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UNDERGROUND ECONOMY IN SAUDI ARABIA: A STUDY BASED ON CURRENCY DEMAND FUNCTION

The main objective of this study aims to estimate the size of underground economy in Saudi Arabia over the period of 1980–2010. Contrary to previous studies, this one examines the link between fiscal expenditures and underground economy using a currency demand function model with structural break. The results show that the estimated Saudi's underground economy is about 47.07% of the official GDP. Toda-Yamamoto dynamic Granger causality test indicates the causality between expenditures and underground economic activities in Saudi economy. Saudi government should restrict the expansion of its public expenditure policy to ensure that expenditures are directed for the true purpose as been planned.

Keywords: *underground economy; currency demand function; Toda-Yamamoto causality test; Saudi Arabia.*

JEL classification: E26; E41; C18.

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ТІНЬОВА ЕКОНОМІКА САУДІВСЬКОЇ АРАВІЇ: ДОСЛІДЖЕННЯ НА ОСНОВІ ФУНКЦІЇ ВАЛЮТНОГО ПОПИТУ

У статті зроблено спробу визначити розмір тіньової економіки в Саудівській Аравії в період з 1980 по 2010 роки. На відміну від попередніх досліджень, у даному перевірено взаємозв'язок між фіскальними витратами країни та тіньовою економікою з використанням функції валютного попиту за наявності структурного розриву. Результати демонструють, що тіньова економіка СА дорівнює приблизно 47,07% від офіційного ВВП країни. Тест Тода-Ямамото демонструє наявність причинно-наслідкового зв'язку між видатками країни та активністю тіньової економіки в Саудівській Аравії. Уряду СА необхідно переглянути та обмежити політику державних видатків з тим, щоб гарантувати, що вони йдуть на дійсно заплановані заходи.

Ключові слова: *тіньова економіка; функція валютного попиту; тест Тода-Ямамото на причинність; Саудівська Аравія.*

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ТЕНЕВАЯ ЭКОНОМИКА САУДОВСКОЙ АРАВИИ: ИССЛЕДОВАНИЕ НА ОСНОВЕ ФУНКЦИИ ВАЛЮТНОГО СПРОСА

В статье сделана попытка определить размер теневой экономики в Саудовской Аравии в период с 1980 по 2010 годы. В отличие от предыдущих исследований, в данном проверена взаимосвязь между фискальными расходами страны и теневой экономикой с использованием функции валютного спроса при наличии структурного разрыва. Результаты показывают, что теневая экономика СА равна примерно 47,07% от официального ВВП страны. Тест Тода-Ямамото демонстрирует наличие причинно-следственной связи между расходами страны и активностью теневой экономики в Саудовской Аравии. Правительству СА необходимо пересмотреть и ограничить политику государственных расходов с тем, чтобы гарантировать, что они идут на действительно запланированные мероприятия.

Ключевые слова: *теневая экономика; функция валютного спроса; тест Тода-Ямамото на причинность; Саудовская Аравия.*

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Introduction. It is recognized among economists that the issue of underground economy is a common feature of all the economies in the world. There is no country able to avoid underground economy as such (Blackburn, Bose and Capasso, 2012). Because of its hidden nature and various manifestations, estimating its size has been conducted using various methods. One of the most empirically used methods to capture underground economy is the currency demand function model (CDFM) approach (Pickhardt and Sarda, 2006). The basic idea of this method stems from the assumption that an increasing money demand in terms of cash is attributed to higher rates of taxation imposed on business firms in the economy. The method assumes that the fiscal variable of taxation is the key factor that can drive individuals to engage into underground economic activities. That is individuals increase their use of cash to elude paying taxes (Ardizzi et al., 2014). On the contrary, this study investigates the link between the fiscal variable of expenditures and underground economy through the growing changes in money demand within Saudi economy. On the basis of public expenditure we estimate the elasticity of money demand where substantial amount of public spending is suspected goes to some fictitious projects. Since 1983, the increase in public expenditures out of government revenues has become a channel for financial fraud that enhanced underground economy. The existence of illegal practices such as corruption caused people hold more cash and the trend is increasing. Cash normally ended up in underground economic activities. In line with the work of (Gadea and Serrano-Sanz, 2002), the likelihood ratio (LR) test for weak exogeneity proposed by (Johansen and Juselius, 1992) was also carried out to derive a single-equation model for currency demand, and estimate it as an Autoregressive Distributive Lags (ADL) model.

