

***Shadow Economy And Unemployment Rate In U.S.A. Is There A Structural Relationship? An Empirical Analysis.***

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**ABSTRACT**

*This paper aims to estimate the size of the U.S. shadow economy (SE) using a Structural Equation Approach and to evaluate if a structural relationship exists between the SE and the unemployment rate (UR) in the United States. The size of the SE is estimated to be decreasing over the last two decades. We extend the Okun's law to estimate the structural relationship between growth rate of official GDP, SE and UR. Our results indicate a significant positive relationship between the SE and the UR. Furthermore, we corroborate the existence of a structural relationship by estimating a Structural VAR.*

*Keywords:* Shadow Economy, MIMIC model, Okun's Law.

*JEL code:* E26, O17.

## **1. Introduction**

This paper aims to estimate the size of the U.S. shadow economy and to evaluate if a structural relationship exists between the shadow economy and the unemployment rate in the United States. The structural relationship between the two variables is demonstrated by re-examining the Okun's law. The results obtained are buttressed by the use of a Structural VAR which shows the response of the shadow economy to an aggregate supply shock.

The shadow economy can be defined as that part of the economy that operates outside the purview of Government regulation. According to the literature<sup>1</sup>, the reasons for the emergence of the shadow economy has primarily been due to tax burden, excessive government regulation and the role of public services which provide incentives to operate in the shadow economy. We describe the role of these factors on the size of the shadow economy.

In many empirical and theoretical studies, it has been found that the tax burden is one of the biggest causes of the shadow economy. Higher taxes affect the labour-leisure choice in favour of an increase in the supply of labour in the shadow economy. This is because a higher tax increases the difference between the cost of labour and the after-tax returns from working. Therefore, the larger the difference the greater the incentive to work in the shadow economy.

Secondly, an increase in government regulations such as through labour market regulations can lead to a huge increase in the cost of labour in the shadow economy. These costs can be shifted to the employees providing an additional incentive to work in the shadow economy. This observation has been supported by various empirical studies such as Johnson *et al.* (1997). A one-point rise in the regulation index causes an 8.1 percent increase in the shadow economy.

A third reason is the role of the shadow economy in reducing public revenues. This reduces the quality and quantity of public and private services provided by the Government. A reduction in public revenue can also lead to an increase in the tax rate in the official economy which is almost always associated with a decrease in the quality of public goods. This relationship is presented in a simple model by Johnson *et al.* (1998a,b) in which countries with higher tax revenues were associated with fewer regulations and less corruption. As a result, they had smaller shadow economies. A reduction in public revenue also reduces public investment in infrastructure that can stimulate investment and growth.

A growing shadow economy has an impact on the formal sector through its effect on the product, money and labour markets.

In the product market, a growing shadow economy encourages the flow of inputs out of the formal sector which can depress productivity in the formal sector. Secondly, most transactions in the shadow economy are carried out in cash. This raises the demand for currency. Finally, an increase in the

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<sup>1</sup> For a detailed overview of the size of the shadow economy around the world see Schneider (2005).

unemployment rate reduces the proportion of workers employed in the formal sector. Consequently this leads to higher labour participation rates in the informal sector.

This paper is divided into seven sections. Section 2 provides an overview of related literature on the definition of the shadow economy and the link between the shadow economy and unemployment. Section 3 describes how the shadow economy is estimated using the Multiple Indicators Multiple Causes Model (MIMIC). Section 3.A describes the data used in the estimation. The results of the estimated coefficients of the MIMIC model are then discussed in Section 3.B. This is followed by a description of how a time series of the U.S. shadow economy is obtained in sub-section 3.B.1. Section 4, motivates the presence of a structural relationship between the shadow economy and unemployment by estimating an unrestricted VAR. In Section 5, we re-examine the Okun's law by introducing the shadow economy into the relationship between unemployment rate and growth rate of output. The results of our OLS regressions suggest the presence of a structural relationship between the growth of the shadow economy and the unemployment rate in the U.S. In Section 6, the structural relationship is further tested by imposing long-run restrictions in a Structural VAR model to analyse the impact of the shadow economy to a temporary shock in unemployment. The impulse response function generated by the Structural VAR buttresses the results of the OLS regressions carried out in Section 6. Section 7 is the conclusion.

## ***2. An overview on the shadow economy definition and its relationship to unemployment***

In this section, we provide an overview on the shadow economy as well as discuss how the shadow economy leads to unemployment through lower labour participation rates.

### ***2.A What Shadow Economy Measures?***

The shadow economy has been characterized with confusion with regard to its meaning. Each definition draws out a different set of attributes that describe it. The shadow economy is also referred to as underground, informal, hidden, parallel, clandestine, second, irregular or household economy. The confusion appears to originate from the work of different fields (economics, sociology, statistics, law etc.) who define the shadow economy based on the "criteria" that lead to its development. Hence, there is no precise definition. Gërzhani (1999) provides a variety of definitions for the shadow economy based on political, economic and sociological classifications. In this paper we focus on the economic definition of the shadow economy, it can be divided into two categories. These are "labour-oriented" and "size-oriented" definitions.

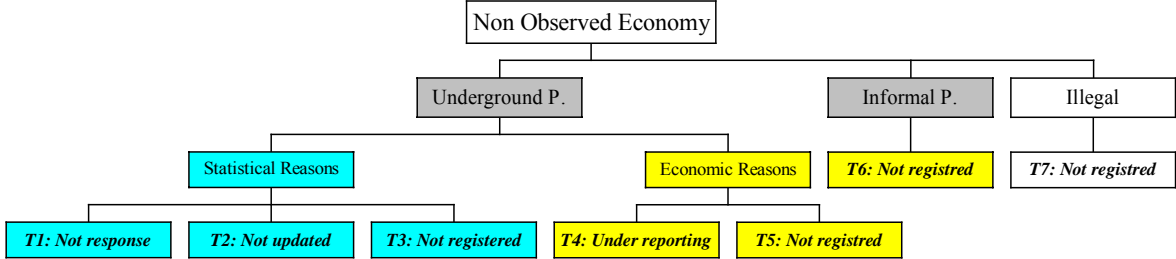
The "labour-oriented" definitions focus on the impact of the shadow economy on the labour market. The shadow economy is defined as the sum total of all income-earning activities excluding contract and legal employment. The labour force that emerges within this economy arises from tax and/or social security evasion.

The "size-oriented" considers the relationship between state regulation and the operation of a business. Swaminathan (1991) defines the shadow economy as "establishments which are unregistered and unlicensed". It also considers the distortions that the shadow economy causes to national accounts. Feige (1981) defines the shadow economy as "all economic activities, which because of accounting conventions, non-reporting or under-reporting, escape social measurement apparatus, most notable the GNP accounts".

It is because of this myriad of definitions that the System of National Accounts (SNA) introduced an aggregate called the "Non-Observed Economy" or NOE. As a result, the Italian National Statistical Institute (ISTAT) classified the NOE as shown in the flowchart in figure 1.

The NOE comprises all product activities that can be classified into the following three areas OECD (2002): Underground production (T1, T2, T3, T4, T5); Informal production (T6); Illegal production (T7).

**Figure 1: ISTAT Framework of Non-Observed Economy**



Underground production represents the area of production activities that are not directly observed can be broadly sub-divided into two. The underground economy can be broadly sub-divided into two: (a) Economic (T4, T5). These are activities carried out outside government regulations such as avoiding tax, minimum wages, number of work hours, working conditions for labourers. (b) Statistical (T1, T2, T3). These are production activities not registered due to failure to fill statistical questionnaires. Their activities go undetected using traditional survey methods due to the small nature of the enterprise.

Informal production (T6) refers to productive institutional units characterised by: (a) A low level of organisation; (b) Little or no division between work and capital; (c) Work relations based on occasional jobs, kinship, or personal relations. (This context comprises the activity of craftsmen, peddlers without licences, farm workers, home workers, and unregistered activities of small merchants).

