An ARDL model of unrecorded and recorded economies in Turkey

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2009

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Abstract

The goal of this paper is twofold: to estimate the unrecorded economy (UE) of Turkey over the period 1987-2007 using a revised version of the currency demand approach and to analyze the relationship between UE and recorded GDP (gross domestic product). In particular, we propose to measure UE by the autoregressive distributed lag (ARDL) approach to cointegration analysis. Toda- Yamamoto casuality tests are also conducted to identify the relationship between unrecorded and recorded GDP. This research provides fresh evidence on the size of the UE to the recorded GDP in Turkey which ranges from 10.65% to 18.91% over the estimation period. Moreover, empirical evidence concretely suggests that causality runs from the recorded GDP to the UE. However, there exists a mild reverse causality. Suggestions for economic policy and hints for further research are also offered.

Keywords: Unrecorded economy, Currency demand approach, ARDL model, Economic Development, Turkey.

1. Introduction

The behavior of the unrecorded economy (UE) may be analyzed over the long and short runs. In the long run, it changes due to the trends in the relative costs and benefits of informality (e.g., level of development, tax burden, labor regulation, strength of monitoring, tax morale, etc.). In the short run, unrecorded Gross Domestic Product (GDP) reacts to the temporary conditions created by the business cycle and moves to close the gap that separates it from its equilibrium (Loayza and Rigolini, 2006). The goal of this paper is twofold. It develops a revised version of the currency demand approach to estimating the size of the UE of Turkey and, subsequently, we use the time-series variation to assess the causality from the recorded economy to the UE and vice versa.

In this study, the term "unrecorded" (underground, unobserved, shadow, measured, informal, black, hidden, etc.) defines the economic activities to be included in the GDP but which, for one reason or another, are not covered in the statistical surveys or administrative records from which the national accounts are constructed (Blades and Roberts, 2002, p. 4). Although the issue of the UE has been investigated for a long time, the discussion regarding the 'appropriate' method by which to assess its scope has not yet reached a solution (Schneider, 2008). Methodologies of calculating the UE may be classified into three categories[1]: (a) direct, (b) indirect and (c) model-based. The "direct" methods are based on contacts with or observations of persons and/or firms to gather direct information about undeclared income. Two kinds of such methods exist: (a.1) the auditing of tax returns (e.g., Thomas, 1992) and (a.2) the questionnaire surveys (e.g., Williams, 2006). The "indirect" methods try to determine the size of the UE by measuring the "traces" that it leaves in official statistics. They are often called "indicator" approaches and use mainly macroeconomic data. We distinguish among three sub-categories of indirect methods: (b.1) approaches based on national accounts (e.g., discrepancy between income and expenditure, discrepancy between official and actual employment); (b.2) monetary approaches; and (b.3) physical input methods (e.g., Kaufmann and Kaliberda, 1996). Finally, (c) the "Model" approach (or MIMIC method) is based on the statistical theory of latent variables (Structural Equation Modeling), which considers several causes and several indicators of the UE (e.g., Dell'Anno, 2007).

With reference to the "indirect" monetary approach followed in this paper, the currency demand approach, which is based on Cagan's (1958) currency demand model, is applied. Tanzi (1980) initially utilized this approach to estimate the size of the USA's underground economy. This method requires econometric estimation of the currency demand models twice: once with a tax variable and once without it. The tax burden is assumed to be the major reason for holding cash. The difference is referred to as the size of the UE.

Recent literature reviews on the UE in Turkey have been provided by Schneider and Savaşan (2007) and Karanfil (2008). According to these analyses, it is clear that researchers have obtained widely divergent estimates of the size of Turkey's UE. Table 1 summarizes some of these estimates.

[1] For a fuller treatment of the several techniques that have been developed to estimate the UE, we refer to, inter alia, Cowell (1990), Thomas (1992), Pedersen (1998), Eilat and Zinnes (2000), Schneider and Enste (2000, 2002), Giles and Tedds (2002), Schneider (2005).

Table 1: The size of the Unrecorded Economy in Turkey (various studies)

Authors	Approach	Period	Size of UE (min-max)
Kasnakoğlu (1993)	currency ratio	1968-1990	4% - 35% of official GDP
	currency demand	1963-1990	0% - 23% of official GDP
	transaction approach	1970-1992	0% - 26% of official GDP
Temel *et al*. (1994)	currency ratio	1970-1992	0% - 26% of official GDP
	currency demand	1975-1992	6% - 20% of official GDP
	Tax auditing	1984-1991	8% - 92% of official GDP
	discrepancy method	1987-1992	1% - 4% of official GDP
	transaction approach		0% - 62% of official GDP
Yayla (1995)	currency ratio	1968-1993	4% - 100% of official GDP
	currency demand		0% - 42% of official GDP
Halicioglu (1999)	currency ratio	1970-1997	0% - 10 of official GNP
Ogunc and Yilmaz (2000)	currency ratio	1980-1988	0% - 46% of official GNP
	currency demand	1971-1999	11% - 22% of official GNP
	discrepancy method	1987-1999	11% - 8% of official GNP
Çetintaş and Vergil (2003)	currency demand	1971-2000	17% - 31% of official GNP
Us (2004)	Physical Input	1978-2000	1% - 33% of official GDP
	currency ratio	1987-2003	0% - 90% of official GDP
	currency demand	1987-2003	3% - 12% of official GDP
	Tax auditing	1985-2002	26% - 184% of official GDP
Savaşan (2003)	MIMIC	1970-1998	10% - 45% of official GDP
Karanfil and Ozkaya (2007)	Environmental method	1973-2003	12% - 30% of official GDP
Schneider and Savaşan (2007)	MIMIC	1999-2005	32% - 35% of official GDP
Davutyan (2008)	expenditure-based approach	2005	21% of official GDP

