The Relationship between Shadow Economy and Unemployment Rate. A ARDL Causality Analysis for the Case Of Romania

PhD.Lecturer Adriana AnaMaria DAVIDESCU (adrianaalexandru@yahoo.com)
Bucharest University of Economic Studies

ABSTRACT

The paper aims to investigate the nature of the relationship between the shadow economy (SE) and unemployment rates (both registered and ILO) for the case of Romania using Pesaran et al.(2001) bounds tests approach for cointegration. The study uses quarterly data covering the period 2000-2010. The size of Romanian shadow economy is estimated using the currency demand approach based on VECM models, stating that its size is decreasing over the analyzed period, from 36.5% at the end of 2000 to about 31.5% of real GDP at the middle of 2010.

To investigate the long-run causal linkages and short-run dynamics between shadow economy and unemployment rate, ARDL cointegration approach is applied. Cointegration test results shows that in short-run both ILO and registered unemployment rate has a negative and statistically significant effect on the size of the shadow economy, while in the long-run the unemployment rates have a positive effect on shadow economy.

The ARDL causality results revealed the existence of a long-run unidirectional causality that runs from unemployment rates (registered or ILO) to shadow economy. In addition, the CUSUM and CUSUMSQ tests confirm the stability of the both causal relationships.

Keyword: *shadow economy, currency demand approach, unemployment rates, vector error correction models, ARDL cointegration approach, CUSUM, CUSUMQ tests.*

JEL Classification: C32, E41, O17

INTRODUCTION

The paper aims to investigate the relationship between the size of the shadow economy(SE) and unemployment rates for the case of Romanian data using bounds test approach and ARDL causality analysis for quarterly data covering the period 2000-2010. The size of Romanian shadow economy is estimated using currency demand approach based on vector error correction models. A detailed description of the estimation methodology is presented in Davidescu and Dobre (2012, 2013).

The currency demand approach uses currency as the main tool for exchanges, because it does not leave traces for public authorities. The shadow banking complements traditional banking system, by expanding the credit access, by providing alternatives to banking deposits and by spreading risks (Barbu, Obreja and Boitan, 2015).

Social responsibility in general, and corporate social responsibility (CSR) of financial institutions in particular have become highly debated topics in the aftermath of the global financial crisis that burst in 2008, as the crisis has arisen due to the irresponsible behavior of the financial companies. CSR is likely to discourage informal economy (Moldovan, 2014).

The empirical results of currency demand approach based on VECM models emphasizes that there is a general downward trend in the size of the shadow economy as % of official GDP for the period 2000-2010 with an highlight on two low periods, 2003Q1 and 2008Q4.Thus, the size of the shadow economy as % of official GDP measures approximately 36.6% in 2000Q1 and follows a downward trend after registering the value of 31% by 2008. For the past few quarters, there is a slightly upward trend in the size of Romanian shadow economy.

The results are consistent with studies of Schneider (2007) and Albu (2007, 2010, 2011) which show a mainly downward trend of shadow economy in Romania.

It is important to note that because of its undetectable nature and character, it is nearly impossible to measure precisely the size of economic activities taking place in the informal economy of any country in the world, whether developed or less developed. Given this, any theoretical or empirical inference derived from these results should always be regarded as an approximation. In the face of these difficulties, the results drawn from these estimates should be interpreted with due reserve, given the limitations of the methods.

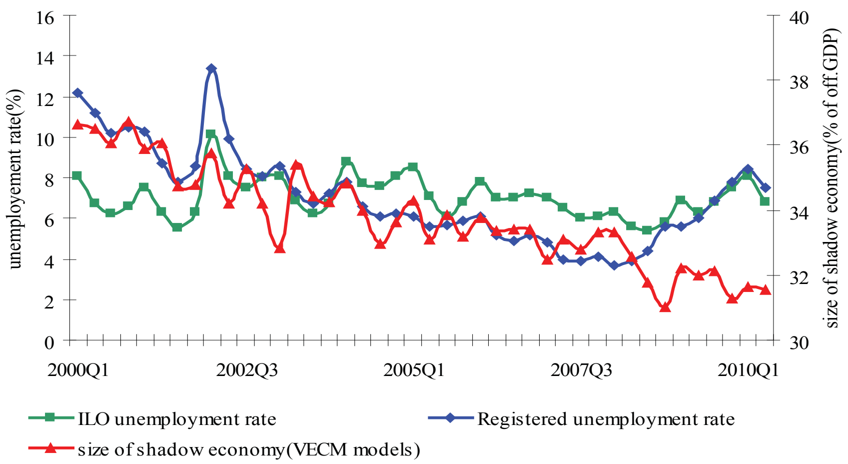
THE RELATIONSHIP BETWEEN UNEMPLOYMENT RATE AND SHADOW ECONOMY IN ROMANIA. A ARDL CAUSALITY ANALYSIS

According to Giles and Tedds (2002), two opposing forces determine the relationship between unemployment and the informal economy. On the one hand, an increase in the unemployment rate may involve a decrease in the informal economy because it is positively related to the growth rate of GDP and eventually negatively correlated with unemployment (Okun's law) (Anghelache et al.(2014). On the other hand, increase in unemployment leads to an increase in people working in the informal economy because they have more time for such activities.

