BOUNDS TEST APPROACH FOR THE LONG RUN RELATIONSHIP BETWEEN SHADOW ECONOMY AND OFFICIAL ECONOMY. AN EMPIRICAL ANALYSIS FOR ROMANIA[1]

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Abstract

The paper aims to investigate the nature of the relationship between the shadow economy (SE) and recorded GDP for the case of Romania using Pesaran et al.(2001) bounds tests approach for cointegration for the period 2000-2010. The size of Romanian shadow economy is estimated using a revised version of the currency demand approach based on autoregressive distributed lag (ARDL) approach to cointegration analysis. To investigate the long-run causal linkages and short-run dynamics between shadow economy and recorded GDP, ARDL cointegration approach is applied.

The ARDL causality results revealed only the existence of a long-run unidirectional causality that runs from shadow economy official economy, revealing a negative relationship betwwen them on long-run. In addition, the CUSUM and CUSUMSQ tests confirm the stability of causal relationships.

Keywords: *shadow economy, currency demand approach, economic development, ARDL cointegration approach, CUSUM, CUSUMQ tests*

1. Introduction

The impact of the shadow economy on overall economic performance was investigated in various studies (Dell'Anno, 2003; Schneider and Klinglmair, 2004; Schneider, 2005; Dell'Anno, 2008; Halicioglu and Dell'Anno, 2009).

Klinglmair and Schneider (2006),Giles (1997a, b), and Giles et al. (2002) pointed out that an increase in the size of shadow economy will affect the tax base, leading to lower official growth. Also, an increased size of SE will be very attractive for workers from official sector, creating unfair competition between unofficial and official firms (Enste, 2003). Hidden activities favor corruption and link with criminal activities.

At opposite side, SE can creates positive effects to official economy, creating an extra-added value that Schneider and Enste(2000) consider that can be spent in the official economy, estimating that at least two-third of the income earned in unofficial market is spent in the official economy. Smith (2002) argues that shadow economy have a positive

effect on employment, helping some individuals that otherwise will be unemployed and so the unofficial sector may represent a social buffer in the countries with high unemployment rate. Giles (1997a, 1997b, 1999a) and Giles and Tedds (2000) carried out one of the most relevant technique-Granger causality approach in New Zealand and Canada, revealing a significant Granger causality that runs from official economy to unofficial one.

Schneider (2005) quantifies the relationship between SE and official economy, pointing out that the degree of economic development has relevant implications on both sectors. The empirical results have pointed out the existence of a negative between SE and the official economy for developing countries and a positive relationship for industrialized and transition countries, revealing that SE is pro-cyclical for developing economies and countercyclical for developed and transition countries.

In this study, I adopted the definition of Schneider (2006) and Schneider et al. (2010) regarding the shadow economy[3] and the subject of the paper do not deal with typical underground, economic (classical crime) activities, which are all illegal actions that fit the characteristics of classical crimes like burglary, robbery, drug dealing and also exclude the informal household economy which consists of all household services and production.

The main empirical results regarding the Romanian shadow economy are obtained by both national and international studies using different estimation methods and are presented in table 1.

Tabel 1. The size of Romanian shadow economy (% of official GDP)

Authors	Approach	Period	Size of SE (min-max)
Albu(2003, 2008, 2010, 2011)	Discrepancy between actual and desired income	1995-2007	14.6%-22.3%
Institutul Național de Statistică	Labour input method	1998-2009	14.5%-23.5%
Johnson(1997, 1998)	Physical input method	1990-1995	18.0%-28.3%
Lacko(1999)	Physical input method	1990-1995	20.9%-31.3%
Schneider et al.(1998, 2000, 2002, 2004, 2005, 2006, 2007, 2009)	DYMIMIC model and currency demand approach	1990-2005	26.2%-37.4%
Schneider et al.(2010)	MIMIC model	1999-2006	34.4%-36.7%

As Schneider and Enste (2000) stated, no approach is exempt from criticism, the empirical results being different. So, if according to National Institute of Statistics, the informal activity represents between 14.5% and 23.5% of official GDP, Schneider et al.(2010) estimates the size of shadow economy in Romania to overcome the threshold of 35% of official GDP.