Illegal production (T7) includes the activities oriented at the production of goods and services whose sale, distribution or possession is prohibited by law. Included in this area are also productive

activities carried out by unauthorised operators<sup>2</sup>. Due to the difficulty in estimation, that could be limited by international comparability, the illegal activities are often excluded by the national accounts.

In this research, we consider the shadow economy as the part of NOE caused by economic reasons (T4, T5, T6).

## **2.A Overview of the relationship between the Shadow Economy and Unemployment**

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. Schneider and Enste (2000) explain that the individual decision to work in the shadow economy is the reaction to being overburdened by tax and state regulations and so they choose the "exit option" rather than the "voice option"<sup>3</sup>.

For instance it is well known that in the OECD countries, unemployment is caused largely by high labour costs. 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.

In an effort to reduce the unemployment rate, France and Germany reduced working hours because of the limited amount of work "and that this quantity has to be redistributed". But Enste (2003) points out that this idea "neglects" the fact that reducing the number of hours of work below worker's preferences raises the quantity of hours worked in the shadow economy. This increases the growth of the shadow economy. Early retirement also increases the quantity of hours worked in the shadow economy.

De Gijbel (1984) and Riebel (1983, 1984) explain that part-time work offers an excellent opportunity to work in an untaxed and unregulated economy. Lemieux *et al.* (1994) using micro data from a survey conducted in Quebec city (Canada) provide extensive research on the supply of labour in the underground economy. Their key results show that "participation rates and hours worked in the underground sector also tend to be inversely related to the number of hours worked in the regular sector". Empirically, there is a huge negative elasticity of substitution between the hours worked in the shadow economy and the wage rate in the regular sector. They also show that there is a high mobility between the sectors.

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<sup>2</sup> The 1993 SNA states explicitly that illegal activities should be included in the SNA, noting that "despite the obvious practical difficulties in obtaining data on illegal production, it is included within the production boundary of the System" (1993, SNA 6.30), and that: "All illegal actions that fit the characteristics of transactions – notably the characteristic that there is mutual agreement between the parties – are treated the same way as legal actions" (1993, SNA 3.54). The 1993 SNA suggests that illegal actions for which there is no mutual agreement can be construed as an extreme form of externality for which, in general, no values are imputed in the national accounts. So it is absence of consent rather than illegality that is actually the criterion for exclusion from the production boundary. OECD (2002, p.38).

<sup>3</sup> Individual choose to exit the formal sector to work or operate business in the shadow economy rather than choose to vote against the government in an election.

In Schneider and Enste (2000, p.108) are reported the size of the labour force in the official and shadow economies in some OECD countries. In France the size of the shadow labour force increased from between 3%-6% in 1975-1982 to between 6%-12% in 1997-1998. This was followed by an increase in the size of the shadow economy from 6.9% to 14.9% within the same period. In Germany, between 1974-1982 the shadow labour force was around 8% -12%. However this increased to around 19%-23% between 1997-1998. The increase may provide a reason for persistent unemployment in Germany as the shadow economy also increased from 10.6% to 14.7%. In Spain the size of the shadow labour force increased from between 9.6%-26.5% in 1979-1980 to between 11.5%-32.3% in 1997-1998. This was followed by an increase in the size of the shadow economy from 19% to 23.1% within the same years<sup>4</sup>. Also in Italy, there is an increase in the size of the shadow labour force from between 20%-35% to 30%-48% as the shadow economy also rises from 16.7% to 27.3% within the same time period<sup>5</sup>.

In Italy, Bertola and Garibaldi (2003) present the case that an increase in payroll taxation can have effect on the supply of labour and the size of the shadow economy. An increase in tax and social security burdens not only reduces official employment but tends to increase the shadow labour force. This is because an increase in payroll tax can influence the decision to participate in official employment (Garibaldi and Wasmer, 2001). Also, Boeri and Garibaldi (2002) show between 1995-1999 a strong positive correlation between average unemployment rate and average shadow employment across 20 Italian regions.

### 3. *Modelling the Shadow Economy*

In this section, we show how the shadow economy is modelled. We model the U.S. shadow economy using the MIMIC model developed by Jöreskog and Goldberger (1975). Using the standard LISREL notation of Jöreskog and Sörbom (1993), equation 1 is a measurement equation where  $\eta_t$  (unobserved or latent) variable determines  $y' = (y_1, y_2, \dots, y_d)'$  column vector of indicators subject to a random error term  $\varepsilon_t$ .  $\eta_t$  is an unobserved or latent and is a scalar.  $\lambda$  is a  $(d \times 1)$  column vector of parameters that relates  $y_t$  to  $\eta_t$ .

$$y_t = \lambda \eta_t + \varepsilon_t. \quad (1)$$

Equation 2 is a structural equation which shows that the unobserved variable  $\eta_t$  is determined by  $x_t$  set of exogenous causes  $(x_1, x_2, \dots, x_c)$  and  $\zeta_t$  a structural disturbance error term.  $\gamma$  is a  $(1 \times c)$  vector of structural parameters:

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<sup>4</sup> A detailed analysis of the Spanish shadow economy is presented in Ahn and De La Rica (1997), Alañón and Gómez-Antonio (2005).

<sup>5</sup> For an analysis of Italian shadow economy and its causes, see Dell'Anno and Schneider (2003).

$$\eta_t = \gamma x_t + \zeta_t. \quad (2)$$

Without loss generality, all variables are taken to have zero expectations. From equations 1 and 2 it is assumed that:

- (a) the elements of  $\zeta_t$  and  $\varepsilon_t$  are n.i.i.d and uncorrelated;
- (b) the variance of the structural disturbance term  $\zeta_t$  is  $\Psi$ ;
- (c) the covariance matrix of the measurement errors is a diagonal covariance matrix  $\Theta_\varepsilon$ .

Substituting equation 1 and 2 yields a reduced form solution which expresses a relationship between the observed variables  $x_t$  and  $y_t$ . This is shown in equation 3:

$$y_t = \Pi' x_t + z_t, \quad (3)$$

where:

- $\Pi = \lambda\gamma'$ : is a  $c \times d$  reduced form coefficients matrix and has rank one expressed in terms of  $c$  and  $d$  elements of  $\lambda$  and  $\gamma$ ;
- $z_t = \lambda\zeta_t + \varepsilon_t$ : is a reduced form disturbance vector;
- $z$  has an  $d \times d$  reduced form covariance matrix ( $\omega$ ) given by

$$\omega = \lambda\varphi\lambda' + \Theta_\varepsilon, \quad (4)$$

where:  $\varphi = \text{var}(\lambda)$  and  $\Theta_\varepsilon$  = the reduced-form covariance matrix of the measurement errors.

The reduced form equation matrix has two restrictions. These are that the  $c \times d$  coefficient matrix  $\Pi$  has rank one and that  $\Theta_\varepsilon$  is the sum of a rank one matrix and a diagonal  $d \times d$  matrix. The necessary condition for identification is that the number of structural parameters should be equal to the number of reduced form parameters. From equations 1 and 2, our structural model has  $c$  elements in  $\gamma$ , an element in the variance of  $\zeta_t$ ,  $\frac{c(c+1)}{2}$  elements in the variance of  $x_t$  and  $d$  elements contained in  $\lambda$  and in the variance of  $\varepsilon_t$ . From equation 3 and 4, the reduced form model contains  $cd$  elements in  $\Pi$ ,  $\frac{d(d+1)}{2}$  elements in  $\Theta_\varepsilon$  and  $\frac{c(c+1)}{2}$  elements contained in the variance of  $x_t$ . An observation of the reduced form parameters shows that unique solutions to  $\lambda$  and  $\gamma$  cannot be obtained from the reduced form model. This is because altering the scale of  $\eta$  yields the same reduced form solution. This inability to obtain unique solutions to  $\lambda$  and  $\gamma$  causes an identification problem which can be resolved by fixing the scale of the unobserved variable. This is the sufficient condition for identification which is achieved by setting one of the coefficients in the column matrix  $\lambda$  to a constant. An alternative is to fix the variance of the unobserved variable  $\eta$  to 1 but the former is more convenient for economic interpretation.