Dell'Anno and Solomon (2007) stated that there is a positive relationship in the short-run between unemployment rate and U.S. shadow economy for the period 1970-2004. Using SVAR analysis, they investigate the response of the shadow economy to an aggregate supply shock (impact of the shadow economy to a temporary shock in unemployment). The empirical results show that in the short-run, a positive aggregate supply shock causes the shadow economy to rise by about 8% above the baseline.

Shadow economy vs. unemployment rates in Romania

Fig.1



Source: Size of the shadow economy (% of official GDP); Tempo database, National Institute of Statistics, Monthly Bulletins 2000-2010, National Bank of Romania.

Regarding the Romanian unemployment data, there are two measures available for unemployed persons: the first is the registered unemployment rate, who is calculated by National Agency for Employment (NAE) and based on statements of people who pass by employment agencies and said that they are unemployed and the ILO unemployment rate, who is published quarterly by the National Institute of Statistics and is based on labour force survey (LFS). The figures are far from identical(Danciu and Strat, 2015).

The graphical evolution of the shadow economy versus unemployment rates reveal the existence of a positive relationship between variables, low for the case of ILO unemployment rate, quantified by a value of about 0.22 of correlation coefficient and strong for the case of registered unemployment rate, quantified by a value of 0.67 of correlation coefficient. Anghelache et al.(2014) offer a description of the methods used in the economic analyses.

The aim of this second part of the paper is to investigate the nature of the relationship between unemployment rates and the size of the Romanian shadow economy and to identify the direction of causality between them using ARDL cointegration and causality approach.

Methodology and data

The data used in the research covers the period 2000:Q1- 2010Q2. The variables used are as follows: the size of the Romanian shadow economy expressed as % of official GDP (SE) obtained by currency demand approach; ILO unemployment rate (ILO_UR) and registered unemployment rate (R_UR). The unemployment rates were seasonally by means of tramo seats method. The main source of the data for unemployment rates is the National Institute of Statistics (Tempo database) and the National Bank of Romania.

According to Pesaran et al.(2001) approach, the existence of a co-integration relationship can be examined between the series regardless of whether they are I(0) or I(1) (under the circumstance that dependent variable is I(1) and the independent variables are either I(0) or I(1). This point is the greatest advantage of the bound test among all the co-integration tests.

In order to investigate the relationship between shadow economy and unemployment rate, we estimate the models:

$$SE_t = \alpha_1 + \beta_1 \cdot R\_UR_t + \varepsilon_{1t} \tag{1}$$

$$SE_t = \alpha_2 + \beta_2 \cdot ILO\_UR_t + \varepsilon_{2t} \tag{2}$$

where: SE_t is the size of Romanian shadow economy as % of official GDP obtained through ARDL models; R_UR_t is the registered unemployment rate; ILO_UR_t is the ILO unemployment rate; α_1, α_2 are constants; ε_{1t}, ε_{2t} is the disturbance terms.

The first step in the ARDL approach to cointegration is to estimate the following relationship using the OLS estimation technique:

$$\Delta SE_t = a_0 + \sum_{i=1}^{m} a_{1i}\Delta SE_{t-i} + \sum_{i=0}^{m} a_{2i}\Delta R\_UR_{t-i} + a_3 \cdot SE_{t-1} + a_4 \cdot R\_UR_{t-1} + \varepsilon_{1t} \tag{3}$$

$$\Delta SE_t = b_0 + \sum_{i=1}^{m} b_{1i} \Delta SE_{t-i} + \sum_{i=0}^{m} b_{2i} \Delta ILO\_UR_{t-i} + b_3 \cdot SE_{t-1} + b_4 \cdot ILO\_UR_{t-1} + \varepsilon_{2t} \quad (4)$$

where: Δ is the difference operator; SE_t is the size of Romanian shadow economy as % of official GDP; R_UR_t is the registered unemployment rate, ILO_UR_t is the ILO unemployment rate; ε_{1t} and ε_{2t} are serially independent random errors with a mean value of zero and a finite covariance matrix; "m" represents number of lags.

The first part of both equations with a_{1i}, a_{2i} and b_{1i}, b_{2i} represents the short-run dynamics of the models whereas the second part with a_3, a_4 and b_3, b_4 represent the long-run phenomenon.

The null hypothesis in the first equation (3) is $H_0 : a_3 = a_4 = 0$, which means the non-existence of a long-run relationship against the alternative $H_1 : a_3 \neq a_4 \neq 0$ meaning that there is a long-run relationship. In the second equation (4), the null is $H_0 : b_3 = b_4 = 0$ against the alternative $H_1 : b_3 \neq b_4 \neq 0$ which states that we have cointegration.

The F- statistic tests therefore checking for the joint significance of the coefficients on the one period lagged levels of the variables. The asymptotic distributions of the F-statistics are non-standard under the null hypothesis of no cointegration relationship between the examined variables, irrespective of whether the variables are purely *I*(0) or *I*(1), or mutually co-integrated. The F test depends upon (i) whether variables included in the ARDL model are I (0) or I (1) , (ii) the number of regressors, and (iii) whether the ARDL model contains an intercept and/or a trend.

