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REVISITING THE RELATIONSHIP BETWEEN U.S. SHADOW ECONOMY AND THE LEVEL OF UNEMPLOYMENT RATE USING BOUNDS TEST APPROACH FOR COINTEGRATION AND CAUSALITY

Abstract: *This paper aims to investigate the long-run equilibrium relationship and the direction of causality between U.S. shadow economy (SE) and unemployment rate (UR) using bounds test for co-integration and granger causality approach. The size of U.S. shadow economy (SE) is estimated using a Structural Equation Approach with quarterly data for the period 1980-2009.Thus, the shadow economy is modeled like a latent variable using a special case of the structural equation models-the MIMIC model. His dimension is decreasing over the last two decades.*

The empirical results reveal the existence of a long run relationship between the two variables. Furthermore, the Granger causality test identifies a unique direction of causality that runs from unemployment rate to shadow economy but only in the short term.

Keywords: *shadow economy, unemployment rate, MIMIC model, cointegration, ARDL bounds test approach, conditional Granger causality, conditional VECM.*

JEL classification: C51, E26, H20, H50, O17

1. Introduction

Studies trying to measure the dimension of shadow economy face the difficulty of how to define it. One commonly used working definition is: all currently unregistered economic activity which contributes to the officially calculated (or observed) Gross National Product[1]. 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."

In the problem of measuring the dimension of shadow economy, there are various approaches who include using surveys of taxation compliance, using the discrepancy between national income and national expenditure; considering fluctuations in labour force participation rates; the monetary "transactions approach" of Feige (1979); modifications of currency demand equations, where the pioneer was Cagan (1958).One criticism of most of these approaches is that it focus on one cause of hidden economic activity, and one indicator.

In contrast, the MIMIC("Multiple Indicators, Multiple Causes") model of Zellner(1970), Goldberger(1972), Jöreskog and Goldberger(1975), Jöreskog and Sörbom(1993)) allows for several indicators variables and several causal variables in forming structural relationships to explain the latent variable. Frey and Weck-Hanneman (1984) estimated underground economy MIMIC models for a range of OECD countries; Aigner *et al.*(1988) applied a dynamic MIMIC model to U.S.A. data; and Tedds (1998) used this approach to model the Canadian underground economy.

The main goal of the paper is to investigate the relationship between the size of the shadow economy and the unemployment rate using bounds tests for cointegration and causality. The paper is divided three sections presenting the data, the methodology and the main econometrical results.

2. Investigating the relationship between shadow economy and unemployment rate using bounds tests for cointegration and causality

People work in the shadow economy because of the increased cost that firms in the formal sector have to pay to hire a worker. The increased cost comes from the tax burden and government regulations on economic activities. In discussing the growth of the shadow economy, the empirical evidence suggests two important factors: (a) reduction in official working hours, (b) the influence of the unemployment rate.

Enste (2003) points out that the reduction of the number of working hours below worker's preferences raises the quantity of hours worked in the shadow economy. Early retirement also increases the quantity of hours worked in the shadow economy.

An increase in the unemployment rate reduces the proportion of workers employed in the formal sector. Consequently this leads to higher labour participation rates in the informal sector. Boeri and Garibaldi (2003) show a strong

[1] This definition is used by Feige (1989-„ economic activities include conscious efforts to avoid official detection) and by Schneider and Enste(2000- all economic activities which contribute to officially calculated gross national product).

positive correlation between average unemployment rate and average shadow employment across 20 Italian regions during the period 1995-1999.

Giles and Tedds (2002) state that the effect of unemployment on the shadow economy is ambiguous (i.e. both positive and negative). 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.

Dell'Anno and Solomon (2006) found a positive structural relationship between UR and U.S. shadow economy for the period 1970-2004 by imposing long-run restrictions in a Structural VAR model to analyze the impact of the shadow economy to a temporary shock in unemployment.

2.1. Data

In the econometrical demarche of the investigation of the relationship between U.S. shadow economy (SE) and unemployment rate (UR), we used quarterly data seasonally adjusted covering the period 1980:Q1 to 2009:Q2.

The size of the shadow economy (SE) as % of official GDP is obtained applying the MIMIC model, that allows to consider the SE as a "latent" variable linked, on the one hand, to a number of observable indicators (reflecting changes in the size of the SE) and on the other, to a set of observed causal variables, which are regarded as some of the most important determinants of the unreported economic activity (Dell'Anno, 2003). A detailed description of the estimation methodology is presented in Alexandru and Dobre (2010).The 4-1-2 MIMIC model with four causal variables (taxes on corporate income, contributions for government social insurance, unemployment rate and self-employment) and two indicators (index of real GDP and civilian labour force participation rate) is chosen to be the best model for the U.S. shadow economy.

