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SHADOW ECONOMY AND TAX EVASION: A PANEL VAR APPROACH. THE CASE OF E.U. 27

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Abstract
The paper investigates the biunivoque relationship between shadow economy (s) and tax evasion (t), considering a panel data-series, from 1997 to 2005, in the case of European Union 27 (E.U.27) countries. The empirical results show that:
(1) A positive 1% impulse in s determines a strong descendent reaction of t on short term (first 2-3 years), becoming "aggressive descendent" on the medium and long term, and
(2) A positive 1% impulse in t determines a very low ascendant reaction of s's level on medium and long term.
The main finding reveals that the relationship between shadow economy and tax evasion has different amplitude and signs.

Keywords: Shadow economy, Tax evasion, Effects, Panel VAR

JEL classification: O17, H26, C23

1. Introduction and literature framework

The shadow economy and tax evasion represent two main important realities of contemporaneous economic systems. Smith (1994) defines shadow economy as "portion of the total economy that is unobserved due to the efforts of some businesses and households to keep their activities undetected", while Feige (2004) argues that shadow economy represents the totality of unregistered economic activities, contributing on the official estimation of GDP.

Table 1 - The classification of shadow economic activities

Type of activity	Monetary transactions		Non-monetary transactions	
Illegal Activities	Trade in stolen goods; drug dealing and manufacturing; prostitution; gambling; smuggling, fraud etc.		Barter: drugs, stolen goods, smuggling etc. Produce or growing drugs for own use. Theft for own use.	
	Tax Evasion	Tax Avoidance	Tax Evasion	Tax Avoidance
Legal Activities	Unreported income from self-employment; Wages, salaries and assets from unreported work related to legal services and goods	Employee discounts, fringe benefits	Barter of legal services and goods	All do-ityourself work and neighbour help

Source: from Lippert and Walker (1997), modified by Schneider (2005).

As Cebula and Feige (2011) note, tax evasion describes the process that "effectively defrauds the government of legally due tax revenues, thereby reducing the government's ability to provide public services, while increasing the nation's debt burden".
Based on the elements presented above, we see that the shadow economy includes the tax evasion, but this last phenomenon is assimilated with legal economic activity also. The literature in the field regarding the relationship between shadow economy and tax evasion is relatively poor. There are some authors that have focused on this connection: Corchón (1992), Torgler and Schneider (2009), Dell' Anno (2009), Blackburn et all. (2010), and Busato et all. (2011).

Corchón (1992) performed a partial equilibrium model of tax evasion. In his approach the tax evasion is modelled as a discrete variable. i.e. whether to join the underground economy or not. Torgler and Schneider (2009) used a multivariate analysis in order to examine the effects of tax morale and institutional quality on shadow economy. Their main conclusion reveals that higher tax morale and higher institutional quality generate a smaller shadow economy. As high tax morale is assimilated with low tax evasion, the low level of tax evasion determines a low level of shadow economy. In the same year, Dell' Anno (2009) found that tax evasion can be explained by tax morale, concept connected with taxpayers' intrinsic attitude to honesty and social stigma. Moreover, the author concluded that there is a high correlation between tax evasion and shadow economy. Blackburn et all. (2010) focused on the relationship between the underground economy and financial development in a model of tax evasion and bank intermediation. The empirical results illustrate that high level of tax evasion is correlated with high shadow economy thought the stage of development.
In a recent investigation, Busato et all. (2011) introduces underground activities and tax evasion into a one-sector dynamic general equilibrium model, using aggregate external effects. The main finding stresses that the underground economic area, and the associated tax evasion, sustains a regressive tax rate system.

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Our paper investigates the biunivoque relationship between shadow economy and tax evasion, considering a panel data-series, from 1997 to 2005, in the case of European Union 27 (E.U.27) countries. As some series are not officially available, Cyprus, Bulgaria, Lithuania, Latvia, Luxembourg, and Malta were eliminated. Two variables are considered for our analysis: Tax Evasion and Shadow Economy Index.
Based on the literature review, there is a strong connection between shadow economy and tax evasion, with different sign and different direction.

The rest of the paper is organized as follows: Section 2 contains the data and methodology. Section 3 presents the empirical results. Section 4 concludes.