The computed F-statistics is compared with the critical values tabulated by of Pesaran[1] (2001) or Narayan[2] (2005) for limited samples (40-45 observations).

Two sets of asymptotic critical values are provided by Pesaran and Pesaran (1997). The first set, the lower bound critical values, assumes that the explanatory variables x_t are integrated of order zero, or I(0) while the second set, while the upper bound critical values, assumes that x_t are integrated of order one, or I(1).

If the computed F-statistics is greater than the upper bound critical value, and then we reject the null hypothesis of no cointegration (no long-run relationship) and conclude that there exists steady state equilibrium between

1. Pesaran et al. (2001) have generated critical values using samples of 500 and 1000 observations.

2. Narayan (2005) argued that these critical values are inappropriate in small samples which are the usual case with annual macroeconomic variables. For this reason, Narayan (2005) provides a set of critical values for samples ranging from 30 to 80 observations for the usual levels of significance.

the variables. If the computed F-statistics is less than the lower bound critical value, then we cannot reject the null of no cointegration. If the computed F-statistics falls within the lower and upper bound critical values, then the result is inconclusive.

When the order of integration of the variables is known and all the variables are *I(1)*, the decision is made based on the upper bounds. Similarly, if all the variables are *I(0)*, then the decision is made based on the lower bounds.

Once cointegration is confirmed, we move to *the second stage* and estimate the long-run coefficients of the level equations (1)-(2) and the short-run dynamic coefficients via the following ARDL error correction models[1]:

$$\Delta SE_t = \gamma_0 + \sum_{i=1}^{m} \gamma_{1i} \Delta SE_{t-i} + \sum_{i=0}^{n} \gamma_{2i} \Delta R\_UR_{t-i} + \gamma_3 ECT_{t-1} + \varepsilon_{1t} \quad (5)$$

$$\Delta SE_t = \lambda_0 + \sum_{i=1}^{m} \lambda_{1i} \Delta SE_{t-i} + \sum_{i=0}^{n} \lambda_{2i} \Delta ILO\_UR_{t-i} + \lambda_3 ECT_{t-1} + \varepsilon_{2t} \quad (6)$$

where: SE_t, UR_t are the variables described above; Δ is the difference operator and ECT_{t-1} is the one-period lagged error correction term, γ_3, λ_3 indicate the speed of adjustement to the equilibrium level after a shock. The expected sign of ECT is negative. The coefficients $\gamma_{1i}, \gamma_{2i}, \lambda_{1i}, \lambda_{2i}$ are the coefficients for the short-run dynamics of the model's convergence to equilibrium, and $\varepsilon_{1t}, \varepsilon_{2t}$ are the error terms.

To ascertain the goodness of fit of the ARDL models, diagnostic and stability tests are conducted. The diagnostic test examines the serial correlation, functional form, normality, and heteroscedasticity associated with the model. Parameter stability is important since unstable parameters can result in model misspecification (Narayan and Smith, 2004). Pesaran and Pesaran (1997) argued that it is extremely important to ascertain the constancy of the long-run multipliers by testing the above error-correction model for the stability of its parameters. The commonly used tests for this purpose are the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMQ), both of which have been introduced by Brown et al. (1975).

The third stage includes conducting standard Granger causality tests augmented with a lagged error-correction term. The advantage of using an error correction specification to test for causality is that, on the one hand, it allows testing for short-run causality through the lagged differenced

1. The Optimal ARDL models are specified on a basis of a set of criteria (Schwarz, Akaike).

explanatory variables and, on the other hand, for long-run causality through the lagged ECT term. A statistically significant ECT term implies long-run causality running from all the explanatory variables towards the dependent variable.

An augmented form of Granger causality test for the case of registered unemployment rate is involved to the error-correction term and it is formulated in a bi-variate p-th order vector error-correction model (VECM) which is as follows:

$$\Delta SE_t = c_1 + \varphi_{11}^{p}(L)\Delta SE_t + \varphi_{12}^{q}(L)\Delta R\_UR_t + \delta_1 \cdot ECT_{t-1} + \varepsilon_{1t} \qquad (7)$$

$$\Delta R\_UR_t = c_2 + \varphi_{21}^{p}(L)\Delta R\_UR_t + \varphi_{22}^{q}(L)\Delta SE_t + \delta_2 \cdot ECT_{t-1} + \varepsilon_{2t} \qquad (8)$$

where:

$$\varphi_{11}^{p}(L) = \sum_{i=1}^{P_{11}} \varphi_{11,i}^{p} L^i \,, \varphi_{12}^{p}(L) = \sum_{i=0}^{P_{12}} \varphi_{12,i}^{p} L^i \,, \varphi_{21}^{p}(L) = \sum_{i=1}^{P_{21}} \varphi_{21,i}^{p} L^i \;\; \varphi_{22}^{p}(L) = \sum_{i=0}^{P_{22}} \varphi_{22,i}^{p} L^i$$

SE_t , R_UR_t are the variables described above; Δ denotes the difference operator. L denotes the lag operator, where $(L)\Delta Y_t = \Delta Y_{t-1}$, ε_{1t} and ε_{2t} are serially independent random errors with a mean of zero and a finite covariance matrix.

