An estimation of the underground economy and tax evasion

Empirical analysis from an emerging economy

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Abstract

Purpose – This paper aims to use an econometric model to estimate tax evasion from the size of the underground economy and examined the factors that trigger it.

Design/methodology/approach – The study used time series data sourced from world development indicators and Bank of Ghana covering the period 1990-2015 to estimate tax evasion from the underground economy using an autoregressive distributed lag model drawing on the currency demand approach.

Findings – The results confirmed the existence of a large underground economy and a high incidence of tax evasion in Ghana. The Ghanaian situation has been aggravated by an underground economy-triggering factor of mobile money activities, which increased by 83.1 per cent in 2015. Tax evasion averaged 20.78 per cent of GDP over the period. The study, thus, concludes that the increased number of mobile money activities, high tax burden and unemployment contribute to the worsening of the tax evasion problem in Ghana.

Originality/value – The study is one of the premier attempts to introduce electricity power consumption variables in the currency demand model to estimate tax evasion from the size of the underground economy. The authors hypothesize that the emergence of mobile money activities in its current form triggers underground and tax-evading activities. The study, thus, calls for the formalization and regulation of the operations of mobile money activities in emerging economies as a way of managing the underground economy, which incubates tax evasion.

Keywords Ghana, Mobile money, Underground economy, Tax evasion, ARDL cointegration

Paper type Research paper

1. Introduction

The challenges of tax administration have been variously researched and chronicled. Otieku (1992) posited that the major problems of tax administration in Ghana are the poor level of voluntary compliance with tax laws by taxpayers, complex and fragmented tax laws, predominance of cash transactions and tax evasion.

Tax evasion is widespread, always has been and probably always will be Slemrod (2007). Alleyne and Harris (2017) concluded that tax evasion is a major challenge for governments the world over, with innovative and ever-changing schemes, which makes it increasingly difficult to regulate. Tax evasion has been defined as "an illegal act or practice of failing to pay taxes, which are owed to the state" (Benk *et al.*, 2015).

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In 2010, the Global Financial Integrity (GFI, 2010) estimated that African countries have lost US$854bn in cumulative capital flight[1] over the 1970-2008 period. The more the incidence of tax evasion, the greater the share of the tax burden that falls on the few law-abiding and tax compliant citizens. Therefore, policymakers need to address the issue to avoid a breakdown of the tax system as taxpayers burdened by the high tax rates caused by tax evasion may desert their tax obligations and become tax evaders.

In a time when the government's debt levels are high[2] and the budget deficits are worsening, the size of the tax evasion should be a key variable in the tax policy equation. Where the level of tax evasion is low, the government has high potential to mobilize tax revenues for developmental projects. Hence, addressing tax evasion is vital if public services are to be well preserved while providing support to businesses and taxpayers.

The inability of the formal private sector to generate jobs in their required numbers has forced many Ghanaians into the informal sector. The unemployment rate as a percentage of labour force stood at 1.8 per cent in 2013 but shot up to 2.4 per cent in 2014 (WDI, 2015). This is because, in the absence of appropriate social protection mechanisms, informal activities have become survival strategies for many Ghanaians both old and young. The origin of the informal sector in Ghana's economy can be traced to the pre-independence period. Though it was heterogeneous in nature, it accommodated varieties of peasant proprietors and agricultural labourers, distribution agents, buyers, transport owners and employees, porters and repairers.

Over the years, instead of fading as modern economies grew, the informal sector has actually grown in the rural and urban areas of Ghana. Ghana's structural adjustment programme of the early 1980s with its attendant significant retrenchment of labour and the inability of government to provide employment for the growing labour force was enough for a large pool of unemployed persons to gravitate towards the informal sector. Osei-Boateng and Ampratwum (2011) reported that in 2011, about 88 per cent of the Ghanaian workforce was in the informal sector.

