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Trade-off between the exchange rate and inflation

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Abstract

Since Romania embarked the economic path of structural reforms at the start of the transition, its aim is to gain full European Union membership and integrate the single European currency area. Though Romania is generally considered to be at the bottom of the European candidate list of transition countries ready for accession, having experienced the worst economic performances so far, some optimistic views consider 2007 as a reasonable year for accession. This paper focuses on the dynamics of the convergence of both the exchange rate and inflation to the optimum pre-accession requirements revealing the trade-off existing between those two macroeconomic variables both in the short and the long term.

The main findings of the paper are that as Romania prepares from next year to adopt a new policy regime (that of inflation targeting) it has to implement and make use of an adequate interest rate policy as the instrument to fight-off inflation pressure considering the short-run trade-off between the two mentioned above. In the long run, I show that though the appreciation of the real exchange rate has been part due to productivity gains only since approximately 2000, it can develop into a trade-off effect, as mentioned, with negative impact on the stability of both the exchange rate and inflation as required for entry into the monetary union.

CONTENTS

1. Introduction

The desire to join the European Union and the European Monetary System is nearly universal among the transition economy political leadership and populations as a whole. Since the beginning of the 1990s, the Central and Eastern European countries (CEECs) have aimed at future membership in the European Union (EU). After more than ten years of economic reform, most of the acceding countries have largely succeeded in adjusting their economies to market principles, at a lesser extent being Romania and Bulgaria which lag behind in the reform process. As a result, the EU started membership negotiations with five CEECs in 1998, which were extended to all ten associated countries about two years later[1].

The European Union, including the Eurosystem, has outlined a three-step approach to the monetary integration of the candidate countries from Central and Eastern Europe, which is described in more detail by Backe´ and Radzyner (1998) and Backe´ (1999). The applicants will first join the EU, then enter the exchange rate mechanism (ERM II) of the European Union and finally, after fulfillment of the Maastricht convergence criteria, accede to the Euro area, i.e. participate fully in Economic and Monetary Union (EMU).

In Helsinki, in December 1999, Romania was invited to start admission negotiations with the European Union. Although an official accession date has not yet been decided, the most optimistic forecasts would set it around the year 2007. By this date it will face the monetary integration challenge, a process that may last a few more years. In the current decade, Romania should undertake important structural transformations in order to set its economy in line with Western ones. Fast integration requires the fulfillment of a set of social, political and economic criteria. Essential economic criteria are a low inflation rate, low public debt and deficits, low interest rates and a stable currency against the Euro. Less explicit, but also very important, it should reduce gaps vis-à-vis the Western partners, in order to be able to comply with obligations related to the participation to the Western club.

Unfortunately, given a limited number of instruments and resources, these goals may sometimes be conflicting and policy choices should take into account the trade-off between them. Using Romania's recent economic experience, I specify and estimate several vector

[1] Ten of thirteen candidates have already been invited to join the European Union.. These ten are Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia. Bulgaria, Romania and Turkey are not considered ready yet.

autoregressive models that focus on the effectiveness of the monetary mechanisms and instruments available in a possible inflation targeting framework as it is forecasted to happen. The resulting dynamic responses to the identified interest rate policy shock as well as to interventions on the foreign exchange market are shown to lead to conflicting results, both of the instruments displaying short-run trade-off effects between inflation and the exchange rate.

On the advantages of joining the Euro zone there has been written a lot of literature and have been issued useful theories concerning the exact timing of adopting the single currency. The theory of optimum currency areas (OCA)[2], which was developed by Mundell (1961) and McKinnon (1963), has become particularly popular for analyses of the costs and benefits of monetary integration, in particular with reference to EMU. However all these advantages are not taken for granted but the convergence to the economic criteria has to be made into a more adverse economic environment than that of the last accessions[3]. The economic distance for the new entrants to catch-up is much larger than for any other previous entrants to the EU and also the previous accessions allowed for a larger menu of options; ERM membership was not required and also EMU was not in existence. That is fixing the exchange rate and later abandoning the domestic currency. The rate at which the currency is pegged is critical. If the domestic currency is overvalued the domestic industry will not be competitive and be forced into bankruptcy. Similarly if the domestic currency is undervalued then domestic firms producing exportable goods and services will enjoy a competitive advantage to the detriment of other domestic firms and EU member country firms. These highlight another important aspect of the accession process: in a developing economy, one which is catching up with the income levels in the more economically advanced countries, productivity in the sectors producing tradable goods will tend to rise faster than in those producing non-tradable. Since wage increases tend to be more or less the same in all sectors, inflation will be relatively higher in the non-tradable sector, an effect that will be strengthened if demand in a growing economy is biased towards services. The

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[2] A comprehensive study about the OCA is found in 'More "Pre-Ins" Ante Portas?' by Jarko Fidrmuc and Franz Schardax

[3] Greece, Portugal and Spain were the last to join the EU

result is that relatively faster productivity growth in the tradable sector will lead not only to an unavoidably higher inflation rate for non-tradable but also to a real appreciation of the exchange rate. The hypothesis, known as the Balassa – Samuelson, deserved a lot of attention[4] recently through a series of studies suggesting that the faster appreciation of the real exchange rate of the accession countries compared with the Western ones will cause a real trade-off between the exchange rate and inflation during the two-year ERM membership period. The question that naturally arises, is that given the weak economic performance of Romania, could we still talk of real inflationary pressure as due to the Balassa – Samuelson effect? Co-integration analysis under PPP theory is used to argue that the real appreciation of the Romanian leu against the US dollar can be explained as the correction of an undervalued currency, with no evidence of an appreciation in the equilibrium real exchange rate so far as the forecast of 2000. The strong form of the PPP doctrine cannot be rejected; the leu–dollar exchange rate and the Romanian–US price differential appear to move together in the long run. The error correction equations indicate that the adjustment to the real exchange rate is due to changes in Romanian inflation and not to movements in the nominal exchange rate.

The paper is organized as follows. After presenting some technical aspects concerning IT in Romania, in the third part I will introduce the first econometric estimation. The fourth part will interpret the effects of the monetary policy instruments from the data. The following section will deal with the PPP theory against the Ballassa-Samuelson hypothesis. In the fifth part, results are obtained and discussed from the second econometric estimation. Section seven will conclude.

2. Technical aspects of IT in Romania

In the 90's, the continuing request for price stability as a basis for solid economic growth, led to the adoption of several central banks of a new strategy of monetary policy, specifically *inflation targeting*. As an engagement for the nominal and real convergence to the conditions imposed by the integration within the single currency area, the Romanian government stated in its 2001 "Economic program of pre-accession" that inflation targeting would be the first option in the policy strategy of the NBR for the years 2003-2004, on the

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[4] Halpern & Wyplosz (1997, 2001), Egert Balasz (2002), Fischer C. (2002) etc.

basis of solid previous victories in the disinflation process, accompanied by a perseverant and coherent discipline of the macroeconomic policies.

As a general guideline, IT[5] requires that the monetary authorities announce a numerical target for the inflation rate (point or range). They must have a strong and credible commitment to price stability as the prime objective of the central bank accompanied with central bank independence and more transparent and clear communication with the public and the markets detailing the instruments that will be used to achieve and maintain the inflation target.

Currently among the East-European acceding countries, Czech Republic, Hungry and Poland are all using IT as their monetary policy regime. Given the strong pace of adoption over the past five years, the literature has moved from analyzing implementation issues[6] to analyzing the technical issues of how IT should be practiced in emerging markets and how recommendable it is for these countries to have it and for others to adopt it.

Basically the literature on IT can be separated in two[7] categories. In the first category the monetary authority uses interest rate policy as the instrument variable to implement and control the inflation target; the interest rate reacts to output and inflation gaps, and in the case of open economies they include, sometimes, a nominal or a real exchange rate gap. The second type illustrates when the monetary authorities use international reserves as the instrument to influence the nominal exchange rate in such a way that the depreciation rate matches the necessary rate to comply with the overall inflation target.

Some emerging markets that use IT as their monetary policy regime explicitly announce which of the two instruments they will use and therefore an interesting question arises: Is one better than the other or are they equal? I find that there are important

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[5] A detailed research on the opportunity of implementing the new policy regime in Romania was conducted by Dr. Cristian Popa et al. from the NBR - "Inflation Targeting: A new strategy of monetary policy – Romania's case" April 2002

[6] The implementation issues refer to how well these countries meet basic requirements for Inflation Targeting, Masson, Savastano and Sharma (1997) laid the foundation for these analysis and others like Mishkin and Savastano (2001) and Agenor (2000) followed their lead. The initial conclusion was that these countries did not need the requirements, basically they lacked central bank independence and could not commit to having low and stable inflation rates as the overriding objective of the monetary policy. After a few years these conditions have changed to some extend and the current conclusion is that some emerging economies meet the requirements.

[7] Javier A. Reyes (2002) uses the case of an open economy with two goods, home and traded, to address this issue.

differences between these choices in Romania's case and that the answer to the question about which one is better depends on the availability of the economic tools to alter the inflation, given the underdeveloped and weak financial system of Romania's economy.

Regarding exchange rate issues, Eichengreen (2001) is the first to emphasize that the differences should be taken seriously when analyzing IT in emerging economies. The analysis should take into account the differences between open-economy and developing country aspects. He addresses the question of how the simple closed economy IT framework should be extended to take into account the shocks that emerging economies are prone to. As a condition of the new regime, the exchange rate will be forced to float freely. Fisher (2002) notices that most of the countries forced to float have been very unhappy about the subsequent behavior of the exchange rate. Specifically the analysis of IT in emerging economies should consider the higher pass-through effect from the exchange rate movements into inflation pressure, the difficulty of forecasting inflation in a volatile environment and liability dollarization and euroization.. Different shocks cause exchange rate movements and threaten to destabilize the economy, and the central bank will be unwilling to let the exchange rate move. In other words it will intervene directly or indirectly in the foreign exchange market.

However, the volume and the frequency of the transactions of the NBR in the foreign exchange market exceed what we normally can see as specific to a managed float regime[8]. In mature market economies, the central bank resorts to interventions in the foreign exchange market only in exceptional cases, and tries to influence the exchange rate by monetary policy, in particular by managing short-term interest rates. But given that in Romania the Treasury bonds market is quite thin and the banking sector does not demand refinancing credits, the central bank had limited control over market determined short-term interest rates. Moreover the interest channel – used by all banks which adopted the IT strategy – has been altered in the last years by the position of net debtor of the NBR towards the banking system; interest rates used in the sterilization operations of NBR have proved their efficiency guiding the market for the first time in 2001[9], but it cannot be said that the central bank has yet an efficient instrument in conducting its monetary policy through which

[8] Romania has retained a managed float regime since the early years of transition, with no pre-announced exchange rate path

[9] See Cristian Popa and al (2002) for a more complete discussion on the efficiency of interest rates in Romania

to signal the orientation of its monetary policy or influence the formation of the inflation expectations. However as Fisher (2002) puts it, there is an unresolved issue about whether monetary policy in a flexible rate system should be used in the short run to try to affect the exchange rate, because there is almost certainly a short-run trade-off between the exchange-rate and inflation.[10]

Therefore I will proceed in my paper to analyze how those two instruments will work in the framework of the Romanian economy with the evidence that in both cases a trade-off effect between the exchange rate and inflation, will alter their effectiveness in the fight-off against inflation pressures.

3. Econometric estimation (I)

3.1. VAR methodology

The econometric methodology adopted in the first part is that of Vector Autoregressive (VAR). The choice for this methodology is justified by the nature of the investigation. Macroeconomic phenomena manifest as dynamic systems, with feed-back and reciprocal causality. VAR models focus on the analysis of the "innovations" on the variables under study. Shocks or innovations represent that part of a variable that cannot be explained by past values of itself or other variables in the system. An innovation is therefore an error term (residual) in the stochastic equation of the system. Considering the simple bivariate system:

$$y_t = b_{10} - b_{12}* z_t + \gamma_{11}*y_{t-1} + \gamma_{12}*z_{t-1} + \varepsilon_{yt} \qquad (3.1)$$

$$z_t = b_{20} - b_{21}* y_t + \gamma_{21}*y_{t-1} + \gamma_{22}*z_{t-1} + \varepsilon_{zt} \qquad (3.2)$$

ε_{yt}, ε_{zt} represent the shocks (innovations) at "t" moment on the variables y_t, z_t respectively. The model above is a VAR in structural form where it is assumed (1) that both y_t, z_t are stationary; (2) ε_{yt} and ε_{zt} are white–noise disturbances with standard deviations of σ_y and σ_z respectively; and (3) $\{\varepsilon_{yt}\}$ and $\{\varepsilon_{zt}\}$ are uncorrelated white–noise disturbances.

Equations (3.1) and (3.2) are not reduced form equations since y_t has a contemporaneous effect on z_t and z_t has a contemporaneous effect on y_t. Fortunately, it is possible to transform the system of equations into a more usable form. Using matrix algebra, we can write the system in the compact form:

[10] Based on the paper by Cushman and Zha (1997), Fisher notices the implied tradeoff in the Canadian case

$Bx_t = \Gamma_0 + \Gamma_1 x_{t-1} + \varepsilon_t$ where

$$B = \begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix} \quad x_t = \begin{bmatrix} y_t \\ z_t \end{bmatrix} \quad \Gamma_0 = \begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix} \quad \Gamma_1 = \begin{bmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \end{bmatrix} \quad \varepsilon_t = \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \end{bmatrix}$$

Premultiplication by B^{-1} allows us to obtain the VAR in standard form :

$x_t = A_0 + A_1 x_{t-1} + e_t$ (3.3)

where $A_0 = B^{-1}\Gamma_0$, $A_1 = B^{-1}\Gamma_1$, $e_t = B^{-1}\varepsilon_t$

Using the new notation the following system of equations results:

$$y_t = a_{10} + a_{11}*y_{t-1} + a_{12}*z_{t-1} + e_{1t} \quad (3.4)$$

$$z_t = a_{20} + a_{21}*y_{t-1} + a_{22}*z_{t-1} + e_{2t} \quad (3.5)$$

The new system is a VAR in standard form where the two error terms (i.e. e_{1t} and e_{2t}) are composites of the two shocks ε_{yt} and ε_{zt}. Since ε_{yt} and ε_{zt} are white-noise processes it follows that both e_{1t} and e_{2t} have zero means, constant variances, and are individually serially uncorrelated. A critical point to note is that the errors from the model in standard form in comparison with the ones from the structural VAR may be correlated since they are in fact forecast errors.[11]

The main purpose of the VAR analysis is that of evaluating the impact of different shocks on the variables in the system. As shown in the models above each variable is affected by innovations of its own and also by shocks in the other variables. Therefore we will be able to analyze how shocks of the interest rate and monetary aggregate affect variables like inflation and the exchange rate.