We can express the augmented form of Granger causality test into a matrix form as follows:

$$\begin{bmatrix} \Delta SE_t \\ \Delta R\_UR_t \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \end{bmatrix} + \sum_{i=1}^{p} \begin{bmatrix} \varphi_{11}^{p} & \varphi_{12}^{p} \\ \varphi_{21}^{p} & \varphi_{22}^{p} \end{bmatrix} \begin{bmatrix} \Delta SE_{t-i} \\ \Delta R\_UR_{t-i} \end{bmatrix} + \begin{bmatrix} \delta_1 ECT_{t-1} \\ \delta_2 ECT_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \qquad (9)$$

where: Δ is a difference operator, ECT representing the error-correction term derived from long-run co-integrating friendship via ARDL model, c_i (i = 1, 2) is constant and e_i (i = 1, 2) are serially uncorrelated random disturbance term with zero mean. The optimal lag length p is based on the Akaike Information Criterion.

The t-ratio of ECT must be statistically significant to prove the existence of long-run causations. Through the ECT, the VECM provide new directions for Granger causality to appear. Long-run causality can be revealed through the significance of the lagged *ECTs* by t test, while F-statistic or Wald test investigate short-run causality through the significance of joint test with an application of sum of lags of explanatory variables in the model. Finally, according to the VECM for causality tests, having statistically significant *F* and *t* ratios for ECT_{t-1} in equations (7) and (8) would meet conditions to have causation from *SE* to R_UR and from R_*UR* to *SE* respectively.

Empirical results

The main goal of the study is to investigate the nature of the relationship between the shadow economy and unemployment rates(registered and ILO) and to identify any possible direction of causality between them. The analysis of stationarity revealed that all series are integrated on the same order, I(1).

Forthmore, we investigated the possibility of cointegration between the shadow economy and the unemployment rates using the bounds tests within the ARDL modeling approach. The optimal lag length[1] required in the bounds test cointegration test has been selected on the both SBC and AIC Information Criteria.

For the model describing the relationship between shadow economy and registered unemployment rate, the lag order selected by AIC is $p = 6$ if a trend is included and $p = 5$ if not and those selected by SBC is $p = 1$ if a trend is included and $p = 5$ if not. In view of the importance of the assumption of serially uncorrelated errors for the validity of the bounds tests, the lag $p = 5$ has been selected.

For the ILO unemployment rate shadow economy relationship, the lag order selected by AIC is $p = 7$ irrespective of whether a deterministic trend term is included or not. The lag length selected by SBC is $p = 1$ if a trend is included and $p = 2$ if not. In view of the importance of the assumption of serially uncorrelated errors for the validity of the bounds tests, it seems prudent to select p to be 7. As in Pesaran et al.(2001), the results indicate that there is little to choose between the conditional ECM with or without a linear deterministic trend.

A bounds F-test was applied to equations (3)-(4) for registered unemployment rate and ILO unemployment rate to establish a long-run relationship between the variables under the three scenarios: with restricted deterministic trends (F_{IV}), with unrestricted deterministic trends (F_V) and without deterministic trends (F_{III}) and with all intercepts unrestricted. The results are presented in Table 1.

1. The maximum duration of lags for both models has been taken as 7.

The Bounds Test for Co-integration

Table 1

Variables	With Deterministic Trends F_{IV}	F_V	t_V	Without Deterministic Trends F_{III}	t_{III}	Conclusion
						H_0
SE and R_UR						
F_{SE} (SE / R_UR)						Rejected
p = 5*	-	-	-	4.45b	-2.90b	
6	4.52b	6.03b	-3.45c	2.70a	-2.15a	
7	2.64a	3.25a	-2.35a	2.93a	-2.29a	
8	3.39a	5.04a	-1.99a	5.34c	-3.24c	
9	3.82a	5.50a	-3.31a			
SE and ILO_UR						
F_{SE} (SE/ ILO_UR)						Rejected
p = 7*	4.37b	6.18b	-0.19a	6.81c	-3.44c	
8	2.09a	3.02a	-0.47a	3.34a	-2.48a	
9	2.77a	3.43a	-0.66a	4.46b	-2.98c	
10	1.26a	0.97a	-0.11a	2.08a	-1.94a	

Note: Akaike Information Criterion (AIC) and Schwartz Criteria (SC) were used to select the number of lags required in the co-integration test. The term p shows lag levels and * denotes the optimum lag selection in each model, as suggested by AIC and SBC. F_{IV} represents the F statistic of the model with unrestricted intercept and restricted trend. F_V represents the F statistic of the model with unrestricted intercept and trend, and F_{III} represents the F statistic of the model with unrestricted intercept and no trend. t_V and t_{III} are the t ratios for testing $\alpha_3 = 0$ in Equation (4.12) with and without a deterministic linear trend. [a] indicates that the statistic lies below the lower bound, [b] that it falls within the lower and upper bounds, and [c] that it lies above the upper bound (Katircioglu, 2009).

The cointegration test under the bounds framework involved the comparison of the F and t statistics with the critical values of F and t for ARDL approach, presented in Table 2 for the three different scenarios.