These results clearly indicate that the methods for estimating the size of the UE are still problematic. As Schneider and Enste (2000) stated, it is evidence that no approach is exempt from criticism, and further research is necessary to overcome several limitations. In particular, the proposed ARDL approach aims to overcome the criticism that the previous currency demand estimations of the UE are based on partial adjustment models.

In the second part of paper, we present an analysis of the relationship between the UE and recorded GDP. The debate on the relationship between the UE and the recorded economy has attracted the attention of several researchers. Scholars have investigated the overall sign of the impact of the UE on economic performance, but they have often obtained controversial results (e.g., Giles *et al*., 2002; Dell'Anno, 2003, 2008; Schneider and Klinglmair, 2004; Schneider, 2005; Galli and Kucera, 2003; Dreher *et al*., 2007). These outcomes led to the hypothesis that beneficial and damaging effects of the UE on the growth of official GDP coexist.

A relevant contribution concerning which (negative or positive) effects of the UE prevail on official GDP was made by Schneider (2005). He estimated a quantitatively important influence of the UE on the growth of the official economy. Empirical evidence revealed a correlation between changes in these two phenomena according to the degree of economic development. In particular, Schneider (2005) found a negative correlation between the UE and the official economy for developing countries and a positive relationship for industrialized and transition countries. This outcome implies that the UE could be procyclical for developing economies and countercyclical for developed and transition countries.

In sum, this research differs from prior work in that it considers an application of the ARDL cointegration approach to estimate the currency demand function, with a view of obtaining a measurement of the UE in Turkey. Not surprisingly, this question assumes fundamental relevance for investigations of the interactions between official and unofficial GDP.

This article is organized as follows. Section 2 presents an overview of the empirical research analyzing the relationship between the official economy and UE. Section 3 describes the currency demand model and econometric methodology. Empirical outcomes are discussed in Section 4. The article ends with general conclusions.

2. The relationship between unrecorded and recorded economy

The relationship between the recorded economy and the UE has been investigated for a long time. Although the issue of the link between the UE and the formal economy is evident, the debate regarding whether the UE follows the formal economy through the cycle rather than vice versa is still ambiguous.

According to Chen (2007), there are at least three schools of thought on the link between informal and formal economies: dualism, structuralism, and legalism. The "dualists" argue that unofficial activities have few linkages to the official economy but, rather, operate as a separate sector. This approach is based upon the neoclassical hypothesis that rigidities in the official sector, introduced through legislation or negotiation, segment the market (Harris and Todaro, 1970). The dualist hypothesis asserts that these two sectors are subsidiaries. Common factors lead to the flow of workers and activities from the formal to the informal economy.

The "structuralists" consider the informal and formal sectors as intrinsically linked. Formal enterprises promote informal production and employment relationships with subordinated economic units and workers to reduce their input costs (Chen, 2007). Both informal enterprises and informal wage workers are inclined to meet the interests of increasing the competitiveness of regular firms by providing cheap goods and services (Moser, 1978; Portes *et al*., 1989). For this reason, a growing official economy boosts unofficial production.

The "legalists" direct their interests on the relationship between informal activities and the formal regulatory environment. According to the legalist school, the UE comprises micro-entrepreneurs who choose to operate informally to avoid the costs, time and effort of formal registration (de Soto, 1989). These entrepreneurs will continue to produce informally as a response to unreasonable government rules and regulations. In this view, a growing formal economy boosts unofficial production if the regulatory framework is burdensome and government procedures costly.

For Chen *et al*. (2004), previous schools of thinking regarding the informal economy are old-fashioned. These authors suggest an integrated approach that looks at which elements of the dualist, legalist and structuralist schools of thought are most appropriate to which segments and contexts of the UE.

The literature on the UE over the business cycle has often concentrated on the analysis of informal employment (Bosch and Maloney, 2005, 2008; Loayza and Rigolini, 2006; Fiess *et al*. 2008). Unexpectedly, studies on the issue of causality between recorded and unrecorded GDP are relatively scarce.