The empirical results point out that the shadow economy measured as percentage of official GDP records the value of 13.41% in the first trimester of 1980 and follows an ascendant trend reaching the value of 16.77% in the last trimester of 1982.

At the beginning of 1983, the dimension of USA shadow economy begins to decrease in intensity, recording the average value of 6% of GDP at the end of 2007. For the last two year 2008 and 2009, the size of the unreported economy it increases slowly, achieving the value of 7.3% in the second quarter of 2009. The results of this estimation are not far from the last empirical studies for USA (Schneider 1998, 2000, 2004, 2007, Schneider and Enste 2001).Schneider estimates in his last study, the size of USA shadow economy as average 2004/05, at the level of 7.9 percentage of official GDP.

The series of unemployment rate expressed in % was seasonally adjusted taken from Bureau of Labour Statistics.

Analyzing the graphical evolution of the both variables, it can be point out that we have a strong direct relationship between SE measured as % of official GDP and the UR.

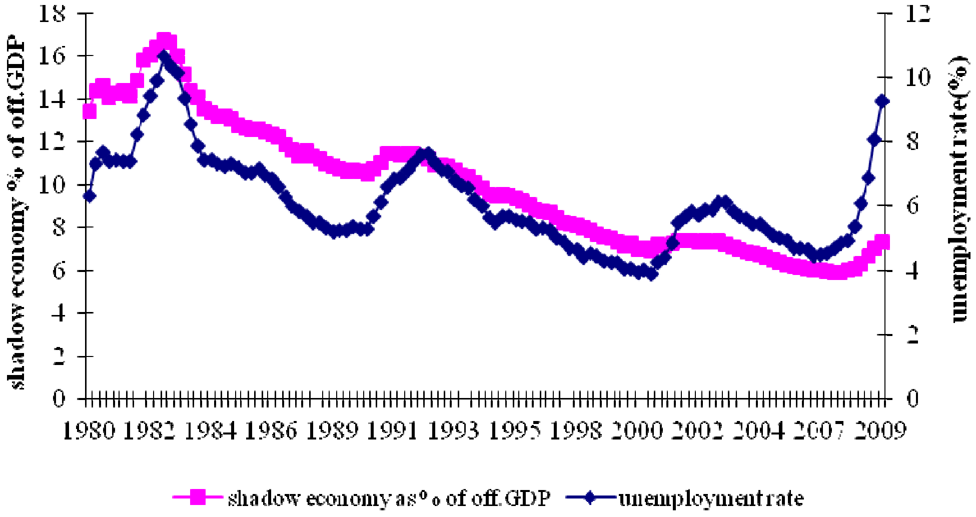

Figure 1. Shadow economy vs. unemployment rate

2.2. Methodology

In the process of investigating the relationship between SE and UR, first we will employ the unit root tests(The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP)) to identify the integration level of each variables (Dickey and Fuller 1981).

Furthermore, we will test the series for structural break, using Perron (1990) test in order to see if the order of integration is changed by the structural break.

The test has two stages. A detailed description of Perron test is provided by (Katircioglu, 2009).

In the first stage, there are estimated the residuals using OLS for the following model:

$$X_t = \mu + \delta DU_t + e_t \tag{1}$$

where $DU_t=1$ *if* $t>T_b$ and *0* otherwise(T_b is the point where the break occurs).

In the second stage, we run the following regression models using OLS.

$$\Delta e_t = \sum_{i=0}^{K} \phi_i (DUTB)_{t-i} + \gamma e_{t-1} + \sum_{i=1}^{K} \alpha_i \Delta e_{t-i} + \varepsilon_t \quad \text{(level)} \tag{2}$$

$$\Delta\Delta e_t = \sum_{i=0}^{K} \phi_i (DUTB)_{t-i} + \gamma \Delta e_{t-1} + \sum_{i=1}^{K} \alpha_i \Delta\Delta e_{t-i} + \varepsilon_t \quad \text{(first difference)} \tag{3}$$

where: $(DUTB)_t=1$ if $t=T_b+1$ and 0 otherwise, T_b is the break year, $DUTB$ is dummy variable for the break year, e_t is residual obtained from equation (1) using OLS, ϕ_i, γ, α_i are coefficients and ε_t is an error term.

If order to see if the series is stationary or not, we compare the t-value of γ coefficient with the appropriate critical values reported by Perron(1990, 1992) or by Rybinski(1994, 1995) for small samples. If the t-value is superior to critical values in absolute terms we can conclude the series hasn't a unit root and therefore it is stationary.

