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THE IMPACT OF UNEMPLOYMENT RATE ON THE ROMANIAN SHADOW ECONOMY: AN EMPIRICAL INVESTIGATION USING GRANGER CAUSALITY ANALYSIS

Abstract. *The paper aims to estimate the size of the Romanian shadow economy (SE) in the period 1998Q1-2008Q4 using the currency demand approach and to evaluate if there is any relationship between the SE and unemployment rate (UR) in the case of Romania. In order to do that, we used the cointegration-based error correction mechanism in vector autoregression models. A special attention it was given to the problem of non-stationarity and cointegration. The results indicate that the shadow economy grows constantly during 1998-1999 until it reaches its maximum at the end of 1999(38.12% in 1999Q2). Then, it decreases slowly and stabilizes around 27% of official GDP.*
Evaluating the Granger causality relationship between the unemployment rate and the size of the shadow economy, the results support a unidirectional granger causality that runs only from the unemployment rate to the shadow economy.
Using the generalized impulse response functions, the analysis leads to the finding that a 1% increase in the unemployment rate contributes to shadow economy decrease by 3.7% over the next 8 quarters.
Keywords: *shadow economy, currency demand approach, VECM, unemployment rate, Granger causality, Romania.*

JEL classification C32, E41, O17

I. Introduction

Economies in most developing countries are characterized by shadow sectors. Although the problem of shadow economy is not new, an agreement on a unique accepted definition, on a theoretical model as well as a clear measuring method are still missing. From now on, we will refer to the shadow economy as "all currently unregistered economic activity which contributes to the officially calculated (or observed) Gross National Product". Smith (1994) defines it as „market-based production of goods and services, whether legal or illegal that escapes detection in the official estimates of GDP."

F.Schneider[1] and D. Enste (1998) estimates the size of 67 developing, transition and OECD countries, using different methods currency demand, physical input (electricity) measure, model approach. Using the physical input (electricity) method the average size of the shadow economy (in % of GDP) over the period 1989-1993 in transition countries is 23.2%. For Romania, the average size of shadow economy is 26% of official GDP for the period 1990/93, and 28.3% in 1994/95.

Using two different estimation methods[2] of the size of shadow economy, the currency demand approach and the DYMIMIC model, the Schneider's results reveal an ascendent trend on the terms of the Romanian shadow economy who registers about 27.3% of official GDP in 1990-1993, 33.4% in 2000-2001 and 37.4% in 2002-2003. In the last years, it can be observed a decreasing evolution of the shadow economy, who registers 36.2% of official GDP in 2003-2004 and 35.4% in 2004-2005.

The results of applying different methods of estimation of shadow economy differ. In the case of Romania, the size of the shadow economy range between about 20% of GDP, obtained on the basis of the energy consumption method (Enste and Schneider, 2000) and more than 45% computed using the monetary approach (French, Balaita, and Ticsa, 1999). Also, the dimension of the shadow economy (based on the national accounts methodology) reported by the National Institute for Statistics (NIS) has increased (mainly due to changes in methodology) from about 5% in 1992, to 18% in 1997 and to 20-21% in 2000-2001.

Albu L.(2007)[3] analyze the structure of households' income by sources: main job, secondary job, and hidden activities, using two Romanian household surveys (September 1996 and in July 2003) and the results reveal the fact that the income from the shadow economy amounts about 1/4 of the total household income (23.6% in 1996 and 22.7% in 2003). From this study, certain conclusions could be outlined: a) people perceive taxation as the main cause of the shadow economy; b) separating the main motivations of operating in the shadow sector in two groups, "subsistence" and "enterprise", the surveys suggest that the subsistence represented a relevant reason for the households' decision to operate in the shadow economy, including its underground segment; c) shadow activities supplied a "safety valve" within the surviving strategies adopted by the poorest households; d) participation in shadow economy seems to be not simply correlated with poverty: in the shadow economy are involved poor people (having probably a low educational level), as well as rich persons, but their motivations are quite different.

[1] Enste, D., Schneider, F., 1998. "Increasing Shadow Economies all over the World - Fiction or Reality?," IZA Discussion Papers 26, Institute for the Study of Labor (IZA).

[2] Schneider (1998, 2002, 2004, 2005, 2006, 2007)

[3] Albu, Lucian Liviu, 2007. "Estimating the Size of Underground Economy in Romania," Working Papers of Institute for Economic Forecasting 070601, Institute for Economic Forecasting

Also, Albu (2008)[4] uses the data from these surveys in order to estimate the theoretical limit-values for the size of shadow economy on the basis of limited available macroeconomic data and extends the model to estimate the size and dynamics of informal economy to the regional level. Using discrepancy between actual and desired income, it have been estimated the lower and upper bound of the shadow economy:(28.6-35.9)% of official GDP in 1990, (23.5-28.7)% in 1995, (23.2-28.3)% in 2002, (22.7-27.5) % in 2003, (22.5-27.3)% in 2004 and (22.5-27.8)% in 2005.

II. The currency demand approach

The currency demand approach can be classified among the indirect methods of estimation of the shadow economy. This approach is one of the most commonly used. It has been applied to many OECD countries[5] but has nevertheless been criticized on various grounds[6]. The currency demand approach was first used by Cagan (1958), who calculated a correlation of the currency demand and the tax pressure (as one cause of the shadow economy) for the United States over the period 1919 to 1955. Twenty years later, Guttmann (1977) used the same approach, but he hasn't used any statistical procedures; instead he „only" looked at the ratio between currency and demand deposits over the years 1937 to 1976.