The Gregory-Hansen test was carried out to derive a single-equation model for currency demand which also accounts the effect of structural break in the system. The study also applies the autoregressive distributed lag – ARDL (Pesaran, Shin and Smith, 2001) to estimate the long- and short-run relationship between the variables in CDFM as a proxy to indirectly quantify underground economy. Toda-Yamamoto dynamic Granger causality test is also applied to investigate the casual relationship between underground economy and expenditures in Saudi economy.

The rest of this paper is arranged as follows. The next section provides the reasons for using the CDFM approach as applied to underground economy. The third section introduces data and methodology used along with model specification. In the fourth section, the results of empirical analysis are presented. The last section ends with the conclusions of the study.

The currency demand approach. Many methods have been used to obtain the estimates of underground economy. The CDFM approach is the most commonly employed (Buehn, 2012). It is used as a proxy to measure the magnitude of underground economy through excessive use of money in terms of cash in many countries (Hernandez, 2009). In CDFM, it is assumed that strict regulations and higher tax rates are the main reasons that drive people to engage in underground economic activities (Schneider, Buehn and Montenegro, 2010). Besides, money in cash is used to perform transactions but it also meant to conceal from authorities (Ahumada, Alvaredo and Canavese, 2009). Therefore, excessive use of cash reflects the size of underground activities in an economy (Berger et al., 2014). The most important issue of using CDFM is that the estimation of underground economy should be corrected as suggested by (Ahumada et al., 2007). This is to avoid false estimations and the criticism oriented towards the approach of CDFM in assuming the equality of income elasticity of money in both economies (formal and informal ones) (Ahumada et al., 2009).

In fact, CDFM approach does not operate in isolation of the shortcomings, but it remains an appropriate measurement to estimate underground economy. The method has been applied successfully in the context of other Gulf Cooperation Council (GCC) countries. As in the case of Saudi Arabia, the paper adopts the same approach in estimating the size of underground economy. In Saudi Arabia, the government uses cash to fund social services as part of its public expenditures. However, with rampant corruption, this could become a channel of financial fraud that can heighten the existence of underground economy. Thus, CDFM deems appropriate in estimating the underground economy in Saudi context.

Data and methodology.

1. Model specification. The data used in this paper consists of annual observations that cover the period of 1980—2010. The data are collected from the World Bank Data and Saudi Monetary Agency.

In this paper, the CDFM model for Saudi economy is based on the model introduced by (Ahumada et al., 2009; Hernandez, 2009) with some modifications:

$$M1_t = \alpha_0 EX_t^{\beta_1} G_t^{\beta_2} Rem_t^{\beta_3} \exp^{(\gamma_i h_i)}, \quad (1)$$

where $M1_t$ is the currency in circulation plus demand deposits; EX_t is the sensitive financial variable that can motivate people engage in underground economic activities; G_t is the income; Rem_t is the outflow of money remitted by foreign workers to their home countries; h_t refers to the sum of opportunity cost of holding money i_t, and inflation π_t, i.e. $h_t = (i_t + \pi_t)$. Equation (1) can be re-written as follows with α_0 being a constant and ε_t being the error term.

$$\ln M1_t = \alpha_0 + \beta_1 \ln EX_t + \beta_2 \ln G_t + \beta_3 \ln Rem_t + \gamma_1 i_t + \gamma_2 \pi_t + \varepsilon_t, \quad (2)$$

where $\beta_1, \beta_2, \beta_3 > 0$, $\gamma_1 \gamma_2 < 0$.

2. Unit root and cointegration tests. All variables in the study are tested for unit root using Perron's test (Perron, 1997). The P. Perron (1997) unit root test introduces 3 models namely Innovational Outlier model (IO1), Innovational Outlier model (IO2) and the Additive Outlier model (AO). These 3 forms represent change that occurs in the intercept of the trend function of the series, the change occurs in both the slope and the intercept of series in the trend function, the sudden and rapid change that occurred in the trend function of the series.