In order to investigate long-run relationship between the two variables, we will apply the bounds test for level relationships within ARDL (the autoregressive distributed lag). This approach developed by Pesaran et al. (2001) can be applied irrespective of the order of integration of the variables (irrespective of whether regressors are purely I (0), purely I (1) or mutually cointegrated). The only rule that must be meet is that the dependent variable to be integrated of order 1, I(1).

The ARDL modeling approach involves estimating the following error correction models (Katircioglu, 2009):

$$\Delta Y_t = a_{0_Y} + \sum_{i=1}^{m} b_{i_Y} \Delta Y_{t-i} + \sum_{i=0}^{m} c_{i_Y} \Delta X_{t-i} + \sigma_{1_Y} Y_{t-1} + \sigma_{2_Y} X_{t-1} + \varepsilon_{1t} \tag{4}$$

$$\Delta X_t = a_{0_X} + \sum_{i=1}^{m} b_{i_X} \Delta X_{t-i} + \sum_{i=0}^{m} c_{i_X} \Delta Y_{t-i} + \varpi_{1_X} X_{t-1} + \varpi_{2_X} Y_{t-1} + \varepsilon_{2t} \tag{5}$$

where: Δ is the difference operator, Y_t is the dependent variable, X_t is the independent variable and ε_{1t} and ε_{2t} are serially independent random errors with mean zero and finite covariance matrix, "m" represents number of lags.

The first part of both equations with b_{iY}, b_{iX} and c_{iX}, c_{iY} represents the short-run dynamics of the models whereas the second part with σ_{1Y}, σ_{2Y} and ϖ_{1X}, ϖ_{2X} represent the long-run phenomenon.

In the first equation, in which Y is the dependent variable, the null hypothesis is H_0: $\sigma_{1Y} = \sigma_{2Y} = 0$ (no cointegration) and the alternative is formulated as H_1: $\sigma_{1Y} \neq \sigma_{2Y} \neq 0$ (cointegration).

In the second, in which X is the dependent variable, the null hypothesis is H_0: $\varpi_{1X} = \varpi_{2X} = 0$ (no cointegration) and the alternative is H_1: $\varpi_{1X} \neq \varpi_{2X} \neq 0$(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[2] (2001) or Narayan[3] (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 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.

In the case of cointegration, the conditional Error Correction Model (ECM) using the ARDL approach will be employed in order to estimate the level equation $Y_t = \beta_0 + \beta_1 X_t + \varepsilon_t$.

where: Y is the dependent variable, X is the independent variable, β_0, β_1 are the coefficients and ε_t is the error term.

The conditional VECM under the ARDL approach can be written as:

$$\Delta Y_t = \beta_0 + \sum_{i=1}^{n} \beta_1 \Delta Y_{t-i} + \sum_{i=0}^{n} \beta_2 \Delta X_{t-i} + \gamma ECT_{t-1} + \varepsilon_t \quad (6)$$

where: Y, X are the variables described above, Δ is the difference operator, ECT_{t-1} is the one period lagged error correction term who shows how speed the disequilibrium between the short-run and the long-run values of dependent variable is eliminated each period, γ indicate the speed of adjustement to the equilibrium level after a shock. The expected sign of ECT is negative. The coefficients β_1, β_2 are the coefficients for the short-run dynamics of the model`s convergence to equilibrium and ε_t is the error term.

If we identify cointegration using bounds test, conditional Granger causality tests could be carried out under the conditional error correction model. By doing so, the short-run deviations of series from their long-run equilibrium path are also captured by including an error correction term (Narayan and Smyth, 2004).

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

[3] 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.

Therefore, conditional vector error correction models for Granger causality between the two variables can be specified as follows(Katircioglu, 2009):

$$\Delta Y_t = \alpha_0 + \varphi_{11}^{p}(L)\Delta Y_t + \varphi_{12}^{q}(L)\Delta X_t + \delta ECT_{t-1} + \varepsilon_{1t} \quad (7)$$

$$\Delta X_t = \alpha_0 + \varphi_{21}^{p}(L)\Delta X_t + \varphi_{22}^{q}(L)\Delta Y_t + \delta ECT_{t-1} + \varepsilon_{2t} \quad (8)$$

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

Y, X are the variables described above, Δ denotes the difference operator and 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 mean zero and finite covariance matrix. ECT_{t-1} is the lagged error correction term derived from the long-run co-integration model and the t-ratio for this coefficient must be statistically significant, in order to prove the existance of long-run causations. 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 *ECT* 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.