Consequently, economists and policymakers have become intrigued by the activities, size and possible economic impact of the informal sector, also referred to as the underground, second, parallel, subterranean, hidden, black or shadow economy (Organization for Economic Cooperation and Development (OECD, 2002). To date, there is no consensus on the definition of the underground economy (Schneider and Hametner, 2014).

The activities of most of these economic agents in the informal sector escape the attention of tax officials and are difficult to detect because the participants make private gains by keeping the activities concealed. These gains may take the form of evaded taxes, non-compliance with tax laws, income from prohibited and criminal activities or fraudulent receipt of various government benefits (Tanzi, 1983).

Additionally, the extent of tax evasion in an economy and the size of the hidden economy are difficult to observe and investigate because of their covert nature. Prior literature (Tanzi, 1983; Savasan, 2003; Dell'Anno, 2007; Bayer and Sutter, 2008; Bayer, 2006; Cebula and Saadatmand, 2005; Fishlow and Friedman, 1994; Caballe and Panade, 2004; Aigner, Schenider and Ghosh, 1988; Kasipillai, Aripin and Amran, 2003; Jain, 1987; Joulfaian and Rider, 1996; Martinez-Vazquez and Rider, 2005; Crane and Norzad, 1986; Koyame, 1996; Alleyne and Harris, 2017) have attributed the size of hidden economy and tax evasion to several factors. These tax evading triggering factors include high tax burden, unemployment, complicated tax structure and dishonest staff.

As a result, various methods have been developed since the 1950s by various researchers to calculate the size of the hidden economy and the extent of tax evasion in several tax jurisdictions. These include Cagan (1958), Allingham and Sandmo (1972) and Tanzi (1980) in

the USA; Matthews (1982) in the UK; Klovland (1984) in Norway and Sweden; Bajada (1999) in Australia; Giles (1999a, 1999b) in New Zealand; Koyame (1996) in eight sub-Saharan African countries; Schneider (2002) in 21 OECD countries; Giles and Tedds (2002) in Canada; Ariyo and Bekoe (2012) in Nigeria; Asante (2012) and Bekoe (2012) in Ghana and Cebula and Feige (2011) in the USA. These methods can be classified into three categories, namely, direct, indirect and modelling[3] approaches.

The direct approaches are of two types, namely, the survey and tax auditing methods. The indirect approaches include discrepancy between national expenditure and income approach, discrepancy between official and actual labour force approach, transaction approach, physical input method (electricity consumption approach) and the currency demand approach (CDA). There are two versions of the modelling approach, namely, the multiple indicator–multiple cause and the dynamic multiple-indicator multiple-cause approaches.

The study adopted the CDA because it is the most widely used method (Schneider, 2003; Pickhardt and Sarda, 2006, 2011; Ardizzi *et al.*, 2013). In addition, the CDA approach is appropriate to the conditions of emerging economies to calculate the size of the tax evasion from underground economy.

The objective of the study is to estimate tax evasion from the size of the underground economy by using the CDA and examine the factors that trigger tax evasion. The recent applications of the CDA are important in lending new insights into the size and causes of tax evasion in Ghana and other emerging economies, especially in the face of recent underground economy triggering factors such as the increasing number of mobile money activities and the growing demand for electric power consumption.

Following the preceding discussion, it is hypothesized that as tax burden and unemployment rates increase, taxpayers are encouraged to engage in tax-evading activities. These activities are facilitated by the use of currency and thereby increasing the demand for currency, and consequently, the ratio of currency holdings to money is expected to rise. A high tax burden will, therefore, increase the underground economy, and therefore, tax evasion. It is also expected that an increase in mobile money activities in Ghana will increase the demand for currency for tax evading activities.

The rising trend of cash with the non-bank public in Ghana[4] and the rapid rate of innovation in the financial sector with its attendant impact on the underground economy motivated our research interest in estimating tax evasion. According to the National Communications Authority (NCA), the number of active mobile money customers increased by 92.7 per cent from 2,526,588 in 2014 to 4,868,569 in 2015. The total volume of mobile money transactions grew by 135.2 per cent from 113,179,738 in 2014 to 266,246,537 in 2015. Four mobile network operators offering mobile money service also registered 13,120,367 mobile money customers in 2015, which represents an increase of 83.1 per cent from the preceding year's figure.