In this study we employed the A.W. Gregory and B.E. Hansen (1996) cointegration test method for testing long-run cointegration relation between the variables. The procedure takes into account the effect of the structural break in the system. The 3 forms of the A.W. Gregory and B.E. Hansen procedure are extended in regard to Equation (2) for testing the cointegration relationships between the variables in CDFM:

Model 1: cointegration with level shift dummy:

$$\ln M1_t = \mu_1 + \mu_2 DU_{tk} + \alpha_1 \ln EX_t + \alpha_2 \ln G_t + \alpha_3 \ln Rem_t + \alpha_4 i_t + \alpha_5 \pi_t + \varepsilon_t. \quad (3)$$

Model 2: cointegration equation with level shift dummy and trend:

$$\ln M1_t = \mu_1 + \mu_2 DU_{tk} + \mu_1 t + \alpha_1 \ln EX_t + \alpha_2 \ln G_t + \alpha_3 \ln Rem_t + \alpha_4 i_t + \alpha_5 \pi_t + \varepsilon_t. \quad (4)$$

Model 3: cointegration equation with regime shift dummy (full break) where both the level shift and the slope coefficients change:

$$\ln M1_t = \mu_1 + \mu_2 DU_{tk} + \alpha_1 \ln EX_t + \alpha_{11} \ln EX_t DU_{tk} + \alpha_2 \ln G_t + \alpha_{22} \ln G_t DU_{tk} + \\ + \alpha_3 \ln Rem_t + \alpha_{33} \ln Rem_t DU_{tk} + \alpha_4 i_t + \alpha_{44} i_t DU_{tk} + \alpha_5 \pi_t + \alpha_{55} \pi_t DU_{tk} + \varepsilon_t. \quad (5)$$

3. Long-run and short-run estimates. The study applies the ARDL analysis to capture the estimates of the long-run and short-run based on the CDFM as a proxy to indirectly quantify underground economy, taking into account the presence of structural break. The general form of ARDL representation of the CDFM in Saudi's economy is illustrated as follows:

$$\Delta \ln M1_t = \beta_0 + Dum_j + \sum_{i=1}^{n} \beta_{1i} \Delta \ln M1_{t-1} \sum_{i=0}^{n} \beta_{2i} \Delta \ln EX_{t-1} + \sum_{i=0}^{n} \beta_{3i} \Delta \ln G_{t-1} + \\ + \sum_{i=0}^{n} \beta_{4i} \Delta \ln REm_{t-1} + \sum_{i=0}^{n} \beta_{5i} \Delta i_{t-1} + \sum_{i=0}^{n} \beta_{6i} \Delta \pi_{t-1} + \delta_7 EX_{t-1} + \delta_8 G_{t-1} + \\ + \delta_9 Rem_{t-1} + \delta_{10} i_{t-1} + \delta_{11} \pi_{t-1} + \delta_{12} M1_{t-1} + e_t, \quad (6)$$

where Δ refers to the first difference operator, while n is the lag order. β_0 is the drift term, and e_t is the residuals. Dum_j corresponds to the effect of structural break. δ_s corresponds to the long-run parameters; β_s refers to the short-run dynamics of the model. Equation (6) introduces an estimate of the short-run dynamic error correction model (ECM) as follows:

$$\Delta \ln M1_t = \beta_0 + Dum_j + \sum_{i=1}^{n} \beta_{1i} \Delta \ln M1_{t-1} \sum_{i=0}^{n} \beta_{2i} \Delta \ln EX_{t-1} + \sum_{i=0}^{n} \beta_{3i} \Delta \ln G_{t-1} + \\ \sum_{i=0}^{n} \beta_{4i} \Delta \ln REm_{t-1} + \sum_{i=0}^{n} \beta_{5i} \Delta i_{t-1} + \sum_{i=0}^{n} \beta_{6i} \Delta \pi_{t-1} + \lambda ECM_{t-1} + v_t, \quad (7)$$

where the one period lagged for dynamic error correction model ECM_{t-1} corresponds to the residuals captured from the cointegrating long run equation as in Equation (6), while λ denotes the speed of adjustment to equilibrium. Finally, the model will undergo a series of diagnostic tests on its functionality and stability.