### 3.A Data Issues

In this section we discuss the data used for the estimation. The variables used in the estimation are defined in Appendix 1. The data series are quarterly from 1970 to 2004.

The series in levels or differences have been tested for unit roots using the appropriate frequencies. This is shown in Appendix 2. We use the Augmented-Dicky Fuller (ADF) test, Phillips-Perron (PP) test and the Kwiatkowski, Phillips, Schmidt and Shin (KPSS) test. We test I(2) against I(1) and if we reject I(2), we test I(1) against I(0) as appropriate. All the series have been seasonally adjusted. For particular series that exhibit trends, we include time trend along with a constant in testing for the presence of unit roots using the above tests.

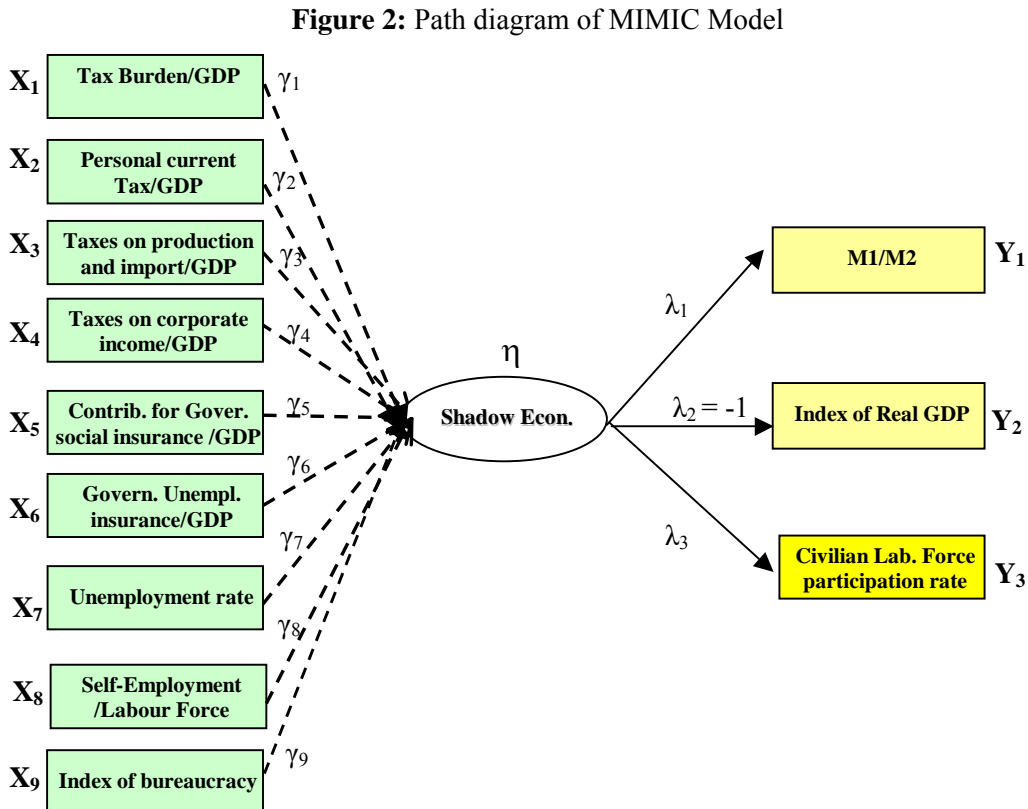
### 3.B Estimating the U.S. Shadow Economy using the MIMIC Model

In this section we describe how the model is estimated using the MIMIC model. We estimate several specifications of the model. We test for identification and then proceed to discuss the sign and significance of the estimated coefficients as well as the Goodness of Fit of our model.

In estimating the size of the shadow economy, the unobserved variable is modelled as a restricted linear function of a set of exogenous factors subject to a random disturbance term  $\zeta_t$  shown in equation 5:

$$\eta_t = \gamma_1 x_{1t} + \gamma_2 x_{2t} + \dots + \gamma_c x_{ct} + \zeta_t. \quad (5)$$

The variables used for estimation are shown in the path diagram in figure 2.



All the data have been filtered to make them stationary. Since all of the variables were found to be I(1) stationary, thus the change in the shadow economy is estimated as a restricted linear function of the changes in each of causal variables.

Several model specifications are considered. These are shown in Table 1. In order to check identification we use MIMIC 4-1-2c as an illustration. The model has 2 indicators and 4 causal factors. The coefficient of the index of real GDP<sup>6</sup> is normalized to -1 to sufficiently identify the model ( $\lambda_2 = -1$ ). This indicates an inverse relationship between the official and shadow (unofficial) economy.

**Table 1:** Estimated Coefficients of the MIMIC Models and descriptive statistics

Models	Tax Burden	Tax person.	Tax produc.	Tax corpor.	Social S. Contr.	Subs. Unempl.	Unempl. Rate	Self Empl.	Index Bureac.	M1/M2	Lab.For. Partic.	Chi-square (p-value) <sup>1</sup>	RMSEA (p-value) <sup>2</sup>	AGFI <sup>3</sup>	Df <sup>4</sup>
MIMIC 5-1-3	0.10 (0.99)	--	--	--	--	1.07 (1.15)	1.17* (6.56)	1.12* (2.19)	-0.26 (-0.27)	-0.01 (0.09)	-0.02 (-0.50)	26.20 (0.024)	0.079+ (0.14)	0.88	14
MIMIC 5-1-2a	0.10 (0.99)	--	--	--	--	1.08 (1.15)	1.17* (6.55)	1.12* (2.19)	-0.26 (-0.28)	--	-0.02 (-0.50)	24.40 (0.004)	0.111+ (0.29)	0.85	9
MIMIC 4-1-2a	0.10 (1.00)	--	--	--	--	1.05 (1.13)	1.17* (6.57)	1.12* (2.22)	--	--	-0.02 (-0.63)	8.40+ (0.135)	0.070+ (0.28)	0.92+	5
MIMIC 4-1-2b	0.09 (0.93)	--	--	--	--	1.04 (1.12)	1.17* (6.57)	1.14* (2.24)	--	-0.01 (-0.05)	--	1.69+ (0.897)	0.000+ (0.94)	0.98+	5
MIMIC 8-1-2a	--	0.12 (1.28)	0.84 (1.42)	-0.71* (-2.28)	0.80* (2.13)	1.20 (1.32)	0.93* (4.78)	1.14* (2.34)	-0.33 (-0.35)	--	-0.02 (-0.47)	25.59 (0.029)	0.077+ (0.16)	0.86	14
MIMIC 8-1-2b	--	0.11 (1.13)	0.67 (1.16)	-0.73* (-2.37)	1.27* (3.44)	1.30 (1.46)	0.87* (4.51)	1.08* (2.24)	-0.06 (-0.06)	-0.27* (-2.37)	--	50.02 (0.000)	0.137 (0.00)	0.73	14
MIMIC 7-1-3	--	0.10 (1.23)	--	-0.60* (-2.28)	2.08* (6.08)	1.43 (1.89)	0.67* (4.00)	0.68 (1.66)	-0.58 (-0.76)	-0.49* (-3.50)	0.05 (1.60)	69.69 (0.000)	0.114 (0.00)	0.54	24
MIMIC 6-1-3	--	0.10 (1.19)	--	-0.58* (-2.27)	2.10* (6.23)	1.37 (1.83)	0.68* (4.11)	0.68 (1.67)	--	-0.50* (-3.53)	0.04 (1.26)	52.87 (0.000)	0.118 (0.00)	0.80	18
MIMIC 6-1-2a	--	0.12 (1.15)	--	-0.75* (-2.46)	0.81* (2.18)	1.29 (1.44)	0.95* (4.92)	1.19* (2.44)	--	--	-0.03 (-0.75)	11.71+ (0.470)	0.000+ (0.74)	0.94+	12
MIMIC 6-1-2b	--	0.08 (0.98)	--	-0.69* (-2.59)	1.98* (5.84)	1.43 (1.85)	0.70* (4.10)	0.84* (2.00)	--	-0.47* (-3.48)	--	39.97 (0.000)	0.130 (0.022)	0.80	12
MIMIC 5-1-2b	--	--	--	-0.76* (-2.48)	0.77* (2.07)	1.18 (1.31)	0.95* (4.89)	1.22* (2.49)	--	--	-0.03 (-0.94)	9.30+ (0.410)	0.016+ (0.66)	0.94+	9
<b>MIMIC 4-1-2c</b>	--	--	--	<b>-0.72* (-2.33)</b>	<b>0.80* (2.13)</b>	--	<b>1.11* (7.40)</b>	<b>1.20* (2.44)</b>	--	--	<b>-0.03 (-0.88)</b>	<b>9.16+ (0.165)</b>	<b>0.062+ (0.34)</b>	<b>0.92+</b>	<b>6</b>
Means of X and Y	27.00%	10.20%	7.61%	2.73%	6.46%	0.44%	6.25%	6.53%	7.95%	26.84%	64.63%				
Var. of X and Y	1.106	0.849	0.253	0.307	0.681	0.041	1.945	0.091	0.178	12.499	5.224				