The second motivation for the research is the increasing demand in electric power consumption in Ghana. This grew by 55.43 per cent from 245.96 kWh per capita in 2007 to 382.31 kWh per capita in 2014 (WDI, 2015). The study, thus, used electric power consumption, as a proxy for the number of mobile money activities in Ghana as a new variable in the currency demand model.

As prior studies ignore the emergence of mobile money activities, the estimated equations may be incomplete, and the coefficient estimates from these equations may be spurious. As this omission is carried over, the calculation of the size of tax evasion may be flawed in recent times and in the context of dynamism in economic activities of emerging

economies. Therefore, methodologically the study extends literature by incorporating electric power consumption as a new variable in the currency demand model.

The rest of the paper is organized as follows: Section 2 reviews theoretical and empirical literature on the underground economy, tax evasion and the CDA. Section 3 outlines the model specification, data sources and estimation techniques. Section 4 discusses the results and findings of the study. Finally, Section 5 concludes the study and proposes recommendations for tax policy decision-making in Ghana and other emerging economies.

2. Literature review

This section discusses relevant theoretical and empirical literature on economic models for calculating tax evasion from the underground economy and key triggering factors of tax evasion. The importance of this review is to provide a strong foundation for the empirical model used for the study.

2.1 Tax evasion theory

Unarguably, the theoretical literature on tax evasion is based on the pioneering research of Allingham and Sandmo (1972), which was modelled on Becker's (1968) economic approach to crime. Their study analysed the tax evasion decision of an individual as a choice under uncertainty and the effect of the tax rate, taxpayer's income, and enforcement parameters on the level of tax evasion under certain assumptions. A major criticism of this study is its inability to address issues of variations in the tax rate.

Yitzhaki (1974) resolved some of the ambiguities in the Allingham and Sandmo's model by assuming that the penalty rate is imposed on the evaded tax rather than on the unreported income. Interestingly, though Yitzhaki's model resolved the ambiguity regarding the effects of the tax rate on the extent of tax evasion, its conclusion is inconsistent with the common view that a higher tax rate increases tax evasion.

Later, researchers such as Pencavel (1979) and Sandmo (1981) extended the Allingham and Sandmo tax evasion model by incorporating labour supply decision with the tax evasion decision to make income endogenous. The second extension to the Allingham and Sandmo model was the consideration of the interaction of taxpayers and tax authority by making the probability of audit endogenous (Andreoni *et al.*, 1998).

Another remarkable feature of the Allingham and Sandmo (1972) model is the assumption that taxpayers will report only a single piece of information to the taxing authorities. However, contemporary tax researchers such as Martinez-Vazquez and Rider (2005) contend that taxpayers report more than a single piece of information. Using their model, Martinez–Vazquez and Rider argued that income and enforcement parameters have an ambiguous effect on compliance.

In Marrelli (1984)'s study on individual firm behaviour towards indirect taxation [sales tax, valued added tax (VAT), etc.], he stated that in the case of a monopolistic firm, tax evasion and pricing policy are independent between themselves, given constant probability to audit.

Scotchmer and Slemrod (1989) incorporated the perceived uncertainty of the true tax liability in the model, which they opined takes the form of a probability distribution. They concluded that because of multiple possible fines at any given level of income concealment, the taxpayer's predicament becomes more complicated.

Extending the tax evasion theory to embrace game theory, Erard and Feinstein (1994) used the basic model, allowing for two types of taxpayers: one honest and one dishonest. They observed that by incorporating honesty into the tax compliance game, equilibrium

solution is substantially altered, depending on the income distribution of dishonest taxpayers and the relative percentage of honest taxpayers.