The paper aims to investigate the relationship between the size of the shadow economy (SE) and official economy 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 was estimated using using a revised version of the currency demand approach based on bounds testing approach to cointegration and error correction models, developed within an autoregressive distributed lag (ARDL) framework. A detailed description of the shadow economy estimation is presented in (Davidescu and Dobre 2013).

The empirical results of currency demand approach based on ARDL 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 45% at the end of 2000 and achieving the value of 37.4% in the last quarters of the period. The estimates are in line with the last empirical studies[4].

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 paper is divided three sections presenting the data, the methodology and the main econometrical results.

2. The relationship between shadow economy and official economy for the case of Romania

Official economic situation plays a crucial role in people's decision to work or not in the informal sector (Bajada and Schneider, 2005; Schneider et al., 2010). In a booming official economy, people have a lot of opportunities to earn a good salary and even extra money. This is noi the case of a economy in recession, when people try to compensate the loss of income from formal economy through involvement in the informal economy.

The shadow economy manifests both positive and negative effects on official economy. The studies of Frey and Weck-Hannemann (1984), Loayza (1996), Kaufmann si Kaliberda (1996), Eilat and Zinnes (2000), Schneider and Enste (2000), Ott (2002), Dell'Anno (2003), Dell'Anno, Gomez and Alañón (2007) and Dell'Anno (2007) argue the existence of a negative effect of shadow economy on GDP growth, based upon the idea that unofficial activities, by creating unfair competition, interfere negatively with the market allocation.

A negative correlation between the size of informal sector and the growth rate of official real GDP per capita for 14 Latin American countries is also found by Loayza(1996), while the same conclusion has been drawed be Eilat and Zinnes (2000) in 24 transition countries, revealing that a one-dollar fall in official GDP was associated with a 31-percent increase in the size of the SE.

Kaufmann and Kaliberda (1996) estimated that for "every 10 percent cumulative decline in official GDP, the share of the irregular economy in the overall increases by almost 4 percent" (ibidem, p. 46).The 76 countries survey conducted by Schneider and Enste's (2000) pointed out that a growing SE has a negative impact on official GDP growth.

At other side, the shadow economy may manifest an positive impact on GDP growth, creating markets, increasing financial resources, enhancing entrepreneurship, and transforming social institutions, economic, legal and necessary capital accumulation (Asea, 1996). The positive realtionship between shadow economy and official one was revealed in studies such as: Adam and Ginsburgh (1985), Giles (1999), Giles and Tedds (2002), Tedds (2005), Schneider and Hametner (2007), Chatterjee, Chaudhuri and Schneider (2003),

Dell'Anno (2008), Bovi and Dell'Anno (2007), Dell'Anno and Halicioglu (2010), Schneider and Klinglmair (2004) and Brambilla (2008).

Schneider and Enste (2000) considers the informal economy creates additional value that can be spent in the economy. The informal economy provides employment opportunities to certain individuals who would otherwise be unemployed and provide services to low income people who are involved in informal production activities. Thus, it represents a "social buffer" for countries with high unemployment. Adam and Ginsburg (1985) found a positive relationship between the growth of the SE and the official economy under the assumption of low probability of enforcement.

Enste (2003) argues that SE stimulates economic development in transition countries. He considers the shadow economy as an incentive to develop both the entrepreneurial spirit and a constraint to limit an excessive growth of the government activities. Schneider (2003) emphasizes that UE, stimulating higher competition, leads to more efficient resource allocation on both sides of economy.

Also Dell'anno(2008) has analysed the relationship between unofficial economy (UE) and official GDP, reaveling a positive correlation is found between unofficial and official GDP, SE being considered as beneficial to sustain economic growth.