**Notes:**

t-statistic are given in parentheses. \* Means |t-statistic|>1.96.

<sup>1</sup> If the structural equation model is correct and the population parameters are known, then the matrix S (sample covariance matrix) will equal to  $\Sigma(\theta)$  (model-implied covariance matrix) therefore the perfect fitting correspond to p-value=1.0; This test has a statistical validity if there are large sample and multinormal distributions.

<sup>2</sup> p-value for Test of Close Fit (RMSEA < 0.05). + Means good fitting (p-value > 0.05).

<sup>3</sup> Adjusted goodness-of-fit index, AGFI is a variant of GFI which uses mean squares instead of total sums of squares in the numerator and denominator of 1 - GFI. It varies approximately from 0 to 1. AGFI should also be at least 0.90.

<sup>4</sup> The degrees of freedom are determined by 0.5(d+c)(d+c+1)-t, where “d” is the number of indicators, “c” the number of causes and “t” is the number of free parameters.

The structural model MIMIC 4-1-2c has 21 structural parameters and the reduced form model has 15 reduced form parameters. Thus, the model is over-identified by the number of additional reduced-form parameters (6). The chi-square statistics tests the null that the covariance matrix is restricted by the number of additional parameters.

<sup>6</sup> The index of real GDP is equal to  $(\text{Real GDP}_t)/(\text{Real GDP}_{1990})$ .

In examining Table 1 we observe the sign, and significance of the variables. In terms of the indicators, the  $(M1/M2)$  is negatively significant showing that the higher the size of the informal sector, the lower the demand for broad money relative to narrow money. Table 1 shows an insignificant relationship between the labour force participation rate and the size of the shadow economy. The causal variables, with exclusion of “Ratio of Taxes on production to GDP”, have the anticipated sign being significantly positive with the size of the shadow economy.

### 3.B.1 Obtaining the size of the shadow economy

In this section, we discuss how we obtain a series for the unobserved variable. According with the reference variable ( $Y_2$ , Real GDP<sub>t</sub>/Real GDP<sub>1990</sub>) the unobserved variable is scaled up to a value in 1990, which is our base year. The year selected is 1990 because this is the year in which there are several estimates of the U.S. shadow economy. This assists us to building an average of the estimates. This is shown in table 2.

**Table 2:** Estimates of the size of U.S. shadow economy (1990)

Author	Method	Size of Shadow Economy
Johnson <i>et al.</i> (1998b)	Currency Demand Approach	13.9%
Làcko (1999)	Physical Input (Electricity)	10.5%
Schneider and Enste (2000)	Currency Demand Approach	7.5%*

**Note:** \*(mean over 1989-93)

The index of changes of the shadow economy in the United States as a percentage of GDP in the 1990 is linked to the index of changes of Real GDP as follow:

$$\text{Measurement equation: } \frac{GDP_t - GDP_{t-1}}{GDP_{1990}} = -\frac{\tilde{\eta}_t - \tilde{\eta}_{t-1}}{GDP_{1990}}, \quad (5)$$

The estimates of the structural model are used to obtain an ordinal time series index for latent variable:

$$\text{Structural Equation: } \frac{\tilde{\eta}_t}{GDP_{1990}} = -0.72X_{4t} + 0.80X_{5t} + 1.11X_{7t} + 1.20X_{8t} \quad (6)$$

Finally, the index is scaled to take up to a value of 10.6 percent in 1990 and further transformed from changes respect to the GDP in the 1990 to the shadow economy as ratio of current GDP. These operations are show in the following benchmark equation<sup>7</sup>:

$$\frac{\tilde{\eta}_t}{GDP_{1990}} \frac{\eta_{1990}^*}{\tilde{\eta}_{1990}} \frac{GDP_{1990}}{GDP_t} = \frac{\hat{\eta}_t}{GDP_t} \quad (7)$$

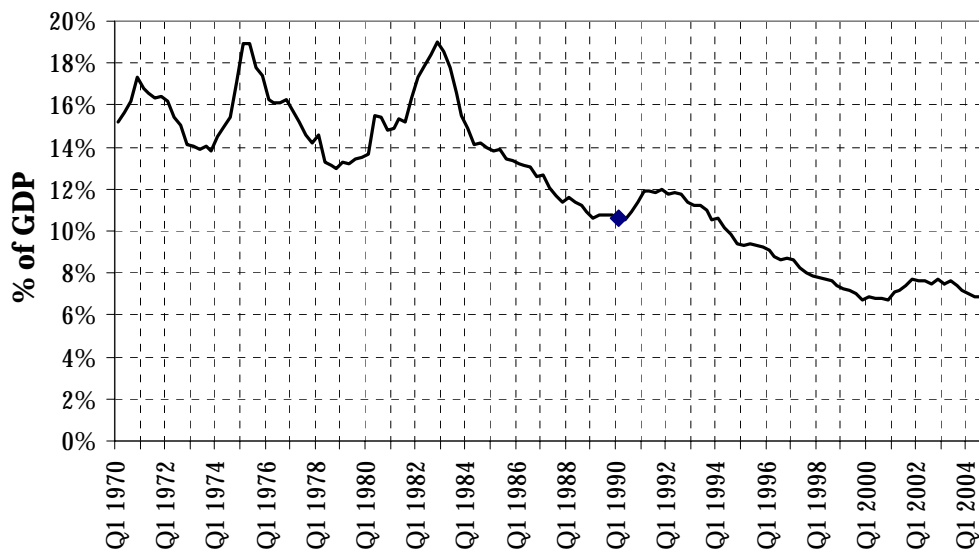
where:

<sup>7</sup> As the variables are all differenced to same degree, to calculate the levels of the latent variable multiplying the structural coefficients for raw (unfiltered) data, it is equivalent to compute the changes in the index by multiplying coefficients for the differenced causes and then to integrate them.

- I.  $(\tilde{\eta}_t / GDP_{1990})$  is the index of shadow economy calculated by eq. 6;
- II.  $(\eta_{1990}^* / GDP_{1990} = 10.6\%)$  is the exogenous estimate of shadow economy;
- III.  $(\tilde{\eta}_{1990} / GDP_{1990})$  is the value of index estimated by eq. 6 in 1990;
- IV.  $(GDP_{1990} / GDP_t)$  is to convert the index of changes respect to base year in shadow economy respect to current GDP;
- V.  $(\hat{\eta}_t / GDP_t)$  is the estimated shadow economy as a percentage of official GDP.