VAR analysis leads to three different type of results: the impulse response function, forecast error variance decomposition and Pairwise Granger causality tests.

The impulse response function (IRF) allows one to trace out the time path of the various shocks on the variables contained in the VAR system. Main info contained in an IRF refers to the sign of the response (positive or negative) and to the duration of the effects cause by different shocks.

Variance decomposition (VD) tells the proportion of the movements in a sequence due to its "own" shocks versus shocks to other variables. If ε_{zt} shocks explain none of the forecast error variance of $\{y_t\}$ at all forecast horizons, we can say that the $\{y_t\}$ sequence is exogenous.

Together, impulse response analysis and variance decomposition are called *innovation accounting* and are useful tools to examine the relationships among economic variables.

Granger causality tests show whether lags of one variable enter the equation of another variable. Thus, if $\{y_t\}$ does not improve the forecasting performance of $\{z_t\}$, then $\{y_t\}$ does not Granger cause $\{z_t\}$.

3.2. Data

My data run monthly from 1996:01 to 2003:01. The period was chosen taking into account the conditions existing before as administrative prices were heavily in place but also for the need for more data and degrees of freedom. Cause of the limitation of data, I have not used VARs with more than 5 variables.

All the variables included have the base fixed in 1995:12, being expressed in logarithm[12] and seasonally adjusted[13]. Variables used for analysis are as follows:

- *lniprodi_sa* as the logarithm of the industrial production index (Y)
- *lnpretprodi* as the logarithm of the industrial price index (PPI)
- *lncpi* as the logarithm of the consumers price index (CPI)
- *m2nom_sa* as the logarithm of the monetary aggregate, seasonally adjusted (M2)
- *dobref* as the reference interest rate used by the National Bank of Romania in influencing the general level of interest rates in the economy; from 1996:01 to 2000:12 I used the medium active refinancing interest rate, and for the rest of the period the reference interest rate started to be calculated monthly by the central authority since 2001 (D1)
- *dobdep* as the percentage of the sterilization ("deposit taking") interest rate (D2)
- *lncursnom* as the nominal exchange rate between the US dollar and ROL (Exc)
- *expnet_sa* as the net export calculated as the difference between export (fob) and import (fob) (Exp)
- *ygrowth* as the output growth, approximated through the growth of the industrial production index (Ygr)

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[11] See Enders for a more detailed analysis
[12] The only exception is the rate of interest, which is expressed in percent
[13] The procedure used to seasonally adjust the series is Tramo-Seats. In comparison with other techniques, this one has the advantage that produces better results in the presence of extreme values of the series and structural changes.

Data have been obtained from reviewed databases of the National Bank of Romania. Two dummy variables are included in each VAR to achieve well-behaved residuals. The dummy *dumf97* takes the value one for February 1997 and zero otherwise and the dummy *dumm97* takes value one in March 1997 and zero otherwise. The first dummy picks up the rapid nominal depreciation at the start of 1997 following the ending of foreign currency rationing. The second dummy is required for the inflationary effect of heavy capital inflows following the resumption of the stabilization program at the start of 1997.(OECD, 1998).

Altogether there are five models I have estimated, as follows:

M(1) : CPI, PPI, Exc

M(2) : CPI, Ygr, Exp, Exc

M(3) : CPI, M2, Exc

M(4) : Y, CPI, D1, M2, Exc

M(5): Y, CPI, D2, M2, Exc

Identification, or decomposition of innovations, is an essential step in the VAR analysis and it has been addressed in the economic literature in different ways. Within the VAR methodology, there have been developed at least two which I will also use in my paper: the recursive one, of Choleski fashion and the structural one of Sims-Bernanke type. The Choleski[14] decomposition arbitrarily imposes restrictions on the coefficients of the variables under study with no economic criteria considered. On the contrary, the structural decomposition gives the analyst the possibility of freely imposing the zero-restrictions, according to economic knowledge, resulting an over-identified system which can be empirically tested.

3.3 Estimation and Specification Issues

For the final results of the analysis to be relevant, I had to test the econometric model, at each step, for the statistical properties to comply with the correct ones. The main steps to a correct specification are: testing the order of integration of the variables, establishing the optimum lag length, testing the existence of the cointegration, testing the VAR stability, testing the white-noise properties of the residuals of the VAR, identifying and testing the zero-restrictions, testing the stability of the coefficients of the model.

[14] See, for instance Hamilton (1994), Enders (1997), Botel (2002)

Testing the order of integration: if all variables are stationary, integrated of zero order, then estimating the variables in levels poses no problem. Also if the time series are not stationary and cointegrated, then it is again possible to estimate the model in levels. However if the series appear to be I(1) and are not cointegrated, then I will have to specify the variables as first differences. For all the variables under study I have used the ADF (Dickey & Fuller, 1979) and Philips-Perron (Philips & Perron) tests. The results obtained show that the variables are not stationary.(see Appendix 1.1. for details).

The choice for the optimum lag length was taken according to common set of joint tests (each test at 5% level): sequential modified LR test statistic, final prediction error, Akaike, Schwartz and Hannah-Quinn information criterion. Considering the data length I have not taken into account models with more than four lags. As a result, I specified 1 lag for models M(1) and M(2), 3 lags for M(3) and 3 for M(4) and M(5).

The test used for the proof of cointegration is the Johansen Cointegration test (1991, 1995), which rejects the existence of cointegration at both 5% and 1% significance levels for the first three models (see Appendix 1.2. for details). However for the last ones the VAR will not fulfill the stability condition anymore. Therefore I will estimate the models in first differences. However since the variables under study are both I(1) and are not cointegrated, the common F-tests used for the finding of Granger-causality are not anymore valid.

The test for the VAR stability considers the properties of the inverse roots of the AR Characteristic Polynomial to be in module less than 1. This is an essential step since without the stability of the VAR the IRF cannot be constructed and the VAR will be explosive. The condition is verified for all the models under study with the specifications made above.

Error terms analysis. As I mentioned before, one of the important properties of the VAR in equations (3.1) and (3.2) is that the error terms are white-noise processes. That means they must be normally distributed, have constant variance (i.e. homoskedasticity property) and have no autocorrelation. Without the display of a first lag autocorrelation, the above mentioned conditions look satisfactorily for all models. (see Appendix 1.3 for details)

Specification for the structural VAR. To identify the structural innovations we have to impose zero-restrictions on the coefficients of matrix B, resulted from the compacted form of equations (3.1) and (3.2). To identify the structural model from an estimated VAR, it is necessary to impose at least $(n^2-n)/2$ restrictions on the elements of B matrix, where *n* denotes the number of variables in a VAR. The Choleski decomposition requires all elements above the principal diagonal to be zero. Hence there are a total of $(n^2-n)/2$ restrictions and the system is exactly identified. However to recover the structural innovations from the residuals $\{e_{1t}\}$and $\{e_{2t}\}$, using economic theory we have to impose at least n(n-1)/2 restrictions. As such, the system becomes over-identified and in this case one can test if the imposed restrictions are consistent with the realities in the economy. Unfortunately, the presence of non-linearities means there are no simple rules that guarantee exact identification.

The identification of the contemporaneous equations between the variables is based on the information likely to be available to the monetary authority within the month. I denoted with “0” the lack of influence (the imposed zero-restriction) and “1” the presence of a influence from the variable on the column to the one on the row. The ones on the principle diagonal reflect the influence of a variable has on its own.

Table 1. M(1) – Direct Pass-Through

	CPI	PPI	EXC
CPI	1	0	1
PPI	0	1	1
EXC	0	0	1

Table 2. M(2) – Indirect Pass-Through

	CPI	Ygr	EXP	EXC
CPI	1	0	0	1
Ygr	0	1	0	0
EXP	0	0	1	1
EXC	0	0	0	1

Table 3. M(3)

	CPI	M2	EXC
CPI	1	0	1
M2	0	1	1
EXC	0	0	1

Table 4. M(4), M(5)

	Y	CPI	D	M2	EXC
Y	1	1	0	0	0
CPI	0	1	0	0	1
D	0	0	1	1	1
M2	1	0	0	1	1
EXC	0	0	0	0	1

In Table1, the consumers price index is influenced by the nominal exchange rate and not by the industrial price index[15], which also depends on the value of the exchange rate. In Table 2, prices and net exports depend on the nominal exchange rate and due to the fact that I approximated output by the industrial production index, within a month I considered output to be exogenous to the net exports (actually all the period under study, Romania experienced acute deficits in trade terms). Because in Romania's case, exchange rate movements have generally been stable with relatively predictable rate of depreciation, so that they have been incorporated into business decisions on output, I considered the exchange rate channel to influence the output with a longer time lag. Also CPI-inflation based rate does not respond to growths in net exports.[16]In Table 3, as shown on Romania's case[17], money growth has no influence on inflationary pressures. In Table 4[18], a test of Granger causality will undoubtedly show that the monetary aggregate Granger causes the interest rate and not the opposite (see Table 7, Appendix 1.5.). Again the monetary aggregate adjusts to the exchange rate and industrial output.

Alternative structures comparative to this ones are prior possible, although other reasonable alternatives have been rejected when tested. As one can see, all four models are over-identified. For the validation of the restriction I used the LR[19] (likelihood ratio) test. Four models have successfully proved their consistency, the p-value showing I cannot reject the hypothesis made:

M(1): Log likelihood	695.3686			
LR test for over-identification:				
Chi-square(1)	0.399370		Probability	0.5274

Table 5.

M(2): Log likelihood	-70.92055			
LR test for over-identification:				
Chi-square(4)	0.743159		Probability	0.9459

Table 6.

M(3): Log likelihood	627.4656			
LR test for over-identification:				
Chi-square(1)	0.986480		Probability	0.3206

Table 7.

[15] See Cristian Popa et al. (2002) for the determinants of inflation-CPI based calculated for Romania's case
[16] It results from the decomposition of IRF shocks on inflation-CPI based, Cristian Popa et al (2002)
[17] See Nicolae Covrig (2002) in his dissertation paper on the determinants of inflation in Romania, p.57
[18] The restrictions in Table 4, are the same for both M(4) and M(5) models
[19] LR is χ^2 distributed with the number of degrees of freedom equaling the number of over-identifying restrictions

Log likelihood		537.3339			
LR test for over-identification:					
Chi-square(4)		2.396429		Probability	0.6633

Table 8

Unfortunately for the fourth model, no matter the restrictions imposed the associated p-value is not satisfactorily. Therefore I will limit to this model at a Choleski decomposition.

The test for the stability of the coefficients was conducted in order to identify any regime changes in the period under study (see Appendix 1.4). A Chow Breakpoint test will indicate for all models two major structural breaks in February and March 1997. Moreover the Recursive Residuals and one-step forecast tests lead to the same conclusion. Therefore the use of the two dummy variables for February and March 1997 is justified. As final tests for parameter instability I use the CUSUM test and CUSUM of squares test (Brown, Durbin, and Evans, 1975) which plot the cumulative sum together with the 5% critical lines. For both, movement outside the critical lines is suggestive of parameter or variance instability. While the CUSUM test indicates stability for all models, CUSUM of squares test suggests the residual variance is somewhat unstable for three models except M(4), in the two months at the beginning of 1997.

Altogether the diagnosis tests suggest the models chosen provide a good approximation of the structures and dynamics of the economic variables under study. All models passed relatively well the diagnostic tests and the validation of the structural imposed restrictions proved the accuracy of the five models.

4. Interpreting the effects of Monetary Policy from the Data

As soon as adopting the new monetary policy, Romania will have to change its exchange rate policy, that is moving from a managed float exchange rate to freely floating the nominal exchange rate. The risks associated with this step are not at all negligible since an abrupt depreciation could cause an increase in the dollar-denominated debt, and an appreciation of it could deteriorate the balance of payments. In this context, the implementation of the new regime in Romania’s partially dollarized economy must be accompanied by strict regulations to insure the capacity of the system to face adverse shocks through the exchange rate. Therefore the exchange rate channel becomes of key importance in the implementation of the inflation targeting framework through the transmission of exchange rate movements to inflation and real outputs.

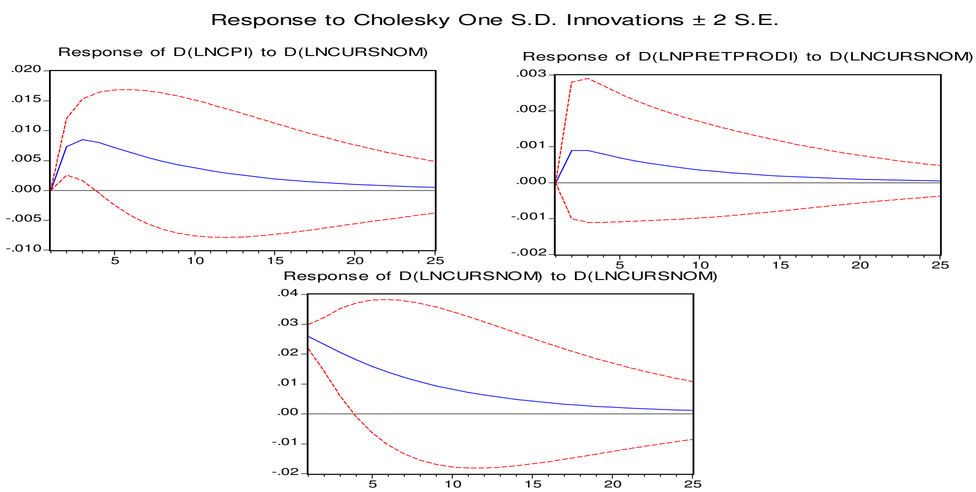
A Granger causality test strengthens the hypothesis that exchange rate hikes lead the rise in prices (see Appendix 1.5, Table 5). According to the theoretical models, exchange rate movements have direct-pass through effects to the inflation through the increase of domestic prices of traded goods[20] and services. Moreover, they affect aggregate supply and demand and thus they cause indirect pass-through effects to inflation[21].