Cagan's approach was further developed by Tanzi (1980, 1983), who econometrically estimated a currency demand function for the United States for the period 1929 to 1980 in order to calculate the shadow economy. His approach assumes that shadow (or hidden) transactions are undertaken in the form of cash payments, so as to leave no observable traces for the authorities. An increase in the size of the shadow economy will therefore increase the demand for currency. To isolate the resulting „excess" demand for currency, an equation[7] for currency

[4] Albu, Lucian Liviu, 2008. "A Model to Estimate Spatial Distribution of Informal Economy," ***Journal for Economic Forecasting***, Institute for Economic Forecasting, vol. 5(4), pages 111-124.

[5] Schneider (1997, 1998a), Johnson, Kaufmann and Zoido-Lobatón (1998a), Williams and Windebank (1995) and Bovi and Dell'Anno(2007) for OECD countries, Tanzi(1983) for USA, Bovi and Castelucci(2001) for Italy, Giles D.E. (1999) for New Zeeland, Brambila Macias Jose(2008) for Mexico, Schneider(1986) for Denmark, Schneider and Hametner(2007) for Colombia.

[6] Thomas (1986, 1992, 1999), Feige (1986), and Pozo (1996).

[7] The variables such as the direct and indirect tax burden, government regulation and the complexity of the tax system, which are assumed to be the major factors causing people to work in the shadow economy, are included in the estimation equation. The basic regression equation for the currency demand, proposed by Tanzi (1983), is the following:

$$\ln(\frac{C}{M_2})_t = \beta_0 + \beta_1 \cdot \ln(1 + TW)_t + \beta_2 \cdot \ln(\frac{WS}{Y})_t + \beta_3 \cdot \ln R_t + \beta_4 \cdot \ln(\frac{Y}{N})_t + \varepsilon_t$$

where:

– $\beta 1 > 0, \beta 2 > 0, \beta 3 < 0, \beta 4 > 0$

- ln denotes natural logarithms;

demand is econometrically estimated over time. Following Cagan's work, a typical currency demand function can be written as:

$$C_0 = A \cdot (1+\Theta)^{\alpha} \cdot Y_0^{\beta} \cdot \exp(-\gamma i) \quad (1)$$

where:

- C_0 represents the observed cash.

- Θ represents the variable that gives incentives to make hidden transactions. This is the key variable of all currency models and it can be approximated using government consumption normalized by GDP, tax rates (direct and indirect taxes), tax revenues to GDP. An increase in Θ is expected to have a positive impact on currency demand, since agents will have more incentives to go to the shadow sector, demanding more currency for their transactions

- Y_0 represents the registered GDP, but also it can be used GDP per capita, consumption per capita.

- i represents the interest rate.

- α, β, γ, A represents the parameters.

Estimating equation (1), it will be obtained $\hat{C}$.Setting the incentive variable Θ equal to zero, and leaving the coefficients of the other variables unchanged, we obtain $\tilde{C}$.The difference between $\hat{C}$ and $\tilde{C}$ is the amount of extra currency. In other words, the difference measures the amount of illegal money in the economy. Forth more, assuming that the velocity of money is the same in both official and

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- C/M2 is the ratio of currency outside the banks and M_2 (broad money).

- TW is a weighted average tax rate (to proxy changes in the size of the shadow economy);

- WS/Y is a proportion of wages and salaries in national income (to capture changing payment and money holding patterns);

- R is the interest paid on savings deposits (to capture the opportunity cost of holding cash);

- Y / N is the per capita income;

- ε is the error term.

The „excess" increase in currency, which is the amount unexplained by the conventional or normal factors (mentioned above) is then attributed to the rising tax burden and the other reasons leading people to work in the shadow economy. Figures for the size and development of the shadow economy can be calculated in a first step by comparing the difference between the development of currency when the direct and indirect tax burden (and government regulations) are held at its lowest value, and the development of currency with the current (much higher) burden of taxation and government regulations.

Assuming in a second step the same income velocity for currency used in the shadow economy as for legal M_1 monetary aggregate(composed by currency in circulation and overnight deposits) in the official economy, the size of the shadow can be computed and compared to the official GDP.

shadow sector[8], we can obtain an estimate of the size of shadow economy multiplying illegal money ($EC = \hat{C} - \widetilde{C}$) by the velocity of money ($v = \frac{Y}{C}$).

The most commonly raised objections of this method are:

- Not all transactions in the shadow economy are paid in cash;
- Most studies consider only one particular factor, the tax burden, as a cause of the shadow economy. But others (such as the impact of regulation, taxpayers' attitudes toward the state, „tax morality" and so on are not considered, because reliable data for most countries is not available[9];
- A further weakness of this approach, at least when applied to the United States, is discussed by Garcia (1978), Park (1979), and Feige (1996), who point out that increases in currency demand deposits are due largely to a slowdown in demand deposits rather than to an increase in currency caused by activities in the shadow economy. Feige (1986, 1997), criticize Tanzi's studies on the grounds that the US dollar is used as an international currency. Tanzi should have considered (and controlled for) the US dollars, which are used as an international currency and held in cash abroad;
- Another weak point of this procedure, in most studies, is the assumption of the same velocity of money in both types of economies. As Hill and Kabir (1996) for Canada and Klovland (1984) for the Scandinavian countries argue, there is already considerable uncertainty about the velocity of money in the official economy; the velocity of money in the hidden sector is even more difficult to estimate. Without knowledge about the velocity of currency in the shadow economy, one has to accept the assumption of an „equal" money velocity in both sectors. Ahumada, Alvaredo, Canavese (2006) show that the currency approach, together with the assumption of equal income velocity of money in both the reported and the hidden transaction is only correct if the income elasticity is 1. As this is not the case for most countries, the calculation has to be corrected.