Looking exclusively at the empirical research on the beneficial or detrimental effect of the UE on economic development, Adam and Ginsburg (1985) estimated a positive relationship between the growth of the UE and the official economy under the assumption of low probability of enforcement. Lubell (1991) considered as significant the influence of the UE on the development of the official economy. Bhattacharyya (1999) shows clear evidence in the case of the United Kingdom (from 1960 to 1984) that the UE has a positive effect on several components of GDP (e.g., consumer expenditures, services, etc.). According to Asea (1996), the UE offers significant contributions "to the creation of markets, increase financial resources, enhance entrepreneurship, and transform the legal, social, and economic institutions necessary for accumulation" (ibidem, p. 166). Enste (2003) argued that the UE stimulates economic development in transition countries. He considered the UE to be an incentive to develop both the entrepreneurial spirit and a constraint to limit excessive growth of government activities. Schneider (2003) emphasized that the UE, by stimulating competition, leads to more efficient resource allocation on both sides of the economy. Again, by assuming complementarities between the UE and the official GDP, Schneider (2005) claims that the unofficial activities, by boosting economic growth, are also able to generate additional tax revenues. Further empirical evidence of a positive correlation between the UE and the official economy have also been found by Giles (1999a, 1999b), Giles and Tedds (2002), Tedds (2005), Hametner and Schneider (2007), Dell'Anno (2008), Bovi and Dell'Anno (2009).

The alternative hypothesis that the UE is countercyclical is mainly based upon the idea that unofficial activities, by creating unfair competition, interfere negatively with the market allocation.

From the demand side, a lack of transparency may distort the information flows, thus hampering market competition and an efficient comparison of goods and services. From the production side, the untaxed return of investment of the unofficial business activities may attract resources from official firms because more productive investments of official activities may have lower taxed returns than unofficial ones. The misallocation then slows economic growth. Loayza (1996) found empirical evidence of a negative correlation between the size of the informal sector and the growth rate of the official real GDP per capita for 14 Latin American countries. The inverse relationship between the UE and economic growth is theoretically supported by the author's hypothesis about the UE's congestion effect. Loayza (1996) set out a model in which the production technology depends on tax-financed public services, the UE does not pay taxes, but must pay penalties, and these resources are not used to finance public services. According to these assumptions, a larger UE reduces the availability of public services to the official economy more than do the existing public services, which are being used less efficiently. Ihrig and Moe (2000) revealed that the changes in the size of the UE have an economically significant and negative effect on the growth of real GDP per worker. When examining the UE in 24 transition countries, Eilat and Zinnes (2000)

found an inverse relationship between the official economy and the UE. They estimated that a one-dollar fall in official GDP was associated with a 31 percent increase in the size of the UE. Kaufmann and Kaliberda (1996) observed that the UE mitigates the decrease in the official GDPs of transition countries. They estimated that for "every 10 percent cumulative decline in official GDP, the share of the irregular economy in the overall increases by almost 4 percent" (ibidem, p. 46). Schneider and Enste's (2000) overall survey of 76 countries concluded that a growing UE has a negative impact on official GDP growth. Ihrig and Moe (2004) estimated a negative convex relationship between real GDP per worker and the percent of output produced in the informal sector. According to Chong and Gradstein's (2007) findings, a large informal sector implies, inter alia, slower economic growth. Among the other scholars who have found a negative relationship between the UE and the official economy are Frey and Weck-Hannemann (1984); de Soto (1989); Turnham et al. (1990); Thomas (1992); Johnson *et al*. (1998, 1999); Friedman et al. (2000); Ott (2002); Dell'Anno (2003, 2007); Dabla-Norris and Feltenstein (2005); and Dell'Anno *et al*. (2007).

As this survey has summarized, the literature presents contradictory results. A noteworthy contribution to reconciling these findings comes from Schneider's (2005) research. He found that the effects of the UE on official economic growth are just prima facie ambiguous. The sign of the correlation becomes well defined if it is conditioned to the degree of economic development. He estimated a negative relationship between the UEs of low-income countries and their official rates of economic growth, but a positive relationship between the UE and economic growth in industrialized and transition countries. Schneider's motivation was that the citizens of high-income countries are overburdened by taxes and regulation so that an increasing UE stimulated the official economy as the additional income earned in the UE was spent in the official sector. On the contrary, for low-income countries, an increasing UE "erodes the tax base, with the consequence of a lower provision of public infrastructure and basic public services with the final consequence of lower official economy" (Schneider, 2005, p. 613). Schneider (2005) stated that the effects of the UE on economic development should be evaluated by considering the beneficial effects of a smaller size of the UE in terms of tax revenue. In other words, discovery of a hidden tax base means additional resources for policy makers, thus leading to more resources for investment in productive public goods and services. From this viewpoint, if the policy maker lacks the resources to finance public investments (e.g., infrastructures, education, etc.), as in low-income countries, then a smaller UE makes possible the promotion of economic growth through finance policies.

Finally, the issue of cyclical movement in the UE is addressed in a volume of literature concerning informal employment. For instance, according to Loayza and Rigolini (2006), in the short run, the informal sector is counter-cyclical for the majority of countries, with the degree of counter-cyclicality being lower in countries with more informal employment and better police and judicial services. However, Fiess *et a*l. (2008) also showed that in numerous Latin American countries, informal employment behaves procyclically across some periods. Similarly, Bosch and Maloney (2008) found that in Brazil and Mexico, the "flows from formality into informality are not countercyclical, but, if anything,

pro-cyclical". Gang and Gangopadhyay (1990) provided theoretical support for the hypothesis of the procyclicality of the UE. They investigated in a general equilibrium model the conditions under which the informal sector increases its capital stock more rapidly than the formal sector. They concluded that the informal sector is often a dynamic actor in the process of economic development, frequently outpacing the growth of the formal sector.

