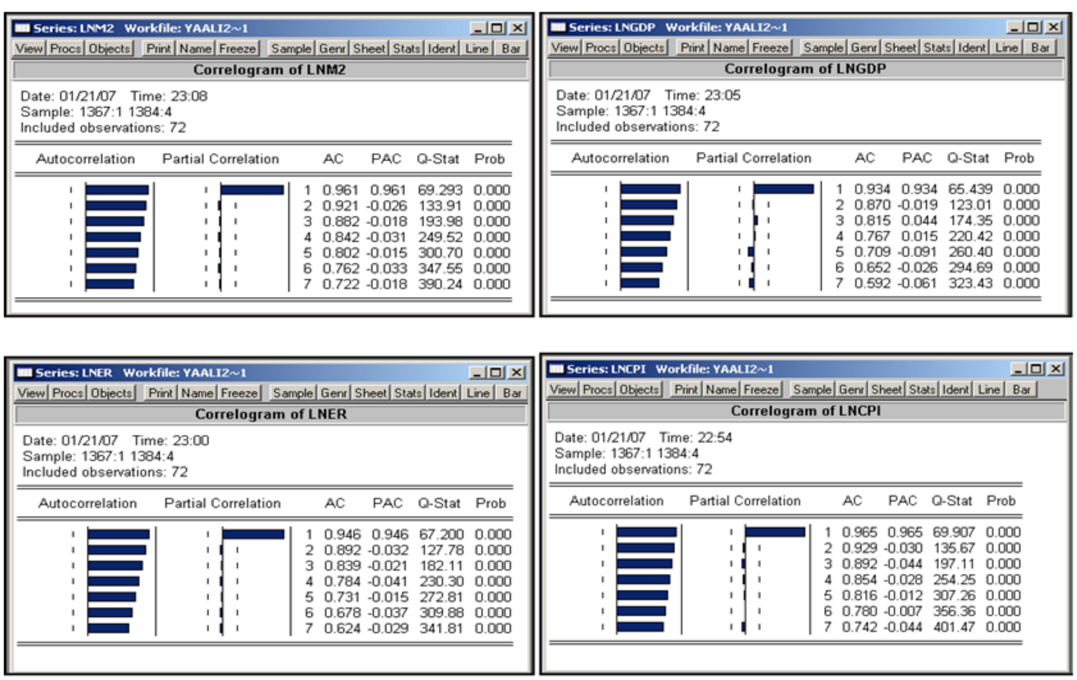

Figure 1. Correlogram test.

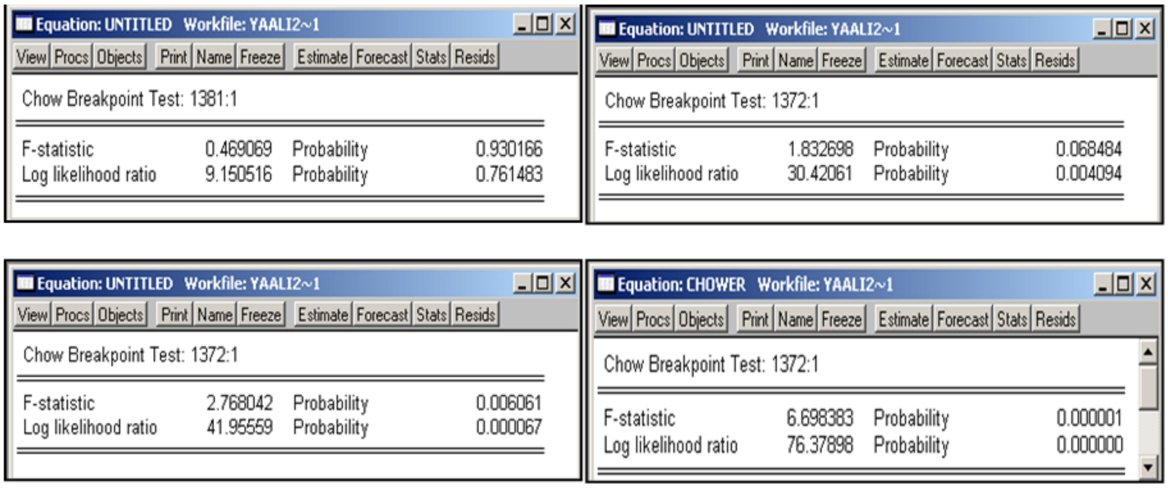

Figure 2. Chow test.