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SOME COMMENTS CONCERNING INFORMAL ECONOMY, UNEMPLOYMENT AND INFLATION RATES- ROMANIA'S CASE

Abstract. *The aim of this article is to point out the relationships between three key economic variables from an economy: inflation rate, unemployment rate and the size of the informal economy. The data series on inflation and unemployment rate, built for the whole transition period, highlight three different sub-periods for the two variables, but which are not identical. The estimation of the informal economy size through a monetary approach emphasizes its high values and also a high volatility for the considered period. Using causality analysis are identified a set of causal relationships between the variable measuring the size of the informal economy and other macroeconomic variables. The estimation of Philips curve parameters shows a negative linear dependence between the unemployment and the inflation rate, and a direct linear relationship between unemployment rate and the informal economy share in the formal economy.*

Keywords: *informal economy, inflation rate, unemployment rate, Philips curve, Granger causality, econometric models.*

JEL Classification: : C_{13}, C_{22}, C_{51}, E_{24}, E_{31}.

1. INTRODUCTION

In this part of the work there are presented some theoretical aspects and applications of VAR-type models and Box-Jenkins procedure applied to time series defined at national level. Model's parameters estimation is made based on data sets corresponding to three key economic variables: unemployment rate, inflation rate and the share of informal economy in the formal economy. In the article we try to introduce the variable measuring the size of the informal economy into the model that defines the Philips curve. Under these conditions, the Philips curve is defined in two situations: in the classical form, according to which there is a negative linear dependence between inflation and unemployment; in a model in which is introduced the variable which measures the informal economy based on the hypothesis which supposes that at an increase of the informal economy size, the unemployment rate will increase. In this study is also analyzed the relationship between inflation and unemployment rate by estimating the parameters of a VAR-type model.

In order to estimate the parameters of the Philips curve model in the two versions quarterly data for the period 1998-2009 are used and to estimate the VAR model parameters, based on the inflation and unemployment rates, monthly data series are used for the period 1991-2009.

It should be noted that the main problems in the estimation process of the Philips curve in the two variants and the estimation of the VAR-type model parameters are related to the proper use of the data series for the three variables. In this regard we note that important issues are related to the filtering of the seasonal component, aberrant values and of the long-term components from the used data series.

Applying the descriptive analysis of the two data series we make the following preliminary comments on the evolution of inflation and unemployment rates in Romania during the period 1991-2009:

- In the dynamics of the two data series can be observed, according to the graphical representation from Figure 1, three different periods of evolution. For example, in the analysis of the inflation rate, both for the real data series and for the seasonally adjusted one, the three periods are defined as follows: the first one, from the beginning of 1991 until the end of 1993, characterized by a large fluctuation of inflation from a month to another; the second one, from 1994 until the mid of 1997, is characterized by relatively low inflation rate values for the middle of this period and by high values at the beginning and the end of the period; the third period begins with high values of inflation during the second part of 1997 and continues with a stabilization of this variable until 2009. In the analysis of inflation characteristics for the last period should be taken into account that in 1997 major steps were taken that led to the liberalization of prices and full liberalization of the currency market. *"Since then, the macroeconomic variables of prime interest, such as prices, exchange rate, the basis and the money supply multiplier etc. can trustable be considered random",* Boțel (2002). Under these conditions, the data series with macroeconomic content or at regional level can be efficiently used to estimate the parameters of certain econometric models;

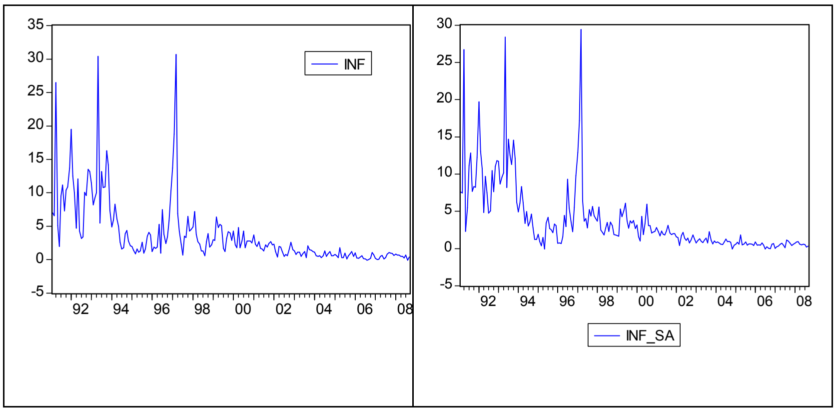
- With very small differences, the three periods are found also in the case of unemployment rate;