Lately, the broad literature on tax evasion theory has shifted towards tax compliance and tax non-compliance issues. Torgler (2003a) in his empirical analysis, approximates tax morale as the "justifiability" of cheating on taxes and the "belief" of the extent of wrongdoing by underreporting to reduce tax liability. He identified the factors affecting tax morale by focusing on the analysis of institutions in a setting where direct democracy can be distinguished from federalism.

Lederman (2003) investigates the interdependence of social norms and effective enforcement from a legal standpoint. She contends that consistency of enforcement mechanism underlines normative tax compliance.

Further, Torgler (2003b) relied on world value survey and taxpayer opinion survey data to investigate the effect of rules on tax morale. He provided empirical evidence to suggest that trust in the constitutional and political process have positive effect on tax morale. As a tax policy direction, he advised governments and tax authorities to endeavour to create a stable, fair and predictable environment, to inspire confidence and increase tax revenue through increased tax morale. As an extension of his earlier work, Torgler (2006a, 2006b) finds direct democracy and finds religiosity to influence positively tax morale.

Finally, Frey and Torgler (2007) posited that taxation should be perceived as a social act. According to them, a taxpayer's decision is largely influenced by the perception of the honesty of others forming a social norm. They find strong evidence that conditional cooperation is an important trigger of tax morale.

From the foregoing, tax administration has been and will continue to be an important aspect of tax revenue collection and tax evasion policies in both emerging and developed economies. Therefore, it is imperative to calculate and quantify tax evasion from the extent of the underground economy of these economies and to examine the tax evasion triggering factors.

As the findings from the numerous previous studies are mixed, the calls for further studies from multiple perspectives will continue in both formal and informal contexts. The context and dynamism of tax evasion is much more compelling and demanding of empirical evidence on the operational and practical efficacies or otherwise of tax administration orientations.

2.2 The currency demand approach for estimating tax evasion

The CDA relies on demand for money in circulation as an indicator of the underground economy. Taxes are seen as the main reason why people engage in underground economic activities leading to tax evasion. The approach assumes that individuals who are involved in the underground economy use cash in their transactions to evade taxes on their underground economic activities.

The CDA was first used by Cagan (1958) to calculate the size of the US underground economy over the period 1919-1955 by computing the correlation between the currency demand and the tax burden for the USA. Although, the study investigated the determinants of currency to M2 ratio, it did not use the relationship to estimate the size of tax evasion. Cagan's argument was that as currency leaves no traces for tax evasion activities, taxpayers would use currency rather than other modes of payment such as cheques. Therefore, as the tax burden increases, tax evasion increases, and hence, the demand for currency relative to broader money (M2) increases.

Gutmann (1977) and then Feige (1979) used the same approach but without any econometric procedures. What Gutmann sought to do was to segregate the US money

supply, M1, into currency and demand deposits. He calculated the size of the shadow economy using the currency in circulation method. He observed that currency in circulation was growing more than demand deposits in the USA in 1976, and argued that "currency is the only form of cash suitable for transactions that go unrecorded and untaxed; the disparity is a reflection of growth in the subterranean, extra-legal economy". By taking the ratio of the money in circulation to the size of gross national product (GNP), he calculated the size of the shadow economy in 1976.

Tanzi (1980, 1983) is one of the pioneers in developing CDA in calculating tax evasion from the size of the shadow economy using econometric techniques. He finds that for 1976, the underground economy of the USA was between 10-31 per cent, depending on the tax rate definition used.

A number of researchers have also successfully replicated Tanzi's method on OECD countries. For example, Matthews (1982) studied the effect of the income tax rate and the VAT rate on the ratio of cash to demand deposits in the UK. Using this relationship, he estimated the underground economy for UK, which he pegged at about 7.5 per cent of GNP.