In the following, we aim to contribute to this debate by applying the Toda-Yamamoto causality tests. This econometric approach aims to determine the direction of causal influence between two variables (e.g., recorded and UE). Giles (1997a, 1997b, 1999a) and Giles and Tedds (2000) carried out similar causality tests for New Zealand and Canada, respectively. In both countries, they found significant evidence of Granger causality from the measured economy to the UE. They concluded that the UE follows the official economy through the cycle, rather than vice versa. For Turkey, this issue has been taken into account in one recent paper. Akalin and Kesikoğlu (2007) estimated the size of the unrecorded economy using a monetary ratio approach. Their Granger causality test results indicated the existence of one-way causality from the underground economy to economic growth. However, their results are flawed. They established that the variables of unrecorded and recorded GDP are integrated on the order of one. In spite of this fact, they implemented the Granger-causality test in the first differences of the variables, which makes the results misleading.

Finally, this study aims to further extend the existing literature with an appropriate causality testing procedure. In the following paragraphs, we attempt to provide further evidence to solve the indeterminacy of the direction of causal influence between the UE and official GDP in Turkey.

3. Model and econometric methodology

3. 1 Model

Following the empirical literature in demand for currency, we form the long-run relationship between currency demand, income, interest rates, foreign currency and tax burden in linear logarithmic form, with a view of estimating the size of the UE in Turkey as follows:

$$c_t = a_0 + a_1 y_t + a_2 r_t + a_3 e_t + a_4 b_t + \varepsilon_t \qquad (1)$$

where c_t is real currency issued, y_t is real income, r_t is nominal interest rates on savings, e_t is nominal exchange rates, b_t is tax burden on businesses, and ε_t is the regression error term . The lower case letters in equation (1) demonstrate that all variables are in their natural logarithms. It is assumed that a rise in the tax burden variable will lead to an increase in the size of the unrecorded economic activities which requires a higher level of demand for currency. The expected signs for the parameters in equation (1) are as follow: $a_1 > 0$, $a_2 < 0$, $a_3 < 0$, $a_4 > 0$.

3.2 The bounds testing method

The recent advances in econometric literature dictate that the long-run relation in equation (1) should incorporate the short-run dynamic adjustment process. It is possible to achieve this aim by expressing equation (1) in an error-correction model as suggested in Engle-Granger (1987).

$$\Delta c_t = c_0 + \sum_{i=1}^{m} c_{1i}\Delta c_{t-i} + \sum_{i=0}^{m} c_{2i}\Delta y_{t-i} + \sum_{i=0}^{m} c_{3i}\Delta r_{t-i} + \sum_{i=0}^{m} c_{4i}\Delta e_{t-i} + \sum_{i=0}^{m} c_{5i}\Delta b_{t-i} + \gamma\varepsilon_{t-1} + \mu_t \quad (2)$$

where Δ represents change , γ is the speed of adjustment parameter and ε_{t-1} is the one period lagged error correction term, which is estimated from the residuals of equation (1). The Engle-Granger method requires all of the variables in equation (1) to be integrated of order one, *I*(1) and the error term is integrated to be order of zero, *I*(0) for establishing a cointegration relationship. If some variables in equation (1) are non-stationary, we may use a new cointegration method offered by Pesaran *et al*. (2001). This approach, also known as autoregressive-distributed lag (ARDL), combines Engle-Granger (1987) two steps into one by replacing ε_{t-1} in equation (2) with its equivalent from equation (1). ε_{t-1} is substituted by linear combination of the lagged variables as in equation (3).

$$\begin{aligned}\Delta c_t = {} & b_0 + \sum_{i=1}^{m} b_{1i}\Delta c_{t-i} + \sum_{i=0}^{m} b_{2i}\Delta y_{t-i} + \sum_{i=0}^{m} b_{3i}\Delta r_{t-i} + \sum_{i=0}^{m} b_{4i}\Delta e_{t-i} + \sum_{i=0}^{m} b_{5i}\Delta b_{t-i} + \\ & b_6 c_{t-1} + b_7 y_{t-1} + b_8 r_{t-1} + b_9 e_{t-1} + b_{10} b_{t-1} + \mu_t\end{aligned} \quad (3)$$

Equation (3) can be further transformed to accommodate the one period lagged error correction term (EC_{t-1}) as in equation (4):

$$\Delta c_t = b_0 + \sum_{i=1}^{m} b_{1i}\Delta c_{t-i} + \sum_{i=0}^{m} b_{2i}\Delta y_{t-i} + \sum_{i=0}^{m} b_{3i}\Delta r_{t-i} + \sum_{i=0}^{m} b_{4i}\Delta e_{t-i} + \sum_{i=0}^{m} b_{5i}\Delta b_{t-i} + \lambda EC_{t-1} + \mu_t \quad (4)$$