- For the inflation rate must be noticed four values which are very high, all belonging to the period 1991-1997. For this reason, for the estimation of econometric models is recommended that they must not be taken into account. Specialists from the National Bank of Romania (NBR) recommend the estimation with predilection of some macroeconomic models only by using statistical data starting from 1998;

- The models estimated in this paper aim to identify some characteristics of the inflation and unemployment rate dynamics, both over the transition period, and also during the period 1998-2009. Estimating the parameters we must take into account of the aberrant values presence during the three time periods indicated.

By analyzing the dynamics of the two variables using Box-Jenkins procedure and VAR we will also consider a number of issues related to the dynamics of the Romanian economy during the transition period. We present below some of them which are strictly related to the dynamics of the two variables:

- The transition process in Romania was more difficult compared with other countries from Central and Eastern Europe for several reasons: the economy was highly centralized; the economy was controlled by a single party; policy decisions after 1989 led to the loss of large external markets; the lack of a coherent process of privatization of major production capacity generated significant losses on economic and social plan etc.
- The development of many Communist period industries has been achieved mostly from the accumulated funds from the export of agricultural products and not from the export of these industries products;
- If during the early 90', Romania exported less than 40% from the total volume of goods and services exported to the countries of the European Union, in 1999 this proportion had increased to almost 69%, and, recently, grew to more than 75%;
- During the transition period, from the countries that joined the European Union, Romania had the highest level of inflation;
- Throughout the transition period, Romania has registered an increase of the informal economy size. Major studies, Schneider (2002), rank Romania among the EU countries with the highest level of informal economy.



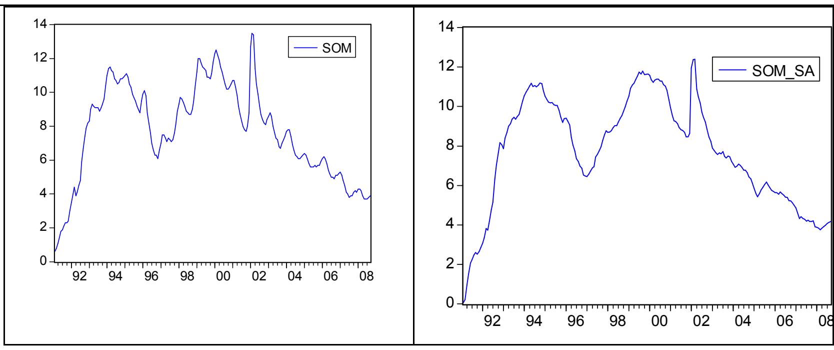


Figure 1. The evolution of the monthly inflation and unemployment rate during the period 1991m2-2008m9

2. UNEMPLOYMENT RATE AND INFORMAL ECONOMY

In this section are estimated the parameters of two econometric models. The obtained results are used to highlight the effects of the informal economy on unemployment rate. The two models define the Philips curve under the following two aspects:

- the classic form;
- by introducing a variable in the initial model to evaluate the size of the informal economy from the economy.

In the following are presented two analysis models by defining working hypotheses, the quantitative relationship between variables and data sets used.

The calculus of the equilibrium unemployment rate is based on Philips's curve theory under which there is a negative linear dependence between the inflation and unemployment rate in an economy. Under these conditions, the classic model of analysis is defined by the relation:

$$s_t - E(s_t | I_{t-1}) = a(u_t - u^*) \quad [1]$$

where s_t represents the inflation rate, $E(s_t | I_{t-1})$ is the expected inflation rate based on the available information from the last period, u_t is the unemployment rate and u^* is the natural unemployment rate.