Halicioglu and Dell'Anno(2009) estimated the size of unrecorded economy (SE) of Turkey over the period 1987-2007 using a revised version of the currency demand approach and analyzed the relationship between UE and recorded GDP (gross domestic product) revealing that causality runs from the recorded GDP to the SE.

In Latin American countries, the study of Maloney(1999) revealed empirical evidence on substantial flow of workers back and forth between formal and informal employment. Galli and Kucera (2003) assess that "informal employment serves as a macroeconomic buffer for formal sector employment over the course of business cycles, with informal employment expanding during downturns and contracting during upturns (ibidem, p. 17)".

In 2005, Schneider considers that the effects of SE on the official economic growth are conditioned to the degree of economic development, revealing a negative relationship for low-income countries and a positive one in industrialized and transition countries. The explanation was that in high-income countries citizens are overburdened by taxes and regulation so that an increasing SE stimulated the official economy as the additional income earned in the SE was spent in the official sector. On the contrary, for low-income countries, an increasing SE "erodes the tax base, with the consequence of a lower provision of public infrastructure and basic public services with the final consequence of lower official economy" (Schneider, 2005, p. 613).

A valuable paper that traits the relationship between official and unofficial economy for the ASEAN from 1996 to 2013 is written by Vo and Pham (2014) who finds that when the official economy is proxied by the GDP growth or the GDP per capita growth, the unofficial economy negatively contributes to the official economy.

2.1. Data

In the econometrical demarche of the investigation of the relationship between shadow and official economies, it has been used quarterly data covering the period 2000:Q1 to 2010:Q2.

The size of Romanian shadow economy as % of official GDP has been obtained using a revised version of the currency demand approach based on bounds testing approach to cointegration and error correction models, developed within an autoregressive distributed lag (ARDL) framework.A detailed description of the shadow economy estimation is presented in (Davidescu & Dobre, 2013).

The empirical results of currency demand approach based on ARDL 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 45% at the end of 2000 and achieving the value of 37.4% in the last quarters of the period. The estimates are in line with the last empirical studies[5].

The official economy was quantified using real official gross domestic product(2000=100) expressed in millions RON taken from Tempo database of National Institute of Statistics.

The graphical evolution of the shadow economy versus official economy reveals the existence of a negative relationship between variables, intermediate as intensity quantified by a value of -0.65 of correlation coefficient.

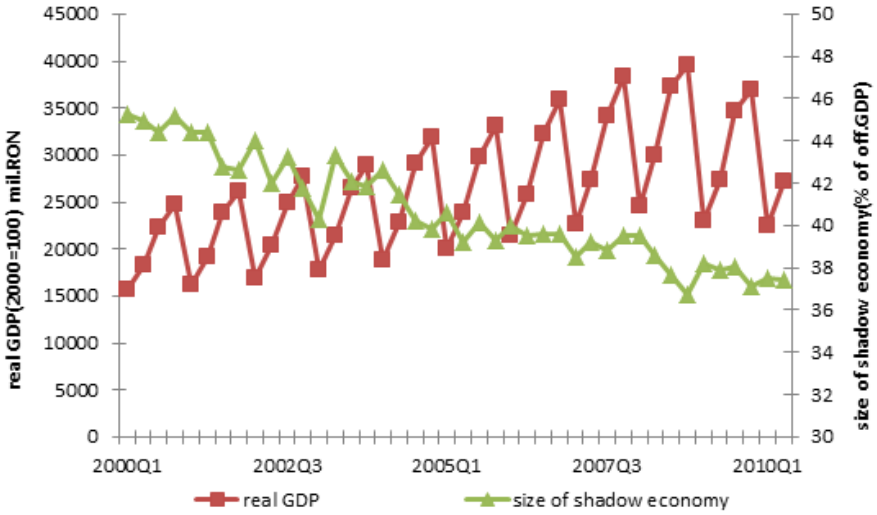

Figure 1. The size of the shadow economy vs. official economy in Romania
Source: Tempo database of National Institute of Statistics

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

2.2. Methodology

The non-stationary analysis is realised using the the unit root tests (The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP)). The bounds test approach were applied in prder to verify the possible relationship between these two variables, having the advantage that the regressors can have different order of integration.