4. Estimating underground economy. Our analysis of the underground economy in Saudi Arabia is in line with the procedures introduced by (Hernandez, 2009). From currency demand function we obtained $M1$ with the financial variable $\ln \hat{M1}_t^{EX}$ and $M1$ without the financial variable $\ln \hat{M1}_t^{WEX}$. The size of illegal money ($IM1$) is obtained by multiplying $M1$ with the difference between $\ln \hat{M1}_t^{EX}$ and $\ln \hat{M1}_t^{WEX}$. The actual legal money ($LM1$) is the difference between $M1$ and illegal money $IM1$ and the velocity of income elasticity of money demand is given as a ratio of income (GDP) to actual legal money. The size of Saudi underground economy is then calculated by multiplying illegal money with money velocity. Finally, the estimation of the underground economy should be corrected as suggested by (Ahumada et al., 2007) as follows[3]:

[3] Equation (8) corrects our estimation of the underground economy when the coefficient of income elasticity is not equal to the one expected in this paper.

$$\frac{Underground_t}{GDP_t} = \left(\frac{IllegalCurrency_t}{LegalCurrency_t}\right)^{\frac{1}{\beta}} = \left(\frac{Underground_t}{GDP_t}\right)^{\frac{1}{\beta}}. \qquad (8)$$

5. Toda and Yamamoto causality test. The Toda and Yamamoto causality test is conducted to test the causal link between underground economy and public expenditures in Saudi economy (Toda and Yamamoto, 1995). As argued by (Zapata and Rambaldi, 1997), the advantage of this procedure is that it does not require the knowledge of cointegration properties of the system. It has a normal standard limiting χ^2 distribution and usual lag selection procedure to the system can be applied even if there is no contegration and/or the stability and rank conditions are not satisfied as long as the order of integration of the process does not exceed the true lag length of the model' (Toda and Yamamoto, 1995). In addition, under this procedure VARs can be estimated using the data in levels and "testing general restrictions even if the process may be integrated or cointegrated of an arbitrary order" (Toda and Yamamoto, 1995).

The procedure utilizes a modified WALD test for restrictions on the parameters of VAR(k), or MWALD procedure, where k is the lag length in the system. The test has an asymptotic χ^2 distribution when a VAR($k+d_{max}$) is estimated (where d_{max} is the optimal order of integration suspected to occur in the system).

In our case, causality test equations between the underground economy (Y) and the expenditures (X) in Saudi economy can be expressed as follows:

$$\ln Y_t = \alpha_0 + \sum_{i=1}^{h+d} \beta_i \ln Y_{t-i} + \sum_{i=0}^{k+d} \gamma_j \ln X_{t-j} + u_{yi}; \qquad (9)$$

$$\ln X_t = \alpha_0 + \sum_{i=1}^{h+d} \theta_i \ln X_{t-i} + \sum_{i=0}^{k+d} \delta_j \ln Y_{t-j} + u_{xi}. \qquad (10)$$

From (9) $\ln X_t$ causes $\ln Y_t$, indicates $\gamma_{1i} \neq 0 \forall_i$, and from (10) $\ln Y_t$ causes $\ln X_t$ if $\delta_{1i} \neq 0 \forall_i$.

Empirical results.

1. Unit root and cointegration tests. The results of P. Perron's (1997) unit root test of the variables are displayed in Table 1. The results reveal that all the variables concerned are integrated in order one or I(1) process at the 5% significance level with a different time break points, except the variables of the outflow of money and interest rate on deposits are integrated in order one at the 10% significance level.

The empirical result of the Gregory-Hansen cointegration test is displayed in Table 2. The result shows that the t test-statistics (-5.34) of ADF is significant at the 5% level for model 2. Since the null hypothesis of no cointegration in the Gregory-Hansen model 2, with a structural break point of money demand is rejected. This leads us to the conclusion that Saudi money demand in GH-2 has a long-run relationship with its determinants. The result indicates a break point for 1987[4].

[4] This break date of 1987 corresponds to the economic policy of Saudi government aimed to cover public budget deficit due to the decline in oil revenues during that period (Looney, 1992).