If it's considered that the anticipated inflation is calculated as $E(s_t | I_{t-1}) = s_{t-1}$, then is defined the econometric model used to estimate the Philips curve using the following relationship:

$$s_t - s_{t-1} = \Delta s_t = b + c \cdot u_t + \varepsilon_t , \quad [2]$$

where ε_t is the residual variable of zero mean, homoscedastique and respecting the non correlation hypothesis.

The definition of the second model is based on the assumption that a higher rate of informal economy leads to an increase of the unemployment rate in the economy. Under these conditions, the second model is defined on the basis of the following relation:

$$s_t - s_{t-1} = \Delta s_t = b + c \cdot u_t + a \cdot h_t + \varepsilon_t, \qquad [3]$$

where h_t is a variable that assesses the size of the informal economy in the economy. The values of this variable will be calculated based on a methodology which will be presented very briefly in this section and its values are subunitary. To estimate the Philips curve in the form [2], the informal economy and the model parameters [3] were used quarterly data series for Romania during the period 1998-2009.

In order to estimate the size of the informal economy a monetarist method is used, Cagan (1958) and Ahumada (2008). The following variables were used: NB - cash outside the banking system, CG - total government expenditures, PIB - Gross Domestic Product, RD - short-term interest rate, RI - inflation rate and TA - Taxes on products. In this approach were estimated three equations:

- The first equation describes cash outside the banking system depending on three variables. The obtained results are presented in Table 1 (in the parenthesis, under each estimator, standard deviations are presented for each one).

Table 1. **The characteristics of the model which estimates the cash outside the banking system**

Dependent variable	$\ln NB$		
Intercept	Independent variables		
	$\ln(1 + CG / PIB)$	$\ln(PIB)$	$\ln(RD - RI)$
11.334* (0.5157)	1.896* (0.5943)	1.793* (0.0438)	111.249* (45.3002)
R^2	0.98		

$\alpha = 0.00$

- In the second equation is evaluated the size of the transactions from the official economy (NB_R). In order to estimate them, in the case of the equation [4], we consider that $CG / PIB = 0$. In these conditions, the following result is obtained:

$$NB\_R_t = \exp(11.334 + 1.795 \log(PIB_t) - 111.249(DR_t - RI_t)) \qquad [4]$$

- The size of the transactions from the informal economy is evaluated using the relation:

$$EH_t = NB_t - NB\_R_t \qquad [5]$$

- The h_t variable is defined on the basis of the following relation:

$$h_t = \frac{EH_t}{NB_t} \cdot 100 \qquad [6]$$

Based on the above methodology were determined, for the period 2000:1-2009:4, the variable values defined on the basis of the relation [6]. They are situated in the range of values between 25% and 40%. In the paper, Andrei (2010), are presented the estimated values for this economic variable.

In the following table are presented the obtained results after the estimation of the [2] and [3] models parameters. Parameter estimation was done by applying OLS and TSLS.

Table 2. The results of models [2] and [3] parameter estimation

	Model [2]		Model [3]	
	OLS	TSLS	OLS	TSLS
b	0.086^{*} (0.0090)	0.111^{*} (0.0111)	-0.194^{*} (0.0069)	-0.204^{*} (0.0147)
c	-0.020^{*} (0.0012)	-0.024^{*} (0.0014)	-0.017^{*} (0.0002)	-0.016^{*} (0.0004)
a			0.793^{*} (0.0180)	0.817^{*} (0.0383)
R^2	0.87	0.84	0.93	0.92

$\alpha < 0.01$; Between the parentheses are the standard deviations corresponding to the estimators.