A VAR with Choleski decomposition shows that both direct and indirect pass-trough effects are quite strong and that exchange rate shocks dominantly contribute to the variability of inflation.

Direct Pass-Through effect is measured through the impulse response of tradable good prices and inflation to shocks on exchange rate.

Figure 1. Impulse response to exchange rate shock

M(1): Exchange rate shock→Tradable good price→Inflation rate



The findings reveal that during the analyzed period, an exchange rate shock had negative impact on inflation rate which according to the theory, would be transmitted directly through tradable good prices. However the impulse response graph shows that the inflation rate was much more responsive to the exchange rate changes than the tradable

[20] As Halpern & Wyplosz (2001) I have approximated the traded sector with the industrial one, and the non-tradable with services

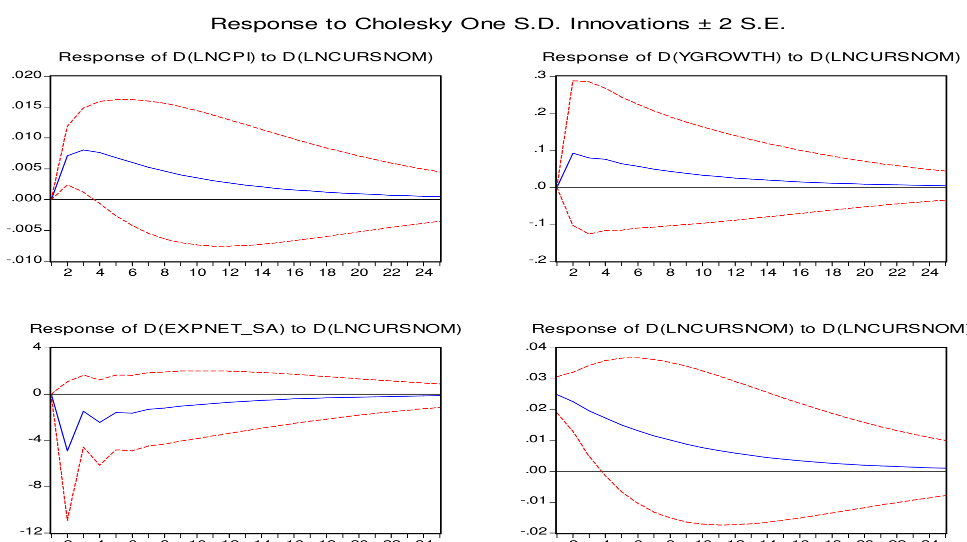
[21] P. Warjiyo and A. Hutabarat (2002) analyze in detail the direct and indirect pass-through effects on Indonesia's case

good prices. A shock of exchange rate depreciation was responded immediately since the second month by increased inflation of up to 0.8% whereas the tradable price acceleration barely reached 0.1%. This strengthens the assumptions made in Table 2, that in the conditions of a managed float, tradable prices have been quite predictable and did not exercise inflationary pressures, which suggest that Choleski decomposition only is not sufficient to isolate the direct-pass through effect. The maximum response achieved at the third month diminished only after a two years lag. The persistence response of inflation to exchange rate shock is further confirmed by the variance decomposition which indicates that the exchange rate was mainly the cause of the increase in inflation and at a quite insignificant level by the industrial production index.

Indirect pass-through effect. The analysis on indirect pass-through effect is done through impulse response of net export, output growth and inflation rate to shocks on exchange rate (Figure 2). The findings show that indirect pass-through effect also worked well during the period.

Figure 2. Impulse response to exchange rate shock

M(2): Exchange rate shock→Net export→Output growth→Inflation rate



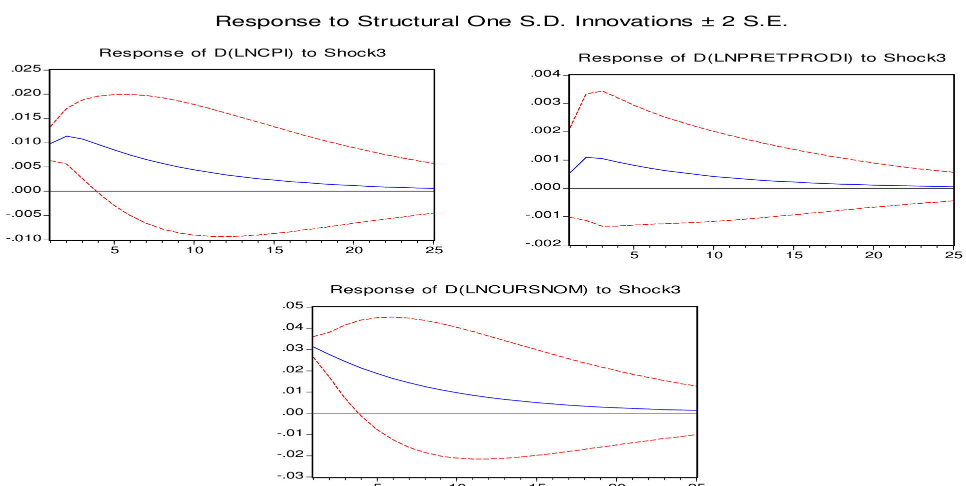
A depreciation of the exchange rate causes the inflation to accelerate by approximately 0.7%, a bit lesser than in the previous case, reaching the maximum level at a three month lag and again taking the system about two years to come back to the equilibrium. The response of the output growth comes at the second lag, reaching the highest level the next month when it starts to diminish. The response of the net exports is quite surprising, depreciation of the exchange rate does not support the export competitiveness, showing that in Romania's case it has been quite difficult to achieve real depreciation (i.e. other causes, like quicker growth in the monetary base lead to real appreciation).

For some clearer evidences on how the exchange rate channel worked so far I will move on to the structural identification of the effects.

For the *direct-pass through effect* one can notice the stronger impact of a shock in the exchange rate.(Figure 3)

Figure 3. Impulse response to exchange rate shock

M(1): Exchange rate shock→Tradable good price→Inflation rate



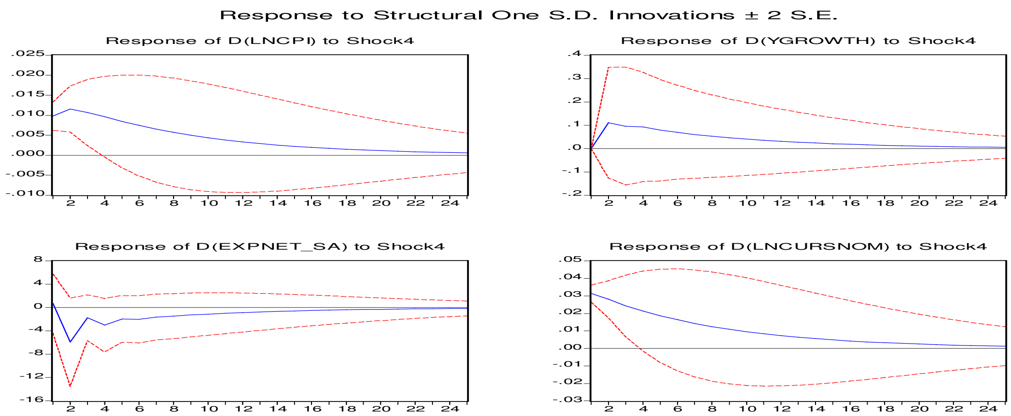
Comparative to the Choleski decomposition, the inflation acceleration is of 1% from the first month reaching the highest level the following month (1.3%). Again the response of the tradable prices is much lower – the maximum level is reached at the second lag, with an acceleration of less then 0.12%.

In the case of the structural *indirect pass-through effect*, the results display a rapid effect in the growth of inflation of about 1.3% reached in the second month. Also the response of the output growth is felt only the second lag and the exchange rate shock has a puzzling effect on the net exports: the depreciation of the exchange rate does not lead to an increase in the net exports.

The results obtained so far reveal the strong inflationary pressures streaming out from the exchange rate channel, in all cases the acceleration effect being extremely significant. However there are also some puzzling effects which show a lack of efficiency when trying to increase exports through a nominal depreciation of the exchange rate.

Figure 4. Impulse response to exchange rate shock

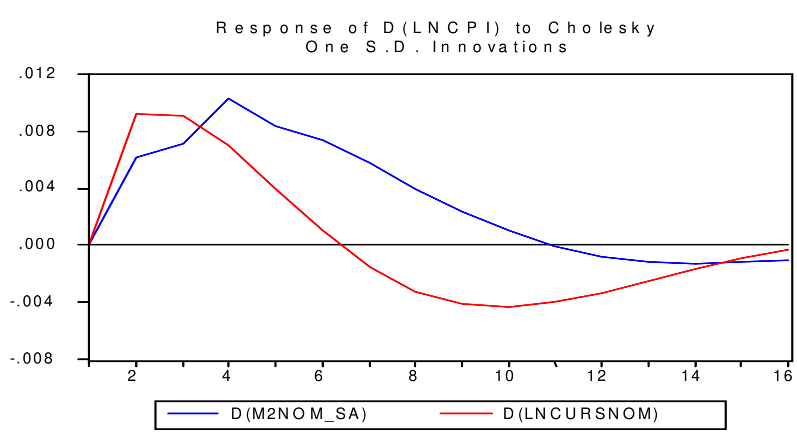
M(2): Exchange rate shock→Net export→Output growth→Inflation rate



As a consequence I will try to look in more depth at the interventions of the central bank on the foreign exchange market, in order to depreciate the exchange rate in real terms and boost exports.

The next VAR is the one in M(3), which considers the interplay between prices, growth in the money stock and changes in the nominal exchange rate. A similar Granger causality test run this time on inflation and money growth shows that the money growth rate also leads the price increase.

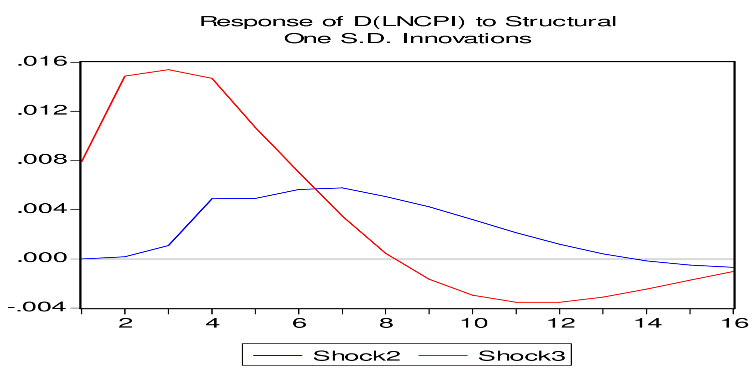
Figure 5. M(3) The impulse response function



As can be seen, a one standard deviation impulse in the former variables entails significant inflation acceleration (up to 1.1% per month inflation increase). The maximum impact is reached with a two-month lag for devaluation and a four-month lag for money. It takes some more than one-year to the system to return at the pre-shock equilibrium. This would point to a source of ineffectiveness of the NBR policy of managing real exchange rates by systematic interventions in the foreign exchange market over the 1996-2000 period. If the central bank buys dollars in an attempt to depreciate the leu, it simultaneously increases the money stock, which, two months later, already brings about higher inflation. In this context, the real depreciation is hard to be achieved. The effect described above could be identified as a trade-off between the exchange rate and inflation, that becomes of significant importance in the context of the inflation targeting framework as interventions on the foreign exchange market are one of the instruments to fight-off inflation pressures.

The structural decomposition of the model also strengthens the conclusions reached so far, with the difference that the trade-off effect appears at a longer lag (the 7th month).

Figure 6. M(3): The impulse response

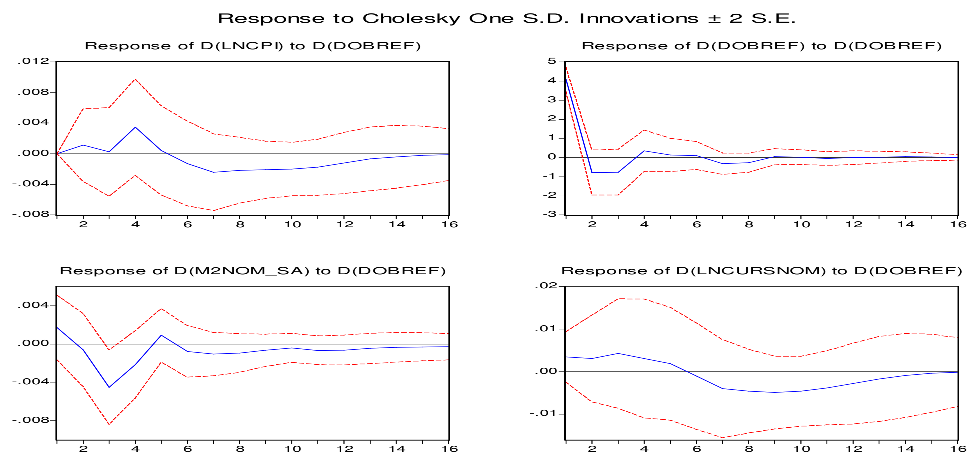


As it resulted from the data so far, the interventions on the foreign exchange market can have undesired consequences, legitimating the consideration of the interest policy as the main instrument to fight-off inflation. However one problem that I encountered at this stage, is that due to the issues discussed in the theoretical introductory part and lack of useful data on the analysed period , I limited myself to conducting the VAR analysis with only two types of interest rate: as a general reference interest rate and instrument of monetary policy I used the variable D2, but also for a strengthening of the results I also conducted a second VAR using the sterilisation interest rate for “deposit taking” operations.