The models that describe the relationship between these two variales are:

$$official\_economy_t = \alpha_1 + \beta_1 \cdot SE_t + \varepsilon_{1t} \quad (1)$$

$$SE_t = \alpha_2 + \beta_2 \cdot official\_economy_t + \varepsilon_{1t} \quad (2)$$

where: SE_t is the size of Romanian shadow economy as % of official GDP obtained through ARDL models; the official economy is cuantified using is real GDP expressed in prices of 2000; α_1, α_2 are constants; $\varepsilon_{1t}, \varepsilon_{2t}$ are the disturbance terms.

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

$$\Delta official\_economy_t = a_0 + \sum_{i=1}^{m} a_{1i} \Delta official\_economy_{t-i} + \sum_{i=0}^{m} a_{2i} \Delta SE_{t-i} + \\ + a_3 \cdot official\_economy_{t-1} + a_4 \cdot SE_{t-1} + \varepsilon_{1t} \quad (3)$$

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

where: Δ is the difference operator; SE_t is the size of Romanian shadow economy as % of official GDP;official economy is expressed using real GDP(2000=1000; ε_{1t} and ε_{2t} are are the disturbance terms ; "m" lags.

The first part of equations (3)-(4) with a_{1i}, a_{2i} and b_{1i}, b_{2i} represents the short-run dynamics of the models and 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 tests for the joint significance of the coefficients on the one period lagged levels of the variables is compared with the F critical taken from Pesaran[6] (2001) or Narayan[7] (2005).

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[8]:

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

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

where: SE_t, $official\_economy_t$ are the variables analysed; Δ is the difference operator and ECT_{t-1} is one lag error correction term that maust be negative, γ_3, λ_3 are the adjustement speed to the equilibrium after a shock. 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). The stability of parameters is tested using the Cusum and CusumQ tests.

The third stage includes conducting standard Granger causality tests augmented with a lagged error-correction 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 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:

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

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

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, $official\_economy_t$ are the analysed variables; 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 the disturbance terms.
Iinto a matrix form, the Granger causality looks as follows:

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

where: Δ is a difference operator, ECT is the error-correction term from ARDL model, c_i (i = 1, 2) is constant and ε_i (i = 1, 2) are the disturbance terms. The optimal lag length p is based on the Akaike Information Criterion. Long-run causality can be revealed through the significance of the lagged *ECTs* by t test, while short-run causality is validated by using F-statistic or Wald test.

2.2. Empirical results

The main goal of the study is to investigate the nature of the relationship between the shadow economy and the official economy and to identify any possible direction of causality between them. The analysis of stationarity using Dicley-fuller tst revealed that all series are integrated on the same order, I(1).

Forthmore, we investigated the possibility of cointegration between the shadow economy and official one using the bounds tests within the ARDL modeling approach. The optimal lag length[9] required in the bounds test cointegration test has been selected on the both SBC and AIC Information Criteria.

The lag order selected by AIC in the model in which official economy is the dependent variable is $p = 2$ if a trend is included and $p = 4$ if not and those selected by SBC is $p = 2$ irrespective of whether a deterministic trend term is included or not. In view of the importance of the assumption of serially uncorrelated errors for the validity of the bounds tests, the lag $p = 2$ has been selected.

In the model in which shadow economy is the dependent variable, the lag order selected by AIC and SBC is 1, irrespective of whether a deterministic trend term is included or not.

A bounds F-test was applied to equation (4) for shadow economy and official economy 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 2.