Table 1. **Perron unit root test results in level and first difference,** *authors'*

Variable	K	$t_{\hat{a}}$	*t-Crit.*	I(*d*)	TB	Model	$t_{\hat{a}}$	*t-Crit.*	I(*d*)	TB	Model
Ln(M1)	1	-3.99**	5.295.	I(0)	2000	B	5.64**	5.29	I(1)	1991	B
Ln(EXP)	1	-3.12**	23	I(0)	2004	A	5.62**	5.23	I(1)	1991	A
Ln(G)	1	-2.69**	5.23	I(0)	2003	A	6.19**	5.23	I(1)	1988	A
Ln(REM)	1	-3.78**	5.23	I(0)	1987	A	5.06***	4.93	I(1)	1994	A
(I)	1	-4.27**	4.83	I(0)	1987	C	4.70***	4.48	I(1)	1987	C
(π)	1	-4.97**	5.23	I(0)	2005	A	7.21**	5.23	I(1)	1991	A

Notes: 1. ** and *** denote the level of significance at 5% and 10 respectively. 2. The optimal lag selection is based on Schwert criteria (1989). 3. A, B and C refer to the change in intercept, intercept and trend, and change in the trend only, respectively.

Table 2. **Results of Gregory-Hansen Cointegration test for money demand model,** *authors'*

Type of model	TB	ADF-Stat.	*t*-Crit.	Reject of Null
GH-2(Eq.4)	1987	-5.34(2)**	-4.99	Yes

Notes: 1. ** denotes to the level of significance at 5%. The numbers in parentheses are lags. 2. Chosen for an optimal lag length is based on the criteria of Schwartz Bayesian information (BIC).

2. Long-run and short-run estimates. To obtain the estimates of Saudi CDFM in the long- and short-run, the ARDL model was applied. ARDL results are reported in Table 3. The empirical results show that all the explanatory variables as well as the dummy variable have an effect on CDFM in Saudi Arabia. The results are in line with the economic theory and are statistically significant at the 5% level. The value of adjusted R-squared indicates that about 83% of the variation in Saudi CDFM can be interpreted with its determinants. In addition, the value of the Durbin-Watson statistic test (DW-statistic = 2.11) indicates shows no evidence of serial correlation or heteroscedastic disturbances. The value of ECM met its advantages (it has a negative sign and is statistically significant at the 5% level). It represents 0.77% of the disequilibrium in the previous period is amended in the current period.

Table 3. **ARDL (3, 1, 3, 3, 2, 1) estimated long-run coefficients and short-run ECM (dependent variable – LM1),** *authors'*

Panel A: Long-run Coefficients Estimate selected on the basis of R BAR						
Cons	Dum1987	Ln(G)	Ln(EX)	Ln(Rem)	(I)	(π)
-13.04	-0.05(-1.36)	1.49(3.46)	0.85(3.81)	-0.33(-3.42)	-0.02(2.73)	-0.01(-2.58)

Panel B: Short-run Coefficient Estimates		
Regressors	Coefficient	t-Ratio[Prob]
ΔLM1(-1)	-0.614	-3.536[0.004]
ΔLM1(-2)	-0.629	-2.839[0.014]
ΔLnG	0.559	1.707[0.111]
ΔLnEX	0.707	2.929[0.012]
ΔLnEX(-1)	-0.151	-0.702[0.495]
ΔLnEX(-2)	-0.599	-2.309[0.038]
ΔLnRem	-0.075	-0.731[0.478]
ΔLnRem(-1)	0.239	3.170[0.007]
ΔLnRem(-2)	0.092	1.014[0.329]
ΔI	-0.016	-3.806[0.002]
ΔI(-1)	-0.008	-2.405[0.032]
Δ π	-0.005	-1.967[0.071]
Intercept	-9.999	-3.593[0.003]
Dum1987	-0.037	-1.212[0.247]
ECM(-1)	-0.766	-3.353[0.005]

Diagnostic tests:

$$DW = 2.11,\ R^2 = 0.95,\ AdjustedR^2 = 0.83,$$

$$SER = 0.001,(14,13)10.69[0.000], Period: 1980-2010.$$

$$\chi^2_{SC} = 0.29(0.58),\ \chi^2_{hS} = 0.15(0.70),\ \chi^2_{ff} = 1.94(0.16),\ \chi^2_{N} = 1.95(0.38).$$