The ratio between II and III is the coefficient of standardization: it satisfies the condition that estimated shadow economy divided to the GDP in 1990 should be equal to 10.6%. Finally, the third addend of LHS converts the index of changes respect to base year into a ratio between shadow economy and current GDP. In figure 3 the plot of eq. (7) is shown.

**Figure 3:** Shadow Economy as percentage of official GDP



#### 4. *Is there a structural link between the Shadow Economy and Unemployment?*

In this section we examine if a structural relationship exists between the U.S. shadow economy and unemployment rate.

**Figure 4: Shadow Economy Vs Unemployment rate**

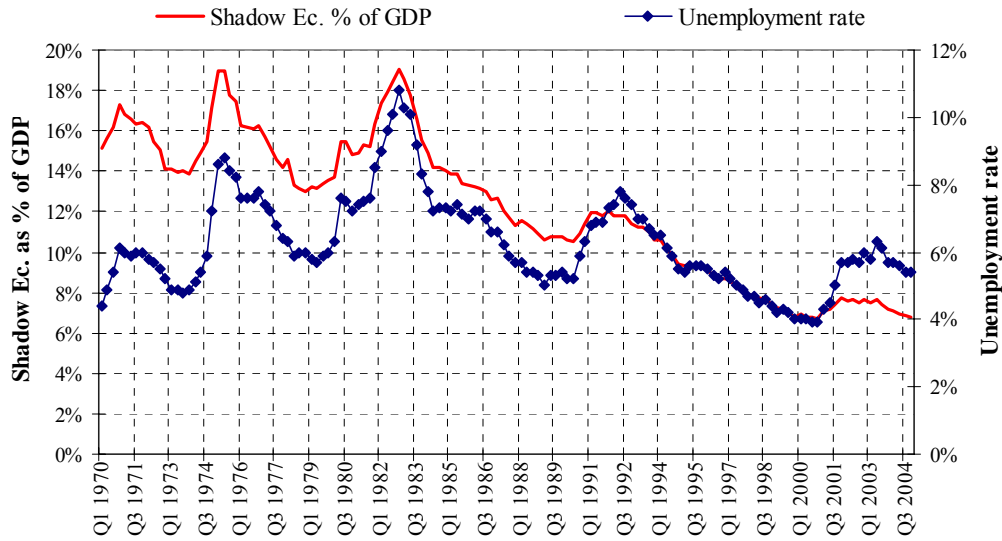


Figure 4 compares the trend of the shadow economy estimated by MIMIC and the unemployment rate (UR) for the U.S. Figure 4 shows a direct relationship between the shadow economy as a percentage of GDP and the unemployment rate. The correlation between the estimated shadow economy and unemployment is found to be 0.71<sup>8</sup>. Thus confirming the presence of a strong positive relationship between the shadow economy and UR in the U.S.

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<sup>9</sup>. This ambiguous relationship is also mentioned by Tanzi (1999) as the class of labourers that compose the "shadow labour force" are extremely heterogenous. These include the officially "unemployed" to retired people, housewife and minors as well as those workers who work both in the official and shadow labour force.

A general way of showing the relationship between the shadow economy and UR is to estimate an unrestricted VAR model. The optimal number of lags were chosen based on the Schwartz Bayesian Criterion. The optimal lag length was found to be 1. UR and shadow economy are found to be non-stationary and so they are both detrended by taking the first differences. For UR and shadow economy, we simply take the first difference. The sample period is a quarterly series of 1970-2004. Figure 5 reports the response of the shadow economy to a shock in the unemployment rate.

<sup>8</sup>  $[\text{Corr}(\eta_t, UR_t) = 0.71]$ .

<sup>9</sup> For an overview on the relationship between shadow economy and official economy see Dell'Anno (2003).

**Figure 5:** Response of the Shadow Economy to a shock in the Unemployment rate

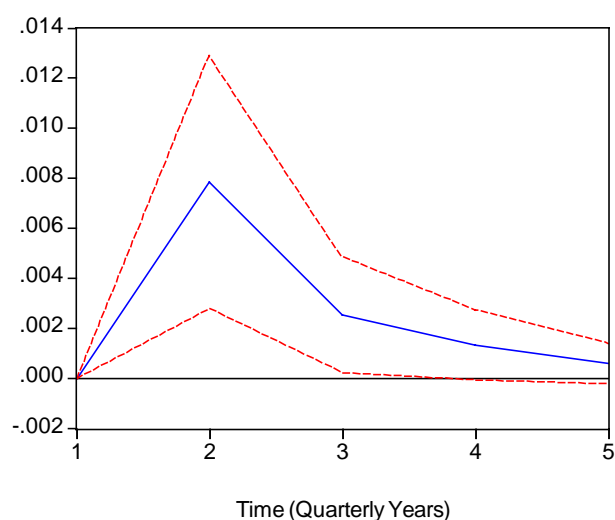


Figure 5 shows that the shadow economy increases by about 8% above the baseline in response to a shock in UR. This is followed by a gradual decline towards the baseline. This occurs at the second quarter following the initial shock. This observation concurs with the theory that, an increase in the unemployment rate in the formal sector, fuels an increase in the number of people who work in the shadow economy. Consequently, there is an expansion in the size of the shadow economy. Thus, our analysis is indicative of the presence of a structural relationship between the shadow economy and UR.

### ***5. A re-examination of Okun's law - The relationship between unemployment and growth of official economy in presence of shadow economy***

The results of the VAR analysis carried out in Section 4 motivate us to re-examine the statistical relationship between unemployment and growth of official economy known as "Okun's law". This will enable us determine if a structural relationship exists between the shadow economy and the unemployment rate. We choose the Okun's law because it's results are one of the most consistent in macroeconomics. As developed by Okun (1962), the "law" relates decreases in the unemployment rate to increases in output growth. Over time and cross-countries, the exact quantitative form of this relationship has changed somewhat. However, the negative correlation between changes in the unemployment rate and changes in GDP growth is viewed as one of the most consistent empirical relationships in macroeconomics<sup>10</sup>. We suggest that the shadow economy has significant effect on this empirical evidence. The economic intuition is derived from the hypothesis that a lower growth rate of official GDP from potential output is associated with higher deviations of the unemployment rate from

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<sup>10</sup> In literature the association between changes in the unemployment rate and output growth can become less reliable for a variety of reasons, however the predominant factor that has tended to undermine specific representations of Okun's law has been changes in productivity. See among others: Dixon and Thomson (2000), Kaufman (1988), Sögner and Stiasny (2002).

its "natural" level. The increase in unemployment leads to an increase in the number of labourers who work in the unofficial labour market. This causes an increase in the growth of the shadow economy. Thus, an increase in the unemployment rate has two antagonist effects:

- direct effect (observed) - it reduces the growth of official GDP.
- indirect effect (partially unobserved)<sup>11</sup> - it increases the growth of the shadow economy via the increase in the unofficial labour market.

The increase in the shadow economy causes a decrease in growth official GDP but by less than the direct impact of unemployment rate.

The presence of shadow economy stabilizes the effect of higher unemployment on the growth rate of output through its ability to absorb the unemployed into the unofficial labour force as workers in the shadow economy.

Our statement is confirmed by the significant statistical relationships among growth rate of official GDP, changes in unemployment rate and growth of shadow economy in the U.S. economy. The statistical correlations between 1970 to 2004 are shown in figure 6.