Table 2. The Bounds Test for Co-integration

	With Deterministic Trends			Without Deterministic Trend		
Variables	F_{IV}	F_V	t_V	F_{III}	t_{III}	Conclusion
Off. economy and SE						
$F_{off\ ec}$ (off_ec / SE)						Ho Accepted
p = 2*			-1.65a		-	
3			-1.30a		-	
4			-1.57a		-1.82a	
5			-0.81a		-1.44a	
6					-1.41a	
7					-1.65a	
F_{SE} (SE / off_ec)						Ho Rejected
p = 1*			-5.47c		-4.40c	
2			-3.57b		-2.71b	
3			-2.53a		-1.73a	
4			-2.93a		-1.67a	

Note: Akaike Information Criterion (AIC) and Schwartz Criteria (SC) were used to select the number of lags required in the co-integration test. p shows lag levels and * denotes optimum lag selection in each model as suggested by 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 $\sigma_{1Y} = 0$ in equation (4) and $\varpi_{1X} = 0$ in Equation (5) respectively with and without 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 involves the comparison of the F and t statistics against the critical values of F and t for ARDL approach presented in table 3 for the three different scenarios.

Table 3. Critical Values for ARDL Modeling Approach

	90% level		95% level		99% level	
k = 1	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)
F_{IV}	4.05	4.49	4.68	5.15	6.10	6.73
F_V	5.59	6.26	6.5	7.30	8.74	9.63
F_{III}	4.04	4.78	4.94	5.73	6.84	7.84
t_V	-3.13	-3.63	-3.41	-3.95	-3.96	-4.53
t_{III}	-2.57	-2.91	-2.86	-3.22	-3.43	-3.82

Source: Pesaran(2001) for F-statistics pg.300-301 and for t-ratios pg.303-304.

Note: (1) k^{10} 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 trend, 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 a3 = 0 in Equation (4) and b3= 0 in Equation (5) respectively with and without deterministic linear trend (Katircioglu, 2009).

Using equations (4)-(5)-each variable is considered as dependent variable in the calculation of the and t-ratios.

When official economy is the dependent variable, the values of t-ratios for each lag lies below the lower bound for all lags, revealing that there is not a level official economy equation, irrespective of trend restrictions. When shadow economy is the dependent variable, for lag 1 irrespective of trend impositions, the values of t-ratios lies outside the 0.01 critical value bounds, and reject the null hypothesis that there is no level shadow economy equation.

Overall, the bounds test results support the existence of a mutual long-run relationship between SE and official economy.

Having cointegrated relationships in bounds tests, the ARDL approach can be now adopted to estimate the level relationship. On the Akaike Selection Criterion, the selected ARDL order is 6 for the official economy and 0 for SE without deterministic trend.

The empirical estimates of level relationship for the ARDL error corection model(lags: 5, 0) revealed that the estimated parameters are statistically significant and the model shows that official economy have inelastic but negative coefficients. In the long run period, the long run elasticity (coefficient of offical economy) is statistically significant. (Prob. =0.00). All five lagged changes in shadow economy are statistically significant, further justifying the choice of p=5.

The equilibrium correction coefficient is estimated as -0.90 (0.173) which is reasonably large and highly significant at 1% level. This shows that Romanian shadow economy coverge to its long run level by 90% by the contribution of official economy. The intercept is not statistically significant and the lagged coefficients in the short term are inelastic, but not totally statistically significant.

The adjusted R^2 is 0.60 suggesting that such error correction model 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 coefficient carries the expected negative sign and are highly significant in both cases. This helps reinforce the finding of cointegration.

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 official economy.

Table 4. Results of Granger Causality

	F-statistics [probability values]		
Dependent Variable	Official economy$_t$	SE$_t$	t-stat (prob) for ECT$_{t-1}$
Official economy$_t$	-	()	-1.40 [0.18]
SE$_t$	()	-	-1.80* [0.09]

* denote the rejection of null hypothesis respectively at 0.10 levels.

The empirical results reveal the existence of a long-run unidirectional causality that runs from official economy to shadow economy but in the short run, the lack of F-statistics

results does not support short-run causations. We have a Granger causality for long-run period, because the t-statistics for ECT(error correction term) is statistically significant at 10% levels.