Klovland (1984) tests the effect of marginal tax rates on currency demand for Norway and Sweden. While the estimations for Sweden corroborate the positive effect of marginal tax rate on currency holdings, the effects for Norway were found to be negative. For Sweden, the hidden economy was estimated to be 3-20 per cent of GDP, depending on the different specifications calculated and the tax rate definition used. The hidden economy of Norway was not calculated, as there was no strong relationship between tax rate and currency holdings.

Bajada (1999) modifies Tanzi's model by using error correction model (ECM) and including a welfare benefits variable, along with other variables, in estimating the demand for money in circulation in Australia using quarterly data for the period 1967-1996. He finds that the increase in average tax rates and the rise in welfare benefits in Australia induced Australians to be involved in the shadow economic activities to supplement their disposable income. The results show that the shadow economy in Australia increases from 13.9 per cent of GDP to a peak of about 15.7 per cent. It was, thus, concluded that a significant and volatile shadow economy was shown to have adverse implications on the nature of the business cycle in Australia. Other studies that use the currency approach for OECD countries include Giles (1999a, 1999b) for New Zealand, Schneider (2002) for 21 OECD countries and Giles and Tedds (2002) for Canada with mixed results.

Cebula and Feige (2011) used a modified version of Feige's (1989) general currency ratio model to estimate a time series of the ratio of unreported income to reported income. They computed the quantum of income tax evasion in the USA from 1940 to 2008 and investigated the extent of tax non-compliance and the determinants of federal income tax evasion. Their initial empirical study assumption, being that in a particular year the income tax evasion is zero was dropped.

The CDA has also been used in calculating the underground economy and tax evasion in some developing and emerging economies. For example, Saunders and Loots (2005) for South Africa; Koyame (1996) for eight sub-Saharan African countries; Ariyo and Bekoe (2012) for Nigeria; Bekoe (2012) for seven selected African countries; Asante (2012), Annan *et al.* (2014) and Asiedu and Stengos (2014) for Ghana. These recent applications of the currency demand method for developing and emerging economies are significant in offering new understandings into the size and causes of tax evasion in these tax jurisdictions. Interestingly, the findings are mixed.

Most of the CDA studies are fraught with various weaknesses that make it necessary to investigate the issue further. One major limitation found with prior studies of the CDA is the

discounting of tax burden in the model. We argue that the burden of tax will have a strong impact on the levels of tax compliance and evasion. Thus, a country with higher tax burden will have a higher tax evasion and vice versa. We, therefore, incorporated the tax burden variable in our model.

The second limitation of prior research of the currency demand equation in developing countries is that they inappropriately apply the Tanzi method in the context of these countries. In some developing and transitional economies, some residents hold a large part of foreign currency either for tax evasion purposes or sometimes because of lack of confidence in the monetary sector. This has been aggravated by the emergence of mobile money activities in most emerging economies, hence, its inclusion in our model.

Thirdly, the approach assumes that any increase in the demand for currency is because of an expansion of the informal economy. However, an increase in demand for currency is not always because of informal activity only. For example, Feige (1986) found that the reason for the rise in currency demand deposits was largely the decline in the demand deposits and not because of an increase in informal activity.

Notwithstanding the limitations, Schneider (2003), Pickhardt and Sarda (2006, 2011) and Ardizzi *et al.* (2013) posits that the CDA is the most commonly used approach to provide the most reasonable estimates of the size of the shadow economy, and hence, tax evasion. Further, it is a technique appropriate to the conditions of emerging economies such as Ghana.

The study contributes to the literature by incorporating electric power consumption as a new variable in the currency demand model.

2.3 Factors promoting tax evasion

The disposition of taxpayers to pay taxes varies widely across tax jurisdictions, hence, in this section, we discuss the factors, which trigger tax evasion in general.

One of the main causes of tax evasion is the tax burden. Savasan (2003) and Dell'Anno *et al.* (2007) are amongst the researchers who have indicated that an increase in tax burden will lead to high underground economy and tax evasion. Bayer (2006) concluded that higher tax rates led to more evasion in European economies. In related work, Cebula and Saadatmand (2005) indicated that higher tax rates on income led to an increase tax evasion for the USA during the 1967-1997 periods.