For each model, Hausman test is applied. For model [2] the statistics test value is 14.75, which is higher than 9.21, value which corresponds to $\alpha = 0.01$ and $p = 2$. .In these conditions, the estimations obtained by applying TSLS are accepted. The same response is obtained for the model [3]. Based on the above results we make some comments:

- for the model [2] is verified the negative linear dependence between the inflation and unemployment rate. Using this model is obtained from the relationship, b/c, the natural unemployment rate as being equal to 4.3%. In the paper, Andrei (2010), using data series for the period 1990-2008, has estimated the size of the natural unemployment rate as being equal to 6.6%;
- for the model [3] resulted a positive linear dependence between the unemployment rate and the size of the informal economy. The higher size of the informal economy in Romania might be one of the important causes of the higher unemployment rate.

3. THE ESTIMATION OF MODELS PARAMETERS

The inflation and the unemployment rate are also estimated based on autoregressive models. For the parameters estimation of the autoregressive models for the two variables is used a Box-Jenkins procedure, which is presented in Baltagi (2009). To identify the best model used for each of the two variables the following five autoregressive models are considered which are defined in Table 3. Autoregressive models are estimated for the original and seasonally adjusted data series.

Table 3. Models used for the analysis of the inflation and unemployment rate

Model	Explanatory variables for INF	Explanatory variables for SOM
1. AR(1)	INF(-1)	SOM(-1)
2. AR(2)	INF(-1) INF(-2)	SOM(-1) SOM(-2)
3. ARMA (1,1)	INF(-1) MA(1)	SOM(-1) MA(1)
4. ARMA (2,1)	INF(-1) INF(-2) MA(1)	SOM(-1) SOM(-2) MA(1)
5. ARMA (2,2)	INF(-1) INF(-2) MA(1) MA(2)	SOM(-1) SOM(-2) MA(1) MA(2)

For example, by estimating the [3] model parameters for the inflation rate (ARMA (1,1)) are obtained the results which are displayed in Table 4. Because the intercept is not significantly different from zero (Prob = 0.1770> 0.05), this model is not validated. In Table 4 are presented the characteristics of the models defined in the above table for the analysis of inflation rate. The inflation rate data series is seasonally adjusted by Census X12 method. It results the INF_SA data series. Both for the initial series, as well as for the seasonally adjusted one, using the AIC criterion, it results that the best estimation is provided by an AR (2) model.

Table 4. Autoregressive models used for the inflation rate analysis

Autoregressive models used for the inflation rate												
Model	Type of model	Intercept	AR(1)	AR(2)	MA(1)	MA(2)	R^2	DW	AIC	F	λ_1	λ_2
1_INF_SA	AR(1)	1.238* 0.3119	0.664* 0.0517	-	-	-	0.442	2.39	5.369	165.3	-	-
2_INF_SA	AR(2)	0.855* 0.3119	0.469* 0.0664	0.292* 0.0665	-	-	0.488	1.88	5.211	115.81	-	-
3_INF_SA	ARMA (1,1)	0.139 0.1215	0.950* 0.0250	-	-0.656* 0.0639	-	0.526	1.85	5.370	96.94	0.61	-
4_INF_SA	ARMA (2,1)	0.105 0.1025	1.079* 0.1146	-0.121* 0.1014	-0.733* 0.0877	-	0.537	1.82	5.202	79.48	0.73	-
5_INF_SA	ARMA (2,2)	0.268 0.2348	0.283 0.2367	0.625* 0.2157	0.074 0.2321	-0.488* 0.1346	0.556	1.79	5.168	64.25	0.68	-0.78
1_INF	AR(1)	1.305* 0.3250	0.646* 0.0528	-	-	-	0.418	2.34	5.477	149.87	-	-
2_INF	AR(2)	0.946* 0.3285	0.478* 0.0671	0.261* 0.0671	-	-	0.456	1.91	5.423	86.88	-	-
3_INF	ARMA (1,1)	0.203 0.1500	0.933* 0.0311	-	-0.611* 0.0704	-	0.482	1.85	5.370	96.94	0.61	-
4_INF	ARMA (2,1)	-0.004 0.0010	1.379* 0.0640	-0.387* 0.0633	-0.997* 0.0073	-	0.514	1.94	5.319	72.73	1.00	-
5_INF	ARMA (2,2)	0.268 0.2348	0.283 0.2367	0.625* 0.2157	0.074 0.2321	-0.488* 0.1346	0.501	1.76	5.355	51.53	0.66	-0.74