2. Data and methodology

In order to investigate the biunivoque relationship between shadow economy and tax evasion, we consider a panel data-series, from 1997 to 2005, in the case of European Union 27 (E.U.27) countries. As some series are not officially available, Cyprus, Bulgaria, Lithuania, Latvia, Luxembourg, and Malta were eliminated. Two variables are considered in this investigation:
(a) Shadow Economy Index (*s*): represents the level of shadow economy as percent in GDP, where 0% is the minimum level, and 100% the maximum one. The data is taken from Schneider (2007).
(b) Tax evasion (*t*): measures the tax evasion as percent in GDP, where 0% is the minimum level, and 100% the maximum one. The data is taken from International Monetary Fund (IMF), World Competitiveness Online 1995-2010 Edition.
Based on considered working hypotheses, we study the connection between *s* and *t* using an unrestricted Vector Autoregression Model (VAR). As Cromwell et al. (1994) note, this type of model is commonly used for forecasting systems of interrelated time series and for analyzing the dynamic impact of random disturbances on the system of variables.
The model, which has two equations, with *i* cross-sections, *k* lag values, and *n* period, can be written:

$$s_{in} = \alpha_1 + \sum_{i=1}^{m}\sum_{j=1}^{k}\beta_{ij}s_{in-j} + \sum_{i=1}^{m}\sum_{j=1}^{k}\chi_{ij}t_{in-j} + u_{1_{in}} \quad (1)$$

$$t_{in} = \alpha_2 + \sum_{i=1}^{m}\sum_{j=1}^{k}\phi_{ij}s_{in-j} + \sum_{i=1}^{m}\sum_{j=1}^{k}\eta_{ij}t_{in-j} + u_{2_{in}} \quad (2)$$

or in matrix form:

$$\begin{bmatrix} s_{in} \\ t_{in} \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \begin{bmatrix} \beta_1\chi_1 \\ \phi_1\eta_1 \end{bmatrix}\begin{bmatrix} s_{in-1} \\ t_{in-1} \end{bmatrix} + \ldots + \begin{bmatrix} \beta_{ik}\chi_{ik} \\ \phi_{ik}\eta_{ik} \end{bmatrix}\begin{bmatrix} s_{in-k} \\ t_{in-k} \end{bmatrix} + \begin{bmatrix} u_{1in} \\ u_{2in} \end{bmatrix} \quad (3)$$

where α_1, α_2 are the intercept terms; β, χ, ϕ, η are the coefficients of the endogen variables, and the *u* is the stochastic error terms.

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The econometrical analysis has four steps: (a) unit root tests of variables; (b) joint lag selection and VAR; (c) stability test, and finally (d) residuals and Heteroskedasticity tests.
(a) Unit root tests of panel variables are based on Levin, Lin & Chu t; Breitung t-stat Im; Pesaran and Shin W-stat; ADF - Fisher Chi-square; PP - Fisher Chi-square; and Hadri Z-stat tests (Table 2).

Table 2 - Unit root tests of variables - level and 1st difference

Variable	Assumption	Tests	Level	1st difference
s	Individual intercept	Levin, Lin & Chu t	-19.661***	4.9868***
		Breitung t-stat Im	0.7506	0.9941
		Pesaran and Shin W-stat	-3.5549***	-1.91285**
		ADF - Fisher Chi-square	86.0943***	61.5517**
		PP - Fisher Chi-square	27.6034	60.3191**
		Hadri Z-stat tests	6.1932***	3.3017***
	Individual trend and intercept	Levin, Lin & Chu t	-20.9891***	-4.2597
		Breitung t-stat Im	-0.4955	-0.1683
		Pesaran and Shin W-stat	-0.41341	0.2507
		ADF - Fisher Chi-square	53.0803	42.7094
		PP - Fisher Chi-square	19.8396	106.280***
		Hadri Z-stat tests	13.3014***	42.8325***
t	Individual intercept	Levin, Lin & Chu t	-4.6161***	-6.5139***
		Breitung t-stat Im	-0.3924	-1.9482**
		Pesaran and Shin W-stat	-0.3732***	-2.1753**
		ADF - Fisher Chi-square	50.9782**	62.2357***
		PP - Fisher Chi-square	62.1543*	127.873***
		Hadri Z-stat tests	6.5074***	3.22801***
	Individual trend and intercept	Levin, Lin & Chu t	-5.4493***	-4.2895***
		Breitung t-stat Im	-1.1722	-0.9448
		Pesaran and Shin W-stat	0.2821	-0.14932
		ADF - Fisher Chi-square	40.4173	38.2166
		PP - Fisher Chi-square	74.9217***	111.847***
		Hadri Z-stat tests	15.6401***	20.3222***

Note: ***, **, and * reflect significance at 1, 5 and 10 % level of significance, respectively.