Usually, in an inflation targeting framework the reference interest rate adopted by the monetary authority is the *reverse repo*[22] or *Treasury bond rate.*

Therefore due to the lack of adequate data, the results from the VAR analysis have to be conducted very carefully. (Figure 7)

Figure 7. The impulse response



A positive shock from the interest rate leads to puzzling effects in both the exchange rate and inflation: there is an initial depreciation of the exchange rate up to the third month and an initial insignificant response of the inflation, which amplifies at the fourth lag where there is a strong acceleration of it. Beginning only with the fourth month the two variables have the desired evolution, the appreciation of the exchange rate being accompanied by a fall in the prices level.

Anyway we have to bear in mind that so far Romania's current regime is one of monetary targeting, in which the interest played an insignificant role due to the monetary and non-monetary adverse conditions. Moreover, the power of the monetary authority has been altered by the dominance of the fiscal policy, where in such cases the efficiency of the monetary policies is severely restrained.(Niepelt, 2001).

The last model strengthens the findings so far, on the short run being obvious a trade-off between the exchange rate and the inflation.

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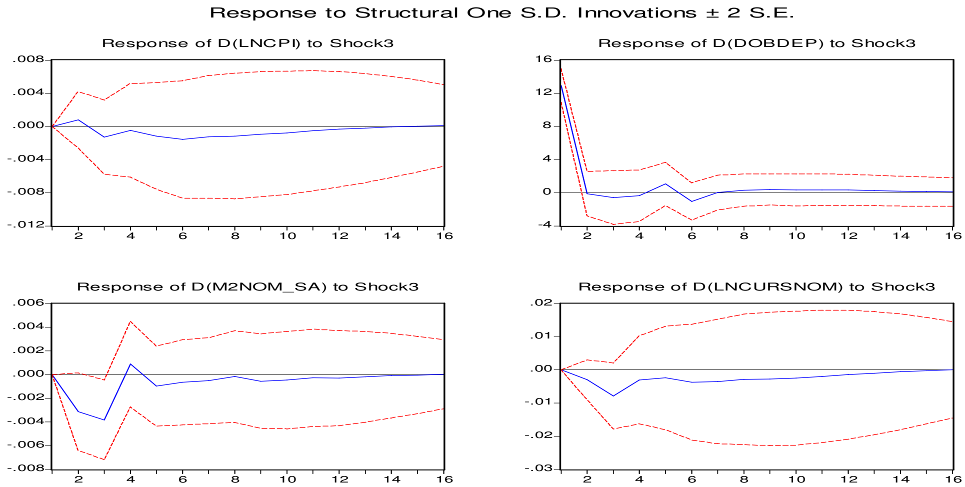
[22] The reverse repo rate has been adopted as the reference rate by the majority of the IT economies in Central and Eastern Europe

Figure 8. The impulse response



If the central authority proceeds to an increase in the general level of the serialisation interest rate, up to the second month there is again a puzzling effect, an appreciation of the exchange rate being accompanied by an increase in the prices level. However the response of the monetary aggregate is a significant one consisting in an important fall in the stock of money, taking the system approximately nine months to return to the pre-shock equilibrium.

The findings reveal that there are still important steps which need to be made in order for the new monetary policy to came into being. As seen in this paper, so far the responses of exchange rates, inflation and other variables have often been puzzling. While the interventions on the foreign exchange rate have been predominant they still lead to adverse effects (i.e. inflation acceleration). Concerning the interest rate instrument we can affirm that in spite the short-run trade-off, there are some positive signs about the capacity of the interest policy to decrease inflation while appreciating the exchange rate (at least for the “deposit taking” interest rate). However both of the instruments display up to a certain degree unwanted consequences. Therefore, the change of the current policy regime has to be preceded by the finding and implementing of an adequate interest rate instrument that will guide the market about the policy orientation of the central bank and will help formulate inflation expectations. Further research on the subject need to be conducted as more data becomes available and financial instruments are put in place.

5.Purchasing Power Parity versus Balassa-Samuelson hypothesis[23]

Real exchange rates in transition economies followed a process of real appreciation. Thus, it would seem to contradict the purchasing power parity (PPP) theory, which predicts that nominal exchange rates should move in line with price differentials, at least in the long run.
As Barlow and Radulescu (2002) argue "the PPP theory is based upon the idea that in a frictionless world the price of a good in different countries should be the same when it is expressed in the same currency. Clearly, a number of frictions exist, such as transport costs, tariffs and quotas, which may invalidate the model. These frictions could be seen as a wedge between the prices in different countries but, so long as the frictions are reasonably constant, prices expressed in a common currency are expected to move together over time. The PPP theory is meant to apply to goods that are traded internationally and the existence of goods that are not internationally traded means that the PPP theory need not hold for aggregate price series, even if it does hold for traded goods. When aggregate prices are used, the real exchange rate could be found to vary owing to changes in the pattern of demand for goods or changes in production conditions that bring about changes in the relative prices of traded and non-traded goods. This would seem particularly likely in transition economies, which have been subjected to changes in the transition period not experienced by the majority of their trading partners".

Therefore the PPP theory implies that, in the long run, domestic and foreign price levels and the exchange rate move together in time to induce a stationary real exchange rate. However in the short run there may be deviations from the long run relationship. The current evidence on the issue is mixed. Studies by Frankel (1986), Taylor & McMahon (1988) and Choudhry *et al.* (1991) utilize unit root tests and reject the null hypothesis of nonstationarity of the real exchange rate, thereby providing supportive evidence in favor of the PPP hypothesis. A more recent and relevant study is conducted by Barlow and Radulescu (2002), showing strong support for the PPP theory on Romania's case. However, studies by Taylor (1988) and Corbae & Ouliaris (1988) fail to provide support for the PPP hypothesis over that floating period. Also, Dornbusch (1987) characterizes the experience

[23] Here the discussion and arguments follow Barlow and Radulescu (2002) and the results are extended up to January 2003.

with floating exchange rates as a period of wide gyrations in the real exchange rate between many of the major currencies, with the real consequence of changes in international competitiveness.

As Barlow and Radulescu (2002) state “in theory, the constancy of the equilibrium real exchange rate is dependent upon the terms of trade and the demand for non-tradables relative to tradables remaining constant”. They point that Balassa (1964) and Samuelson (1964) show that if productivity gains in the tradables sector exceed those in the non-tradables sector, then the equilibrium real exchange should appreciate. Thus it would be possible that in economies undergoing rapid change, such as the transition economies, the equilibrium real exchange rate is not stationary. Attempts have been made to measure the contribution of productivity changes to the real appreciation of transition currencies (see Halpern & Wyplosz, 1997, 2001; Begg, 1998; and Liorgovas, 1999).

To sum up the discussion above, two possible explanations can be advanced for the real appreciation of currencies in the transition. First, the currency may have been undervalued in real terms at the start of the transition, in which case the real appreciation occurred to restore equilibrium. This mechanism is characterized by the nominal appreciation due to the expansion of net exports, a rise in prices due to the high cost of imports, or a mixture of both. This seems to be a reasonable explanation for the transition economies since a part of the initial stabilization program was to devalue their currencies, which the black market prime indicated were considerably overvalued during the communist era. As Barlow and Radulescu (2002) argue “while the black market exchange rates could have offered some guidance to the appropriate scale of devaluation, it is likely that miscalculations and the scarcity of useful information would have resulted in an excessive devaluation of some currencies”.

The second explanation for a real appreciation is that the transition would bring about changes in demand and production that could cause an appreciation. Halpern & Wyplosz (1997, 2001) list six possibilities. (1) Rising incomes as productivity increases following structural reforms could raise demand for non-tradables, such as services, which would result in a real appreciation. (2) Following Balassa (1964) and Samuelson (1964), real appreciation could be a consequence of productivity gains in the tradables sector exceeding those in the non-tradables sector. (3) Prior to reform, the prices of non-traded goods were held down by subsidies and input prices were held below world levels. As these distortions are removed and the prices of non-traded goods rise, the real exchange rate will appreciate. (4) Reforms of taxation and a move away from monetary financing of the government debt are likely to have an impact on relative prices, though the effect on the real exchange rate is ambiguous. (5) Inflows of foreign direct investment in the traded sector cause the real exchange rate to appreciate as productivity rises. (6) The terms of trade improve as the quality of traded production improves. Some of these explanations are likely to apply to some transition economies, such as those that have undergone deep reform, but are they likely to apply to those economies in which reform has been more inconsistent, such as Romania? The issue deserves serious attention, because as mentioned in the introductory part, as Romania prepares to join the single currency system in the near future, faster appreciation of the real exchange rate compared with the Western ones will could cause a trade-off effect between the exchange rate and inflation during the two-year ERM membership period.

6. Econometric estimation (II)

6.1. Methodology

The PPP hypothesis states that the movements of domestic prices and exchange rates form an equilibrium relationship, which can be expressed as:

$$Cursscht = C(1) + C(2)*Inflromt - C(3)*Inflsuat + ut, \quad (6.1)$$

where *Cursscht* is the logarithm of the exchange rate, the domestic currency price of the dollar;2 *LIPIt* is the logarithm of the domestic price index; *Inflromt* is the logarithm of the US price index; and *ut* represents deviations from PPP. For the PPP theory to hold, it is required that *C(2)*= C(3) = 1. Furthermore, if the nominal exchange rate and the two price series are non-stationary, then the strong form of the PPP hypothesis requires that the nominal exchange rate and relative prices are co-integrated. Co-integration would imply that the nominal exchange rate and relative prices move together over time, thus *ut* must be stationary. In this case the real appreciation is explained by an initially relatively devalued real exchange rate returning to the long-run equilibrium level. In contrast, if the real appreciation is due to an appreciation of the equilibrium real exchange rate, then the nominal exchange rate and the price series cannot be co-integrated with a unit vector because a non-stationary variable that explains the real appreciation has been excluded. The test for co-integration uses Johansen's methodology, which is based upon a VAR representation. One advantage of this methodology is that it permits both the nominal exchange rate and the price series to be regarded as endogenous. In addition, the presence of multiple co-integration vectors can be tested and hypotheses can be tested on the vectors.

Based on the idea of Barlow and Radulescu (2002), I expanded the testing of the PPP relation on two periods: one from 1992:01-2000:08, and the second from 1992:01-2003:01 questioning whether results are the same on the two sample monthly data. Both the small sample and the short period of time could present problems for testing. The PPP theory has been found to be most relevant to the long run, the period taken for one half of any deviation from PPP equilibrium to be removed typically being up to five years (Rogoff, 1996). The biases introduced by these problems would tend to raise the probability of rejecting a co-integrating relationship between the nominal exchange rate and the price series. Whilst caution is then required in rejecting co-integration, a failure to reject co-integration would be strong evidence in favor of a stationary real exchange rate and against an appreciation of the equilibrium real exchange rate.

6.2.Data

This section uses monthly data taken from databases of the National Bank of Romania, covering the period from January 1992 to January 2003. *Inflrom* is defined as the logarithm of the Romanian industrial price index, *Inflsua* as the logarithm of the US industrial price index. The choice of price index is forced upon us by the availability of Romanian data. The nominal exchange rate, *Cursscht* is the logarithm of the exchange rate for dollars. The data series are plotted in Figures 9-11. The nominal exchange rate has a tendency to depreciate (see Figure 9), with some notably large episodes of depreciation, especially in the early transition period and at the start of 1997. Comparison of Figure 10 with Figure 11 shows that inflation has been much more severe in Romania than in the USA. Figure 12 shows that initially there was a large real depreciation but this has since been followed by a steady appreciation, which has only been temporarily reversed by nominal depreciation of the currency. Over the second half of 1998 there was a period of real depreciation, which has been followed by a period of relative stability of the real exchange rate. Whilst the real appreciation may be driven by real factors, Figure 12 suggests that at least part of the real appreciation is a correction following an excessive nominal depreciation.

Before analyzing our data a few points to complete the discussion about the foreign exchange market in Romania are worth mentioning. From 1992 Romania has followed a managed float regime, with various forms of official intervention in the market. Though since 1991 firms have been given access to foreign currency to pay for their imports, foreign currency was rationed until 1997. The foreign exchange market became considerably more liberalized from 1997, rationing has disappeared, foreign investors can repatriate profits earned in Romania in foreign currency and capital controls have been generally removed.