** significance level α = 0.00; ** significance level α = 0.05*

4. THE ANALYSIS OF THE CAUSALITY BETWEEN VARIABLES

Using an Engel-Granger type test (EG) is analyzed the relationship between the inflation and unemployment rate. This one is applied for the initial and seasonally adjusted data series. For both cases, from the two data series are eliminated the aberrant values. For this reason are defined two VAR type models: one for the initial data and other for the seasonally adjusted ones. In order to define the VAR type model are considered two stationary variables X and Y. In these conditions, we define the following VAR model:

$$\begin{cases} y_t = a_{10} + \sum_{i=1}^{n} a_{1i} x_{t-i} + \sum_{i=1}^{m} b_{1i} y_{t-i} + \varepsilon_{1i} \\ x_t = a_{20} + \sum_{i=1}^{n} a_{2i} x_{t-i} + \sum_{i=1}^{m} b_{2i} y_{t-i} + \varepsilon_{2i} \end{cases} \quad [7]$$

Where the two residual variables, ε_{1t} and ε_{2t} , are uncorrelated white noises.

For the interpretation of the two equations are highlighted the following four situations:

- If $n \neq 0$ and $m = 0$, then it results that variable X causally determines variable Y;
- If $m = 0$ and $n \neq 0$, then it results that variable Y d causally determines variable X;
- If $n \neq 0$ and $m \neq 0$, then it results that between the two variables there is a mutual causality relation;
- If $n = 0$ and $m = 0$, then it results that the two variables are independent.

The statistics of the Wald test is defined by the following relation:

$$F = \frac{(SPE_R - SPE_{FR}) / m}{SPE_{FR} /(T - p)}, \quad [8]$$

Where: SPE_R – the sum of the squared errors for the regression model with restrictions; SPE_{FR} – the sum of the squared errors for the regression model without restrictions; T - the length of the data series; p - the number of the parameters which are estimated.

By applying this methodology for the initial and seasonally adjusted data are obtained the results from Table 5.

Table 5. The Engle-Granger causality test

The null hypotheses	F-statistics	The test conclusion
Case 1: INF doesn't G-causes SOM	1.14	H_0 is accepted
Case 2: SOM doesn't G-causes INF	1.23	H_0 is accepted
Case 3 : INF_SA doesn't G-causes SOM_SA	4.36	INF_SA $\rightarrow$ SOM_SA
Case 4: SOM_SA doesn't G-causes INF_SA	0.48	H_0 is accepted
Case 5 : INF_C doesn't G-causes SOM_SA	4.17	INFC $\rightarrow$ SOM_SA
Case 6: SOM_SA doesn't G-causes INF_C	0.24	H_0 is accepted

From the above table we observe that there is a causality relationship between the inflation and unemployment rate for the seasonally adjusted data series (see Case 3) and for the corrected of aberrant values inflation rate data series and the seasonally adjusted data series unemployment rate (see Case 5).

For a more detailed analysis of the informal economy implications is determined the nature of the causal relationship between the variable which evaluates its size and other macroeconomic variables as: gross earnings from industry (LCB_ID), the average gross earnings at the level of the entire national economy (LCB_TO), net earnings from public administration (LCN_AP), the unemployment rate (SOM) and the inflation rate (INF) from the economy. To analyze the causal relationship between these variables is applied an EG test. In order to apply this test for all the variables considered above are used quarterly data series for the period 1998-2009. By applying the EG test, the results are presented in Table 6.