A negative and statistically significant estimation of λ not only represents the speed of adjustment but also provides an alternative means of supporting cointegration between the variables. Pesaran *et al's* cointegration approach, also known as bounds testing, has certain econometric advantages in comparison to other single cointegration procedures, which are outlined in Bahmani-Oskooee and Tankui (2008).[2]

The bounds testing procedure is based on the Fisher (F) or Wald-statistics and is the first stage of the ARDL cointegration method. Accordingly, a joint significance test that implies no cointegration hypothesis, ($H_0: b_6 = b_7 = b_8 = b_9 = b_{10} = 0$), against the alternative hypothesis, ($H_1: b_6 \neq b_7 \neq b_8 \neq b_9 \neq b_{10} \neq 0$) should be performed for equation (3). The F-test used for this procedure has a non-standard distribution. Narayan (2005) computes two sets of critical values for a given significance level with and without a time trend for small samples between 30 to 80 observations. One set assumes that all variables are *I*(0) and the other set assumes they are all *I*(1). If the computed F-statistic

[2] Note that EC_{t-1} is formed using the long-run coefficient estimates from (3). For details see Bahmani-Oskooee and Tanku (2008).

exceeds the upper critical bounds value, then the H_0 is rejected. If the F-statistic falls into the bounds then the test becomes inconclusive. Lastly, if the F-statistic is below the lower critical bounds value, it implies no cointegration.

Equation (3) provides the short-run and long-run effects simultaneously after the adjustment is completed. The short-run effects between the dependent and independent variables are inferred by the size of b_{2i}, b_{3i}, b_{4i}, and b_{5i}. The long-run impacts are inferred by the estimates of b_7, b_8, b_9, and b_{10} that are normalized on estimate of b_6. Similar applications of the bounds testing approach have been employed by different empirical studies; see for example Narayan and Narayan (2005), Bahmani-Oskooee *et al*. (2005), Narayan *et al*. (2007), and Mohamadi *et al*. (2008)

3. 3 Causality

Toda and Yamamoto (1995) causality test is applied in level VARs irrespective of whether the variables are integrated, cointegrated, or not.

Toda and Yamamoto (1995) argues that F-statistic used to test for traditional Granger causality may not be valid as the test does not have a standard distribution when the time series data integrated or cointegrated.

The procedure applies a modified Wald test to carry out the restrictions on the parameters of the VAR (k) model. The test has an asymptotic χ^2 (chi-square) distribution with k degrees of freedom in the limit when a VAR [$k+d$(max)] is estimated (where, d(max) is the optimal order of integration for the series in system). The test essentially involves two stages. The first stage determines the optimal lag length (k) and the maximum order of integration (d) of the variables in the system. The lag length, k is obtained in the process of the VAR in levels among the variables in the system by using different lag length criterion such as AIC or SBC. The unit root testing procedure, such as Dickey-Fuller ADF (1981), may be used to identify the order of integration, d.

The second stage uses the modified Wald procedure to test the VAR (k) model for causality. The optimal lag length is equal to p= [$k+d$(max)]. The VAR (k) models are estimated by Ordinary Least Squares (OLS) estimation technique. In the case of a bivariate (Y, X) relationship, Toda and Yamamoto (1995) causality test is represented as follows:

$$Y_t = a_0 + \sum_{i=1}^{p} b_{1i} Y_{t-i} + \sum_{i=1}^{p} c_{2i} X_{t-i} + v_{1t} \tag{5}$$

$$X_t = d_0 + \sum_{i=1}^{p} e_{1i} X_{t-i} + \sum_{i=1}^{p} f_{2i} Y_{t-i} + v_{2t} \tag{6}$$

The null hypothesis that X does not cause Y is constructed as follows: $H_0 : c_{2i} = 0$.

Similarly the second null hypothesis that Y does not cause X is formulated as follows: $H_0 : f_{2i} = 0$.

The joint hypotheses are tested via modified Wald test. Different aspects and applications of causality testing procedures have been presented in many empirical research; see for example Papapetrou (2001), Love and Chandra (2005), Kalyoncu and Yucel (2006), and Valadkhani and Chancharat (2008).

4. Empirical results

Annual data over the period 1987Q1-2007Q4 were used to estimate equation (3) via the Pesaran *et al*. (2001) procedure. Data definition and sources of data are cited in the Appendix.

The time series properties of the variables in equation (1) were checked through Augmented Dickey-Fuller (ADF) of Dickey and Fuller (1981) and Phillips-Perron (1988) unit root-testing procedures. The results are not displayed here due to space consideration. All of the series in equation (1) appear to contain a unit root in their levels but are stationary in their first differences except the income variable which is stationary in its level form. Therefore, it is appropriate to use the Pesaran *et al*. (2001) procedure. The visual inspection of the variables in the logarithm does not indicate structural breaks in time series.