In Barbados, Alleyne and Harris (2017) found that unfavourable attitudes towards tax evasion perceived difficulty to perform the action and a strong sense of moral obligation influence lower intentions to engage in tax evasion.

Some researchers, including Crane and Norzad (1986), Fishlow and Friedman (1994) and Caballe and Panade (2004), who investigated the link between inflation rate and tax evasion for the US economy postulated that inflation rate and tax evasion are positively related.

A high underground economy, and hence, tax evasion could be caused by the size of the government and intensity of regulations. The bigger the size of the government, justifying the intensity of its regulations, the more the difficulty the government could have in controlling each of its sectors. This has the potential to increase the level of tax evasion. Prior studies, which investigated the relationship between the size of government, its regulation and shadow economy such as Aigner *et al.* (1988), found that high intensity of government regulation led to high underground economic activities, and hence, high tax evasion:

> Trade openness is yet another factor that can trigger tax evasion. Trade regulations become complicated when the size of trade shores up. Some traders tend to avoid doing trade legally as a

result. Therefore, smuggling will escalate, and hence, inducing tax evasion as difficult laws and more restrictions are imposed on trade.

The tax culture of a tax jurisdiction is another factor that causes tax evasion. Kasipillai *et al.* (2003) assessed the influence of education on tax compliance among undergraduate students in Malaysia and found that there is a close relationship between education and tax compliance.

Unemployment is another factor that causes tax evasion. Dell'Anno *et al.* (2004) showed that unemployment and self-employment are important factors that breed the underground economy, and hence, tax evasion in France, Spain and Greece.

Lack of transparency and accountability in the disbursement of public funds creates distrust. This, therefore, triggers the inclination to evade taxes (Kirchler *et al.*, 2007).

Cagan (1958) states that the degree of urbanization is a potential factor affecting tax evasion. He argued that the effect of the degree of urbanization is two-fold. Urbanization causes people to transact business where they are not known, which increases the use of cheques as a medium for payment. On the other side, the usage of cheques is lower in rural areas.

The level of education is considered a factor that promotes tax evasion (Koyame, 1996). The higher the level of education of a country's citizens, the more prevalent the use of cheques and other saving accounts will be, and hence, less underground activities.

Jain (1987) also identified complicated tax structure, dishonest staff, high tax rates and high tax rate on sales as factors that cause high black money, and hence, tax evasion in India.

Finally, high compliance costs, which are costs taxpayers bear to collect the required information and fill out essential tax forms, could be tax evasion enhancing factor (Everest-Phillips, 2008).

2.3.1 Mobile money activities in Ghana. Mobile money is a form of transfer system where cash is transferred from one person to another through an agent; the identities of both the transferor and recipient are not required to be disclosed. In an emerging economy like Ghana, as mobile money transactions in its current form leave little or no trace, is as good as the use of cash for business transactions.

Kaufmann and Kaliberda (1996) assume that to measure overall economic activity (official and underground), electric power consumption is observed as the single best physical indicator. They posit that general economic activity and electricity consumption have been empirically observed worldwide to move in tandem with an electricity-to-GDP elasticity. Further, Lackó (2000) assumes that in each country, a part of the household consumption of electricity is used in the underground economy. As activities of mobile money transfer system depend on electricity usage for their operations, an increase in their activities will lead to an increase in demand for electric power consumption.

From the foregoing, the study introduces the number of mobile money activities as a factor, which encourages underground activities, and hence, tax evasion in an emerging economy like Ghana. The rise in the phenomenon of mobile money activities as payment and transfer of cash system is very significant in Ghana. Statistics show that the total volume of mobile money transactions grew by 135.2 per cent in 2015 (NCA) and between 2007 and 2014 electric power consumption increased by 55.43 per cent (WDI, 2015).