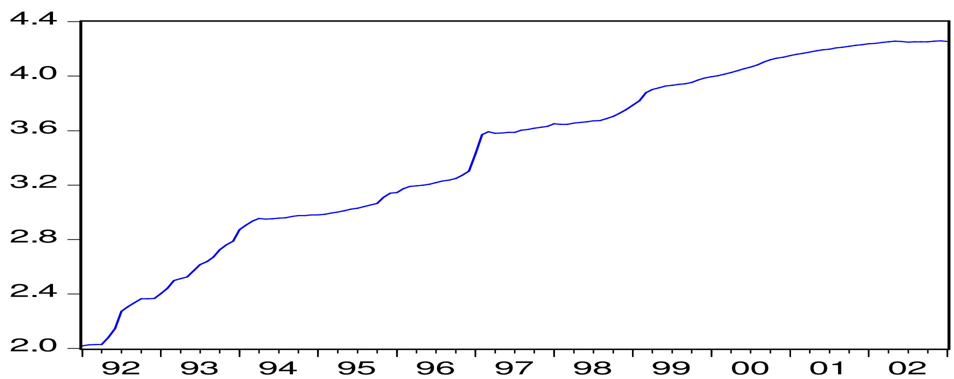


Figure 9. Log of the nominal exchange rate against the dollar

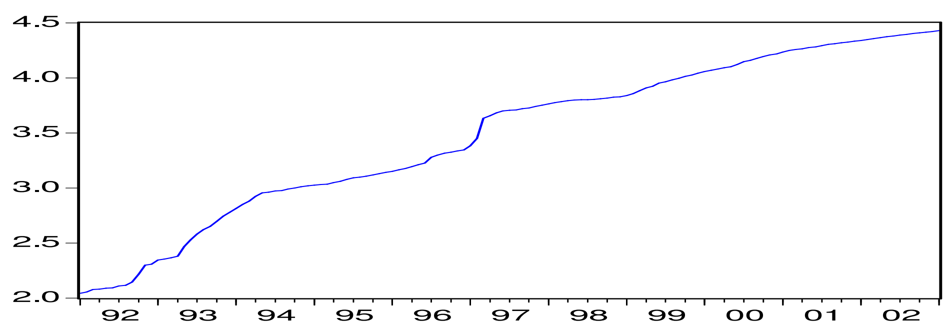


Figure 10. Log of the industrial price index

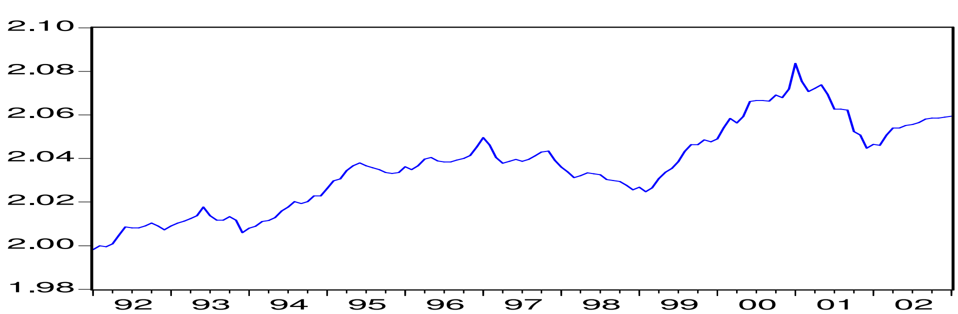
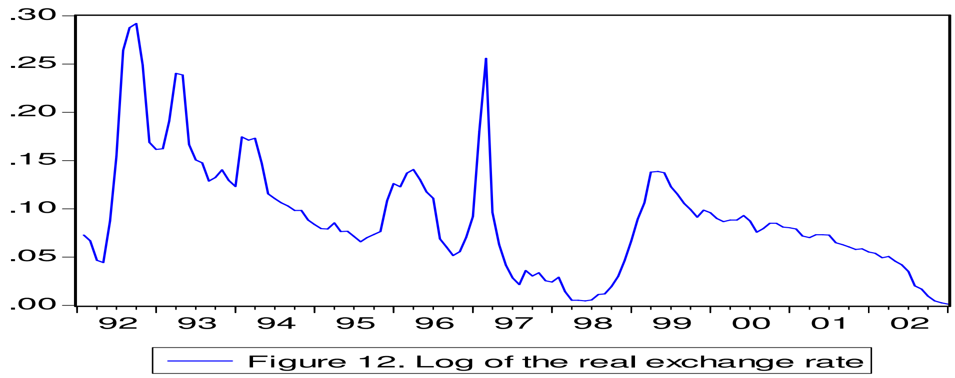


Figure 11. Log of the US industrial price index



6.3. Unit Roots and Cointegration

The orders of integration of the individual series were tested for each variable on the two periods. The Augmented Dickey Fuller and Philips Perron tests show that each variable is integrated of order one, with the critical values from MacKinnon (1991).

Co-integration is tested using Johansen's (1988) maximum likelihood procedure. A general long-run relationship is given by equation (6.1). The maximum lag length of the VAR is set to 10 on the basis of the optimum lag length criteria. As in the first econometric part, two dummy variables were included for February and March 1997. It is also found that the US price level can be treated as exogenous[24]. (see Appendix 2.2.)

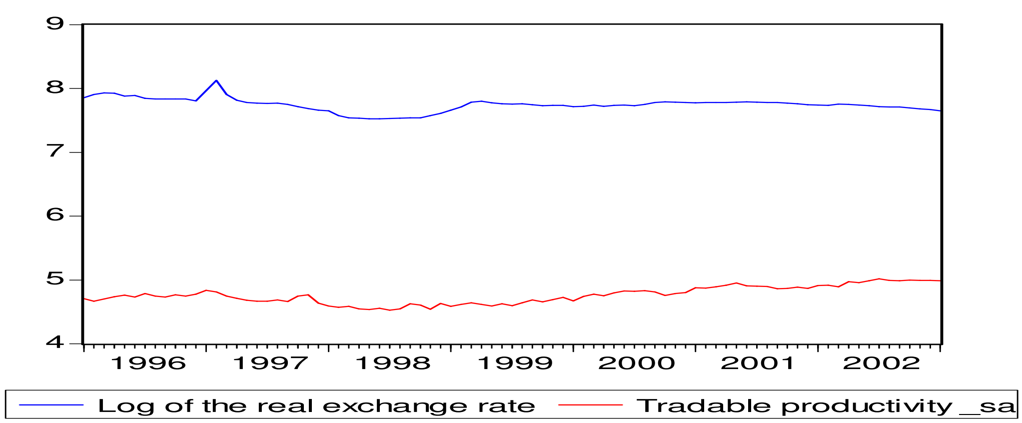
Concerning the first period under study, that is from 1992:01 to 2000:08[25], the following results have been obtained: as presented in Appendix 2.1, both the maximal eigenvalue and the trace tests reject the null hypotheses of zero co-integrating vectors at the 5% significance level. The null hypothesis of $r \leq 1$ cannot be rejected against the alternative of two co-integrating vectors. The maximum likelihood estimates of the co-integrating vector are also reported in Appendix 2.1. The coefficients are correctly signed, significant at the 1% confidence level and the restrictions required by the PPP hypothesis cannot be

[24] Causation from the co-integrating residual and the lags on Curscch and Inflrom to Inflsua is rejected in both cases ($\chi^2(18)$=18.62, p-value=0.4154 and ($\chi^2(18)$=19.08, p-value=0.3868)

[25] Several other samples have been tested within 2000, all leading to the same general results; samples up to 1999 or 2001 led to unsatisfactorily values for the prices parameters

rejected (χ^2= 0.000582, p-value = 0.980747).[26] The implication of this evidence is that the real appreciation was simply to restore the real exchange rate to its equilibrium level. To support the results obtained by applying the Johansen procedure, I used the Engle-Granger method. Engle & Granger (1987) suggest running an OLS regression in the levels of the I(1) variables and then testing the residuals for non-stationary. Stationary residuals indicate that the series are co-integrated and in this case the OLS regression yields consistent estimators of the co-integrating parameters. The results in Appendix 2.4. show that the residuals are stationary according to the critical values provided by Engle & Granger and that the parameters of the domestic and foreign prices have the correct sign and are close to unity.

However, regarding the second period of time the results do not seem to comply anymore with the theoretical model of the PPP relation.(see Appendix 2.5.) Though again I can reject the null of no co-integration, both of the maximal eigenvalue and trace tests indicating 1 co-integrating equation(s) at both 5% and 1% levels, the value of the foreign inflation is close to zero and its significance is strongly rejected.[27] Therefore I am led to conclude that appreciation of the real exchange rate could at least be explained in real terms, that is due to productivity growths. That is, to a certain extent such an evolution is consistent with the Balassa-Samuelson paradigm. An intuitive graph displays the evolution of the real exchange rate as being accompanied by a growth in the tradable sector.



6.4.The Error Correction Equations

[26] The restrictions imposed are that C(2)=1 and C(3)=-1, so that they enter the co-integrating equation with a unit coefficient

[27] C(2) = 0.0863, and the associated t-statistic is 0.09821 compared to 1.96 at 5% significance level

According to the Engle & Granger (1987) representation theorem, a valid error correction model implies co-integration. As a final test of the stationarity of the real exchange rate up to the year 2000 sub-sample, error correction models (ECMs) with a constant exchange rate as the long-run solution are estimated. Both the nominal exchange rate and domestic prices could be endogenous, hence I specify two error correction equations, for which the dependent variables are the nominal depreciation and domestic inflation. Owing to the potential endogeneity, contemporaneous values of each variable cannot appear in the equation for the other variable. The error correction term is given by the long-run residuals derived from the restricted co-integrating vector estimated by Johansen's method. The parsimonious equations are reported in Appendix 2.3. The ECM estimates pass a series of diagnostic tests, including those for serial correlation and heteroskedasticity.

The error correction equations indicate that the adjustment of the real exchange rate towards equilibrium has fallen almost entirely on domestic prices, as it is only prices and not the nominal exchange rate that adjust to bring the real exchange rate into line with the equilibrium level. The nominal exchange rate appears to be represented by a first order auto-regression. Nonetheless, the existence of a valid error correction model for the price level in which the equilibrium real exchange rate is a constant supports the argument that in Romania the real appreciation was due to the initial undervaluation of the currency for most of the transition period, that is approximately up to the year 2000. The error correction models indicate that a major consequence of this policy was the high inflation rate.

7. Conclusion

The paper revealed some important facts about the current efficiency of the monetary policy instruments to fight-off inflationary pressures in the light of a possible change to an inflation targeting framework and also highlighted the weak performance of Romania so far in terms of a real appreciation of the exchange rate through productivity gains. The interventions of the central bank on the foreign exchange market, though have been frequent they led in the past to adverse effects (i.e. inflation acceleration). The use of a interest rate policy has been limited by the position of net debtor of the central bank towards the banking sector and the fiscal dominance from the Government. Though the National

Bank still lacks a proper interest rate instrument to orient the markets about the state of its policy, NBR's original sterilization instrument, of deposit taking, has proved to lead to positive results. However on the short-run there is a puzzling effect, as a trade-off between inflation and exchange rate seems to have an adverse effect in fighting-off inflation pressures. This is an issue that deserves serious attention and future research has to be done, as more data and financial instruments are put in place to develop answers of how to deal with such an effect in an inflation targeting framework on the short-run.

Concerning the second part, the evidence strongly suggests that the real appreciation of the leu over the period since transition began is partly due to the excessive nature of the initial devaluation, occurring through higher inflation. The arguments made by Halpern & Wyplosz (1997, 2001) for an equilibrium appreciation rely very heavily on deep reforms to either raise incomes or raise productivity. Reform in Romania has been relatively shallow and halting. However, one can notice that some positive structural changes have been made, as with the forecast of year 2000, with a new Government in place, some productivity gains seem to help an appreciation of the real equilibrium exchange rate. Again further studies need to be done on the possible appreciation of the exchange rate as due to the Balassa-Samuelson effect, regarding the future joining of Romania to the monetary union and the possible trade-off effect when trying to have both a fix nominal exchange rate and a stable inflation, according to ERM2 mechanism.

Appendix 1

1. Unit root tests[28]

ADF Test Statistic	-1.239212	1% Critical Value*	-4.0727
		5% Critical Value	-3.4645
		10% Critical Value	-3.1585

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNCURSNOM)
Method: Least Squares
Sample(adjusted): 1996:04 2003:01
Included observations: 82 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNCURSNOM(-1)	-0.029889	0.024119	-1.239212	0.2190
D(LNCURSNOM(-1))	0.793317	0.103738	7.647315	0.0000
D(LNCURSNOM(-2))	-0.350513	0.108038	-3.244349	0.0017
C	0.177883	0.116738	1.523782	0.1317
@TREND(1996:01)	0.000600	0.000799	0.750905	0.4550

ADF Test Statistic	-1.581376	1% Critical Value*	-4.0756
		5% Critical Value	-3.4659
		10% Critical Value	-3.1593

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNCPI)
Method: Least Squares
Sample(adjusted): 1996:06 2003:01
Included observations: 80 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNCPI(-1)	-0.025616	0.016198	-1.581376	0.1181
D(LNCPI(-1))	0.515600	0.112820	4.570094	0.0000
D(LNCPI(-2))	0.094397	0.127394	0.740983	0.4611
D(LNCPI(-3))	-0.017854	0.127783	-0.139720	0.8893
D(LNCPI(-4))	-0.175469	0.112255	-1.563125	0.1223
C	0.167034	0.080297	2.080219	0.0410
@TREND(1996:01)	0.000447	0.000581	0.768833	0.4445

ADF Test Statistic	-2.511818	1% Critical Value*	-4.0756
		5% Critical Value	-3.4659
		10% Critical Value	-3.1593

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(M2NOM_SA)
Method: Least Squares
Sample(adjusted): 1996:06 2003:01
Included observations: 80 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
M2NOM_SA(-1)	-0.046637	0.018567	-2.511818	0.0142
D(M2NOM_SA(-1))	0.126561	0.113662	1.113483	0.2692
D(M2NOM_SA(-2))	-0.102212	0.109732	-0.931465	0.3547
D(M2NOM_SA(-3))	0.252921	0.110048	2.298280	0.0244
D(M2NOM_SA(-4))	-0.017274	0.111710	-0.154631	0.8775
C	0.264879	0.091696	2.888668	0.0051
@TREND(1996:01)	0.001283	0.000628	2.043355	0.0446

ADF Test Statistic	-2.622410	1% Critical Value*	-4.0756
		5% Critical Value	-3.4659
		10% Critical Value	-3.1593

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNPRETPRODI)
Method: Least Squares
Sample(adjusted): 1996:06 2003:01
Included observations: 80 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNPRETPRODI(-1)	-0.084473	0.032212	-2.622410	0.0106
D(LNPRETPRODI(-1))	0.190827	0.109281	1.746193	0.0850
D(LNPRETPRODI(-2))	-0.090000	0.109264	-0.823693	0.4128
D(LNPRETPRODI(-3))	0.259919	0.107835	2.410339	0.0185
D(LNPRETPRODI(-4))	0.270467	0.110914	2.438535	0.0172
C	0.387863	0.148095	2.619012	0.0107
@TREND(1996:01)	7.76E-05	4.06E-05	1.913509	0.0596