8 This assumption has been criticized and, as Ahumada et al. (2006) claim, even if the velocity is the same, previous works that find $\beta \neq 1$ (i.e. income elasticity different from 1) are incorrect. Therefore, they propose an alternative way of correcting the estimates.

9 Schneider, F.(2000), Illegal Activities, But Still Value Added Ones (?): Size, Causes, and Measurement Of The Shadow Economies All Over the World, CESifo Working Paper Series CESifo Working Paper No. 305, pg.29- "One (weak) justification for the use of only the tax variable is that this variable has by far the strongest impact on the size of the shadow economy in the studies known to the authors. The only exception is the study by Frey and Weck-Hannemann (1984) where the variable „tax immorality" has a quantitatively larger and statistically stronger influence than the direct tax share in the model approach. In the study of Pommerehne and Schneider (1985), for the U.S., besides various tax measures, data for regulation, tax immorality, minimum wage rates are available; the tax variable has a dominating influence and contributes roughly 60-70 percent to the size of the shadow economy".

- Finally, the assumption of no shadow economy in a base year is open to criticism. Relaxing this assumption would again imply an upward adjustment of the figures attained in the bulk of the studies already undertaken.

III. Methodology and Data

The data cover each quarter between 1998 and 2008: the number of observations is 44. The main sources used to collect the data are: Eurostat, National Bank of Romania and National Institute of Statistics, Tempo database. A description of the variables and their sources is summarized in the table 1 of Appendix.

As point out by Guissari (1987), one of the first decisions to be taken in a currency demand model is how to deflate the currency series. Tanzi (1983) imposes currency deflation using M_2.Spiro (1996) considers the use of monetary aggregate M_2 inadequate, since it contains amounts that corresponds to long-term wealth accumulation, while currency is used mainly for transaction processes. Schneider and Enste (2000) use the currency per capita in real terms. So, we deflate the series using the national GDP deflator and we construct the following function[10]:

$$C_t = \beta_0 + \beta_1 \cdot Y_t + \beta_2 \cdot Tax_t + \beta_3 \cdot R_t + \beta_4 \cdot Wages_t + \varepsilon_t \qquad (2)$$

where:
C represents the natural logarithm of currency in circulation outside the banks (at the end of the period in millions RON) normalized by the GDP deflator;
Y represents the natural logarithm of real gross domestic product in millions RON, base year (2000=100);
TAX represents the natural logarithm of total tax revenues normalized by GDP;
R represents the natural logarithm of 1 year nominal saving deposit interest rate;
$WAGES$ represents the natural logarithm of wages normalized by GDP;
ε represents the error term.

This specification captures the long-run relationships between the explanatory variables and the currency demand. Regarding the sign of the variables in the model, we expect a positive impact on currency demand for GDP, taxes and wages ($\beta_1, \beta_2, \beta_4$>0)[11], and a negative effect from the part of interest rate (β_3<0)[12].

Unit root tests: As a preliminary step, tests of stationarity (or tests for the presence of unit roots) were carried out for each series. Furthermore, Augmented Dickey-

[10] This function is a log-linearization of equation (1).
[11] The expected positive impact of taxes on currency demand can be interpreted, following Tanzi: if the level of taxation increase, economic agents will be encourage engaging tax-evading activities, using currency, due to the intractability of cash, and than the currency rises.
[12] If the interest rate increases, the economic agents get ride to their currency holdings.

Fuller (ADF) and Phillips-Perron (PP)) tests were employed in order to identify each variable's integration level (Dickey and Fuller, 1981).

Cointegration and Johansen test: After the order of integration is determined, co-integration between the series can be tested to identify any long run relationship. Johansen trace test is used for the co-integration test in this study. Cheung and Lai [3] mention that the trace test is more robust than the maximum eigenvalue test for co integration. The Johansen trace test attempts to determine the number of co-integrating vectors among variables. There should be at least one co-integrating vector for possible co integration.

This procedure [13][20] can be expressed in the following VAR model:

$$X_t = \Pi_1 X_{t-1} + ... + \Pi_K X_{t-K} + \mu + e_t \quad t = 1,..,T \tag{3}$$

where $X_t, X_{t-1}, ..., X_{t-K}$ are vectors of current and lagged values of P variables which are $I(1)$ in the model; $\Pi_1,....,\Pi_K$ are matrices of coefficients with (PXP) dimensions; μ is an intercept vector[i]; and e_t is a vector of random errors. The number of lagged values, in practice, is determined in such a way that error terms are not significantly auto-correlated.. The rank of Π is the number of co integrating relationship(s) (i.e. r) which is determined by testing whether its Eigen values (λ_i) are statistically different from zero. Johansen and Juselius [16] propose that using the Eigen values of Π ordered from the largest to the smallest is for computation of trace statistics[14]. The trace statistic (λ_{trace}) is computed by the following formula[15]:

$$\lambda_{trace} = -T \sum \ln(1 - \lambda_i) \tag{4}$$

$i = r+1, ..., n-1$ and the hypotheses are :

$H_0: r = 0$ $H_1: r \geq 1$

$H_0: r \leq 1$ $H_1: r \geq 2$

$H_0: r \leq 2$ $H_1: r \geq 3$

VAR model with an error correction mechanism: Given the non-stationarity of our series and the presence of a common stochastic trend, traditional estimation methods are ruled out and we must then estimate a VAR model in which we shall include a mechanism of error correction model (ECM).

[13] This procedure is presented in detail in Katircioglu S.T. "Financial development, trade and growth triangle: the case of India", International Journal of Social Economics, Vol. 34 No. 9, 2007, pp. 586-598.

[14] Asymptotic critical values are obtained from Osterwald-Lenum (1992).