4.1 Tests for cointegration

Equation (3) was estimated in two stages. In the first stage of the ARDL procedure, the long-run relationship of equation (1) was established in two steps. First, the order of lags on the first-differenced variables for equation (3) was obtained from unrestricted VAR by means of the Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC). Second, a bounds F-test was applied to equation (3) to establish a long-run relationship between the variables. To avoid a possible lag selection problem at this stage, one may follow the procedure of Bahmani-Oskooee and Goswami (2003), which suggests applying some arbitrary lag lengths to test the sensitivity of the bounds F-testing procedure. The results of the bounds F testing are displayed in Table 2. The results demonstrate that when demand for currency is the dependent variable the null hypothesis of no cointegration cannot be accepted. Therefore, there exists a unique cointegration relationship between demand for currency and its determinants.

Table 2. The results of F-test for cointegration

Critical value bounds of the F statistic: intercept and no trend					
	90 % level		95% level		
s	*I*(0)	*I*(1)	*I*(0)	*I*(1)	
4	2.30	3.22	2.68	3.69	
Calculated F- test statistics for different lag lengths					
	p=4	*p*=5	*p*=6	*p*=7	*p*=8
$F(c \mid y,r,e,b)$	1.30	1.65	2.63	3.85	3.55

s stands for the number of regressors. *p* is the lag length. Critical values are obtained from Narayan (2005).

4.2 ARDL model selection

The ARDL cointegration procedure was implemented to estimate the parameters of equation (3) with the maximum order of lag set to 4 which was selected on the basis of the AIC. In search of f the optimal length of the level variables of the short-run coefficients, several lag selection criteria such as $\overline{R}^2$, AIC, SBC and the Hannan-Quinn Criterion (HQC) were utilized at this stage. The short-run results of equation (3) based on several lag criteria are reported in Panel A of Table 3 along with their appropriate ARDL models. The results from the model selection criteria of AIC and HQC are identical. The error correction term has the expected sign and statistically significant in all of the models indicating another confirmation

of the existence of the long-run relationship among the variables in equation (1). The long-run results of equation (3) are displayed in Panel B of Table 3. All the long-run models have the expected signs for the parameters. Moreover, the magnitudes of elasticities are very similar in the models of $\overline{R}^2$, AIC and HQC. Finally, Panel C of Table 3 demonstrates the short-run diagnostic test results of equation (3). According to the revealed results, all of the short-run models pass a series of standard diagnostic tests such as serial correlation, functional form, and heteroskedasticity, except normality.

The $\overline{R}^2$ model appears to be more satisfactory in regard to long-run results and short-run diagnostic tests. Therefore, the results from this model will be used to estimate the size of the unrecorded economy.

Table 3. ARDL cointegration results

Panel A: the short-run results Dependent variable Δc_t								
	Model Selection Criterion							
Regressors	$\overline{R}^2$ ARDL (3,1,2,0,0)		AIC ARDL (3,1,0,0.0)		SBC ARDL (3,0,0,0,0)		HQC ARDL (3,1,0,0,0)	
Δc_{t-1}	-0.33	(3.26)*	-0.38	(3.83)*	-0.42	(4.22)*	-0.38	(3.83)*
Δc_{t-2}	-0.02	(3.27)*	-0.30	(3.17)*	-0.38	(4.32)*	-0.30	(3.17)*
Δy_t	0.25	(4.11)*	0.25	(4.05)*	0.24	(3.79)*	0.25	(4.05)*
Δr_t	- 0.11	(1.78)**	-0.11	(3.30)*	-0.13	(3.57)*	-0.11	(3.30)*
Δr_{t-1}	0.10	(0.67)						
Δe_t	- 0.005	(0.36)	-0.007	(0.59)	-0.01	(1.06)	-0.007	(0.59)
Δb_t	0.09	(1.23)	0.21	(1.28)	0.04	(0.05)	0.21	(1.28)
Constant	0.64	(1.04)	0.31	(0.94)	-0.77	(0.33)	0.31	(0.94)
EC_{t-1}	- 0.24	(3.29)*	- 0.19	(2.84)*	- 0.22	(3.35)*	- 0.19	(2.84)*
$\overline{R}^2$	0.48			0.47		0.45		0.47
F-statistic	10.51*			11.43*		10.58*		11.43*
DW-statistic	2.05			2.01		1.87		2.01
RSS	0.49			0.51		0.54		0.51
Panel B: the long-run results Dependent variable c_t								
y_t	0.54	(1.72)**	0.66	(1.52)**	1.07	(2.59)*	0.66	(1.52)**
r_t	- 0.62	(4.57)*	- 0.61	(3.51)*	- 0.57	(3.95)*	- 0.61	(3.51)*
e_t	- 0.01	(0.47)	- 0.04	(0.61)	- 0.06	(1.09)	- 0.04	(0.61)
b_t	0.36	(1.54)**	1.09	(1.56)**	0.18	(1.05)	1.09	(1.56)**
Constant	2.56	(1.12)	1.64	(0.56)	-0.77	(0.31)	1.64	(0.56)
Panel C: the short-run diagnostic test statistics								
	$\chi^2_{SC}(4)=5.29$		$\chi^2_{SC}(1)=1.32$		$\chi^2_{SC}(1)=0.36$		$\chi^2_{SC}(1)=1.32$	
	$\chi^2_{FC}(1)=1.25$		$\chi^2_{FC}(1)=0.82$		$\chi^2_{FC}(1)=1.46$		$\chi^2_{FC}(1)=0.82$	
	$\chi^2_{N}(2)=129.5$		$\chi^2_{N}(2)=7.29$		$\chi^2_{N}(2)=6.53$		$\chi^2_{N}(2)=7.29$	
	$\chi^2_{H}(1)=1.29$		$\chi^2_{H}(1)=0.40$		$\chi^2_{H}(1)=0.34$		$\chi^2_{H}(2)=0.40$	