Critical Values for ARDL Modeling Approach

Table 2

k = 1	90% level I (0)	90% level I (1)	95% level I (0)	95% level I (1)	99% level I (0)	99% level I (1)
F_{IV}	4.34	4.82	5.18	5.73	7.20	7.86
F_V	5.91	6.63	7.13	7.98	10.15	11.23
F_{III}	4.23	5.00	5.26	6.16	7.62	8.82
t_V	-3.13	-3.40	-3.41	-3.69	-3.96	-4.26
t_{III}	-2.57	-2.91	-2.86	-3.22	-3.43	-3.82

Source: Narayan (2005) for F-statistics (n=40 observations) pg. 1988-1990 and Pesaran et. al (2001) for t-ratios pg. 303-304.

Note: (1) k[96] is the number of independent variables in ARDL models (Erbaykal, 2008). F_{IV} represents the F statistic of the model with unrestricted intercept and restricted trend. F_V represents the F statistic of the model with unrestricted intercept and and F_{III} represents the F statistic of the model with unrestricted intercept and no trend. (2) t_V and t_{III} are the t ratios for testing $\alpha_3 = 0$ in Equation (4.12) with and without a deterministic linear trend (Katircioglu, 2009).

In the case of registered unemployment rate, F_V and F_{IV} lay below the lower bound, revealing that there is not a level relationship between shadow economy and registered unemployment rate. When the bounds F-test is applied without a linear trend, the F-statistic lay outside the 0.10 critical value bounds for lag 8 and the null hypothesis of no cointegration can be rejected.

The bounds test results do not allow the imposition of the trend restriction. When the trend term is exluded, the null hypothesis is rejected at lag 8. Overall, test results support the existence of a level relationship between SE and R_UR when a sufficiently high lag order is selected and when the statistically insignificant deterministic trend term is excluded from the conditional ECM.

Analyzing the bounds test results for the case of ILO unemployment rate, F_V and F_{IV} lay below the 0.10 critical value bounds for any lag, accepting the null hypothesis of no cointegration. When the bounds F-test is applied without a linear trend, the null hypothesis of no cointegration is rejected for lag 7 and 9 (because the F_{III} lay outside the upper bound). Also, in the case of ILO unemployment rate, the bounds test results do not alow the impostion of a trend restriction.

If a linear trend is included, the bounds t-test do not reject the null hypothsis of no cointegration for any lag. When the trend term is exluded, the null hypothesis is rejected for lags 7 and 9. Therefore, we do not allow the imposition of the trend rescrictions. Overall, test results support the existence of a level relationship between SE and ILO unemployment rate when a sufficiently high lag order is selected and when the statistically insignificant deterministic trend term is excluded from the conditional ECM.

At the second stage of estimation, we select the optimal lag length for ARDL model to determine the long-run coefficients of the model. The ARDL cointegration procedure was implemented to estimate the parameters of equations (3)-(4) with maximum order of lag set to 5, respectively 7 for ILO unemployment rate, selected for both models on the basis of AIC. The short-run results of equations (3)-(4) without deterministic trend, based on the AIC selection criteria are reported in Panel A of Table 3 along with their appropriate ARDL models.

Examination of error correction model in Panel A shows that lagged registered unemployment rate have a strong effect on the size of shadow economy in the short-run and is statistically significant. This is also the case of ILO unemployment rate, which in short-run has a statistically significant impact on the size of shadow economy. All five lagged changes in shadow economy are statistically significant, further justifying the choice of $p = 7$.

According to the results in Panel A, a short term negative and statistically significant relationship has been detected between the shadow economy and registered unemployment rate, respectively between shadow economy and ILO unemployment rate.

ARDL cointegration results

Table 3

Panel A: the short-run results Dependent variable: ΔSE_t		
Error Correction Representation for the selected ARDL-Model		
Regressors	SE and R_UR AIC ARDL (0,4)	SE and ILO_UR AIC ARDL (6,5)
ΔSE_{t-1}		-0.82 (-5.074)*
ΔSE_{t-2}		-0.94 (-4.608)*
ΔSE_{t-3}		-0.83 (-4.139)*
ΔSE_{t-4}		-0.86 (-4.052)*
ΔSE_{t-5}		-0.66 (-3.502)*
ΔSE_{t-6}		-0.39 (-2.386)**
ΔR_UR_t	0.095 (0.800)	
ΔR_UR_{t-1}	-0.521 (-4.145)*	
ΔR_UR_{t-2}	-0.241 (-1.785)***	
ΔR_UR_{t-3}	-0.341 (-2.761)*	
ΔR_UR_{t-4}	-0.645 (-5.171)*	
ΔILO_UR_t		0.36 (2.084)**
ΔILO_UR_{t-1}		-0.75 (-3.995)*
ΔILO_UR_{t-2}		-0.61 (-2.841)*
ΔILO_UR_{t-3}		-0.55 (-3.087)*
ΔILO_UR_{t-4}		-0.71 (-3.975)*
ΔILO_UR_{t-5}		-0.29 (-1.575)
Constant	-0.001 (-0.150)	9.39E-13 (4.2E-12)
ECT_{t-1}	-0.743 (-5.850)*	-0.416 (-3.967)*
$\overline{R}^2$	0.58	0.68
F-statistic	9.46*	6.59*
DW-stat	2.07	1.86
Log likelihood	-27.89	-16.47
$\hat{\sigma}$	0.57	0.50
AIC	1.88	1.74
SBC	2.19	2.36
Panel B: the short-run diagnostic test statistics		
Serial Correlation LM test	0.45 [0.80]	0.68 [0.68]
Normality test	2.02 [0.36]	2.97 [0.22]
ARCH test	1.24 [0.31]	0.35 [0.91]
White test	0.93 [0.58]	0.34 [0.97]
Ramsey RESET test	0.22 [0.94]	0.76 [0.62]
Panel C: the long-run results Dependent variable: SE_t		
R_UR_t	0.40 (5.70)*	
ILO_UR_t		2.179 (4.760)*
Constant	30.49 (62.77)*	16.463 (4.729)*