[15] At the beginning of the procedure, we test the null hypothesis that there are no co integrating vectors. If it can be rejected, the alternative hypothesis (i.e. $r \leq 1, ..., r \leq n$) are to be tested sequentially. If $r=0$ cannot be rejected in the first place, then there is no co integrating relationship between the variables, and the procedure stops.

The ECM has cointegration relations built into the specification so that it restricts the long-run behavior of the endogenous variables to converge to their cointegrating relationships while allowing for short-run adjustment dynamics. The cointegration term is known as the correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments.

The ECM estimated can be defined as follows:

$$\Delta Y_t = \delta + \Gamma_1 \cdot \Delta Y_{t-1} + \ldots + \Gamma_{t-p-1}\Delta Y_{t-p+1} + \Pi \cdot Y_{t-1} + \varepsilon_t \quad (5)$$

where: Δ is the difference operator, Y is a vector formed by the n variables used in our currency demand(C, Y, TAX, R, and WAGES). Γ denotes an $(n \times n)$ matrix of coefficients and contains information regarding the short-run relationships among the variables. Π is an $(n \times n)$ coefficient matrix decomposed as $\Pi = \gamma \cdot \beta'$, where γ represents the adjustment coefficients and β the cointegrating vectors, ε corresponds to residuals and δ is a constant term which can be separated in two parts-a trend term and the intercept-in the cointegrating relation.

Granger Causality Test: If the series are I(1) and cointegrated, then Granger Causality tests can be run under VECM framework([20], [21]):

$$\Delta Y_t = C_0 + \sum_{i=1}^{k} \beta_i Y_{t-i} + \sum_{i=1}^{k} \alpha_i X_{t-i} + p_i ECT_{t-1} + u_t \quad (6)$$

$$\Delta X_t = C_0 + \sum_{i=1}^{k} \gamma_i X_{t-i} + \sum_{i=1}^{k} \zeta_i Y_{t-i} + \eta_i ECT_{t-1} + \varepsilon_t \quad (7)$$

Where Y, X are the variables, p_i is the adjustment coefficient while ECT_{t-1} expresses the error correction term. In eq.(6), X Granger causes Y if α_i, p_i are significantly different from zero. In eq.(7) Y Granger causes X if ζ_i, η_i are significantly different from zero. F-test alone is not enough to have causation; t-ratio of ECM term should be also negative and statistically significant together with F value of the model to have causation in the models.

IV. Empirical results

IV.I. Estimating the size of the Romanian shadow economy

Before proceeding with the estimation, each series is individually examined under the null hypothesis of a unit root against the alternative of stationarity. Table 2 of Appendix reveals the fact that all most all the series turn out to be non-stationary and integrated of first order, I(1) .

Next, we use Engle-Granger two-step approach to see if all four causes are cointegrated with the dependent variable, in our cause the currency in circulation, and therefore to exhibit a valid error correction representation(Engle, Granger, 1987).To do this, we estimate least square regression with variables in level:

$$C_t = \beta_0 + \beta_1 \cdot Y_t + \beta_2 \cdot Tax_t + \beta_3 \cdot R_t + \beta_4 \cdot Wages_t + \varepsilon_t$$

Next we analyze the assumed cointegration relationship's residuals ε_t using Augmented Dickey-Fuller test. In fact, we reject the null hypothesis of a unit root against the alternative for the error term ε_t at 10% level and we conclude that the causes are cointegrated with the dependent variable (table 3 of appendix). Because all series turn out to be strongly non-stationary and integrated on the same order-I(1), we can apply the Johansen cointegrating test. The trace tests on one hand indicate three cointegrating equations at the 5% level and one at the 1% level, while the eigenvalue test indicates one cointegrating equation at the 1% level (table 4 of appendix). This allows us to conclude that there exists one cointegration relationship[16].

Given the non-stationarity of our series and the presence of a common stochastic trend, traditional estimation methods are ruled out. So, in order to estimate equation (2) and measure the size of the shadow economy, we tackle the problem using a vector error correction model (VECM).

As expected, the estimated model which corresponds to equation (2), the coefficients for output, tax burden and wages have a positive long-run effect, while interest rate take the pressure off on currency demand. All coefficients are strongly significant and assign relevant weight to GDP with a coefficient of 1.706 and taxes with 3.95.

Table 1:Normalized Cointegrating Coefficients[17]

Trace statistic	5% level 1% level	3 3
Max Eigenvalue Statistic	5% level 1% level	1 1
C_{t-1}		1.00
Y_{t-1}		-1.7067* (0.1362)
TAX_{t-1}		-3.9510* (0.8587)

[16] The existence of only one cointegration vector in our system means that there is a long-run equilibrium relationship between C, Y, R, TAX and WAGES.

[17] All variables are in natural logs. All series used are I(1).The complete details and the analysis as well as the matrix of adjustment coefficients can be found in the appendix. The number of lags in the model was determined using the Akaike's information criterion (AIC), Schwarz's Bayesian information criterion (SBIC) and the Hannan and Quinn information criterion (HQIC).The model was estimated using two lags and it assume one cointegrating equation. Standard errors are in parentheses. * indicates significance at the 5% level.

R_{t-1}	0.14318* (0.0336)
$WAGES_{t-1}$	-2.2604* (0.2845)
Constant	16.5973* (1.2090)
Log likelihood	538.7658

After estimating the vector error correction model (VECM)[18] and obtaining the coefficients for the long-run relationship of equation (2), we proceed to estimate the size of shadow economy.