ADF Test Statistic	-2.710904	1% Critical Value*	-4.0756
		5% Critical Value	-3.4659
		10% Critical Value	-3.1593

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EXPNET_SA)
Method: Least Squares
Sample(adjusted): 1996:06 2003:01
Included observations: 80 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXPNET_SA(-1)	-0.365531	0.134837	-2.710904	0.0084
D(EXPNET_SA(-1))	-0.262706	0.146802	-1.789527	0.0777
D(EXPNET_SA(-2))	-0.036171	0.145910	-0.247897	0.8049
D(EXPNET_SA(-3))	0.049631	0.139638	0.355424	0.7233
D(EXPNET_SA(-4))	0.012638	0.118303	0.106826	0.9152
C	22.77050	9.714701	2.343922	0.0218
@TREND(1996:01)	0.034335	0.113563	0.302347	0.7632

ADF Test Statistic	-1.263984	1% Critical Value*	-2.5919
		5% Critical Value	-1.9443
		10% Critical Value	-1.6179

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DOBDEP)
Method: Least Squares
Sample(adjusted): 1996:06 2003:01
Included observations: 80 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DOBDEP(-1)	-0.049317	0.039017	-1.263984	0.2102
D(DOBDEP(-1))	0.042560	0.116151	0.366417	0.7151
D(DOBDEP(-2))	-0.076410	0.114491	-0.667393	0.5066
D(DOBDEP(-3))	-0.133124	0.114000	-1.167746	0.2466
D(DOBDEP(-4))	-0.036587	0.115046	-0.318017	0.7514

[28] Due to lack of space, I included only the results for the Augmented Dickey-Fuller test

ADF Test Statistic	-0.965285	1%	Critical Value*	-2.5919
		5%	Critical Value	-1.9443
		10%	Critical Value	-1.6179

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DOBREF)
Method: Least Squares
Sample(adjusted): 1996:06 2003:01
Included observations: 80 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DOBREF(-1)	-0.017901	0.018544	-0.965285	0.3375
D(DOBREF(-1))	-0.106130	0.113829	-0.932362	0.3541
D(DOBREF(-2))	-0.038587	0.112864	-0.341887	0.7334
D(DOBREF(-3))	-0.156802	0.112798	-1.390111	0.1686
D(DOBREF(-4))	-0.133486	0.113613	-1.174921	0.2437

ADF Test Statistic	-2.275791	1%	Critical Value*	-4.0756
		5%	Critical Value	-3.4659
		10%	Critical Value	-3.1593

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNIPRODI_SA)
Date: 06/24/03 Time: 11:11
Sample(adjusted): 1996:06 2003:01
Included observations: 80 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNIPRODI_SA(-1)	-0.036089	0.015858	-2.275791	0.0258
D(LNIPRODI_SA(-1))	-0.285277	0.106579	-2.676680	0.0092
D(LNIPRODI_SA(-2))	0.056073	0.100132	0.559989	0.5772
D(LNIPRODI_SA(-3))	0.405773	0.096754	4.193858	0.0001
D(LNIPRODI_SA(-4))	0.344199	0.103562	3.323610	0.0014
C	0.158304	0.073624	2.150164	0.0349
@TREND(1996:01)	9.46E-05	8.43E-05	1.121252	0.2659

ADF Test Statistic	-2.646844	1%	Critical Value*	-4.0756
		5%	Critical Value	-3.4659
		10%	Critical Value	-3.1593

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(YGROWTH)
Method: Least Squares
Sample(adjusted): 1996:06 2003:01
Included observations: 80 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YGROWTH(-1)	-0.086672	0.032745	-2.646844	0.0099
D(YGROWTH(-1))	0.180347	0.108964	1.655110	0.1022
D(YGROWTH(-2))	-0.093819	0.108678	-0.863283	0.3908
D(YGROWTH(-3))	0.264556	0.107160	2.468799	0.0159
D(YGROWTH(-4))	0.282665	0.110625	2.555164	0.0127
C	-0.119593	0.173765	-0.688244	0.4935
@TREND(1996:01)	0.008169	0.004263	1.916070	0.0593

ADF Test Statistic	-3.998538	1%	Critical Value*	-4.0771
		5%	Critical Value	-3.4666
		10%	Critical Value	-3.1597

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNCURSNOM,2)
Method: Least Squares
Sample(adjusted): 1996:07 2003:01
Included observations: 79 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNCURSNOM(-1))	-0.590841	0.147764	-3.998538	0.0002
D(LNCURSNOM(-1),2)	0.491589	0.136651	3.597402	0.0006
D(LNCURSNOM(-2),2)	-0.174225	0.142766	-1.220351	0.2263
D(LNCURSNOM(-3),2)	0.234706	0.113895	2.060725	0.0429
D(LNCURSNOM(-4),2)	-0.042420	0.116726	-0.363416	0.7174
C	0.036728	0.012473	2.944672	0.0044
@TREND(1996:01)	-0.000416	0.000199	-2.088730	0.0403

ADF Test Statistic	-4.436403	1%	Critical Value*	-4.0771
		5%	Critical Value	-3.4666
		10%	Critical Value	-3.1597

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNCPI,2)
Method: Least Squares
Sample(adjusted): 1996:07 2003:01
Included observations: 79 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNCPI(-1))	-0.644352	0.145242	-4.436403	0.0000
D(LNCPI(-1),2)	0.187976	0.133839	1.404486	0.1645
D(LNCPI(-2),2)	0.252732	0.125217	2.018346	0.0473
D(LNCPI(-3),2)	0.206117	0.121211	1.700489	0.0934
D(LNCPI(-4),2)	-0.027463	0.112624	-0.243846	0.8080
C	0.045805	0.011775	3.889944	0.0002
@TREND(1996:01)	-0.000508	0.000166	-3.057789	0.0031

ADF Test Statistic	-3.065100	1%	Critical Value*	-3.5142
		5%	Critical Value	-2.8981
		10%	Critical Value	-2.5860

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNPRETPRODI,2)
Method: Least Squares
Sample(adjusted): 1996:07 2003:01
Included observations: 79 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNPRETPRODI(-1))	-0.596209	0.194515	-3.065100	0.0030
D(LNPRETPRODI(-1),2)	-0.200115	0.192284	-1.040725	0.3014
D(LNPRETPRODI(-2),2)	-0.311670	0.176240	-1.768443	0.0812
D(LNPRETPRODI(-3),2)	-0.099768	0.146417	-0.681399	0.4978
D(LNPRETPRODI(-4),2)	0.129524	0.114962	1.126669	0.2636
C	0.000209	0.000792	0.263474	0.7929

ADF Test Statistic	-3.860027	1%	Critical Value*	-4.0742
		5%	Critical Value	-3.4652
		10%	Critical Value	-3.1589

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(M2NOM_SA,2)
Method: Least Squares
Date: 06/24/03 Time: 11:30
Sample(adjusted): 1996:05 2003:01
Included observations: 81 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(M2NOM_SA(-1))	-0.671069	0.173851	-3.860027	0.0002
D(M2NOM_SA(-1),2)	-0.174715	0.144358	-1.210291	0.2299
D(M2NOM_SA(-2),2)	-0.260112	0.109403	-2.377556	0.0199
C	0.035722	0.009963	3.585611	0.0006
@TREND(1996:01)	-0.000272	0.000104	-2.628623	0.0104

ADF Test Statistic	-3.682333	1%	Critical Value*	-4.0742
		5%	Critical Value	-3.4652
		10%	Critical Value	-3.1589

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNIPRODI_SA,2)
Method: Least Squares
Date: 06/24/03 Time: 11:33
Sample(adjusted): 1996:05 2003:01
Included observations: 81 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNIPRODI_SA(-1))	-0.662512	0.179916	-3.682333	0.0004
D(LNIPRODI_SA(-1),2)	-0.481789	0.149098	-3.231368	0.0018
D(LNIPRODI_SA(-2),2)	-0.344840	0.102818	-3.353888	0.0012
C	-0.007873	0.004016	-1.960571	0.0536
@TREND(1996:01)	0.000148	8.08E-05	1.834936	0.0704

ADF Test Statistic	-5.908733	1%	Critical Value*	-4.0771
		5%	Critical Value	-3.4666
		10%	Critical Value	-3.1597

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EXPNET_SA,2)
Method: Least Squares
Sample(adjusted): 1996:07 2003:01
Included observations: 79 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EXPNET_SA(-1))	-2.425776	0.410541	-5.908733	0.0000
D(EXPNET_SA(-1),2)	0.872243	0.360825	2.417357	0.0182
D(EXPNET_SA(-2),2)	0.607196	0.294407	2.062437	0.0428
D(EXPNET_SA(-3),2)	0.443130	0.212687	2.083482	0.0408
D(EXPNET_SA(-4),2)	0.232527	0.116791	1.990978	0.0503
C	1.345760	5.880632	0.228846	0.8196
@TREND(1996:01)	-0.027388	0.116671	-0.234743	0.8151

ADF Test Statistic	-5.866240	1%	Critical Value*	-2.5922
		5%	Critical Value	-1.9443
		10%	Critical Value	-1.6179

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DOBDEP,2)
Method: Least Squares
Date: 06/24/03 Time: 11:40
Sample(adjusted): 1996:07 2003:01
Included observations: 79 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DOBDEP(-1))	-1.632670	0.278316	-5.866240	0.0000
D(DOBDEP(-1),2)	0.633299	0.239508	2.644164	0.0100
D(DOBDEP(-2),2)	0.491419	0.197862	2.483639	0.0153
D(DOBDEP(-3),2)	0.310409	0.157509	1.970736	0.0525
D(DOBDEP(-4),2)	0.258839	0.112290	2.305092	0.0240

ADF Test Statistic	-5.722192	1%	Critical Value*	-2.5922
		5%	Critical Value	-1.9443
		10%	Critical Value	-1.6179

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DOBREF,2)
Method: Least Squares
Date: 06/24/03 Time: 11:41
Sample(adjusted): 1996:07 2003:01
Included observations: 79 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DOBREF(-1))	-1.726206	0.301669	-5.722192	0.0000
D(DOBREF(-1),2)	0.588313	0.257284	2.286630	0.0251
D(DOBREF(-2),2)	0.514246	0.212331	2.421911	0.0179
D(DOBREF(-3),2)	0.345446	0.169891	2.033347	0.0456
D(DOBREF(-4),2)	0.189648	0.114097	1.662168	0.1007

ADF Test Statistic	-3.052173	1%	Critical Value*	-2.5922
		5%	Critical Value	-1.9443
		10%	Critical Value	-1.6179

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(YGROWTH,2)
Method: Least Squares
Date: 06/24/03 Time: 11:44
Sample(adjusted): 1996:07 2003:01
Included observations: 79 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(YGROWTH(-1))	-0.591779	0.193888	-3.052173	0.0032
D(YGROWTH(-1),2)	-0.215648	0.191841	-1.124096	0.2646
D(YGROWTH(-2),2)	-0.331998	0.175859	-1.887861	0.0630
D(YGROWTH(-3),2)	-0.114587	0.145988	-0.784906	0.4350
D(YGROWTH(-4),2)	0.126104	0.114250	1.103755	0.2733

1.2.Johansen Cointegration test

M(1): Sample(adjusted): 1996:03 2003:01
Included observations: 83 after adjusting endpoints
Trend assumption: Linear deterministic trend
Series: LNCPI LNPRETPRODI LNCURSNOM
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None	0.179445	28.77792	29.68	35.65
At most 1	0.112818	12.36260	15.41	20.04
At most 2	0.028818	2.427068	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates no cointegration at both 5% and 1% levels

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None	0.179445	16.41532	20.97	25.52
At most 1	0.112818	9.935537	14.07	18.63
At most 2	0.028818	2.427068	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Max-eigenvalue test indicates no cointegration at both 5% and 1% levels

M(2) :Sample(adjusted): 1996:03 2003:01
Included observations: 83 after adjusting endpoints
Trend assumption: Linear deterministic trend
Series: LNCPI YGROWTH EXPNET_SA LNCURSNOM
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None *	0.228003	47.69954	47.21	54.46
At most 1	0.172898	26.22129	29.68	35.65
At most 2	0.090703	10.46566	15.41	20.04
At most 3	0.030533	2.573765	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level

Trace test indicates 1 cointegrating equation(s) at the 5% level
Trace test indicates no cointegration at the 1% level

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None	0.228003	21.47825	27.07	32.24
At most 1	0.172898	15.75563	20.97	25.52
At most 2	0.090703	7.891893	14.07	18.63
At most 3	0.030533	2.573765	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Max-eigenvalue test indicates no cointegration at both 5% and 1% levels

M(3): Sample(adjusted): 1996:04 2003:01
Included observations: 82 after adjusting endpoints
Trend assumption: Linear deterministic trend
Series: LNCPI M2NOM_SA LNCURSNOM
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None	0.228266	26.26918	29.68	35.65
At most 1	0.044561	5.021707	15.41	20.04
At most 2	0.015534	1.283794	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates no cointegration at both 5% and 1% levels

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None *	0.228266	21.24747	20.97	25.52
At most 1	0.044561	3.737913	14.07	18.63
At most 2	0.015534	1.283794	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Max-eigenvalue test indicates 1 cointegrating equation(s) at the 5% level
Max-eigenvalue test indicates no cointegration at the 1% level

M(4): Sample(adjusted): 1996:04 2003:01
Included observations: 82 after adjusting endpoints
Trend assumption: Linear deterministic trend
Series: LNIPRODI_SA LNCPI DOBREF M2NOM_SA LNCURSNOM
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.387922	100.0720	68.52	76.07
At most 1 **	0.335482	59.81861	47.21	54.46
At most 2	0.189793	26.30570	29.68	35.65
At most 3	0.102062	9.047479	15.41	20.04
At most 4	0.002677	0.219848	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates 2 cointegrating equation(s) at both 5% and 1% levels

