REVISITING THE RELATIONSHIP BETWEEN SHADOW ECONOMY AND THE LEVEL OF UNEMPLOYMENT RATE. A SVAR EMPIRICAL IVESTIGATION FOR THE CASE OF UNITED STATES

Adriana Ana Maria DAVIDESCU
PhD, University Lecturer, Department of Statistics and Econometrics
Bucharest Academy of Economic Studies

E-mail: adrianaalexandru@yahoo.com

Ion DOBRE
PhD, University Professor, Department of Cybernetics and Informatics
Bucharest Academy of Economic Studies

E-mail: dobrerio@ase.ro

Abstract:
The paper analyses the relationship between shadow economy and unemployment rate using a Structural VAR approach for quarterly data during the period 1982-2011. The size of the shadow economy as % of official GDP is estimated using a Structural Equation Approach with quarterly data for the period 1982-2011.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 relationship between the two variables is further tested by imposing a long-run restriction in the Structural VAR model to analyze the impact of the shadow economy to a temporary shock in unemployment. The impulse response function generated by the Structural VAR confirms that in the short-run, a rise in the unemployment rate in formal sector will lead to an increase in the number of people who work in the shadow economy.

Key words: *shadow economy, unemployment rate, MIMIC model, Structural VAR, United States.*

1. INTRODUCTION

The relationship between the shadow economy and the level of unemployment is one of major interest. 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.

Also, Boeri and Garibaldi(2003) show a strong 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 relationship between unemployment rate and shadow economy, showing that a positive aggregate supply shock will cause in increase in the shadow economy by about 8% above the baseline.

The paper analyzes the relationship between SE and UR using a structural VAR approach (SVAR).The paper is divided two sections presenting the data, and the methodology and also the main econometrical results.

2. DATA AND METHODOLOGY

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 1982:Q1 to 2011:Q2.

The size of the shadow economy (SE) as % of official GDP was 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 1982 and follows an ascendant trend reaching the value of 16.77% in the last trimester of 1984.

At the beginning of 1985, the dimension of USA shadow economy begins to decrease in intensity, recording the average value of 6% of GDP at the end of 2009. For the last two year 2010 and 2011, the size of the unreported economy it increases slowly, achieving the value of 7.3% in the second quarter of 2011. 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 2005/06, 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.