**Figure 6:** Growth of Official GDP, Changes of Unemployment and Growth of Shadow Economy

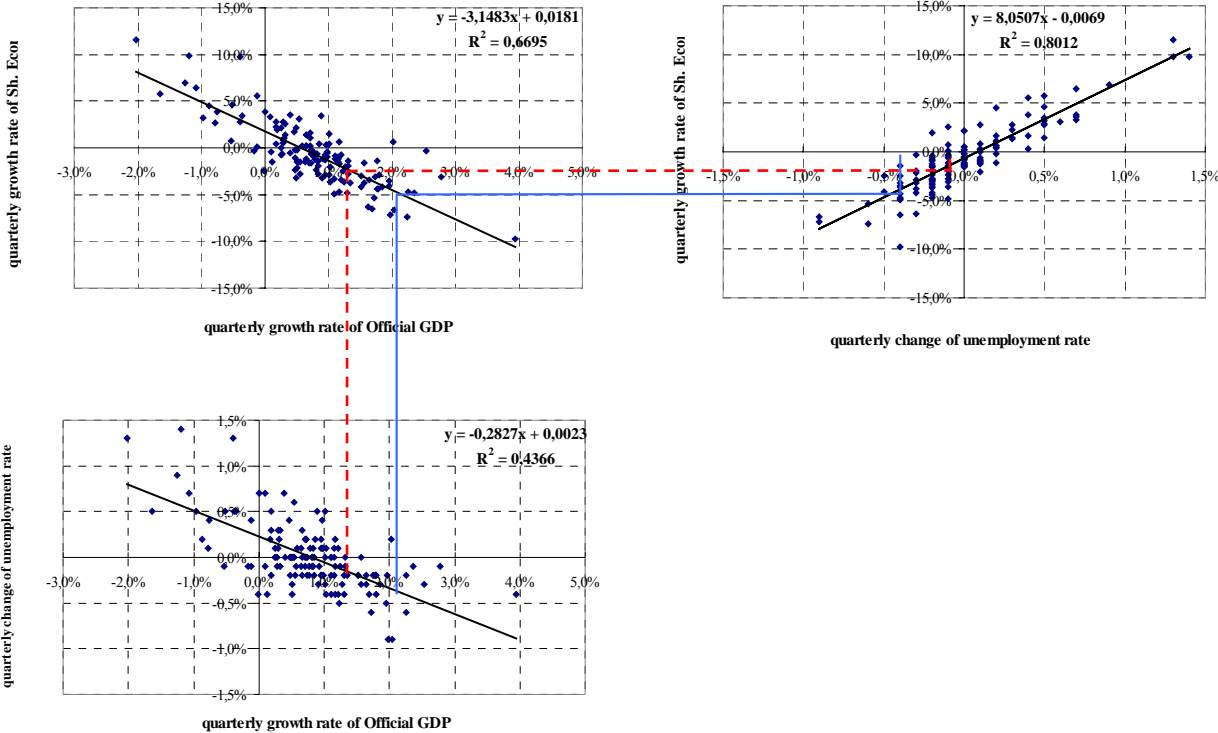


Table 3 shows the estimates obtained based on the standard relation given by Okun’s law:

$$g_t^Y = \alpha_0 \Delta u_t + \varepsilon_t \tag{7}$$

<sup>11</sup> It is only “partially unobserved” because shadow activities create an extra value added that can be spent in the official economy.

Where:  $g_t^Y = (g_t^{off} - \bar{g}_{(70-04)}^Y)$  and  $g_t^\eta = (g_t^{shad} - \bar{g}_{(70-04)}^\eta)$  indicating respectively, the difference of (quarterly) growth rate of the official gross domestic product ( $g_t^{off}$ ) and the shadow economy ( $g_t^{shad}$ ) from their averages calculated over the period 1970 to 2004;  $\Delta u_t$  is the first difference of unemployment rate;  $\varepsilon_t$  are the i.i.d residuals.

**Table 3:** Estimation output of regression:  $g_t^Y = \alpha_0 \Delta u_t + \varepsilon_t$

Dependent Variable:  $g^Y$   
Method: Least Squares  
Sample: 1970:2 2004:4  
Included observations: 139

Variable	Coefficient	Std. Error	t-Statistic	Prob.
$\Delta u$	-0.015440	0.001494	-10.33588	0.0000
R-squared	0.436344	Mean dependent var	-1.00E-18	
Adjusted R-squared	0.436344	S.D. dependent var	0.008549	
S.E. of regression	0.006418	Akaike info criterion	-7.252171	
Sum squared resid	0.005685	Schwarz criterion	-7.231060	
Log likelihood	505.0259	Durbin-Watson stat	2.293277	

The estimates show an inverse relationship between changes in unemployment and the growth rate of official output. Next we use a modified version of Okun's law by including the shadow economy:

$$g_t^Y = \alpha_1 \Delta u_t + \beta g_t^\eta + \varepsilon_t. \quad (8)$$

Table 4 shows the estimates of our modified equation.

**Table 4:** Estimation output of regression:  $g_t^Y = \alpha_1 \Delta u_t + \beta g_t^\eta + \varepsilon_t$

Dependent Variable:  $g^Y$   
Method: Least Squares  
Sample: 1970:2 2004:4  
Included observations: 139

Variable	Coefficient	Std. Error	t-Statistic	Prob.
$\Delta u$	0.008411	0.002470	3.405497	0.0009
$g^\eta$	-0.296371	0.027464	-10.79128	0.0000
R-squared	0.695323	Mean dependent var	-1.00E-18	
Adjusted R-squared	0.693099	S.D. dependent var	0.008549	
S.E. of regression	0.004736	Akaike info criterion	-7.852975	
Sum squared resid	0.003073	Schwarz criterion	-7.810752	
Log likelihood	547.7818	Durbin-Watson stat	2.306191	

The estimated output shows an inversion of the sign of  $\alpha$ . In authors' view the estimated positive sign should be considered cautiously. The OLS regression coefficients are biased when one omits a relevant variable, and the direction and size of the bias depends on the correlation between the omitted and included RHS variables. In this case, the correlation between changes in unemployment rate and

the structural growth of SE is greater than correlation of  $\Delta u_t$  with  $g_t^Y$  (see figure 5). This is probably an overestimation of the compensatory effect that SE has on GDP as a consequence of the changes in unemployment rate<sup>12</sup>.

The econometric results confirm an over-evaluation in Okun's law of the effects that changes in unemployment have on the growth rate of official GDP. We deduce therefore that shadow economy tend to cushion the effects of changes in unemployment on the official GDP.

In order to develop a structural relationship with explicit connections between the official economy, unemployment rate and the growth of the shadow economy, we show the statistical output obtained by estimating regression (9):

$$g_t^{shad} = c + \gamma g_t^{off} + \lambda \Delta u_t + \varepsilon_t. \quad (9)$$

**Table 5:** Estimation output of regression:  $g_t^{shad} = c + \gamma g_t^{off} + \lambda \Delta u_t + \varepsilon_t$

Dependent Variable:  $g^{shad}$   
Method: Least Squares  
Sample: 1970:2 2004:4  
Included observations: 139

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<b>c</b>	0.005296	0.001464	3.616685	0.0004
<b><math>g^{off}</math></b>	-1.549190	0.144108	-10.75023	0.0000
<b><math>\Delta u</math></b>	0.056579	0.003369	16.79397	0.0000
R-squared	0.892489	Mean dependent var	-0.006357	
Adjusted R-squared	0.890908	S.D. dependent var	0.032891	
S.E. of regression	0.010864	Akaike info criterion	-6.185432	
Sum squared resid	0.016051	Schwarz criterion	-6.122098	
Log likelihood	432.8875	F-statistic	564.4924	
Durbin-Watson stat	2.382785	Prob(F-statistic)	0.000000	

For the U.S. economy, the parameter  $\gamma$  shows an inverse relationship between the growth of the official economy ( $g_t^{off}$ ) and growth of the shadow economy ( $g_t^{shad}$ ). On the other-hand, the parameter  $\lambda$  shows a direct relationship between changes in unemployment and the growth of the shadow economy. Our estimations show that the presence of the shadow economy acts as a buffer as it absorbs some of the unemployed workers from the official economy into the shadow economy. It reduces the impact of higher unemployment on official output. Further research is therefore necessary in order to investigate the magnitude by which unemployment affects activity in the shadow economy as it is important to know to what degree developed countries benefit or loose by not considering the impact of the shadow economy on macroeconomic indicators.

<sup>12</sup> Further omitted variables should be considered in regression 8 to be confident of the estimated values.