Next, we examine the stability of short-run and long-run coefficients, performing the CUSUM and CUSUMQ stability tests for the AIC-based error correction models. The tests applied to the residuals indicate the absence of any instability of the coefficients because the plots of the CUSUMQ and CUSUM statistic are confirmed within the 5% critical bounds of parameter stability.

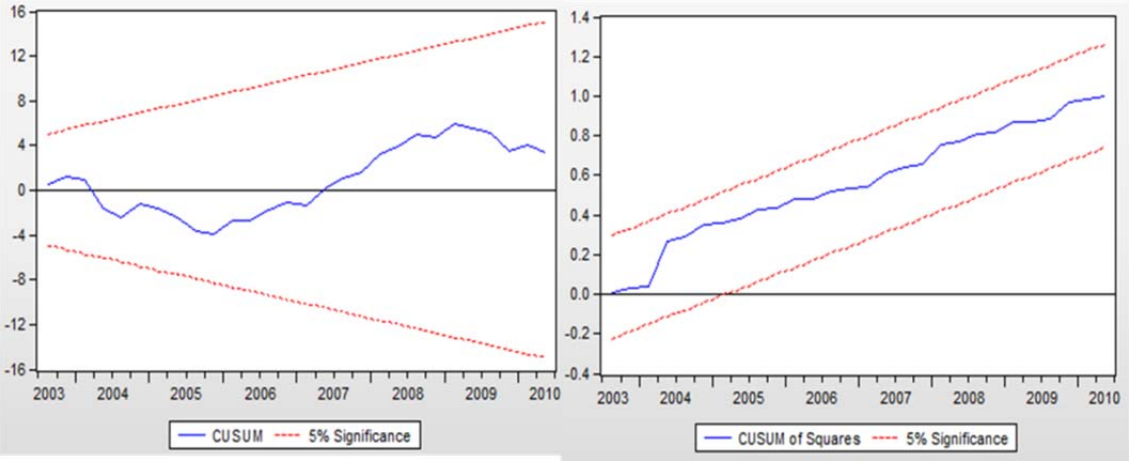

Figure 2. Plots of CUSUM and CUSUMSQ Statistics for Coefficient Stability for the relationship between shadow economy and official economy

Conclusions

In this paper, we investigated the relationship between official economy 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 size of Romanian shadow economy is estimated using a revised version of the currency demand approach based on autoregressive distributed lag (ARDL) approach to cointegration analysis. A detailed description of the estimation process is described in Davidescu and Dobre (2013). The size of the shadow economy as % of official GDP measures approximately 45% at the end of 2000 and achieving the value of 37.4% in the last quarters of the period.

Cointegration test results does not support any short-run relationship between official economy and shadow economy but in the long-run official economy have a negative effect on shadow economy, when it is taken into account a significance level of 10%.

The ARDL causality results revealed the existence of a uni-directional causality that runs official economy to the shadow economy, but only on long-run. The empirical results are in line with the studies of Eilat and Zinnes (2000) for 24 transition countries and Kaufmann and Kaliberda (1996) who estimate a negative impact of official GDP on the size of the shadow economy, mentioning that a decline in official GDP, will lead to an increase in the size of the shadow economy.