In order to obtain an estimate of the size of the shadow economy, we compute $\widetilde{C}$ using all the coefficients in equation (8).Then, we set the tax variable equal to zero and re-estimate the equation, keeping all the other coefficients unchanged to obtain $\hat{C}$:

$$\hat{C}_t = -16.59 + 1.706 \cdot Y_t + 3.951 \cdot TAX_t - 0.143 \cdot R_t + 2.260 \cdot WAGES_t \quad (8)$$

The difference between these two variables- $\hat{C}$ and $\widetilde{C}$ -give the amount of extra currency (EC) in the economy. Following Tanzi (1983), we assume equal velocity in both the formal and informal and estimate it as follows:

$$\frac{Y}{M_1 - EC} = v \quad (9)$$

Equation (9) yields the velocity of money in the Romanian economy. Y is the gross domestic product, M_1 corresponds to total currency and deposits in circulation and extra currency (EC) for extra currency or illegal currency.

The difference between M_1 and EC can be interpreted as the amount of legal money used in economy. Once we estimate the velocity from equation (9), the dimension of shadow economy using the currency demand approach can be obtained multiplying EC by the velocity of money:

$$EC * v = Y_{shadow} \quad (10)$$

Using equation (10), we can infer the size of the shadow sector in formal GDP terms. From the table of normalized cointegrating coefficients, the coefficient of gross domestic product(Y) in the model is different from 1. Following the

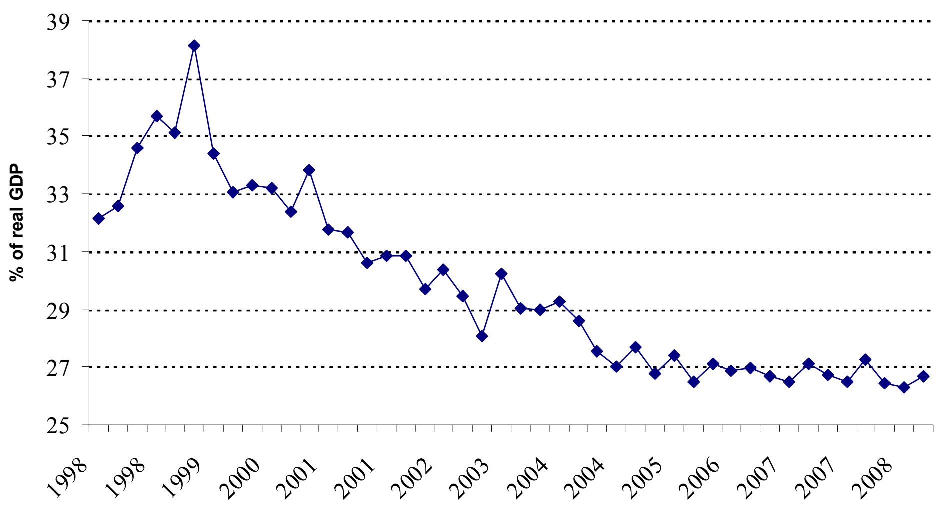
Ahumada et al. (2006), we proceed to correct our estimates using their suggested method[19]:

[18] The long-run relationship between our variables was derived normalizing C.

$$\frac{Y_{shadow}}{Y_{official}} = (\frac{C_{shadow}}{C_{official}})^{\frac{1}{\beta}} = (\frac{\hat{Y}_{shadow}}{\hat{Y}_{official}})^{\frac{1}{\beta}} \quad (11)$$

where: Y is the GDP, C is the currency, while β is the income elasticity. The correction basically deflates the wrong ratio $(\frac{\hat{Y}_{shadow}}{\hat{Y}_{official}})$ that we obtained using inappropriately the assumption $\beta = 1$. Equation (11) corrects the estimation when $\beta = 1$.

Fig.1. The size of the Romanian shadow economy as % of real GDP during the period 1998-2008



In the period 1998-2000, inflation and macroeconomic instability clearly played a major role on currency demand. However, to which extent inflation or informality can explain this peak is difficult to assess. Inflation rates has registered in 1998 the value of 40.%, while in 1999 the value was 54.8%, while the informality increased during the years 1998-1999, achieving the maximum value of 38% of real GDP at the middle of 1999. At the beginning of 2000, the size of the shadow economy normalized by the formal GDP in real terms (2000=100) has decreased slowly,

[19] Ahumada et al.(2006) show that it is wrong to assume the same velocity of money when the hypothesis $\beta = 1$ is rejected by the econometric estimation of the currency demand model. This is our case, since our model gives us a coefficient $\beta = 1.706$.

reaching the value of about 27% of real GDP at the end of 2008. The results are in line with the previous studies[20].

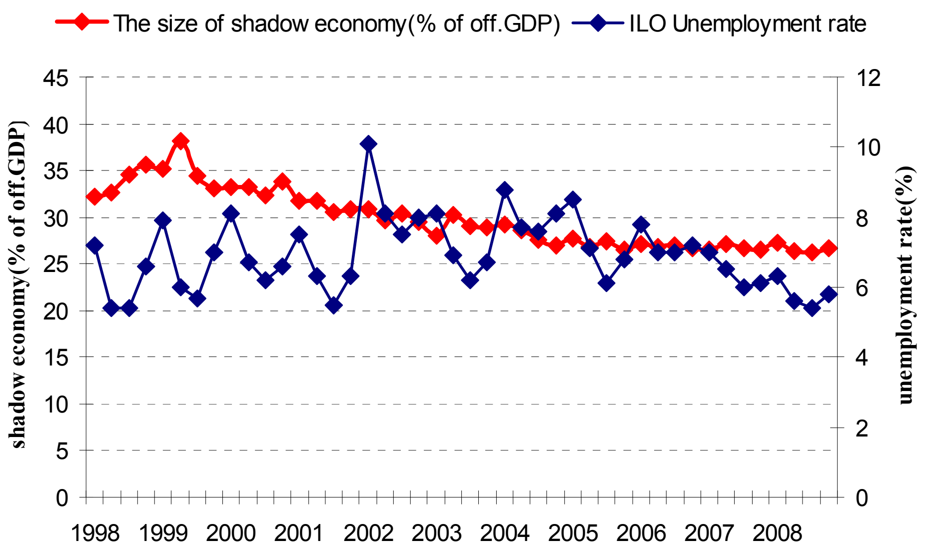
IV.2. Is there a structural relationship between the size of the shadow economy and the unemployment rate in Romania?