## 6. Supporting the Structural Relationship using a Structural VAR

In Section 6, we corroborate the presence of a structural relationship between the shadow economy and unemployment by using a Structural VAR. In Section 4, figure 4 showed the shadow economy as a percentage of GDP and the unemployment rate. Figure 4 shows that the two series follow a common trend. A rise in the unemployment rate is followed by an increase in the size of the shadow economy as a percentage of GDP and vice versa.

To verify if this is the case, we estimate a Structural VAR model. The sample period is 1970:01 to 2004:04. Equation (10) is a Structural VAR model where  $Y_t$  is a vector such that  $Y_t = [SE_t, UR_t]$ , where SE and UR are respectively the shadow economy and Unemployment rate at time  $t$ .

$$\Delta Y_t = a_o + \sum_{k=0}^{\infty} A_k V_{t-k} \quad (10)$$

where  $a_o$  is a vector of intercepts,  $A_k$  is a matrix of shock coefficients and  $V_t$  is a vector of structural shocks. In equation (10), we assume that the shock coefficients follow a stationary process and the structural shocks have zero mean, constant variance. We also assume that there are zero cross-correlations between the two structural shocks.

We use the Blanchard - Quah technique which requires that both variables must be stationary. Thus we take the first differences of both variables and estimate  $\Delta Y_t$  as reduced-form VAR model described in equation (11).

$$\Delta Y_t = b_o + \sum_{k=1}^k B_k \Delta Y_{t-k} + e_t \quad (11)$$

where  $b_o$  is a vector of intercepts,  $B_k$  is a matrix of coefficients in the reduced-form VAR and  $e_t$  is the vector of normally distributed forecast errors.

According to Blanchard and Quah, the key is to assume that one of the structural shocks has a temporary effect on  $\Delta SE$ . 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 ( $V_{1t}$ ) such that:

$$\sum_{k=0}^{\infty} a_{12} = 0 \quad (12)$$

where  $\alpha_{ij,k}$  is the  $i,j^{\text{th}}$  element of  $A_k$ . Equation (12) is an Aggregate Supply Shock stating that the second structural shock (aggregate supply) has no long-run effect on shadow economy. The identifying restrictions stated above and estimates of the Reduced-Form Model in (11) will assist in solving for the estimates of the Structural Model in (10). Secondly, this will also produce impulse response functions for responses to the structural shocks. Figure 7 shows the response of the shadow economy as a proportion of GDP to an aggregate supply shock.

**Figure 7:** Effect of an aggregate Supply Shock on the size of the Shadow Economy

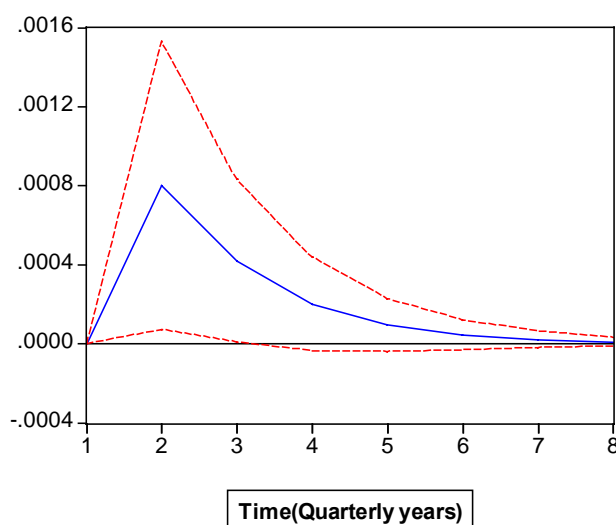


Figure 7 shows that in the short-run, a positive aggregate supply shock causes the shadow economy to rise by about 8% above the baseline. Subsequently there is a steady decline towards the baseline eight quarters (two years) after the initial shock. The shadow economy reaches the baseline thirty-two years (eight quarters) after the initial shock.

## 7. Conclusion

In this paper, we estimate the size of the shadow economy in the U.S. as well as examine if a structural relationship exists between the unemployment rate and the shadow economy in the United States. The size of the shadow economy was estimated using the MIMIC model. Our results show that the size of the shadow economy varies from fourteen to nineteen percent between 1970 and 1983 and then decreases steadily up to 7 percent of official GDP in 2004.

Several specifications of the MIMIC model were used and a significant positive relationship was found between unemployment and the shadow economy. We suppose that this relationship could help to explain the connection between changes in the unemployment rate and output growth (known as Okun's law). Okun's rule of thumb tells us that GDP rises when the unemployment rate increase (eq. 7). We suggest that Okun's coefficient is biased (overstated) as a consequence of the omission of the shadow economy (eq. 8). To understand why, it is necessary to consider how official output and unemployed rate affect the shadow economy (eq. 9). A downturn in the economic official activities leads to a loss of jobs and thus drives part of unemployed into the shadow activities. Consequently, the easier and more profitable it is for the officially unemployed to participate in the unofficial labour force, the lower should be the effect of changes in unemployment to changes in the growth rate of official gross domestic product from potential output (that means a lower Okun's coefficient). The precise magnitude by which the shadow economy assists in stabilizing the impact of unemployment on official GDP may still be in question.

Finally, we estimate a Structural VAR model to examine the response of shadow economy to an aggregate supply shock. The impulse response functions shows that the shadow economy in the U.S. increases following an aggregate supply shock (a shock in unemployment) but this steadily declines after the second quarter. This strengthens the evidence of a structural relationship between the shadow economy and unemployment.

Given that the estimation of the shadow economy whose nature is unobservable, is very complicated, any theoretical and empirical inference derived by these figures should be considered always as an approximation. In light of these difficulties, we believe that the results drawn from these estimations should be interpreted cautiously with a full understanding of their limitations.

However, the results provide an interesting analysis as to the role of the shadow economy in acting as a buffer to the official economy in the presence of changes to the unemployment rate.

## APPENDIX 1: SOURCES OF DATABASE

The data are quarterly and seasonally adjusted. The sources are: Bureau of Economic Analysis (BEA) and Bureau of Labor Statistics Data (BLS).

**Table 6:** Dataset

	<b>CAUSES</b>	<b>Sources</b>	<b>Annotations</b>
X <sub>1</sub>	Tax burden/GDP	BEA	(X <sub>2</sub> + X <sub>3</sub> + X <sub>4</sub> + X <sub>5</sub> )
X <sub>2</sub>	Personal Current Taxes/GDP	BEA	Table 3.1. Government Current Receipts and Expenditures/ Table 1.1.5. Gross Domestic Product. Series Id: (W055RC1/A191RC1)
X <sub>3</sub>	Taxes on production and imports/GDP	BEA	Table 3.1. Government Current Receipts and Expenditures/ Table 1.1.5. Gross Domestic Product. Series Id: (W056RC1/A191RC1)
X <sub>4</sub>	Taxes on corporate income/GDP	BEA	Table 3.1. Government Current Receipts and Expenditures/ Table 1.1.5. Gross Domestic Product. Series Id: (W025RC1/A191RC1)
X <sub>5</sub>	Contributions for government social insurance/GDP	BEA	Table 3.1. Government Current Receipts and Expenditures/ Table 1.1.5. Gross Domestic Product. Series Id: (A061RC1/A191RC1)
X <sub>6</sub>	Government Unemployment insurance	BEA	Table 2.1. Personal Income and Its Disposition/ Table 1.1.5. Gross Domestic Product. Series Id: (W025RC1/A191RC1)
X <sub>7</sub>	Unemployment/ Civilian Labor Force	BLS	Series Id: LNS14000000
X <sub>8</sub>	Self-Employment /Civilian Labor Force	BLS	Employment Level - Non-agricultural, Self-employed Workers /Civilian L.F. (LNS12032192/ LNS11000000)
X <sub>9</sub>	Index of bureaucracy	BLS	Government employment excludes postal (Federal) and education (State and local)/ Civilian Labor Force (CES9091100001/ LNS11000000)
<b>INDICATORS</b>			
Y <sub>1</sub>	M1/M2	BEA	International Monetary Fund Series Id: (11159MA.ZF/11159MB.ZF)
Y <sub>2</sub>	Index of real GDP	BEA	Table 1.1.6. Real Gross Domestic Product, Chained Dollars. Billions of chained (2000) dollars. Seasonally adjusted at annual rates; Series Id: A191RX1/(Real GDP Q1:1990)
Y <sub>3</sub>	Civilian labor force participation rate	BLS	Labor Force Statistics from the Current Population Survey Series Id: LNS11300000