References

1. Albu, L.L., Ghizdeanu, I. and Stanica, C. **Spatial Distribution of the Informal Economy. A Theoretical and Empirical Investigation,** SCIENZE REGIONALI, FrancoAngeli Editore, vol. 0(1), 2011, pp. 63-80
2. Davidescu A.A. and Dobre, I. **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, Vol. 46, No. 2, 2012, pp.91-104
3. Dobre, I. and Davidescu, A. **Long-run demand for money and the size of shadow economy in Romania:An application of ARDL model**, Economic Computation and Economic Cybernetics Studies and Research, Vol. 47, No. 3, 2013, pp. 91-110
4. Eilat, Y. and Zinnes, C. **The Evolution of the Shadow Economy in Transition Countries: Consequences for Economic Growth and Donor Assistance**. CAER II Discussion Paper No. 83, Harvard Institute for International Development. Cambridge, MA, 2000
5. Giles, D.E.A. and Tedds, L.M. **Taxes and the Canadian Underground Economy**, Canadian Tax paper 106, Toronto, Canadian Tax Foundation, 2000
6. Katircioglu, S.T. **Tourism, Trade and Growth: The Case of Cyprus**; Applied Economics, Vol. 41, No. 21, 2009, pp. 2741-2750
7. Maer-Matei, M.M. **Measures Of Occupational Mismatch**. SEA-Practical Application of Science, Vol.5, 2014, pp. 425-430
8. Narayan, P. K. and Smyth, R. **The Relationship between the Real Exchange Rate and Balance of Payments: Empirical Evidence for China from Co-integration and Causality Testing**. Applied Economic Letters, Vol. 11, 2004, pp. 287–291
9. Pesaran, M. H., Shin, Y. and Smith, R. J. **Bounds Testing Approaches to the Analysis of Level Relationships**; Journal of Applied Econometrics, Vol. 16, 2001, pp. 289–326
10. Schneider, F. and Buehn, A. **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, No. 9, 2007, pp. 1-53
11. Schneider, F., Buehn, A. and Montenegro, C. **Shadow Economies All over the World: New Estimates For 162 Countries From 1999 To 2007**, Working Papers wp322, University of Chile, Department of Economics; 2010
12. Strat, V.A. **What Happened with the Attractiveness of the Romanian Counties for FDI during the Period 2001 – 2012?,** Journal of Applied Quantitative Methods, Vol. 9, No. 4, 2014, pp.22-39
13. Vo, D. and Ly, T. **Measuring the Shadow Economy in the ASEAN Nations: The MIMIC Approach**, International Journal of Economics and Finance, Vol. 6, No. 10, 2014, pp.139 – 149
14. Zaman, G., Goschin, Z., Partachi, I. and Herteliu, C. **The contribution of labour and capital to Romania's and Moldova's economic growth,** Journal of applied quantitative methods, 2(1), 2007, pp. 179-185
15. Zaman, G., Goschin, Z., and Herteliu, C. **Analysis Of The Correlation Between The Gdp Evolutions And The Capital And Labor Factors In Romaniam,** Romanian Journal for Economic Forecasting, 2(3), 2005, pp. 5-21
16. Zamfir, A.M., Mocanu, C., Maer-Matei, M.M. and Lungu, E.O. **Immigration and Integration Regimes in EU Countries,** Journal of Community Positive Practices, Vol. 14, No. 1, 2014, pp. 104-115
17. *** Quarterly National Accounts database, Eurostat.
18. *** Quarterly Government Finance Statistics database, Eurostat.
19. *** Quarterly Interest Rates database, Eurostat.
20. *** Quarterly Monetary and Financial Statistics database, Eurostat.

21. *** Tempo database, National Institute of Statistics, www.insse.ro
22. *** Monthly Bulletins of National Bank of Romania, 2000-2010, www.bnr.ro

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[3] this paper addresses the concept of shadow economy as defined by Schneider (2006) and Schneider et al. (2010) and does not trait the informal sector.

[4] For Schneider et al. (2010), the size of shadow economy in % of official GDP, using the DYMIMIC model is 34.4% in 2000, 35.4% in 2002, 35.9% in 2004, 36.2% in 2005 and 36.7% in 2006.

[5] For Schneider et al. (2010), the size of shadow economy in % of official GDP, using the DYMIMIC model is 34.4% in 2000, 35.4% in 2002, 35.9% in 2004, 36.2% in 2005 and 36.7% in 2006.

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

[7] 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.

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

[9] The maximum duration of lags for both models has been taken as 7.

[10] k is the number of repressors for the dependent variable in the ARDL models.