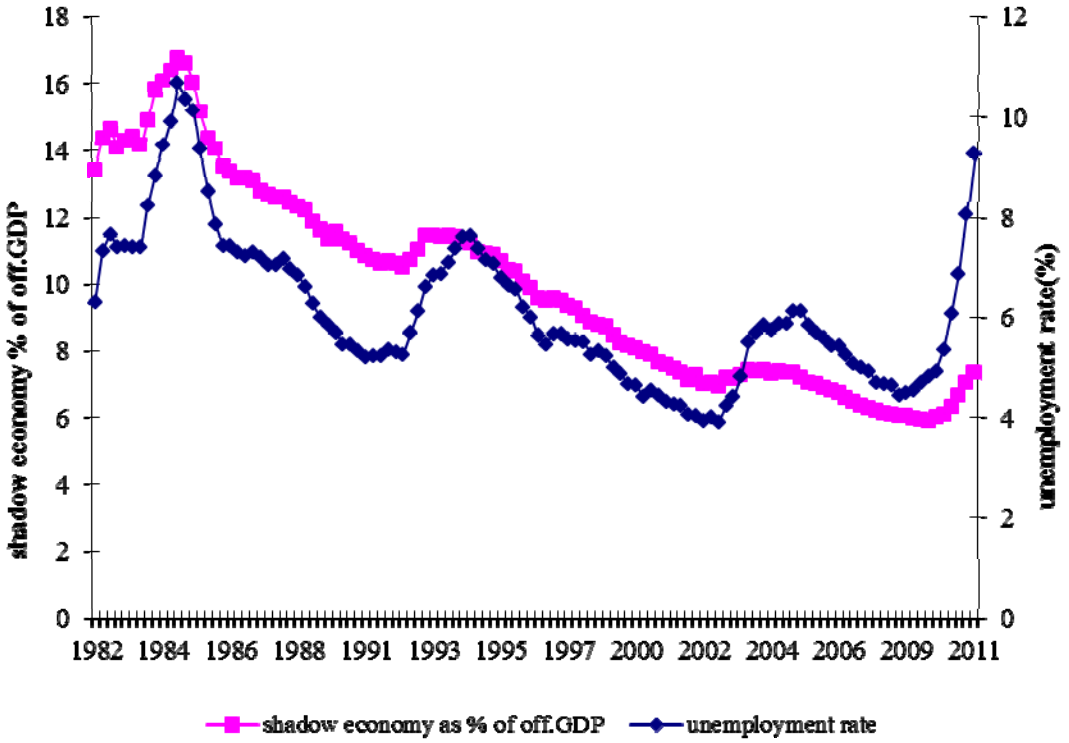

Fig.1. Shadow economy vs. unemployment rate

2.2. Methodology

After we estimate the size of the shadow economy, we investigate the existence of a structural relationship between shadow economy and unemployment in order to extract information on aggregate supply and aggregate demand disturbances. We use the Structural Vector Autoregression Approach (SVAR) to isolate disturbances as developed by Blanchard and Quah(1989).

The structural VAR methodology with long-run restrictions proposed by Blanchard and Quah(1989) does not impose restrictions on the short-run dynamics of the permanent component of output, but incorporates a process for permanent shocks that is more general than a random walk. Also, the methodology provides an alternative way to obtain a structural identification. Instead of associating each disturbance (□t) directly with an individual variable, they consider the shocks as having either temporary or permanent effects. They then treat these shocks like exogenous variables. The objective is to decompose real GNP into its temporary and permanent components. Economic theory is used to associate aggregate demand shocks as being the temporary shocks and aggregate supply shocks as having permanent effects. Using a bivariate VAR, Blanchard and Quah(1989) show how to decompose real GNP and recover the two pure shocks that cannot otherwise be quantified.

In the same manner, we consider a Vector Autoregression representation of a system composed by two variables that are the first differences of the shadow economy (SE) and

unemployment rate (UR). The Blanchard - Quah technique requires that both variables must be stationary.

Thus, the two variables that compose VAR are:

$$X_t = \begin{bmatrix} \Delta SE_t \\ \Delta UR_t \end{bmatrix} \quad (1)$$

The classical VAR can be writing as:

$$\Delta SE_t = b_{10} - b_{12}\,\Delta UR_t + \gamma_{11}^{1}\,\Delta SE_{t-1} + \gamma_{12}^{1}\,\Delta UR_{t-1} + \ldots + \gamma_{11}^{p}\,\Delta SE_{t-p} + \gamma_{12}^{p}\,\Delta UR_{t-p} + \varepsilon_{dt} \quad (2)$$

$$\Delta UR_t = b_{20} - b_{21}\,\Delta SE_t + \gamma_{21}^{1}\,\Delta SE_{t-1} + \gamma_{22}^{1}\,\Delta UR_{t-1} + \ldots + \gamma_{21}^{p}\,\Delta SE_{t-p} + \gamma_{22}^{p}\,\Delta UR_{t-p} + \varepsilon_{st} \quad (3)$$

We can re-write the above equations in a matrix form:

$$\begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix}\begin{bmatrix} \Delta SE_t \\ \Delta UR_t \end{bmatrix} = \begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix} + \begin{bmatrix} \gamma_{11}^{1} & \gamma_{12}^{1} \\ \gamma_{21}^{1} & \gamma_{22}^{1} \end{bmatrix}\begin{bmatrix} \Delta SE_{t-1} \\ \Delta UR_{t-1} \end{bmatrix} + \ldots + \begin{bmatrix} \gamma_{11}^{p} & \gamma_{12}^{p} \\ \gamma_{21}^{p} & \gamma_{22}^{p} \end{bmatrix}\begin{bmatrix} \Delta SE_{t-p} \\ \Delta UR_{t-p} \end{bmatrix} + \begin{bmatrix} \varepsilon_{dt} \\ \varepsilon_{st} \end{bmatrix} \quad (4)$$

Furthermore, in general form it becomes:

$$BX_t = \Gamma_0 + \Gamma_1 X_{t-1} + \ldots + \Gamma_p X_{t-p} + \varepsilon_t \quad (5)$$

where:

X_t is a vector of the two considered variables, Γ_t are the matrices of coefficients, p lags are considered and ε_t is the vector of error terms.