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.387922	40.25338	33.46	38.77
At most 1 **	0.335482	33.51291	27.07	32.24
At most 2	0.189793	17.25822	20.97	25.52
At most 3	0.102062	8.827630	14.07	18.63
At most 4	0.002677	0.219848	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Max-eigenvalue test indicates 2 cointegrating equation(s) at both 5% and 1% levels

M(5): Sample(adjusted): 1996:04 2003:01
Included observations: 82 after adjusting endpoints
Trend assumption: Linear deterministic trend
Series: LNIPRODI_SA LNCPI DOBDEP M2NOM_SA LNCURSNOM
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.492426	114.7131	68.52	76.07
At most 1 **	0.306292	59.10790	47.21	54.46
At most 2	0.207151	29.12011	29.68	35.65
At most 3	0.115736	10.08607	15.41	20.04
At most 4	1.10E-06	9.00E-05	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates 2 cointegrating equation(s) at both 5% and 1% levels

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value

None **	0.492426	55.60521	33.46	38.77
At most 1 *	0.306292	29.98779	27.07	32.24
At most 2	0.207151	19.03404	20.97	25.52
At most 3	0.115736	10.08598	14.07	18.63
At most 4	1.10E-06	9.00E-05	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Max-eigenvalue test indicates 2 cointegrating equation(s) at the 5% level
Max-eigenvalue test indicates 1 cointegrating equation(s) at the 1% level

However for those two last models the VAR does not satisfy the stability condition:

M(5): Roots of Characteristic Polynomial
Endogenous variables: LNIPRODI_SA LNCPI DOBDEP M2NOM_SA LNCURSNOM
Exogenous variables: C DUMF97 DUMM97
Lag specification: 1 3
Date: 06/24/03 Time: 13:03

Root	Modulus
1.030598	1.030598
0.990273 - 0.223123i	1.015098
0.990273 + 0.223123i	1.015098
0.984710	0.984710
0.719366 - 0.355340i	0.802343
0.719366 + 0.355340i	0.802343
-0.635655	0.635655
0.594851	0.594851
-0.183206 - 0.544048i	0.574067
-0.183206 + 0.544048i	0.574067
0.317107 - 0.201219i	0.375561
0.317107 + 0.201219i	0.375561
-0.225284 - 0.178461i	0.287405
-0.225284 + 0.178461i	0.287405
0.165562	0.165562

Warning: At least one root outside the unit circle.
VAR does not satisfy the stability condition.

M(4): Roots of Characteristic Polynomial
Endogenous variables: LNIPRODI_SA LNCPI DOBREF M2NOM_SA LNCURSNOM
Exogenous variables: C DUMF97 DUMM97
Lag specification: 1 3
Date: 06/24/03 Time: 13:05

Root	Modulus
1.015776	1.015776
0.984814	0.984814
0.915555 - 0.210954i	0.939544
0.915555 + 0.210954i	0.939544
0.727723 - 0.093949i	0.733762
0.727723 + 0.093949i	0.733762
0.433412 + 0.497689i	0.659955
0.433412 - 0.497689i	0.659955
-0.520690 + 0.268645i	0.585908
-0.520690 - 0.268645i	0.585908
0.422604	0.422604
-0.068771 - 0.391032i	0.397033
-0.068771 + 0.391032i	0.397033
-0.125113 - 0.231913i	0.263509
-0.125113 + 0.231913i	0.263509

Warning: At least one root outside the unit circle.
VAR does not satisfy the stability condition.

1.3. Error Term Analysis[29]

M(1)VAR Residual Portmanteau Tests for Autocorrelations
H0: no residual autocorrelations up to lag h
Sample: 1996:01 2003:01
Included observations: 83

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	7.945346	NA*	8.042241	NA*	NA*
2	13.95734	0.1239	14.20268	0.1153	9
3	21.30908	0.2641	21.83011	0.2396	18
4	30.94318	0.2735	31.95202	0.2339	27
5	38.34717	0.3635	39.83061	0.3035	36
6	51.66278	0.2297	54.18381	0.1640	45
7	62.58597	0.1978	66.11308	0.1248	54
8	71.39652	0.2189	75.86342	0.1283	63
9	85.46831	0.1327	91.64664	0.0591	72
10	89.99158	0.2315	96.78954	0.1113	81
11	93.35493	0.3834	100.6667	0.2076	90
12	96.89606	0.5411	104.8064	0.3256	99
13	122.1121	0.1670	134.7053	0.0418	108
14	128.1226	0.2271	141.9354	0.0582	117
15	132.0937	0.3374	146.7824	0.0994	126
16	135.4491	0.4729	150.9391	0.1649	135

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution

M(2)VAR Residual Portmanteau Tests for Autocorrelations
H0: no residual autocorrelations up to lag h
Sample: 1996:01 2003:01
Included observations: 83

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	9.034776	NA*	9.144956	NA*	NA*
2	24.51909	0.0788	25.01160	0.0696	16
3	33.46662	0.3960	34.29466	0.3582	32
4	47.88707	0.4774	49.44526	0.4153	48
5	58.28170	0.6779	60.50621	0.6008	64
6	79.37505	0.4987	83.24320	0.3800	80
7	102.5365	0.3053	108.5380	0.1799	96
8	118.8526	0.3109	126.5944	0.1636	112
9	145.3976	0.1394	156.3678	0.0448	128
10	156.5370	0.2244	169.0332	0.0755	144
11	166.2668	0.3509	180.2495	0.1304	160
12	171.7694	0.5760	186.6822	0.2764	176
13	201.5268	0.3042	221.9659	0.0681	192
14	216.5211	0.3282	240.0025	0.0633	208
15	224.9040	0.4704	250.2345	0.1102	224
16	231.8390	0.6354	258.8257	0.1927	240

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution

M(3)VAR Residual Portmanteau Tests for Autocorrelations
H0: no residual autocorrelations up to lag h
Sample: 1996:01 2003:01
Included observations: 81

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	6.273771	NA*	6.352193	NA*	NA*
2	8.612851	NA*	8.750491	NA*	NA*
3	11.21793	NA*	11.45576	NA*	NA*
4	15.67360	0.0740	16.14290	0.0640	9
5	18.16656	0.4447	18.79987	0.4042	18
6	32.36818	0.2187	34.13762	0.1621	27
7	41.80370	0.2333	44.46569	0.1572	36
8	50.17497	0.2757	53.75435	0.1741	45
9	58.76071	0.3054	63.41332	0.1785	54
10	61.71410	0.5223	66.78268	0.3484	63
11	68.03755	0.6105	74.09981	0.4095	72
12	80.56071	0.4929	88.80091	0.2591	81
13	108.2516	0.0923	121.7856	0.0144	90
14	123.9895	0.0453	140.8121	0.0037	99
15	129.1302	0.0810	147.1211	0.0074	108
16	136.8760	0.1011	156.7735	0.0083	117

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution

M(5)VAR Residual Portmanteau Tests for Autocorrelations
H0: no residual autocorrelations up to lag h
Date: 06/27/03 Time: 11:37
Sample: 1996:01 2003:01
Included observations: 81

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	15.08596	NA*	15.27453	NA*	NA*
2	23.17939	NA*	23.57286	NA*	NA*
3	44.97298	NA*	46.20467	NA*	NA*
4	69.80149	0.0000	72.32297	0.0000	25
5	85.65419	0.0013	89.21861	0.0005	50
6	112.1365	0.0035	117.8195	0.0012	75
7	128.3400	0.0296	135.5558	0.0104	100
8	151.3267	0.0546	161.0615	0.0164	125
9	171.7329	0.1081	184.0185	0.0307	150
10	182.1703	0.3396	195.9260	0.1330	175
11	214.9153	0.2233	233.8166	0.0508	200
12	254.1395	0.0886	279.8625	0.0075	225
13	285.7444	0.0597	317.5094	0.0025	250
14	307.1068	0.0889	343.3356	0.0032	275
15	325.2308	0.1516	365.5787	0.0057	300
16	351.1187	0.1529	397.8391	0.0035	325

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution

[29] Due to the lack of space, I displayed results only for M(5), cause M(4) and M(5) lead to the same conclusion; the normality tests are shown for a couple of residuals in models M(2) and M(5).

M(1)VAR Residual Serial Correlation LM Tests
H0: no serial correlation at lag order h
Sample: 1996:01 2003:01
Included observations: 83

Lags	LM-Stat	Prob
1	13.04052	0.1608
2	7.415821	0.5939
3	8.240183	0.5101
4	9.728383	0.3729
5	7.489086	0.5863
6	12.91670	0.1664
7	11.31442	0.2548
8	9.739334	0.3720
9	13.90640	0.1257
10	4.567727	0.8702
11	3.234694	0.9543
12	3.363352	0.9481
13	25.64266	0.0023
14	7.196980	0.6166
15	3.895770	0.9181
16	3.722353	0.9287

Probs from chi-square with 9 df.

M(2)VAR Residual Serial Correlation LM Tests
H0: no serial correlation at lag order h
Sample: 1996:01 2003:01
Included observations: 83

Lags	LM-Stat	Prob
1	21.10563	0.1745
2	18.13971	0.3158
3	9.665302	0.8835
4	14.42289	0.5672
5	10.24023	0.8538
6	21.20979	0.1706
7	23.83138	0.0933
8	17.85892	0.3322
9	29.10356	0.0232
10	11.09812	0.8034
11	9.316009	0.8998
12	5.230199	0.9945
13	30.20638	0.0170
14	18.42751	0.2995
15	8.623870	0.9281
16	7.281799	0.9674

Probs from chi-square with 16 df.

M(3)VAR Residual Serial Correlation LM Tests
H0: no serial correlation at lag order h
Sample: 1996:01 2003:01
Included observations: 81

Lags	LM-Stat	Prob
1	24.87566	0.0031
2	11.49789	0.2431
3	6.708986	0.6674
4	5.298606	0.8075
5	2.888195	0.9686
6	14.89735	0.0938
7	10.36882	0.3215
8	9.580110	0.3855
9	9.291717	0.4108
10	3.139925	0.9585
11	6.564104	0.6824
12	13.00304	0.1625
13	31.99631	0.0002
14	21.33716	0.0112
15	5.915428	0.7484
16	8.328068	0.5015

Probs from chi-square with 9 df.

M(5)VAR Residual Serial Correlation LM Tests
H0: no serial correlation at lag order h
Sample: 1996:01 2003:01
Included observations: 81

Lags	LM-Stat	Prob
1	50.72814	0.0017
2	22.92550	0.5819
3	38.16123	0.0446
4	33.19297	0.1263
5	19.19379	0.7877
6	29.21246	0.2551
7	19.53893	0.7706
8	25.18980	0.4518
9	19.28763	0.7831
10	10.59215	0.9947
11	34.34097	0.1008
12	42.32689	0.0166
13	35.79657	0.0747
14	26.35055	0.3891
15	19.63417	0.7657
16	27.51972	0.3304

Probs from chi-square with 25 df.

M(5)White Heteroskedasticity Test CHSQ(1):			
F-statistic	1.145334	Probability	0.341597
Obs*R-squared	11.39186	Probability	0.327814
M(3)White Heteroskedasticity Test CHSQ(1):			
F-statistic	0.844826	Probability	0.539352
Obs*R-squared	5.188229	Probability	0.519908

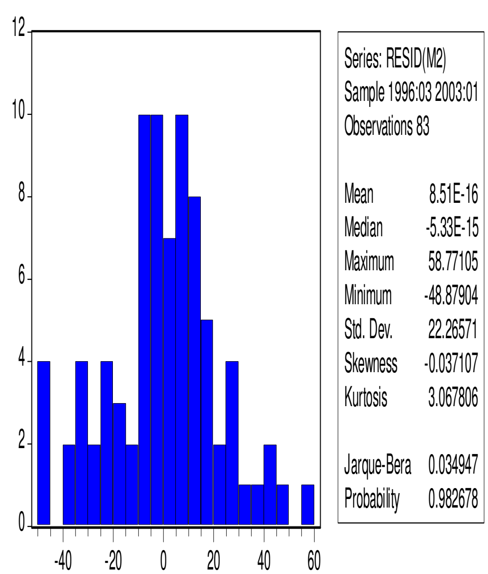
*Due to lack of space, I included only two tests

Empirical Distribution Test for RESID(M2)
Hypothesis: Normal
Sample(adjusted): 1996:03 2003:01
Included observations: 83 after adjusting endpoints

Method	Value	Adj. Value	Probability
Lilliefors (D)	0.077003	NA	> 0.1
Cramer-von Mises (W2)	0.077714	0.078183	0.2188
Watson (U2)	0.076673	0.077135	0.1943
Anderson-Darling (A2)	0.453153	0.457396	0.2650

Method: Maximum Likelihood - d.f. corrected (Exact Solution)

Parameter	Value	Std. Error	z-Statistic	Prob.
MU	8.51E-16	2.443979	3.48E-16	1.0000
SIGMA	22.26571	1.738660	12.80625	0.0000
Log likelihood	-374.8249	Mean dependent var.		8.51E-16
No. of Coefficients	2	S.D. dependent var.		22.26571

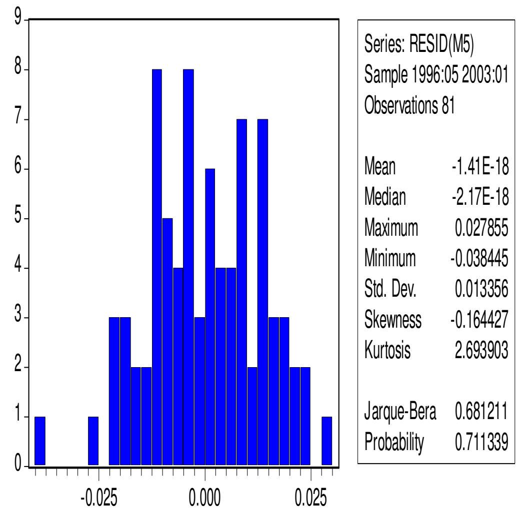


Empirical Distribution Test for RESID(M5)
Hypothesis: Normal
Sample(adjusted): 1996:05 2003:01
Included observations: 81 after adjusting endpoints