Notes: $\overline{R}^2$ is the adjusted squared multiple correlation coefficient, $\hat{\sigma}$ is the standard error of regression, AIC and SBC are the Akaike's and Schwarz's Bayesian Information Criteria. *, ** and *** indicate 1%, 5 % and 10 % significance levels, respectively. RSS stands for residual sum of squares. The absolute value of t-ratios is in parentheses. Godfrey Serial Correlation test, ARCH and White tests for heteroscedasticity and Ramsey Reset test are distributed as F-statistics and Jarque-Bera test for normality are distributed as Chi-squared variate with degrees of freedom in parentheses. The diagnostic test probability is in bracket parenthesis [].

The error correction term (EC_{t-1}) has the expected sign (negative) and statistically significant in both models indicating another confirmation of the existence of the long-run relationship among the variables in equations (1)-(2).

The coefficients of the ECM term (-0.74 for R_UR and -0.41 for ILO_UR) indicate a high rate of convergence to equilibrium, which implies that deviation from the long-term equilibrium is corrected by 74%, respectively 41% over each quarter. The significance of the error correction term (ECT) shows causality in at least one direction.

Diagnostic tests for serial correlation, autoregressive conditional heteroscedasticity, functional form and normality are conducted and the results are shown in Panel B of table 3. These tests show that short-run models pass through almost all diagnostic tests in the first stage. The results also indicated that there is no evidence of serial correlation among variables because functional form of model is well specified (Ramsey Reset test results) and there is no evidence for white heteroscedasticity and autoregressive conditional heteroscedasticity (arch heteroscedasticity). The Jarque-Bera results point out the fact the residuals of short-run models are weakly normally distributed.

The long-run results of equations (3)-(4) are displayed in Panel C of Table 3, indicating that the shadow economy is positively correlated with registered unemployment rate (0.40) and ILO unemployment rate (2.17).

The long-run estimated R_UR and ILO-UR coefficients state that 1% increase in registered unemployment rate yields an average 0.40% increase in the size of the shadow economy under the AIC selection criterion results, while a 1% increase in ILO unemployment rate yields an average 2.17% increase in the size of the shadow economy.

The long-run coefficients reported in Panel C are used to generate the error correction terms (ECT). The adjusted R^2 are 0.58 and 0.68 suggest that such error correction models fit the data reasonably well. In addition, the computed F-statistics clearly reject the null hypothesis that all regressors have zero coefficients for all cases. Importantly, the error correction coefficients carry the expected negative sign and are highly significant in both cases. This helps reinforce the finding of cointegration as provided by the F-test.

Finally, we tested the direction of causality within the conditional Granger causality tests using the ARDL mechanism as a long-run context. The F-statistics for the short-run causations and the t statistics of ECTs for the long-run causations must be statistically significant to achieve Granger causality between the shadow economy and the unemployment rate.

Results of Granger Causality for SE and R_UR

Table 4

Dependent Variable	F-statistics [probability values] R_UR_t	SE_t	t-stat (prob) for ECT_{t-1}
SE_t	3.176* [0.0243]	-	-2.573* [0.0166]
R_UR_t	-	0.244 [0.9383]	-1.453 [0.1590]

** denotes the rejection of null hypothesis respectively at 0.05 levels.*

Results of Granger Causality for SE and ILO_UR

Table 5

Dependent Variable	F-statistics [probability values] ILO_UR_t	SE_t	t-stat (prob) for ECT_{t-1}
SE_t	3.230* [0.024]	-	-3.090* [0.007]
ILO_UR_t	-	0.778 [0.628]	-1.183 [0.254]

** denotes the rejection of null hypothesis respectively at 0.05 levels.*

The empirical results revealed the existence of a long-run uni-directional causality that runs from the registered unemployment rate to the shadow economy.

In table 4, the significance of F-statistic value confirms the short-run causality from registered unemployment rate to shadow economy. The negatively and significance of error correction term provide evidence of long-run causality. The error correction term is significant with the expected sign that confirm long-run unidirectional causality from registered unemployment rate to shadow economy as we concluded through bound test.