By multiplying with the inversion of B matrix $(1 - b_{12}b_{21} \neq 0)$ we obtain:

$$X_t = B^{-1}\Gamma_0 + B^{-1}\Gamma_1 X_{t-1} + \ldots + B^{-1}\Gamma_p X_{t-p} + B^{-1}\varepsilon_t \quad (6)$$

Further, $X_t = A_0 + A_1 X_{t-1} + \ldots + A_p X_{t-p} + e_t$ (7)

$$X_t = A(L)LX_t + e_t \quad (8)$$

Since the demand-side and supply-side shocks are not observed, the problem is to recover them from a VAR estimation. The critical insight is that VAR residuals are composites of pure innovations ε_{dt} and ε_{st}.

In the particular bivariate moving average form, the VAR can be written:

$$\begin{bmatrix} \Delta SE_t \\ \Delta UR_t \end{bmatrix} = \sum_{i=0}^{\infty} L^i \begin{bmatrix} b_{11i} & b_{12i} \\ b_{21i} & b_{22i} \end{bmatrix}\begin{bmatrix} \varepsilon_{dt} \\ \varepsilon_{st} \end{bmatrix} \quad (9)$$

The vector $\varepsilon_t = \begin{bmatrix} \varepsilon_{dt} \\ \varepsilon_{st} \end{bmatrix}$ contains the two structural shocks, the demand one and the supply one. The elements b_{11i} and b_{21i} are the impulse responses of an aggregate demand shock on the time path of the shadow economy and unemployment rate. The coefficients b_{12i} and b_{22i} are the impulse responses of an aggregate supply shock on the time path of shadow economy and unemployment rate respectively.

According to Blanchard and Quah, the key is to assume that one of the structural shocks has a temporary effect on ΔSE. We assume that an aggregate supply (unemployment rate) shock has no long-run effect on shadow economy. In other words, we impose a long-run restriction on the relationship between the observed data (SE) and the unobserved structural shock (ε_{st}) such that:

$$\sum_{i=0}^{\infty} b_{12i} = 0 \qquad (10)$$

Equation (10) is an Aggregate Supply Shock stating that the second structural shock (aggregate supply) has no long-run effect on shadow economy.

3. EMPİRİCAL RESULTS

In order to analyze the nature of the relationship between the two variables, we use the Structural VAR approach, for Blanchard and Quah(1989) methodology. In order to identify supply and demand shocks, we start by running a bivariate VAR model.

Both variables included in the VAR analysis, are suspected to have a unit root. To verify this, ADF and PP unit root tests were applied; the results are presented in table 1. The size of the shadow economy seems to be stationary in ADF test at level, but this is not justified by PP test. Furthermore, 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).

Table 1. ADF and PP tests for Unit Root analysis

		Shadow Economy(SE)			Unemployment rate(UR)		
		T&C	C	None	T&C	C	None
Level	ADF	-3.09	-1.39	-1.68***	-1.03	-2.14	-0.22
	lag	(3)	(3)	(6)	(1)	(1)	(1)
	PP	-2.26	-0.92	-1.61	-1.41	-1.69	0.03
	lag	(6)	(6)	(6)	(6)	(6)	(7)
First diff.	ADF	-3.43*	-3.39**	-3.33*	-4.40*	-4.17*	-4.17*
	lag	(2)	(2)	(2)	(0)	(0)	(0)
	PP	-6.99*	-6.97*	-6.73*	-4.69*	-4.52*	-4.53*
	lag	(5)	(5)	(6)	(3)	(3)	(3)

Note:

[a] T&C represents the most general model with a drift and trend; C is the model with a drift and without trend; None is the most restricted model without a drift and trend. Numbers in brackets are lag lengths used in ADF test (as determined by SCH set to maximum 12) to remove serial correlation in the residuals. When using PP test, numbers in brackets represent Newey-West Bandwith (as determined by Bartlett-Kernel).

[b] Both in ADF and PP tests, unit root tests were performed from the most general to the least specific model by eliminating trend and intercept across the models (See Enders, 1995: 254-255).

[c] *, ** and *** denote rejection of the null hypothesis at the 1%, 5% and 10% levels respectively.

[d] Tests for unit roots have been carried out in E-VIEWS 6.0.

Because the both series are integrated of the same order, I(1) we will difference the variables and we introduce the first difference in the VAR analysis. Including a sufficient number of lags to eliminate serial correlation from the residuals is crucial as using a lag structure that is too parsimonious can significantly bias the estimation of the structural components.

While according to SC and HQ criterions the optimal number of lags is found to be 1, AIC, LR and FPE criterions state that the optimal lag length is 4. Since the usual advice is that when quarterly data are available a minimum length of four is necessary and in order to be sure that through the number of chosen lags the residuals do not remain with autocorrelation, we have selected the optimal number of lags to be 4.