* and ** indicate 5 % and 10 % significance levels, respectively. RSS stands for residual sum of squares. The absolute value of t-ratios is in parentheses. χ^2_{SC}, χ^2_{FC}, χ^2_{N}, and χ^2_{H} are Lagrange multiplier statistics for tests of residual correlation, functional form mis-specification, non-normal errors and heteroskedasticity, respectively. These statistics are distributed as chi-squared variates with degrees of freedom in parentheses.

4.3 Estimating the size of the Turkish unrecorded economy

This study will adopt the approach of Feige (1979) to measure the size of the UE in Turkey. This approach is based on Fisher's (1911) quantity theory of money, which is expressed as follows:

$$M \times V = P \times T \tag{7}$$

where M is money, V is velocity, P is price and T is total transactions.

Another way of showing equation (7) is as follows:

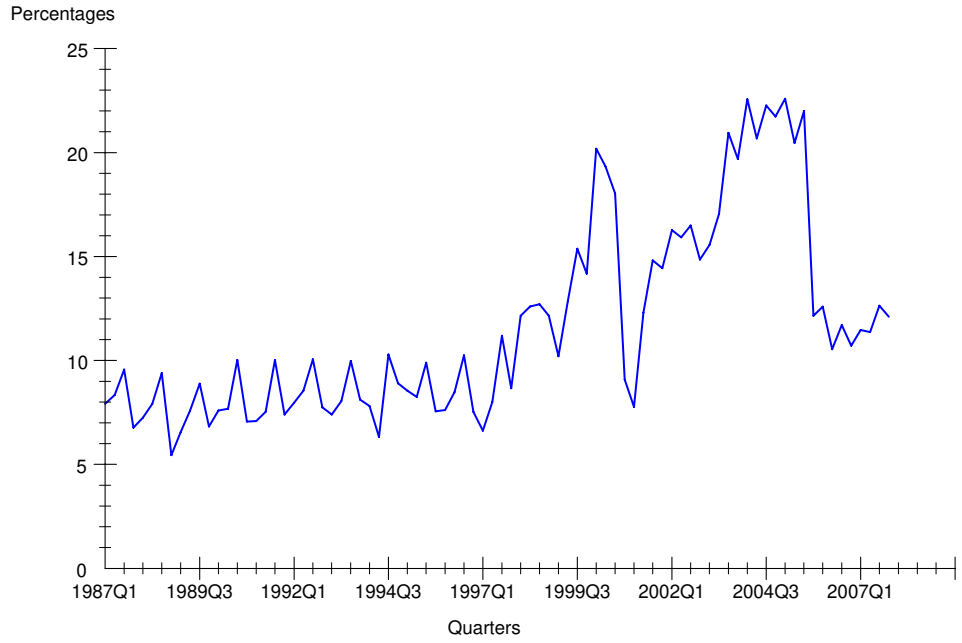
$$(C \times D) \times V = P \times T = GDP \quad (8)$$

where C is currency in circulation, D is deposits and GDP is income.

This approach assumes that the velocity of money in the recorded economy and in the UE is the same. The estimated currency holdings are computed from the above regression equation with the tax burden variable. The same regression equation results are also employed to calculate the currency holdings as the tax burden variable is set equal to zero. The difference between the estimated currency demand with and without the tax burden represents the amount of the illegal money is being held. The amount of legal money is measured by subtracting illegal money from the official narrow money stock M1, which includes currency in circulation (C) and deposits on demand (D). The estimated legal money stock is placed in equation (8) along with the actual level of the official GDP to compute the income-velocity of the legal money. Finally, the estimated income-velocity is multiplied by the illegal money holdings to obtain an estimate of the size of the UE. The size of the UE as a percentage of the official GDP over the estimation period is depicted in Figure 1. The results are, by and large, in line with the previous empirical works. The size of the UE in 1987 is measured as 10.6 % of the official GDP, and then it reached its peak point in 2004 with a figure of 27.4 %. The size of the UE substantially contracted to 16.4 % of the official GDP in 2001 when the Turkish economy had a record negative growth rate. As of 2007, the size of the UE is estimated as 18.9% of the official GDP.

The advances in electronic payment systems along with several effective directives issued by the Turkish Ministry of Finance seem to help in combating underground economic activities. The recent financial directives mandate that almost all of the salary and wages, rents, and direct and indirect taxes should be paid into banking systems. Private firms also intensively offer several financial incentives to their consumers to use their services to buy their products with different forms of electronic payments or cards, which reduce significantly the need for cash.