Table 6. The causal relationship between various macroeconomic variables

The null hypotheses	F Statistics and significance level	Type of causality
The causal relationship between the informal economy and salaries		
LCB_ID doesn't causally determine h	3.330 (0.048)	$LCB\_ID \leftrightarrow h$
rh doesn't causally determine h	4.483 (0.019)	
LCB_TO doesn't causally determine h	2.942 (0.067)	$LCB\_TO \leftrightarrow h$
h doesn't causally determine LCB_TO	2.711 (0.081)	
LCN_AP doesn't causally determine h	3.335 (0.048)	$LCN\_AP \rightarrow h$
h doesn't causally determine LCN_AP	0.546 (0.584)	

The causal relationship between the informal economy and other macroeconomic variables		
SOM doesn't causally determine h	6.386 (0.004)	$SOM \rightarrow h$
h doesn't causally determine SOM	0.200 (0.888)	
INF doesn't causally determine h	6.037 (0.005)	$INF \leftrightarrow h$
h doesn't causally determine INF	3.431 (0.044)	

The above results highlight at the level of the 1998-2009 period the following:

- a reciprocal relationship between the average gross earnings from industry, the average gross earnings at the level of the national economy and the size of the informal economy;
- net earnings from public administration causal determine the size of the informal economy;
- unemployment rate causal determines the size of the informal economy;
- between inflation and the informal economy there is a reciprocal causality relationship.

5. VAR MODEL

For the two variables used to define the VAR model we must solve two important problems:

- The analysis of the data series stationarity for the two indicators. By applying the ADF and PP tests it results that the data series for inflation (real and seasonally adjusted) are I(0), while the data series for the second variable are I(1).
- The determination of the number of the last periods taken into account to define the VAR model. For this purpose we apply the AIC criterion.

Due to the fact that the data series for the inflation rate is a stationary one and the one for the unemployment rate is a first order integrated one, to define the VAR type model were used the following variables:

a. For the inflation rate will be used INF_SA;
b. For the unemployment rate will be applied the difference operator to obtain a stationary series. In these conditions, in the model will be used the variable DIF_SOM_SA, which is defined using the relationship: $DIF\_SOM\_SA = \Delta SOM\_SA$.

By estimating the VAR models are obtained the above results. Between parentheses, under each estimator, are presented the standard deviations of the estimators.

Table 7. The parameter estimation for VAR(1) model for seasonally adjusted data series

	INF_SA	DIF_SOM_SA	D_INF
INF_SA(-1)	1.034	0.018	0.009
	(0.0538)	(0.0060)	(0.0022)
DIF_SOM_SA(-1)	0.181	0.373	-0.002
	(0.5705)	(0.0639)	(0.0238)
D_INF_SA(-1)	-23.719	-0.270	-0.230
	(2.0668)	(0.2316)	(0.0862)
C	0.174	-0.053	-0.015
	(0.2648)	(0.0297)	(0.0110)
R-squared	0.66	0.22	0.07
S.E. equation	2.7673	0.3102	0.1154
F-statistic	133.25	19.50	5.36
Akaike AIC	4.892	0.515	-1.462

Table 8. The parameter estimation for VAR(1) model for data series with seasonality

	INF	DIF_SOM	D_INF
INF(-1)	1.013	0.015	0.009
	(0.05720)	(0.00724)	(0.00219)
DIF_SOM(-1)	0.045	0.532	-0.007
	(0.46781)	(0.05921)	(0.01792)
D_INF(-1)	-24.023	-0.393	-0.237
	(2.28620)	(0.28934)	(0.08759)
C	0.263	-0.044	-0.015
	(0.28430)	(0.03598)	(0.01089)
R-squared	0.62	0.33	0.07
S.E. equation	3.0117	0.3812	0.1154
F-statistic	114.23	34.35	5.36
Akaike AIC	5.061	0.927	-1.462

On the basis of the two VAR type models are determined the impulse response function values and the confidence interval of its values and the error data series variance decomposition on influence factors is performed. In the below charts are presented the impulse response functions realized for the two regression models and in Table 8 is presented the error data series variance decomposition.