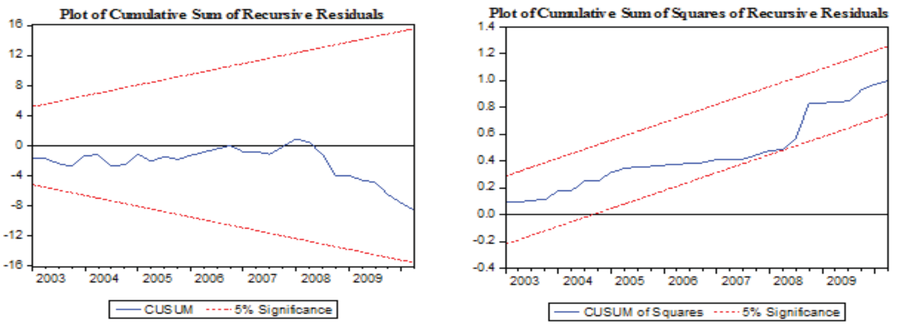
For the case of ILO unemployment rate, the empirical results reveal a long-run causality between ILO_UR and SE, due to the fact that the error correction term is negative and statistically significant; the long-run coefficient is also statistically significant. The results are presented in table 5. Therefore, in the long-run we have proved that there is a unidirectional causality that runs from unemployment rate (registered or ILO) to shadow economy.

Next, we examine the stability of short-run and long-run coefficients of both models, performing the CUSUM and CUSUMQ stability tests for the AIC-based error correction models. The tests applied to the residuals of the

ECM model (eq.(7)-(8)). The results indicate the absence of any instability of the coefficients because the plots of the CUSUMQ and CUSUM statistic for both models are confined within the 5% critical bounds of parameter stability.

Plots of CUSUM and CUSUMSQ Statistics for Coefficient Stability for the relationship between SE and R_UR

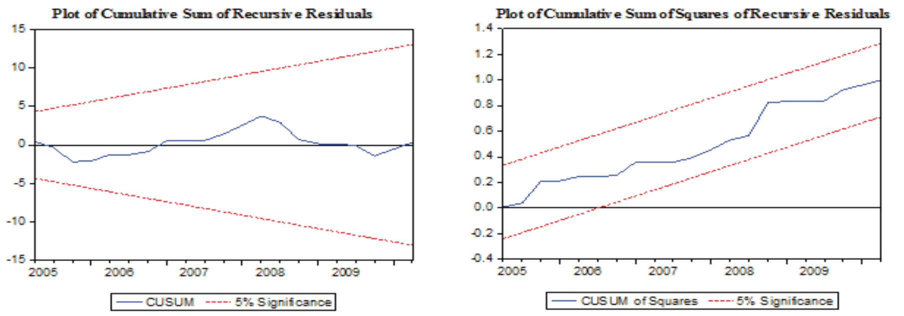
Fig.2



Note: The straight lines represent critical bounds at 5% significance level.

Plots of CUSUM and CUSUMSQ Statistics for Coefficient Stability for the relationship between SE and ILO_UR

Fig.3



Note: The straight lines represent critical bounds at 5% significance level.

CONCLUSIONS

In this paper, we investigated the relationship between unemployment rates and the size of the Romanian shadow economy using bounds test approach and ARDL causality analysis for quarterly time series data from 2000-2010. The Romanian shadow economy as % of official GDP was estimated using currenct demand approach based on vector error correction models. A detailed description of the estimation process is described in Davidescu and Dobre(2013). Its size is decreasing over the analyzed period, from 36.5% at the end of 2000 to about 31.5% of real GDP at the middle of 2010.

Cointegration test results shows that in short-run both ILO unemployment rate and registered unemployment rate has negative and statistically significant effect on shadow economy; however in the long-run both unemployment rates have a positive effect on shadow economy.

The ARDL causality results revealed the existence of a long-run uni-directional causality that runs from the both unemployment rates to the shadow economy.

One possible explanation of the negative impact in the short run can be the the inability of the labor market to provide more jobs whether they are official or ‘hidden’/ unregistered (clandestine in some extent of course) in the event of rising unemployment, underlining a limitation of opportunities to work in the informal economy. But on the long run, an increase in unemployment leads to an expansion of the activities in the shadow economy, underlining a positive impact on the size of the shadow economy.

Acknowledgments

This work was supported from the European Social Fund through Sectorial Operational Programme Human Resources Development 2007 – 2013, project number POSDRU/ 159/1.5/S/142115, project title “Performance and Excellence in Postdoctoral Research in Romanian Economics Science Domain”.

REFERENCES

1 Acaravci, S.K., Acaravci, A., Ozturk, I.(2011), Stock Returns and Inflation Nexus in Turkey: Evidence from ARDL Bounds Testing Approach; Economic Computation and Economic Cybernetics Studies and Research, 3/2011, pg.143-154.

2 Albu, L.L., Iorgulescu, R., Stanica, C.(2010). Estimating Hidden Economy and Hidden Migration: The Case of Romania, Journal for Economic Forecasting, Institute for Economic Forecasting, vol. 0(2), 46-56.

3. Albu, L.L., Ghizdeanu, I., Stanica, C.(2011). Spatial Distribution of the Informal Economy. A Theoretical and Empirical Investigation, SCIENZE REGIONALI, FrancoAngeli Editore, vol. 0(1), 63-80.

4. ANGHELACHE, C., ANGHEL, M. G., SACALA, C. (2014). The Gross Domestic Product Evolution. Romanian Statistical Review Supplement, 62(12), 2014, pg.12-20.