2.3. Empirical results

In order to identify the level of integration of the two series, ADF and PP unit root tests were applied. The size of the shadow economy seems to be stationary in ADF test at level but this result is not supported by PP test. Further more, both tests reveal that the variables are non-stationary at their levels but stationary at their first differences, being integrated of order one, I(1).

The graphical analysis suggests as possible structural break for unemployment rate the period 1983Q3.Perron (1990) unit root tests for structural break are reported in table 1. The results reveal the existence of no structural break in the series of unemployment rate.

Table 1. Perron(1990) unit root test for structural break

Variable	Break year	Test statistic	Critical value and $\lambda = 0.127$		
			90%	95%	99%
Unemployment rate(UR)	**1983Q3**	**-0.44**	**-1.09**	**-0.28**	**0.98**

The corresponding break fraction for $T = 118$ observations was computed $\lambda = \frac{T_b}{T}$. For the 1983Q3 break period, $\lambda = 15/118 = 0.127$.

Furthermore, we will investigate the possible existence of cointegration between the shadow economy and the unemployment rate using the bounds tests within the ARDL modelling approach.

In order to determine the lag length p required in the co-integration test, Akaike and Schwarz Information Criteria (AIC and SBC) are used. In table 2 are also displayed Lagrange multiplier (LM) statistics for testing the hypothesis of no residual serial correlation against orders 1 and 4 ($\chi^2_{SC}(1)$ and $\chi^2_{SC}(4)$).

For the relationship in which shadow economy is the dependent variable, F_{SE} (SE / UR), the lag order selected by SBC is $\hat{p}_{SBC}=1$, irrespective of whether a deterministic trend term is included or not. The AIC criteria estimates $\hat{p}_{AIC}=5$ if a trend is included and $\hat{p}_{AIC}=6$ if not. For the relationship F_{UR} (UR / SE), the lag order selected by SBC is $\hat{p}_{SBC}=2$, and by AIC is $\hat{p}_{AIC}=5$ irrespective of whether a deterministic trend term is included or not.

Table 2. Statistics for Selecting Lag Length in Bounds Tests Equation

	Without deterministic trends				With deterministic trends			
	F_{SE} (SE / UR)							
p	AIC	SBC	X^2sc(1)	X^2sc(4)	AIC	SBC	X^2sc(1)	X^2sc(4)
1	-1.11	-1.02	0.35	9.77**	-1.15	-1.03	2.21	18.96*
2	-1.12	-0.97	0.001	7.10	-1.15	-0.98	0.10	18.18*
3	-1.11	-0.92	1.65	10.24**	-1.14	-0.92	0.18	18.60*
4	-1.12	-0.88	0.002	19.17*	-1.19	-0.93	2.33	19.67*
5	-1.18	-0.89	2.79	12.40**	-1.30	-0.98	2.03	12.37**
6	-1.21	-0.87	0.30	10.37**	-1.27	-0.91	2.10	10.17**
	F_{UR} (UR / lSE)							
p	AIC	SBC	X^2sc(1)	X^2sc(4)	AIC	SBC	X^2sc(1)	X^2sc(4)
1	-0.5	-0.48	5.60**	16.31*	-0.61	-0.49	9.40*	25.99*
2	-0.76	-0.62	5.08**	12.16**	-0.80	-0.63	4.2**	15.20*
3	-0.79	-0.60	0.090	7.53	-0.81	-0.59	0.21	8.84
4	-0.76	-0.52	6.97*	11.00**	-0.78	-0.52	15.06*	16.84*
5	-0.83	-0.54	0.88	2.73	-0.91	-0.59	0.006	7.08
6	-0.79	-0.45	0.26	6.50	-0.87	-0.50	6.62*	18.97*

*Note: p is the lag order of the underlying VAR model; *, ** denote significance at 0.01, 0.05 levels respectively.*

For completeness, we will report test results for lag 5 to 8 in order to remove residual serial correlation.

The results of the bounds test for co-integration under three scenarios of Pesaran (2001) with restricted deterministic trends (F_{IV}), with unrestricted deterministic trends (F_V) and without deterministic trends (F_{III}), and with all intercepts unrestricted are presented in table 3.