Table 1 shows that *s* is I(0) and *t* is I(1). Assuming a "constant term", this conclusion is enforced by Vogelvang (2005), who emphasis that an additional trend term is generally superfluous. As one of variables is I(0) and another I(1), we worked in level, according Harvey (1990), even if in the VAR methodologies all the variables should be stationary.
(b) Joint lag selection and VAR illustrate the joint lags selection criteria, and the VAR performing. For selection of the joint lag we have used Lag Exclusion Wald Test (Table 3), and VAR Lag Order Selection Criteria (Table 4).

Table 3 - Lag Exclusion Wald Test

Lag	*s*	*t*	Joint
Lag 1	*98.07380*	*20.79160*	*119.3588*
	[0.000000]	*[3.06e-05]*	*[0.000000]*
Lag 2	12.70020	0.295575	13.24611
	[0.001747]	[0.862614]	[0.010134]
Lag 3	23.05822	0.252789	23.18167
	[9.84e-06]	[0.881267]	[0.000116]
Lag 4	5.517844	2.347045	7.659003
	[0.063360]	[0.309276]	[0.104899]
Lag 5	1.223133	0.091816	1.323693
	[0.542500]	[0.955130]	[0.857343]
df	2	2	4

Table 4 - VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-311.8634	NA	26.89059	8.967527	9.031769	8.993045
1	-99.94491	405.6726	0.070747	3.026997	*3.219726**	*3.103551**
2	-97.82509	3.936807	0.074679	3.080717	3.401931	3.208307
3	-88.90692	16.05271	0.064945	2.940198	3.389897	3.118824
4	-82.85835	10.54180*	0.061346*	2.881667*	3.459852	3.111329
5	-82.08070	1.310901	0.067423	2.973734	3.680404	3.254432

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

The results in Table 3 show that we cannot reject the joint Hypothesis that the coefficient of the lags 2, 3, 4, and 5 are all equal to zero. More, two criteria of VAR Lag Order Selection (SC and HQ) recommend joint lag 1 (Table 4). In conclusion, we keep for our VAR estimation the lag 1. Table 5 illustrates the VAR estimation.

Table 5 - "Unrestricted Vector Autoregression *s - t*" estimates

Variables	*s*	*t*
s(-1)	0.981808	-0.020117
	(0.01988)	(0.01013)
	[49.3919]	[-1.98529]
t(-1)	0.066470	0.771594
	(0.09100)	(0.04639)
	[0.73045]	[16.6338]
Constant	-0.063679	1.424958
	(0.71934)	(0.36668)
	[-0.08853]	[3.88608]
R-squared	0.960197	0.762227
Adj. R-squared	0.959663	0.759035
Sum sq. resids	260.0504	67.57342
S.E. equation	1.321100	0.673434
F-statistic	1797.213	238.8238
Log likelihood	-256.4903	-154.0681
Akaike AIC	3.414346	2.066685
Schwarz SC	3.474028	2.126367
Mean dependent	19.98816	4.420658
S.D. dependent	6.577817	1.371886
Determinant resid covariance (dof adj.)		0.658145
Determinant resid covariance		0.632422
Log likelihood		-396.5343
Akaike information criterion		5.296504
Schwarz criterion		5.415868

Note: Standard errors in ( ) & t-statistics in [ ]

(c) The VAR stability condition check test, illustrate in Table 6, reveals that the VAR satisfies the stability condition.

Table 6 - VAR stability condition check test

Root	Modulus
0.975242	0.975242
0.778160	0.778160
No root lies outside the unit circle. VAR satisfies the stability condition.	

(d) Residuals tests are focused on VAR Residual Portmanteau Tests for Autocorrelations (Table 7) and White Test for Residual Heteroskedasticity (Table 8).

Table 7 - VAR Residual Portmanteau Tests for Autocorrelations

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df**
1	25.87672	NA*	26.04809	NA*	NA*
2	26.87235	0.0000	27.05699	0.0000	4
3	27.51651	0.0006	27.71412	0.0005	8
4	28.73396	0.0043	28.96448	0.0040	12
5	30.48178	0.0157	30.77175	0.0144	16

* The test is valid only for lags larger than the VAR lag order.
** df is degrees of freedom for (approximate) chi-square distribution.