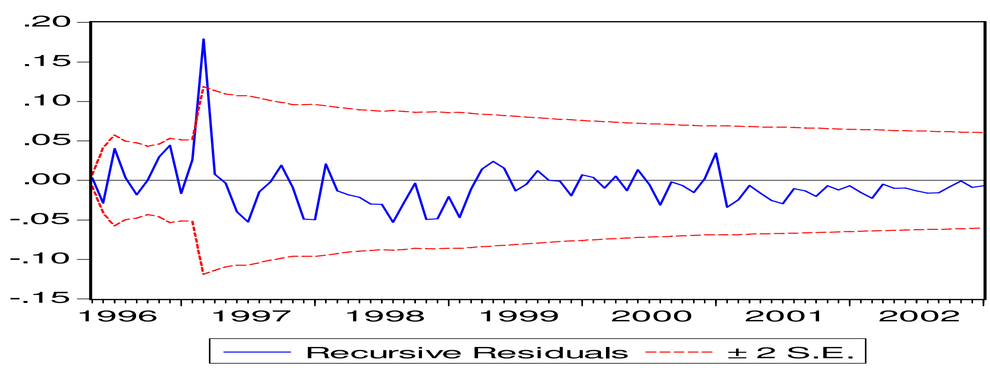
Method	Value	Adj. Value	Probability
Lilliefors (D)	0.055364	NA	> 0.1
Cramer-von Mises (W2)	0.041921	0.042180	0.6415
Watson (U2)	0.041629	0.041886	0.5907
Anderson-Darling (A2)	0.268717	0.271297	0.6734

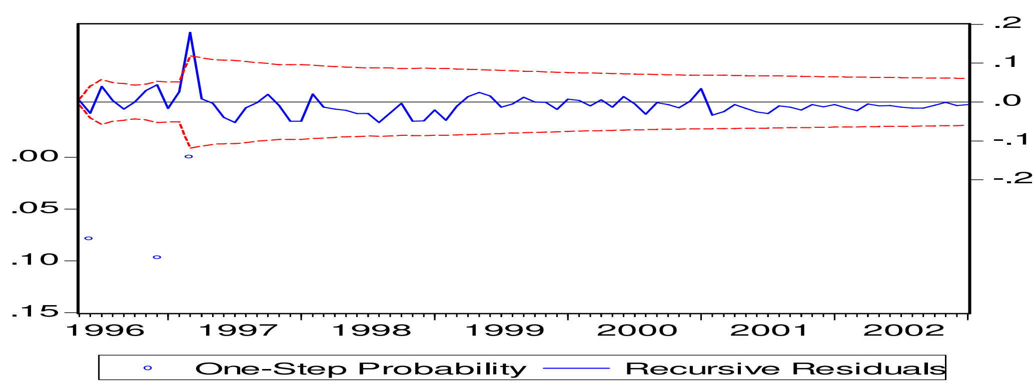
Method: Maximum Likelihood - d.f. corrected (Exact Solution)

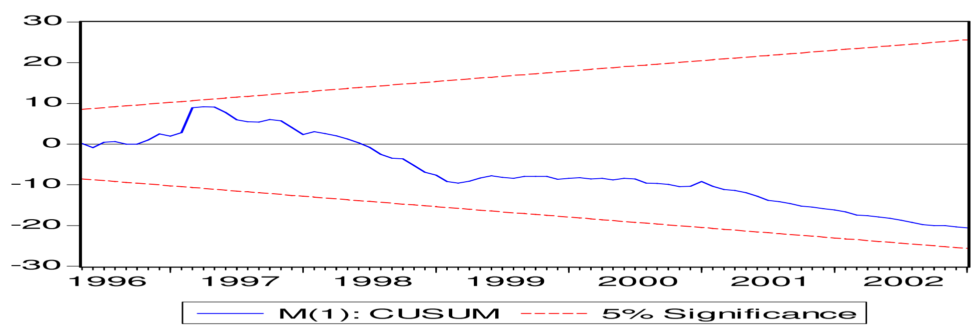
Parameter	Value	Std. Error	z-Statistic	Prob.
MU	-1.41E-18	0.001484	-9.52E-16	1.0000
SIGMA	0.013356	0.001056	12.64911	0.0000
Log likelihood	235.1441	Mean dependent var.		-1.41E-18
No. of Coefficients	2	S.D. dependent var.		0.013356

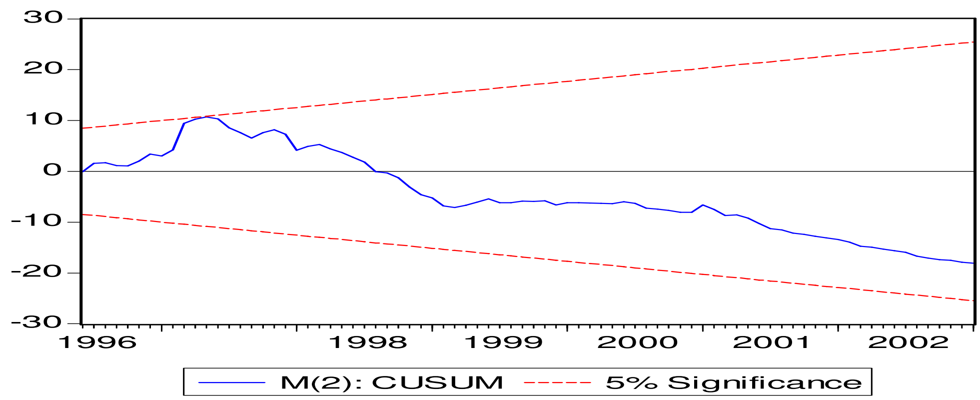


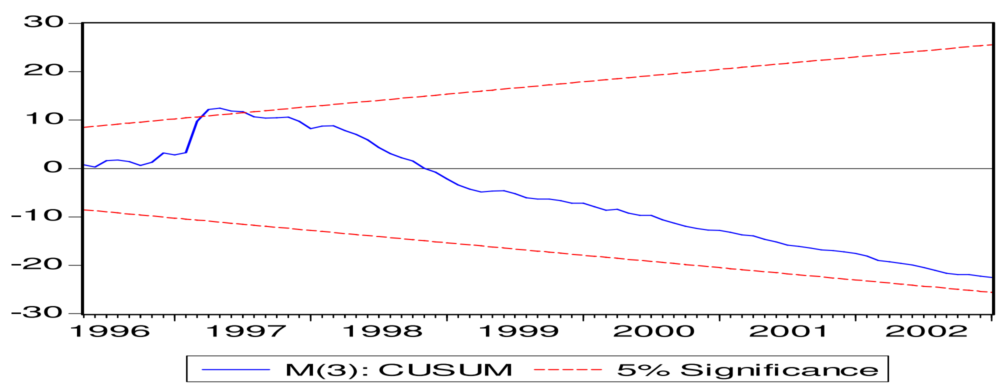
2. Stability coefficient tests

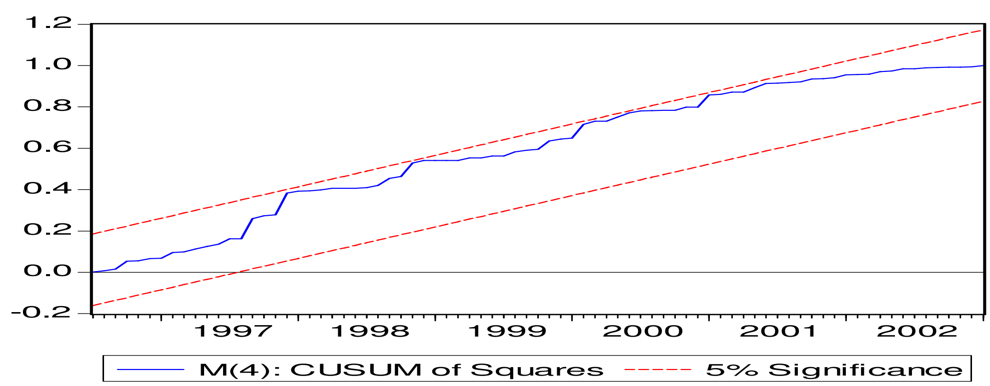


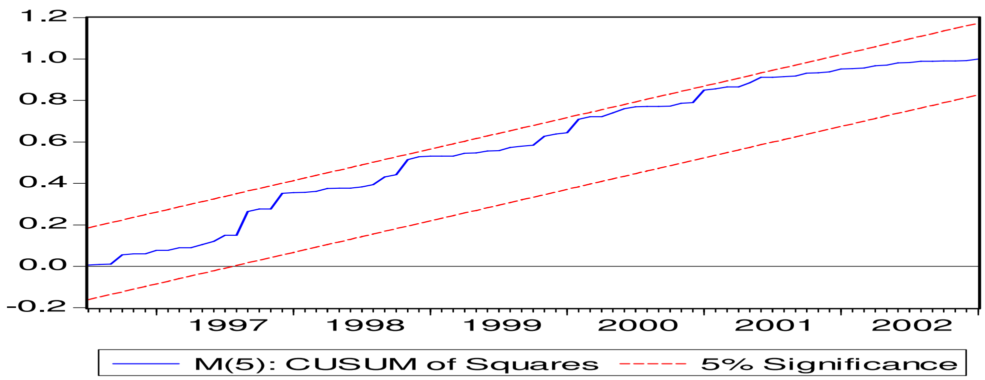





30
20
10
0
-10
-20
-30
1996
1998
1999
2000
2001
2002
M(2): CUSUM
5% Significance


30
20
10
0
-10
-20
-30
1996
1997
1998
1999
2000
2001
2002
M(3): CUSUM
5% Significance


1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
1997
1998
1999
2000
2001
2002
M(4): CUSUM of Squares
5% Significance



3. Granger Causality Tests

Pairwise Granger Causality Tests
Sample: 1996:01 2003:01
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
LNCURSNOM does not Granger Cause LNCPI	83	51.7000	5.1E-15
LNCPI does not Granger Cause LNCURSNOM		1.96922	0.14644

Table 5.

Pairwise Granger Causality Tests
Sample: 1996:01 2003:01
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Probability
M2NOM_SA does not Granger Cause LNCPI	81	7.20517	6.2E-05
LNCPI does not Granger Cause M2NOM_SA		0.71955	0.58136

Table 6.

Pairwise Granger Causality Tests
Date: 06/25/03 Time: 09:46
Sample: 1996:01 2003:01
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
M2NOM_SA does not Granger Cause DOBDEP	83	6.85608	0.00181
DOBDEP does not Granger Cause M2NOM_SA		0.25677	0.77420

Table 7.

Appendix 2

2.1. Johansen Test for Co-integration

Sample(adjusted): 1992:11 2000:08
Included observations: 94 after adjusting endpoints
Trend assumption: Linear deterministic trend
Series: CURSSCH INFLROM INFLSUA
Lags interval (in first differences): 1 to 9

Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None *	0.224919	34.98063	29.68	35.65
At most 1	0.098284	11.03054	15.41	20.04
At most 2	0.013794	1.305693	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates 1 cointegrating equation(s) at the 5% level

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None *	0.224919	23.95009	20.97	25.52
At most 1	0.098284	9.724844	14.07	18.63
At most 2	0.013794	1.305693	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Max-eigenvalue test indicates 1 cointegrating equation(s) at the 5% level

Normalized cointegrating coefficients (std.err. in parentheses)

CURSSCH	INFLROM	INFLSUA
1.000000	-0.963950	0.980738
	(0.01677)	(0.68234)

2.2. Pairwise Granger Causality/Block Exogeneity Wald Tests

Sample: 1992:01 2000:08
Included observations: 94

Dependent variable: INFLSUA

Exclude	Chi-sq	df	Prob.
CURSSCH	10.07772	10	0.4337
INFLROM	15.60763	10	0.1114
All	22.01074	20	0.3399

2.3. ECM[30]

Error Correction:	D(CURSSCH)	D(INFLROM)
CointEq	-0.039486	0.181091
	(0.04405)	(0.02959)
	[-0.89648]	[6.11977]

[30] Inflsua, according to the causality test, is considered exogenous

Breusch-Godfrey Serial Correlation LM Test CHSQ(16):			
F-statistic	1.471220	Probability	0.133201
Obs*R-squared	22.70248	Probability	0.121922

White Heteroskedasticity Test CHSQ(1):			
F-statistic	1.817391	Probability	0.132248
Obs*R-squared	7.101673	Probability	0.130612

2.4. Test for the Engle-Granger stationarity of the residuals

Test statistic	-3.703572	1% Critical Value*	-3.51
		5% Critical Value	-2.89
		10% Critical Value	-2.58

*Engle-Granger critical values for rejection of hypothesis of a unit root.

2.5. Johansen Test for Co-integration

Sample(adjusted): 1992:11 2003:01
Included observations: 123 after adjusting endpoints
Trend assumption: Linear deterministic trend
Series: CURSNOM PPIROM PPISUA
Lags interval (in first differences): 1 to 9

Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.168340	36.25787	29.68	35.65
At most 1	0.072742	13.58503	15.41	20.04
At most 2 *	0.034321	4.295594	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates 1 cointegrating equation(s) at both 5% and 1% levels

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None *	0.168340	22.67284	20.97	25.52
At most 1	0.072742	9.289435	14.07	18.63
At most 2 *	0.034321	4.295594	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Max-eigenvalue test indicates 1 cointegrating equation(s) at the 5% level
Max-eigenvalue test indicates no cointegration at the 1% level

1 Cointegrating Equation(s): Log likelihood 1291.554

Normalized cointegrating coefficients (std.err. in parentheses)

CURSNOM	PPIROM	PPISUA
1.000000	-0.976765	0.086388
	(0.02625)	(0.87964)
	[-37.2079]	[0.09821]

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