Table 3. The Bounds Test for Co-integration

	With Deterministic Trends			Without Deterministic Trend		
Variables	F_{IV}	F_V	t_V	F_{III}	t_{III}	Conclusion
						H_0
SE and UR						
F_{SE} (SE / UR)						Rejected
$p = 5^*$	5.53c	8.08c	-3.65c	-	-	
6	3.51a	5.16a	-2.73a	0.96a	1.18a	
7	5.21c	7.62c	-3.29b	1.48a	1.51a	
8	3.84a	5.71b	-2.65a	1.72a	1.08a	
9	-	-	-	3.55a	0.43a	
F_{UR} (UR / SE)						Rejected
$p = 5^*$	3.77a	4.77a	-2.84a	0.52a	0.26a	
6	3.61a	4.52a	2.75a	0.55a	0.32a	
7	5.10c	6.30c	-3.29b	0.83a	0.32a	
8	5.94c	7.74c	-3.53b	0.74a	0.60a	

*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 AIC. 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 $\sigma_{IY} = 0$ in equation (4) and $\varpi_{IX} = 0$ 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 4 for the three different scenarios.

Table 4. 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[4] 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 $\sigma_{IY} = 0$ in Equation (4) and $\varpi_{IX} = 0$ in Equation (5) respectively with and without deterministic linear trend (Katircioglu, 2009).

Using equations (10)-(11)-each variable is considered as dependent variable in the calculation of the F-statistics.

When SE is the dependent variable F_{SE} (SE / UR), for the p=5 and 7, the F_{IV} and F_V lies outside the 0.05 critical value bounds and reject the null hypothesis that there is no level shadow economy equation, irrespective of whether the regressors are I(0) or I(1). When the bounds F-test is applied to the shadow economy equation without a linear trend, the F_{III} lies below the lower bound for all lags, revealing that there is not a level shadow economy equation.

The results of the bounds t-test allow the imposition of the trend restrictions in the model. If a linear trend is included, t_V for lag 5 lies outside the critical value bounds and the null hypothesis is rejected for 90% confidence level. Without deterministic trend, the null hypothesis is accepted irrespective of the lag length. When UR is the dependent variable F_{UR} (UR / SE), for p=7 and 8, the F_{IV} and F_V lies outside the 0.05 critical value bounds and reject the null hypothesis that there is no level unemployment rate equation, irrespective of whether the regressors are I(0) or I(1).

Overall, the bounds test results support the existence support the existence of a mutual long-run relationship between SE and UR when a sufficiently high lag

[4] k is the number of regressors for the dependent variable in the ARDL models.

order is selected and when the statistically significant deterministic trend is included in the conditional ECM.

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 5 for the both variables, irrespective whether the trend is considered or not.

The empirical estimates of level relationship for the ARDL error corection model(lags: 5, 5) can be given by:

$$SE_t = 10.19 + 0.62 \cdot UR_t + \hat{\varepsilon}_t \qquad (9)$$
$$(0.49) \quad (0.062)$$

where $\hat{\varepsilon}_t$ is error correction term and standard errors are given in parantheses. The estimated parameters are statistically significant and the model shows that unemployment rate(0.62) have inelastic but positive coefficients. In the long run period, the long run elasticity (coefficient of unemployment rate) is statistically significant. (Prob. =0.00). All four lagged changes in shadow economy are statistically significant, further justifying the choice of p=5.

The equilibrium correction coefficient is estimated as -0.228 (0.0554) which is reasonably large and highly significant at 1% level. This shows that U.S. shadow economy coverge to its long run level by 22.8% by the contribution of unemployment rate. The intercept is not statistically significant and the lagged coefficients in the short term are inelastic, but not totally statistically significant.

Finally, the direction of causality is tested within conditional Granger causality tests under the ARDL mechanism as a long-run context. F-statistics for short-run causations and t statistics of ECTs for long-run causations must be statistically significant in order to achieve granger causality betwen shadow economy and unemployment rate.

Table 5. Results of Granger Causality

F-statistics [probability values]			
Dependent Variable	UR_t	SE_t	t-stat (prob) for ECT_{t-1}
UR_t	-	1.670 [0.148]	1.031 [0.304]
SE_t	2.544* [0.032]	-	-1.435 [0.154]

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

The empirical results reveal the existence of a unidirectional causality that runs from unemployment rate to shadow economy but only in the short run, because the F-statistics for short-run causations are statistically significant at 5% level. We don't have a granger causality for long-run period, because the t-statistics for ECT(error correction term) is not statistically significant.

4. Conclusions

The main goal of the paper was to investigate the long-run equilibrium relationship and direction of causality between shadow economy, expressed as % of official GDP and the level of unemployment rate in United States.

The empirical results reveal the existence of a long-run relationship between the both variables. The long-run effects of the unemployment rate on the size of the shadow economy are inelastic and statiscally significant, instead of the short-run effects that are inelastic but not entirely statistically significant.

The study results point out a unique direction of causality that runs from unemployment rate to shadow economy but only in the short term.

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