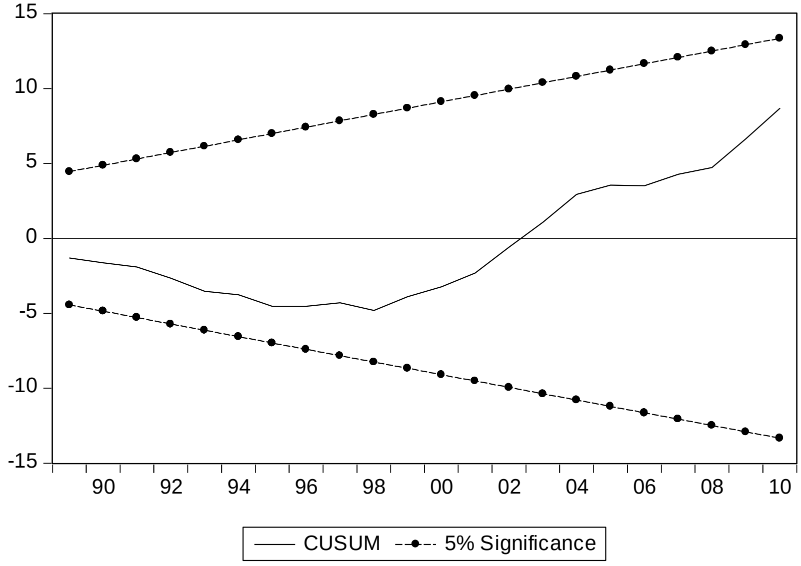

Figure 1. **Plot of CUSUM statistics for Saudi CDFM,** *authors'*

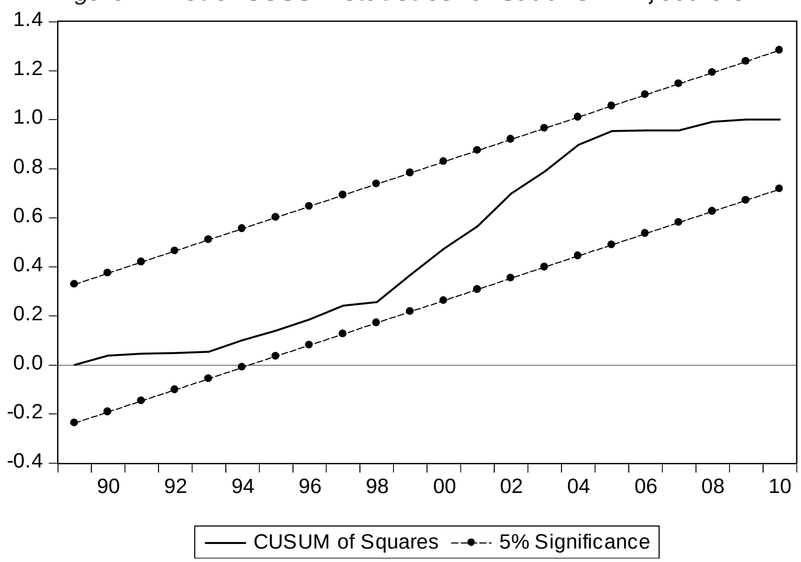

Figure 2. **Plot of CUSUMSQ statistics for Saudi CDFM,** *authors'*

The diagnostic tests support the validity of the short-run model. For the stability test of Saudi CDFM, CUSUM and CUSUMSQ tests of (Brown, Durbin and

Evans, 1975) were applied. The graphical plots of CUSUM and CUSUMSQ statistics tests are presented in Figures 1 and 2. Both plots indicate that Saudi CDFM is stable over the study period.

3. Saudi underground economy. Based on the currency demand function model (CDFM), the size of the long-run underground economy in Saudi Arabia is estimated using the ARDL procedure. The estimates obtained are corrected based on the condition, introduced by Ahumada et al. (2009). The results are displayed in Figure 3.