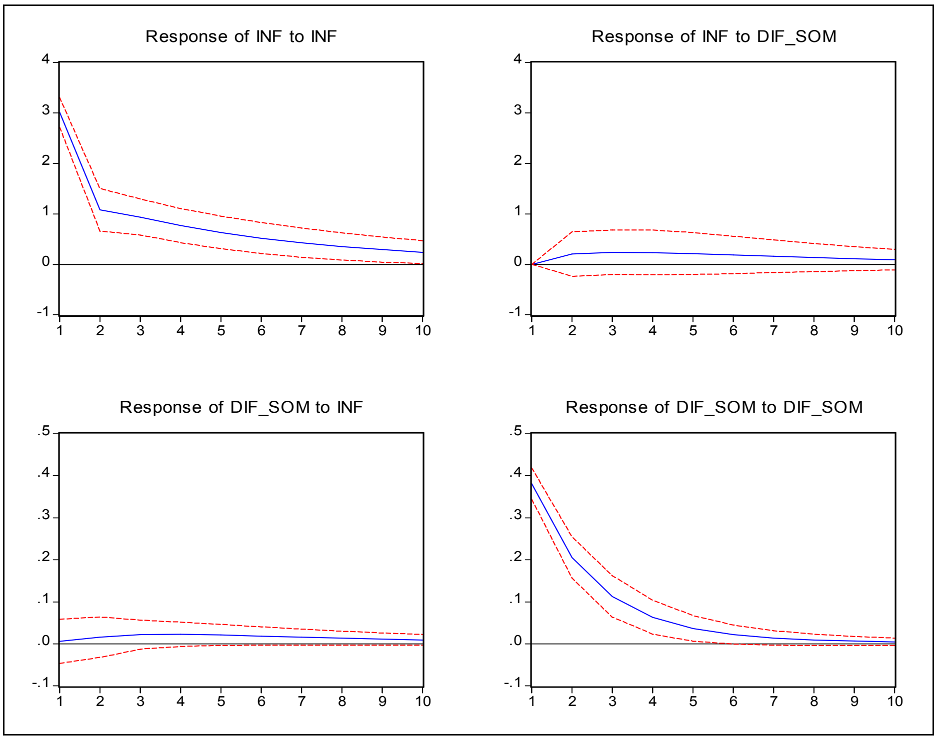


Figure 2. The impulse response function for INF and SOM at a INF and SOM shock unit

Table 9. The error data series variance decomposition

	INF				DIF_SOM			
	S.E.	INF	DIF_SOM	D_INF	S.E.	INF	DIF_SOM	D_INF
1	3.0117	100.00	0.00	0.00	0.3832	0.03	99.97	0.00
2	3.7474	72.90	0.30	26.80	0.4345	0.15	99.31	0.53
3	4.1538	64.45	0.57	34.96	0.4510	0.37	98.41	1.21
4	4.4092	60.24	0.79	38.95	0.4576	0.60	97.52	1.86
5	4.5750	57.86	0.96	41.16	0.4609	0.80	96.78	2.40
6	4.6847	56.42	1.07	42.49	0.4628	0.96	96.21	2.82
7	4.7582	55.51	1.16	43.32	0.4640	1.07	95.79	3.12
8	4.8077	54.92	1.21	43.86	0.4648	1.16	95.49	3.34
9	4.8413	54.52	1.25	44.21	0.4654	1.21	95.29	3.49
10	4.8641	54.26	1.28	44.45	0.4658	1.25	95.14	3.59