Figure 1. The size of the Turkish unrecorded economy as % of GDP



4.4 Results of causality

To conduct a Toda-Yamamoto type causality test between the recorded (y_t) and the unrecorded (x_t) economies, equations (5) and (6) were employed. The integration properties of the variable x_t are inspected through the usual unit root tests but are not displayed here either to conserve space. However, the variable x_t is $I(1)$. VAR (k) is determined on the basis of the AIC which suggests, k=5. The summary results of the Toda-Yamamoto causality test are reported in Table 4.

Table 4. The results of the Toda -Yamamoto causality test[a]

Equation	Null Hypotheses	p	χ^2_7 -statistic	Decision[b]
Eq. (5)	H_0: x_t does not cause y_t	7	12.55 (0.084)	Do not reject H_0
Eq. (6)	H_0: y_t does not cause x_t	7	17.32 (0.015)	Reject H_0

[a] p= [k+d(max)] stands for optimal lag length k=5, d_{max}=2. The probability values are reported in parentheses.
[b] at 5% level of significance.

According to the Toda-Yamamoto causality test results shown in Table 4, there is strong evidence of causality running from the recorded economy to the UE at the 5 percent level of significance. There is also noticeable evidence of the causality running from the UE to the recorded economy at the 10 percent level of significance. Therefore, it is plausible to conclude that the causality is bi-directional.

In term of economic implication, it suggests that the phenomenon of the UE exhibits a self-reinforcing mechanism which causes informality to persist. This "informality trap" (OECD, 2004) is more dangerous when the economy is in expensive phase. Hence, during a positive business cycle, it is clearly desirable for the government that the anti-UE controls be more effective.

5. Conclusions

In this paper, we estimated the size of the unrecorded economy in Turkey from 1987 to 2007 and investigated the long-run patterns and cyclical properties of the UE time series.

This analysis is subject to a relevant limitation. It is extremely difficult to compute reliable UE estimates. The literature on methods of estimating the UE is still lacking a widely accepted theory. Measures of the UE, and particularly those based on monetary approaches, have been criticized on several accounts[3], including their lack of robustness and weak theoretical foundations (e.g., the velocity of money in the recorded economy and in the UE is the same). To limit arbitrariness in measuring the UE, we suggest a further method based on ARDL models. The ARDL approach to estimating the size of the UE eliminates the criticism that the previous currency demand estimations are based on partial adjustment models (Ahumada *et al*., 2008). Therefore, our econometric selected cointegration methodology and causality test are an improvement over the existing studies. Furthermore, given their construction, these ARDL estimates are best considered in index form, rather than as absolute estimates seemingly comparable to official GDP calculations. The limited reliability of the UE estimates undermines the empirical assessments of theoretical statements on the effects of UE on recorded GDP and vice versa.

On the positive side, the size of the UE in 1987 is measured as 10.7% of the official GDP, and then it reached its peak point in 2004 with a figure of 27.4%. In 2007, the size of the UE was estimated as 18.9% of the official GDP

Empirical evidence concretely suggests that causality runs from the recorded GDP to the UE. However, there exists a mild reverse causality. Furthermore, the analysis indicates that the UE is pro-cyclical with respect to the recorded GDP, supporting the hypothesis that the official and unofficial sectors are complements rather than substitutes. This result fits with Dell'Anno's (2008) recent findings for Latin American countries.

We conclude that the UE in Turkey thus sustains the growth of the official GDP because it mainly creates additional resources to reinvest in the economy.

The pro-cyclicality of the UE has interesting economic policy implications. It suggests that the UE is increasing when the official economy is in expensive phases. Hence, government policies aimed at reducing the UE should mainly be carried out during a positive business cycle.

[3] Among the most recent research: Ahumada *et a*l. (2007, 2008); Simanjuntak, (2008); etc.

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Appendix - *Data definition and sources*

All data are collected from International Financial Statistics of the International Monetary Fund (IMF), Online Data Delivery System of the Central Bank of the Turkish Republic (CBTR), Main Economic and Social Indicators of State Planning Organization of Turkey (SPO), and Annual Statistics the (Turkish Statistical Institute (TSI).

c is real currency in circulation in billions of Turkish Lira (TL), in logarithm. It is deflated by the consumer price index of Turkey (CPI=2000=100) of Turkey Sources: CBTR, IMF.

y is real gross domestic product in billions of TL, in logarithm. It is deflated by the CPI. Sources: IMF and CBTR.

r is a weighted average of the interest rates on time demand deposits, in logarithm. Source: CBTR.

e is nominal exchange rates between TL and USA dollar, in logarithm: Source: CBTR.

b is tax burden of businesses which also includes the social security payments, in logarithm. Source: SPO and TSI.

x is computed size of the unrecorded economy in billions of TL, in logarithm. Source: own calculation.

M1 is narrow money supply in billions of TL. This data is used to compute the size of unrecorded economy. Source: CBTR.