We have estimated a VAR model with four lags who verifies the stability condition[1]. Furthermore, we impose on this VAR a long-run restriction which specifies that the long run effect of the supply shocks on the shadow economy is null. Starting from this model, we analyze the impulse response function for the structural version of the model.

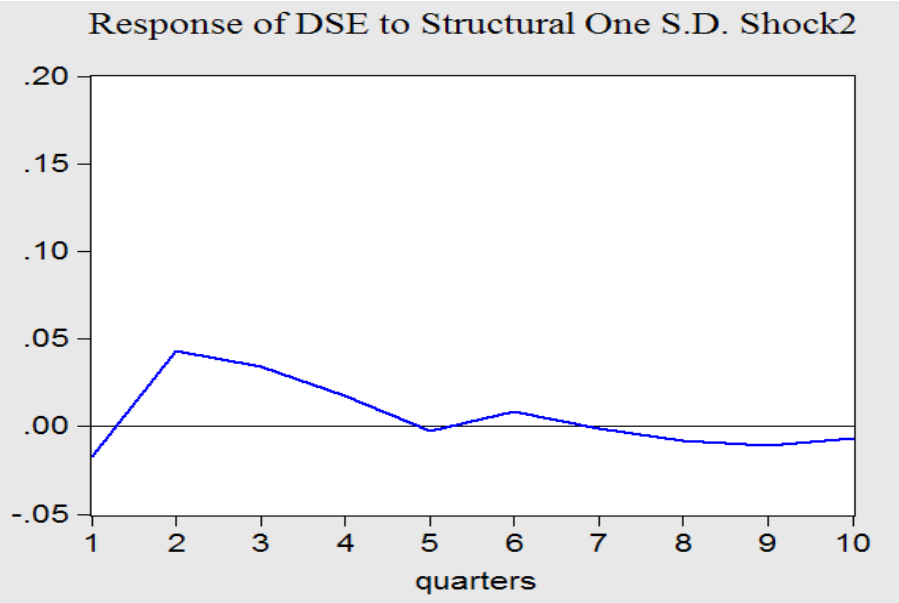

Fig 2. Effect of an aggregate Supply Shock on the size of the Shadow Economy

In the short-run, the positive aggregate supply shock causes a rise in the shadow economy by about 5% above the baseline. This occurs in the second quarter following the initial shock. Subsequently there is a steady decline towards the baseline until the first quarter of the second year. It can be observed that in second quarter of the year, the size of the shadow economy as % of official GDP fits on a slightly upward slope, but lower than the initial rise. Further, we have a gradually downward tendency until the end of the period.

The interpretation that we might derive from here could be the following; Assuming that the hypothesis according to which there is a strong and positive correlation between the size of the shadow economy measured as % of a country's GDP and the unemployment rate is valid then, we might conclude from here that employment in the shadow economy

[1] Since each VAR represents a system of linear first-order difference equations, it is stable only if the absolute values of all eigenvalues of the system matrix lie inside the unit circle.

constitutes a form of labor market transition between or rather from unemployment back into formal employment.

In other words one might also conclude that an unemployed worker dislocated by the shock from the formal economy, while being unemployed finds, via employment in the shadow economy a way of updating its skills and competencies and thus facilitates his or her own return into formal employment. This also can serve as to validate a rather less punitive approach towards undeclared work, more into the line of the "*emersione*" (surfacing) techniques adopted in Italy.

Severe recessions typically produce strong labor market recoveries. If growth continues, it may soon lead to more hiring. The second quarter of 2010 brought an end to a run of five consecutive quarters of extraordinary productivity growth as firms generated more output with fewer workers. That strategy may now be running out of road. Between April and June businesses sharply increased the number of hours worked by employees, which is often a prelude to hiring new workers[2].

4. CONCLUSİONS

In this paper, a structural VAR methodology with long-run restrictions was applied to analyze to relationship between shadow economy and unemployment rate for the case of United States.

The size of the shadow economy estimated using the MIMIC model is decreasing over the last two decades, from thirteen to seventeen percent between 1982 and 1985 up to 7 % of official GDP at the end of 2011.

The impulse response function generated by the Structural VAR confirms that in the short-run, a rise in the unemployment rate in formal sector will lead to an increase in the number of people who work in the shadow economy.