## APPENDIX 2: ANALYSIS OF NON-STATIONARITY

In this appendix we display the tests employed to detect the order of integration in the time series. The pioneer in tackling the problem of non-stationarity in the MIMIC models has been Giles (1995). As Giles and Tedds (2002) point out, the most appropriate way "...to consider the non-stationary element is to consider the possibility of cointegration. Unfortunately, there is no established literature which may serve as a guide to this procedure in the context of the MIMIC model". To discover the unit roots, the Augmented Dickey-Fuller (ADF) Test and the Phillips-Perron (PP) Test are used; to choose a number of lags sufficient to remove serial correlation in the residuals and the automatic selection of bandwidth we have employed the Schwarz information criterion (ADF) and the Newey-West test using Bartlett Kernel (PP). In the following tables the p-value of the abovementioned tests is reported, while the null hypothesis is the presence of the unit root, and therefore a value greater than 0.05 indicates non-stationary time series. A third unit root test is applied, namely the Kwiatkowski, Phillips, Schmidt and Shin Test (KPSS, 1992)<sup>13</sup>. This test differs from the others in that the series is assumed to be (trend-) stationary, according to the null hypothesis. The table 7 shows the statistical test: we test I(2) against I(1) and if we reject I(2), we test I(1) against I(0) as appropriate, if the estimated values exceed the respective critical values<sup>14</sup>, stationarity must be rejected. The critical values for the LM test statistics are based upon the asymptotic results presented in KPSS (table 1, p. 166).

- KPSS test equation with constant critical values are: 0.347 (10%), 0.463 (5%), 0.739 (1%);
- KPSS test equation with constant and trend: 0.119 (10%), 0.146 (5%), 0.216 (1%).

The econometric software Eviews 4.1 was used in to perform this analysis.

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<sup>13</sup> The Kernel function was chosen according to Bartlett's criteria and the Newey-West method is used for bandwidths.

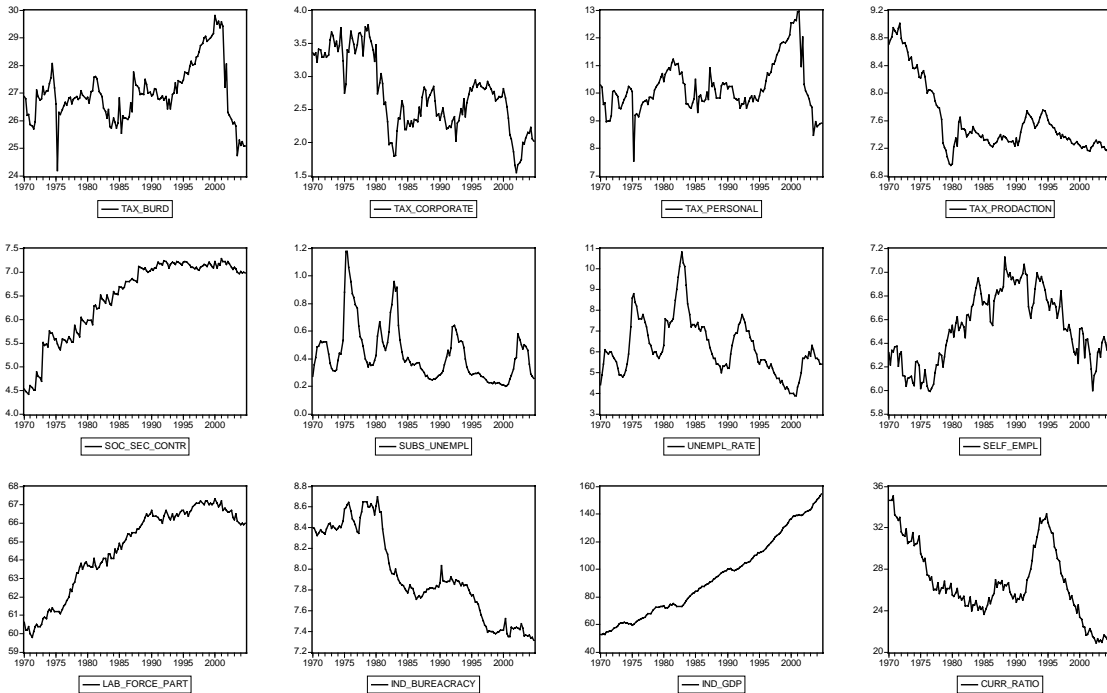
<sup>14</sup> As the ADF and KPSS tests are adversely sensitive to the presence of breaks in the data, by showing critical values it is possible to check these values with Kurozumi's (2002, table 3, p. 86) critical values. Kurozumi's (2002) modified KPSS test allows to use consider the distortion in the statistical test distribution caused by a structural break.

**Table 7: Unit root analysis**

	Variable	Incl. Equat.	Level			First difference			Second difference		
			ADF	P.P	KPSS	ADF	P.P	KPSS	ADF	P.P	KPSS
	<b>Causes</b>										
<b>X<sub>1</sub></b>	Tax burden (X <sub>2</sub> +X <sub>3</sub> +X <sub>4</sub> +X <sub>5</sub> )	C	0.462	0.133	0.303*	0.000	0.000	0.080*	0.000	0.000	0.088*
<b>X<sub>2</sub></b>	Personal current tax/GDP	C	0.377	0.077	0.302*	0.000	0.000	0.057*	0.000	0.000	0.500*
<b>X<sub>3</sub></b>	Taxes on production and imports /GDP	T&C	0.773	0.676	0.252	0.000	0.000	0.072*	0.000	0.000	0.008*
<b>X<sub>4</sub></b>	Taxes on corporate income/GDP	T&C	0.266	0.266	0.132*	0.000	0.000	0.041*	0.000	0.000	0.016*
<b>X<sub>5</sub></b>	Contributions for government social insurance/GDP	T&C	0.682	0.884	0.356	0.001	0.000	0.042*	0.000	0.000	0.047*
<b>X<sub>6</sub></b>	Governm. Unemploy. insurance	C	0.008	0.052	0.533	0.000	0.000	0.054*	0.000	0.000	0.146*
<b>X<sub>7</sub></b>	Unemployment rate	C	0.092	0.113	0.424*	0.000	0.000	0.099*	0.000	0.000	0.155*
<b>X<sub>8</sub></b>	Self-Employment/Civilian Labour For.	C	0.327	0.448	0.491	0.000	0.000	0.174*	0.000	0.000	0.195*
<b>X<sub>9</sub></b>	Index of bureaucracy	T&C	0.620	0.446	0.079*	0.000	0.000	0.073*	0.000	0.000	0.026*
	<b>Indicators</b>										
<b>Y<sub>1</sub></b>	M1/M2	T&C	0.527	0.571	0.161	0.222	0.000	0.117*	0.001	0.000	0.043*
<b>Y<sub>2</sub></b>	Index of real GDP	T&C	0.931	0.958	0.328	0.000	0.000	0.034*	0.000	0.000	0.067*
<b>Y<sub>3</sub></b>	Civilian Labour Force participation rate	T&C	0.999	0.998	0.338	0.000	0.000	0.112*	0.000	0.000	0.010*

**Notes:** For ADF and PP show the MacKinnon (1996) one-sided p-values; the statistical tests are shown for KPSS; \* means stationary at 0.05 level.

**Figure 6: Plots of Variables**



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