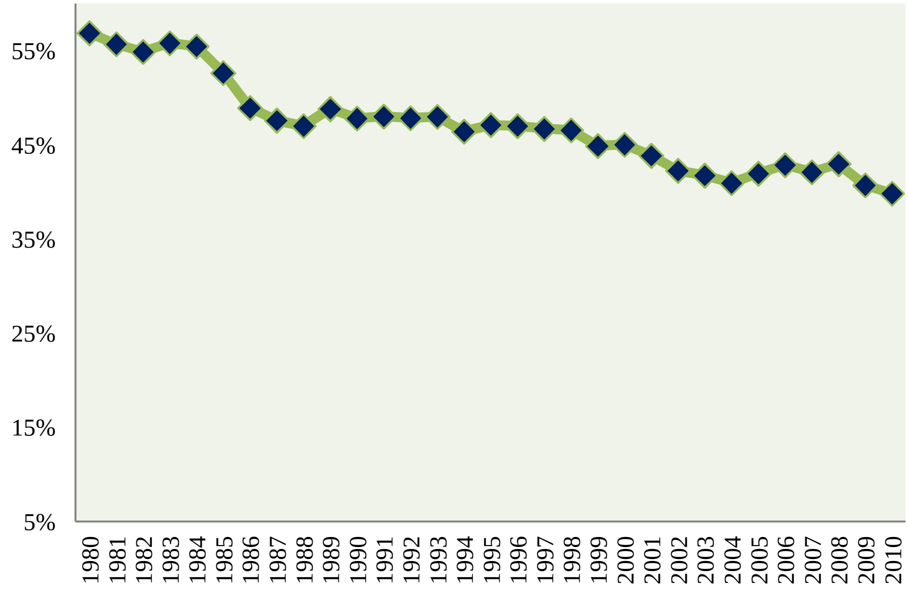

Figure 3. **Long-run estimates of the size of Saudi underground economy, 1980–2010**, *authors'*

The estimated size of underground economy relative to formal economy in Saudi Arabia is ranked between 57–40% over the study period. In term of percentage, the average estimated size is around 47.07% of GDP. The maximum of the estimated size was recorded during the period of 1982–1984, it drops slowly afterwards and then becomes stable around 45% of GDP. The estimated size of underground economy in Saudi Arabia in this study is in line with the earlier study by (Gamal and Dahalan, 2015).

4. Toda and Yamamoto Dynamic Granger causality test results. Using the annual estimated size of underground economy based on CDFM, we next perform a causality test to determine the causal relationship between the estimated underground economy and fiscal expenditure in Saudi Arabia. The Toda and Yamamoto Granger causality test results indicate there is a causality between underground economy in Saudi Arabia and public expenditure with the direction of the relationship from public expenditure to underground economy. The results of the test are presented in Table 4.

Table 4. **Toda and Yamamoto causality MWALD test results**

Hypothesis	Wald Statistics	P-Value	Decision
EX is not the cause of Y	8.89	0.012	Causality from EX to Y
Y is not the cause of EX	1.49	0.474	No Causality from Y to EX

Note: The optimal lag selection is based on Akaike Information criterion (AIC).

The results indicate the nonexistence of causality in the direction from underground economy to public expenditure. Indeed, the relationship between underground economy and fiscal variable, i.e. public expenditure is in tandem with the argument that the increase in public expenditures over time made it a channel for financial fraud that can enhance the existence of underground Saudi economy. Since, a substantial part of public spending have been diverted to fictitious projects rather than true enterprises in the economy. As a result of corruption practices, people holding cash also increased in quantity and this will prompt them to re-employ those amounts into underground economic activities again.

Conclusion. This paper used the currency demand function model CDFM as a proxy to indirectly estimate the underground economy in Saudi Arabia over the period of 1980–2010. On the contrary to prior studies, this study used the fiscal variable of expenditures as the sensitive variable that can enhance underground economy through growing changes in money demand.

In term of percentage, the estimated size of underground share in Saudi economy is about 47.07% of official GDP with the maximum size recorded in 1982–1984. Afterwards, it drops slowly and becomes stable at around 45% of official GDP. The causality analysis of Toda and Yamamoto indicates there is causality from the fiscal variable of expenditures to the underground economy. The results obtained could serve as a guide for Saudi policy makers in implementing measures that could prevent the leakages of fiscal expenditures.

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