For this purpose, we have used quarterly series for the size of the shadow economy obtained by currency demand approach and the unemployment rate, compiled from official data released by the National Institute of Statistics-Tempo database for the period 1998-2008.The unemployment data has been seasonally adjusted using the tramo seats method.

Fig.2 compares the trend of the shadow economy (SE) and the unemployment rate and shows a weak negative relationship between the two variables.

Giles and Tedds (2002) state that the effect of unemployment on the shadow economy is ambiguous. An increase in the number of unemployed increases the number of people who work in the black economy because they have more time. On the other hand, an increase in unemployment implies a decrease in the shadow economy. This is because the unemployment is negatively related to the growth of the official economy (Okun's law) and the shadow economy tends to rise with the growth of the official economy.

Fig.2. Shadow economy vs.Unemployment rate in Romania



[20] For Schneider (2007), the size of shadow economy in % of official GDP, measured like average between the DYMIMIC model and currency demand method is 34.4% in 1999/00, 36.1% in 2001/02, 37.4% in 2002/03, 36.2% in 2003/04 and 35.4% in 2004/05.

A general way of showing the relationship between the shadow economy (SE) and unemployment rate (UR) is to estimate an unrestricted VAR model.

To do this, we test each series for the presence of non-stationarity allowing for the possibilities of I (2), I (1) or I (0) data, using the Augmented Dickey-Fuller (ADF) Test is used. The number of lags sufficient to remove serial correlation in the residuals has been chosen using the Schwarz information criterion. In table 5 are reported the p-values, while the null hypothesis is the presence of the unit root, and therefore a value greater than 0.05 indicates non-stationary time series.

Because the both series are integrated of the same order, I(1)(table 5) we will apply Johansen and Juselius[15] cointegration approach in order to investigate if there is a long run relationship between the two variables. The optimal number of lags is one, established by LR, SBC and HQ criterions, for the relationship between SE and ILO unemployment rate. In order to choose the alternative that we want to test from the five possibilities suggested by Johansen[21], we verify, using ADF test with drift and trend for the both series, if the intercept and the trend coefficient are statistically significant.

In table 6 are presented the results of co-integration tests using Johansen and Juselius approach and confirms that there is a unique co-integration vector(a long run relationship) between the two variables, assuming that we have deterministic trend in data. Assuming that we have deterministic trend (linear or quadratic) in data, we see that we clearly reject the null of zero cointegrating, but cannot reject the null of one cointegrating vector.
According to the normalized parameter estimates, we can conclude that unemployment rate has a negative and elastic effect on the size of the shadow economy. When unemployment rate grows by 1% the Romanian shadow economy will decrease with about 1.42%. A possible explanation can be the fact that the unemployment is negatively related to the growth of the official economy (Okun's law) and the shadow economy tends to rise with the growth of the official economy.

Because a long run equilibrium relationship is found between unemployment rate and the size of the shadow economy, a VECM model is constructed to determine the direction of causality. Table 2 reports the F-statistics and t-statistics for error correction term defined for the null hypothesis of no-causality. The estimated speed of adjustment to disequilibrium is -0.57. F-statistic supports that the model is well specified.

[21] M1-no drift/no trend in cointegrating equation or fitted VAR.
M2-drift/no trend in both cointegrating equation, no drift in fitted VAR.
M3-drift/no trend in both cointegrating equation and fitted VAR.
M4-drift and trend in cointegration equation, no trend in fitted VAR.
M5-drift and trend in cointegration equation and fitted VAR.

We can conclude that we have a unidirectional granger causality that runs from ILO unemployment rate (UR) to SE, (t-ratio of ECT and F-ratio are statistically significant at 1% and 5% levels, and the ECT is negative).

Table 2. Granger Causality Tests

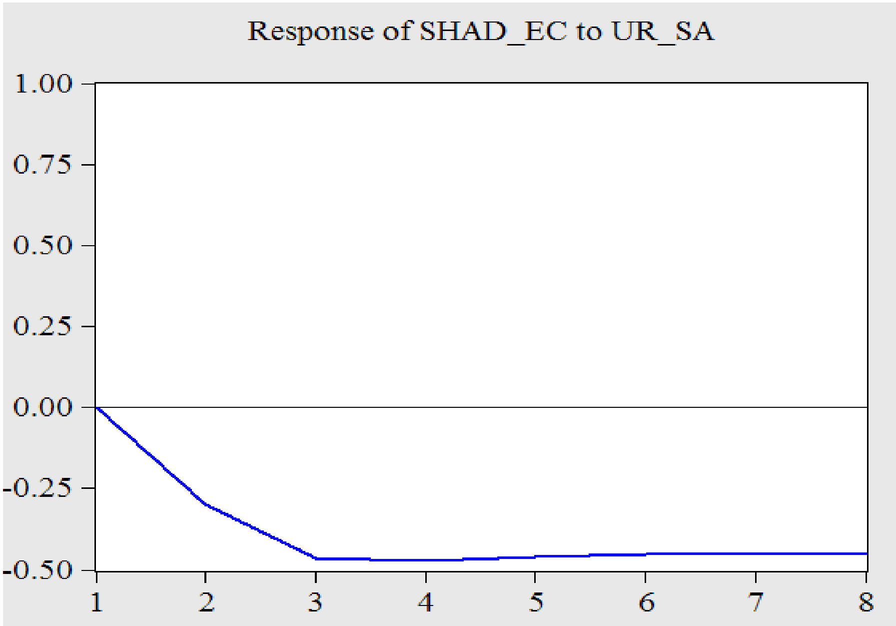
Null hypothesis	Lag level	1		2		Results
		F-stat	$t_{ECT_{t-1}}$	F-stat	$t_{ECT_{t-1}}$	
SE and ILO_UR						
ILO_UR does not Granger cause SE		**9.32****	**-0.57****	**4.76****	**-0.65****	UR $\Rightarrow$ SE
SE does not Granger cause ILO_UR		2.38	-0.20**	1.85	-0.29**	