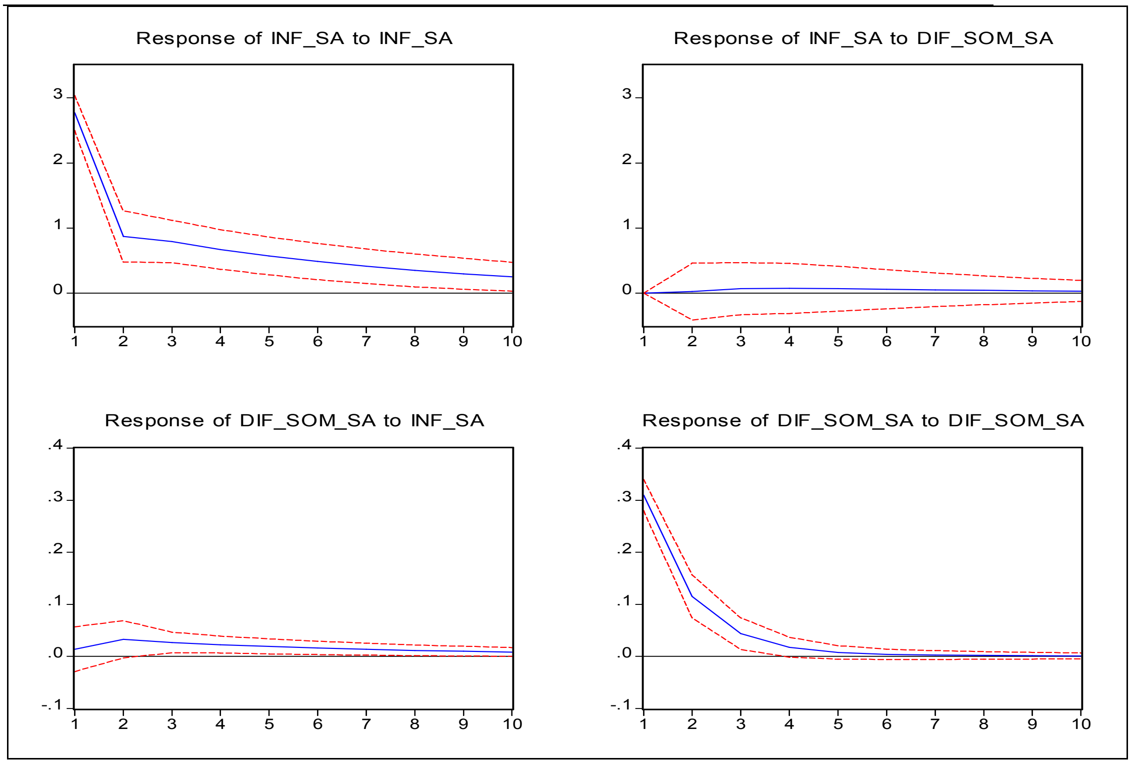


Figure 3. The impulse response function for INF and SOM at a INF and SOM shock unit (seasonally adjusted data series)

The above charts show that an instantaneous shock on inflation determines an impulse on the unemployment rate. Meanwhile, an instantaneous shock applied on unemployment doesn't determine an instant shock on the inflation rate. The results from the table containing the forecast error variance decomposition shows that inflation is largely determined (72.9% for variable INF) of its own innovation and in a very small degree by the innovation of DIF_SOM variable.

6. CONCLUSIONS AND COMMENTS

The analysis of the data series for the inflation and unemployment rate highlights higher values and their higher volatility. For the two data series during the transition period can be identified three periods of evolution. These ones are not the same for the two variables. The size of the informal economy, measured as a share of the informal economy into the official economy, recorded higher values during the period 1998-2009, situated between 25-38%. Under these conditions, Romania registered the highest value of the informal economy between the countries from the European Union. The estimation of the Philips curve model parameters emphasizes the negative linear dependence between unemployment and inflation rate. Equally, for the period 1998-2009, is determined a value of the natural unemployment rate, equal to 4.3%. Similar calculus, but realized for the period 1991-2009, allow the determination of the natural unemployment rate as being equal to 6.6%. By introducing a variable which measures the size of the informal economy into the classical model of Philips's curve allows the identification of a linear dependence between the unemployment rate and the size of the informal economy.

The analysis of the economic implications as a result of the presence, at a higher level, of the informal economy, for the period 1998-2009, highlight the following: the mutual causal relationship between the informal economy and the industry's gross earnings, between the average gross earnings at the level of the economy and the inflation rate; the unemployment rate and the net gain from public administration causally determines the size of the informal economy.

A broader development of the VAR model, used for the analysis of the unemployment rate, recommends taking into consideration of a series of variables with economic content. To avoid using data sets containing aberrant values or for which there are breaks of slope or level is recommended to use the data series since 1998.

Acknowledgements.

This work was supported by CNCSIS –UEFISCDI, project number PN II – IDEI code 1814/2008, financing contract 763/2009.

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