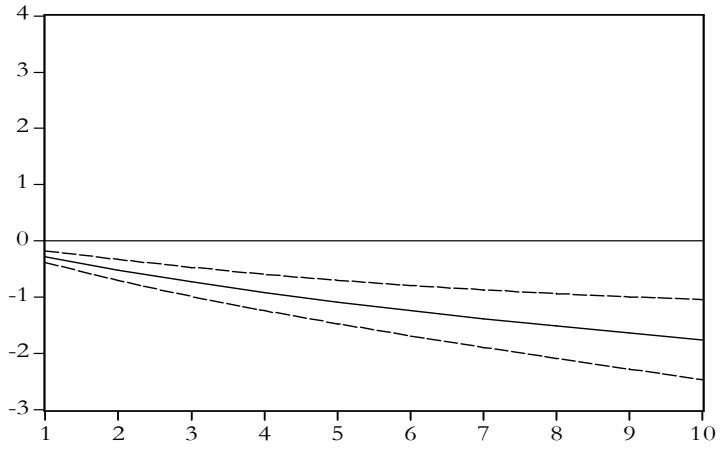
Table 8 - VAR Residual Heteroskedasticity Tests

Joint test:		
Chi-sq	df	Prob.
17.82319	12	0.1212

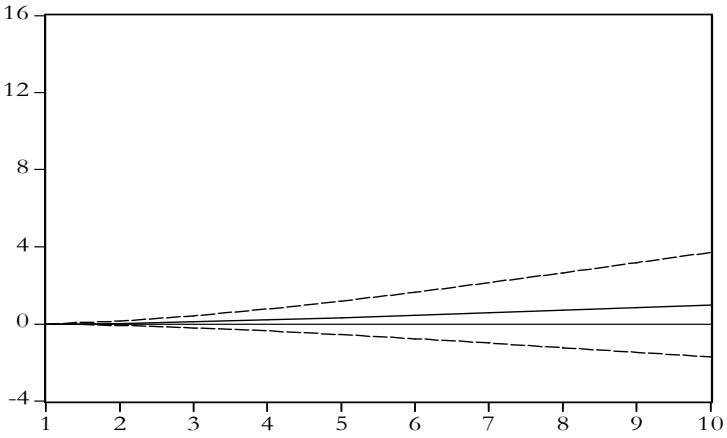
If the results in Table 7 show some autocorrelation problems in residuals for inferior legs, the main results in Table 8 illustrate that the variance of the disturbance term is constant (the null cannot be rejected).
All performed tests emphasise that the "Unrestricted Vector Autoregression *s* - *t*" model may be considered representative and stable to describe, for the case of E.U.27, in the period 1997-2005, the autoregressive biunivoque connection between shadow economy and tax evasion.

3. Results

The model estimates support performing the impulse response functions. An impulse response function describes the effect of a one-time shock to one of the innovations on current and future values of the endogenous variables DT and DG. The accumulated responses of *s* and *t* to Generalized One S.D. Innovations ± 2 S.E., for 10 years, are show in the Graphics 1 and 2. The Graphic 1 illustrates the accumulated response of *t* to *s*, while Graphic 2 reveals the accumulated response of *s* to *t*.



Graphic 1 - Accumulated response of *t* to *s*



Graphic 2 - Accumulated response of *s* to *t*

The graphics allow that:
(1) A positive 1% impulse in *s* determines a strong descendent reaction of *t* on short term (first 2-3 years), which becomes "aggressive descendent" on the medium and long term.
(2) A positive 1% impulse in *t* determines a very low ascendant reaction of *s*'s level on medium and long term. Actually, these two impulse functions performed emphasise that an increase in the level of shadow economy determines an accentuate decrease of tax evasion (the opposite signs), while an increase of tax evasion determines a low decrease of shadow economy (the same signs).

3. Conclusion

As the results of investigations reveals, if an increase of shadow economy is accompanied by a decrease of tax evasion, an increase of tax evasion determinates a low level of shadow economy. In the first stance, the high level of shadow economy diminishes the tax evasion, as a result of superior decrease of tax evasion assimilated to legal activity (unreported legal revenues, unreported legal consumption, or barter of legal goods and services). In this case, the shadow economy is accompanied by a contrary sign of tax evasion in legal activity area.

Per a contrario, an increase in the level of tax evasion determines a low reaction of shadow economy, having the same sign. In this situation the impulse is absorbed by other determinants of shadow economy, such as: trade with stolen goods, prostitution, gambling, smuggling, fraud, barters of drugs etc. More, there is possible that low part of tax evasion impulse to be absorbed by legal activity.

From policy perspective, we note that the relationship between shadow economy and tax evasion has different amplitude and signs. In order to obtain a good control of shadow economy and tax evasion, the public authority must be focused on the same sign direction of variables (the second stance in our case), even if the amplitude of this connection is very low. We can see that the tax control actions should be oriented on tax evasion, and must have strong combative measures. If the tax evasion is better monitored, the shadow economy minimises its level automatically.

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