*and ** denote significance for 1% and 5% levels.

In order to quantify the effect of a shock in unemployment rate on shadow economy we will apply the generalized impulse response functions [22](GIRFs) proposed by Pesaran and Shin (1998).
In Fig.3 and table 3 are indicated the impulse responses and the accumulated responses of the co-integrated VAR model with 1 lag and the one restricted co-integrating vector. We conducted estimations of the GIRFs 8 periods ahead.
The graphics presents the responses of SE to shocks in UR. The results suggest that the shadow economy is decreasing the next three quarters following the initial shock with 0.18% in the first quarter, 0.35% in the second quarter and with 0.53% in the third quarter. Beginning with the fourth quarter we can observe the decrease will count about 0.51% until the end of the period.

[22] An application of IRF is provided by Ito, K." Oil process and Russian Economy: A VEC model Approach", International Research Journal of Finance and Economics, ISSN 1450-2887 Issue 17 (2008).

Fig.3. Generalized impulse response functions (GIRFs) for the VEC Model



Notes: Sample periods are from 1998:Q1 to 2008:Q4 with 1 lag and one restricted co-integrating vector.

Additionally, the accumulated response for up to the 8th quarter is estimated to be a decrease of 3.7% due to the unemployment rate. The results support the fact that a 1% increase in ILO unemployment rate will decrease the size of the shadow economy by 3.7% over the corresponding periods.

Table 3. Accumulated GIRFs for the VEC Model

Period	Accumulated Response of SE ILO Unemployment rate
1	-0.19
2	-0.54
3	-1.07
4	-1.61
5	-2.13
6	-2.65
7	-3.17
8	-3.69

V. Conclusions

In this paper, we used the currency demand approach in order to obtain a measure of the Romanian shadow economy covering the period of the first quarter of 1998 until the four quarter of 2008.The shadow economy grows constantly during 1998-1999 until it reaches its maximum at the end of 1999(38.12% in 1999Q2).Then, it decreases slowly and stabilizes around 27% of official GDP.

Evaluating the Granger causality relationship between the ILO unemployment rate and the size of the shadow economy, the results support a unidirectional granger causality that runs only from the ILO unemployment rate to the shadow economy.

Using the generalized impulse response functions, the analysis leads to the finding that a 1% increase in the unemployment rate contributes to shadow economy decrease by 3.7% over the next 8 quarters.

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APPENDIX
Table 1: The description and sources of data

Variables23	Description	Sources
C	Natural logarithm of currency in circulation normalized by GDP deflator. 1998Q1-2008Q4 in national currency(mil.RON)	Eurostat-Quarterly National Accounts and Monetary Statistics
M_1	Natural logarithm of M_1.1998Q1-2008Q4 in national currency	National Bank of Romania, Monthly Bulletins 2000-2009
Y	Natural logarithm of real GDP(2000=100).1998Q1-2008Q4 in national currency(mil.RON)	Eurostat-Quarterly National Accounts
TAX	Natural logarithm of 1+total of tax revenues over GDP.1998Q1-2008Q4	Eurostat- Quarterly National Accounts
R	Natural logarithm of the 1 year nominal saving deposit interest rate.1998Q1-2008Q4 in %	Eurostat-Interest rates
WAGES	Natural logarithm of the ratio of wages in GDP.1998Q1-2008Q4 in %	National Bank of Romania, Monthly Bulletins 2000-2009 National Institute of Statistics, TEMPO database
ILO_UR	International Labour Organization unemployment rate 1998Q1-2008Q4	National Institute of Statistics, TEMPO database

[23] All variables are in natural logs and seasonally adjusted using the tramo seats method.

Table 2: Analysis of stationarity[24]

Test	Variables	C	Y	TAX	R	WAGES
ADF-Level	None	0.9983	0.8404	0.7367	0.3518	0.7458
	C	0.9999	0.9647	0.2233	0.6381	0.5311
	T&C	0.0031*	0.0000*	0.9909	0.9379	0.9123
ADF-First difference	None	0.0561*	0.0000*	0.0000*	0.0005*	0.0162*
	C	0.0124*	0.0001*	0.0000*	0.0083*	0.1943
	T&C	0.0038*	0.0004*	0.0000*	0.0270*	0.0000*
ADF-Second difference	None	0.0000*	0.0000*	0.0000*	0.0000*	0.0000*
	C	0.0000*	0.0000*	0.0000*	0.0000*	0.0000*
	T&C	0.0000*	0.0000*	0.0000*	0.0000*	0.0000*

Above, it is presented the ADF test- one-sided p-values. * means stationary for the level of significance of 5%.The lag length was chosen using Schwarz Information Criterion. Null hypothesis: variable has a unit root.