5. ANGHELACHE, C., ANGHEL, M. G., PRODAN, L., SACALA, C., & POPOVICI, M. (2014). Multiple Linear Regression Model Used in Economic Analyses. Romanian Statistical Review Supplement, 62(10), 120-127.

6. Barbu T., Obreja C., Boitan I.(2015). Shadow banking – considerations on ethical issues, scope and regulatory prospects, Financial industry at the crossroads between current practices and ethical virtues, 2015, Boitan I./Barbu T. (editors), pag 54-69, Taadler Publishing House, Ukraine, ISBN 978-966-7538-93-9
7. Danciu, A. R, Strat, V. A. (2015), Labor force – Main determinant of the Foreign Direct Investments located in Romania, Romanian Statistical Review, No 1 , pp 3 – 21, ISSN 1844-7694
8. Davidescu A.A., Dobre, I.(2012). Revisiting the relationship between U.S. shadow economy and the level of unemployment rate using bounds test approach for cointegration and causality, Economic Computation and Economic Cybernetics Studies and Research, 2/2012, vol.46, pg.91-104, A, ISSN 0424 – 267 X.
9. Davidescu, A.A, Dobre, I.(2013). The Impact of Unemployment Rate on the Size of Romanian Shadow Economy, Public Finance Review, Special Issue: The Shadow Economy, Tax Evasion, and Money Laundering, September 2013 41(5): 578-607, ISSN: 1552-7530.
10. Dell'Anno, R., Solomon H.(2007). Shadow economy and unemployment rate in USA. There is a structural relationship? An empirical analysis, Annual Meeting of the European Public Choice Society, Finland.
11. Dickey, D.A., Fuller, W.A.(1981).Likelihood ratio statistics for autoregressive time series with a unit root. Econometrica, vol. 49, 1057-1072.
12. Giles, D.E.A., Tedds, L.M. (2002). Taxes and the Canadian Underground Economy, Canadian Tax paper n.106. Canadian Tax Foundation. Canada: Toronto.
13. Ito, K.(2008).Oil process and Russian Economy: A VEC model Approach, International Research Journal of Finance and Economics, issue 17, ISSN 1450-2887.
14. Johnson, S., Kaufmann, D., Shleifer, A.(1997). The unofficial economy in transition, Brookings Papers on Economic Activity, Fall, Washington D.C.
15. Johnson, S., Kaufmann, D., Zoido-Lobatón, P.(1998). Regulatory discretion and the unofficial economy. The American Economic Review, 88/ 2, 387-392.
16. Katircioglu S.T.(2007).Financial development, trade and growth triangle: the case of India, International Journal of Social Economics, vol. 34 no. 9, 586-598.
17. Katircioglu, S.T.(2009). Tourism, trade and growth: the case of Cyprus, Applied Economics, 41:21, 2741 — 2750.
18. Moldovan (Gavril), Ioana Andrada, (2014). Noi paradigme impuse de criza financiară globală, Conferința Internațională "Post-Crisis Developments in Economics", Facultatea de Economie Teoretică și Aplicată, 21-22 noiembrie 2014.
19. Narayan, P.K.(2005). The saving and investment nexus for China: evidence from cointegration tests, Applied Economics,37:17,1979 — 1990.
20. Odhiambo, N.(2011).Tourism Development and Economic Growth in Tanzania, Empirical Evidence from the ARDL-bounds Testing Approach. Economic Computation and Economic Cybernetics Studies and Research, 3/2011, pg. 71-84;
21. Pesaran, H.M., Shin, Y.(1998). Generalized Impulse Response Analysis in Linear Multivariate Models, Economic Letters 58, 17-29.
22. Pesaran, M. H., Shin, Y.,Smith, R. J.(2001). Bounds Testing Approaches to the Analysis of Level Relationships, Journal of Applied Econometrics, 16: 289–326.
23. Schneider, F., Enste, D. (2000). Shadow Economies: Size, Causes and Consequences, Journal of Economic Literature 38, 73-110.
24. Schneider, F.(2003). The Development of the Shadow Economies and Shadow Labour Force of 21 OECD and 22 Transition Countries, CESifo DICE Report, Ifo Institute for Economic Research at the University of Munich, vol. 1(1), 17-23.
25. Schneider, F., Klinglmair, R.(2004). Shadow Economies around the World: What Do We Know?, IZA Discussion Papers 1043, Institute for the Study of Labor (IZA).

26. Schneider, F., Buehn, A.(2007). Shadow economies and corruption all over the world: revised estimates for 120 countries, Economics - The Open-Access, Open-Assessment E-Journal, Kiel Institute for the World Economy, vol. 1(9 (Versio), 1-53.
27. Schneider, F., Hametner, B.(2007).The shadow economy in Colombia: size and effects on economic growth, Economics working papers 2007-03, Department of Economics, Johannes Kepler University Linz, Austria.
28. Schneider, F., Buehn, A., Montenegro, C.(2010). Shadow Economies All Over The World: New Estimates For 162 Countries From 1999 To 2007, Working Papers wp322, University of Chile, Department of Economic.

*** Quarterly Labor Force Survey database, Eurostat.

*** Employment and Unemployment database, Eurostat.

*** Tempo database, National Institute of Statistics, www.insse.ro

*** Eviews 6.0 software