REFERENCES

1. Alexandru, A., Dobre, I. and Ghinararu, C. **Revisiting the relationship between Unemployment rate and the size of the shadow economy for United States using Johansen Approach for Cointegration**, Proceedings of the 11th WSEAS International Conference on Mathematics and Computers in Business and Economics, Iasi, Romania, june 13-15, 2010 pg.199-204, ISBN 1790-2769.

2. Bertola, G. and Garibaldi, P., **The Structure and History of Italian Unemployment**, *CESifo Working Papers*, n.907, 2003.

3. Blanchard, O. and Quah, D. **The Dynamic Effects of Aggregate Demand and Supply Disturbances**, American Economic Review, 79: 655-673, 1989.

4. Boeri, T. and Garibaldi, P. **Shadow Activity and Unemployment in a Depressed Labor Market**, *CEPR Discussion papers,* n.3433, 2002.

[2] The Economist, American unemployment, august 14th 2010, pg.56

5. Dell'Anno, R. **Estimating the shadow economy in Italy: A structural equation approach**, Working Paper 2003, Department of Economics, University of Aarhus.

6. Dell'Anno, R., Gomez, M. and Alañón Pardo, M.A. **Shadow economy in three different Mediterranean countries: France, Spain and Greece. A MIMIC approach**, Empirical Economics 33/2005, pp. 51-84, 2005.

7. Dell'Anno, R. and Schneider, F. **The Shadow Economy of Italy and other OECD Countries: What do we know?,** Mimeo, 2004.

8. Dell'Anno, R. and Solomon, O. **Shadow economy and unemployment rate in USA. Is there a structural relationship?**, Annual Meeting of the European Public Choice Society, Finland, April 20-23, 2006.

9. Dobre, I. and Alexandru, A. **A nonparametric analysis of the relationship between unemployment rate and shadow economy using local polynomial regression models**, Economic Computation and Economic Cybernetics Studies and Research, vol.44, no.1/2010, pg.21-44, ISSN 0424 – 267 X.

10. Evans, G.W.**Output and Unemployment Dynamics in the United States: 1950 – 1985**, Journal of Applied Econometrics, 4/213-238, 1989.

11. Enders, W. and Hurn, S. **Identifying aggregate demand and supply shocks in a small open economy**, Oxford Economic Papers, No. 59, 2007, pp. 411-429.

12. Enste, D.H. **Shadow Economy and Institutional Change in Transition Countries in Boyan Belev (eds.), The Informal Economy in the EU Assessment Countries: Size, Scope, Trends and Challenges of the Process of EU-enlargement**, Center for Study of Democracy, 2003, Sofia, 81-114.

13. Giles, David E.A. and Tedds, L.M. **Taxes and the Canadian Underground Economy**. Canadian Tax paper n.106. Canadian Tax Foundation. Toronto, 2002.

14. Giles David E.A. **Measuring the hidden economy: Implications for econometric modelling**, The Economic Journal, 109/456, pp.370-380, 1999.

15. Gottshalk, J., Willem, V.Z. **Do Bivariate SVAR Models with Long-Run Identifying Restrictions Yield Reliable Results? The Case of Germany**, Kiel Working Paper No. 1068, 2001.

16. Johnson, S., Kaufmann, D. and Zoido-Lobatón, P. **Regulatory discretion and the unofficial Economy**, The American Economic Review, 88/ 2, pp. 387-392, 1998a.

17. Johnson, S., Kaufmann, D. and Zoido-Lobatón, P. **Corruption, public finances and the unofficial economy**, American Economic Review, vol. 88, no. 2, pp. 387-392, 1998b.

18. McCoy, D. **How useful is Structural VAR Analysis for Irish economics?**, Eleventh Annual Conference of the Irish Economic Association in Athlone, April 4-6th, 1997.

19. Schneider, F. **Shadow economies around the world: What do we really know**, European Journal of Political Economy 21, 598-642, 2005.

20. Schneider, F. and Enste, D.H. **Shadow economies: size, causes and consequences**, Journal of Economic Literature 38, 77-114, 2000.

21. Schneider, F. **Shadow Economies and Corruption all over the world: New estimates for 145 Countries,** Economics 2007/9, 1-47, 2007.

22. The Economist, American unemployment, august 14th 2010, pg.56.

*** www.bea.gov , U.S. Economic Accounts

*** www.bls.gov , U.S. Department of Labour Statistics

*** Eviews 6.0 software

*** Lisrel 8.8 package