Table 3. Analysis of Cointegration between Causes and Indicators

Indicators	Causes				t-statistic for Residual	Jarque-Bera Probability
C	TAX (0.000)	Y (0.000)	R (0.000)	WAGES (0.060)	-3.8005	0.99

Note: The critical values of the ADF test's t-statistic are taken from Engle and Yoo(1987).For a sample with 50 observations and for a number of four variables, they are: 4.61(1% level), 3.98 (5% level) and 3.67(10% level). The order of autoregressive correction has been chosen using the AIC as suggested by Engle and Yoo 25(1987, pg.16).Thus, the null hypothesis of a unit root is rejected at the 10% level for residual ε_t .The p-values of the parameter estimators are given in parenthesis.

[24] Following Giles (1995), the problem of non-stationarity is important also the cointegration of time series. To discover the order of integration of the time series used we apply Augmented Dickey-Fuller (ADF) Test. In the following table the p-value of ADF test is reported, and therefore a value greater than 0.05 indicates non-stationary time series. The econometric software Eviews 6.0 was used to perform this analysis.

[25] Engle and Granger (1987) investigated tests for the null hypothesis that a pair of the time series which were each I (1) was "non-co-integrated" against the alternative that they were co-integrated. That is, the null hypothesis is that the system has two unit roots, while the alternative is one unit root. Monte Carlo methods were used to obtain the finite sample critical values and then to examine the power properties of the tests. In a first-order system, two procedures were found to be the best: a Durbin-Watson (DW) test and a Dickey-Fuller (DF) test. In higher-order systems, it is simple to generalize the Dickey-Fuller test to the Augmented Dickey-Fuller test (ADF) which was the recommendation of Engle and Granger. The tests are computed by performing two regressions. The first, called the co-integrating regression, fits the static bivariate model

Table 4. Johansen Cointegrating Test

Null Hypothesis		5% Critical Value	1% Critical Value
Trace statistic test	λ_{trace} *value*		
None**	119.4171	76.07	84.45
At most 1**	70.72629	53.12	60.16
At most 2**	43.74119	34.91	41.07
At most 3	18.05864	19.96	24.60
At most 4	5.194495	9.24	12.97
Max-Eigenvalue Statistic Test	$\lambda_{\max}$ *value*		
None**	48.69083	34.40	39.79
At most 1	26.98510	28.14	33.24
At most 2*	25.68255	22.00	26.81
At most 3	12.86415	15.67	20.20
At most 4	5.194495	9.24	12.97

Note: *(**) denotes rejection of the hypothesis at the 5 %(1%) level. Trace test indicates 3 cointegrating equation(s) at both 5% and 1% levels. Max-eigenvalue test indicates 1 cointegrating equation(s) at both 5% and 1% levels. Given the small size of our series we used a maximum of two lags running the tests. No deterministic trend.

$y_t = \hat{\varphi} + x_t\hat{\pi} + z_t$ where z_t is the residual term which is also interpreted as the co-integrating linear relation. The Durbin-Watson test simply examines the DW of this regression to see if it is significantly greater than zero, which would, be its probability limit if z_t contains a unit root as required by the null hypothesis.

At the second stage, the DF and ADF tests are obtained as the t-statistics of $\hat{\rho}$ in the following regressions: $\Delta\hat{z}_t = \hat{\rho}\cdot z_{t-1}$ or $\Delta\hat{z}_t = \hat{\rho}\cdot z_{t-1} + \sum_{i=1}^{p}\hat{\delta}_i \cdot \Delta z_{t-i}$. In theory, the unknown lag structure in z_t might be handled by allowing p to be a slowly increasing function of the sample size as in Said and Dickey(1984).However, it does not provide practical guidance in the choice of p. A readily available way seems to be to use a standard model selection procedure based upon some information criterion (AIC).

Table 5: Augmented Dickey-Fuller results

Variable		Level	First Difference	Second Difference
SE	None	0.0885	0.0000*	0.0000*
	C	0.7562	0.0000*	0.0000*
	T&C	0.5543	0.0001*	0.0000*
UR	None	0.5602	0.0000*	0.0000*
	C	0.1760	0.0000*	0.0000*
	T&C	0.4436	0.0000*	0.0000*

Note: * means stationary at 0.05 level.

Table 6: Johansen's "trace" likelihood ratio tests

	Drift/Trend Case[26]				
	M1	M2	M3	M4	M5
	Trace Statistic(Ho:zero cointegrating vectors)				
Johansen's tests	6.57	9.75	8.47	29.20*	27.84*
Crit.value 5%	12.53	16.96	15.41	25.32	18.17
Crit.value 1%	16.31	24.6	20.04	30.45	23.46
	Max-Eigen Statistic (Ho: zero cointegrating vector)				
Johansen's tests	5.13	7.48	7.24	25.89**	25.22**
Crit.value 5%	11.44	15.67	14.07	18.96	16.87
Crit.value 1%	15.69	20.20	18.63	23.65	21.47

Note: *(**) denotes rejection of the hypothesis at the 5 %(1%) level. Trace test indicates 1 cointegrating equation(s) at the 5% levels and Max-eigenvalue test indicates 1 cointegrating equation(s) at both 5% and 1% levels, for an optimal lag length equal to 1 and assuming that we have deterministic trend in data.

[26] M1-no drift/no trend in cointegrating equation or fitted VAR.
M2-drift/no trend in both cointegrating equation, no drift in fitted VAR.
M3-drift/no trend in both cointegrating equation and fitted VAR.
M4-drift and trend in cointegration equation, no trend in fitted VAR.
M5-drift and trend in cointegration equation and fitted VAR.