3. Methodology: data sources and empirical specification

3.1 Model specification and data sources

The objective of the study is to estimate tax evasion from the size of the underground economy by relying on the currency demand model of Tanzi (1980, 1983). Tanzi (1983)

assumed that the ratio of the currency in circulation to money supply (C/M2) is a function of income tax rate in addition to other explanatory variables as specified in the following equation (1):

$$\ln(C/M2)_t = \beta o + \beta 1 \ln(1 + TW)_t + \beta 2 \ln(WS/Y)_t + \beta 3 \ln(R_t) + \beta 4 \ln(Y/N)_t + \mu_t$$

where, $C/M2$ is the ratio of currency in circulation to broad money supply, TW is the weighted average income tax rate, WS/Y is the proportion of wages and salaries in national income, R is the interest paid on saving deposits, Y/N is the per capita income and ln denotes the natural logarithms.

Annual time series data covering the period 1990-2015 were used to study the underground economy and tax evasion in Ghana. The choice of the length of the period of the study depended solely on data availability. Data for the dependent variable (currency to M2 ratio) and one of the control variables (tax burden) were drawn from Annual Bank of Ghana (BOG) Reports. Data for the other control variables were sourced from World Bank's database (world development indicators).

In our model specification based on the CDA, the proxy to measure the dependent variable used is the ratio of currency in circulation I to total broad money (M2). The narrow definition of money (M1) comprises notes and coins in circulation with the publI(C) plus domestic demand deposits held by the non-bank private sector. M2 is also the sum of narrow money (M1) plus time savings and foreign currency deposits held in banks.

The study used a modification of Tanzi's method by Bajada (1999), Cebula and Feige (2011) and Ariyo and Bekoe (2012). As an extension to the currency demand model, this paper introduced electric power consumption (KWh per capita) as a control variable, which is the key factor in the electricity consumption approach. This variable proxy for the number of mobile money activities.

Therefore, the econometric model for our research is specified as follows:

$$\begin{aligned} \ln C/M_{2t} = {} & \beta_0 + \beta_1 \ln TGDP_t + \beta_2 \ln GDPP_t + \beta_3 \ln TRAD_t + \beta_4 \ln UNEM_t \\ & + \beta_5 \ln EPCM_t + \varepsilon \end{aligned} \tag{1}$$

where:

- β_0 is the constant of the regression model;
- ln denotes natural logarithms;
- C/M2 is the currency in circulation to broad money ratio;
- TGDP is the ratio of tax revenue to GDP, measure of tax burden, a proxy for the tax rate, to proxy changes in the underground economy;
- GDPP is the GDP per capita (current LCU), to proxy changes in the size of the shadow economy. This is expected to reduce the demand for currency as economic development is assumed to replace the demand for currency by the use of cheques;
- UNEM is the unemployment percentage of total labour, also representing the size of the informal sector;
- TRAD is trade as a percentage of GDP, indicating the volume of trade;
- EPCM is the electric power consumption, kWh per capita (a proxy for the number of mobile money activities);
- ε is the error term that is $\varepsilon_t \sim (0, \sigma^2)$; and
- t is time period ranging from 1990 to 2015.

Stock and Watson (2007) have argued for the need to transform time series data by computing their logarithms because changes in the original series are proportional to percentage changes in the original series. The study followed the Tanzi (1980, 1983) studies by taking the natural logarithms of the variables.

Apart from GDP per capita, we expect all the above variables to have a positive relationship with currency in circulation to broad money ratio.

3.2 Estimation techniques

The study used time series analysis as the main estimation technique. Estimations and interpretations concerning the relationships and properties are then modelled using the autoregressive distributed lag (ARDL). ARDLs are standard least squares regressions that include lags of both the dependent variable and explanatory variables (Greene, 2008). The justification for the choice of the ARDL model is because of the number of observations because of unavailability of data. However, as the theoretical CDA uses macroeconomic variables, the study identified the variables in the specified model above that follow a random walk by taking a natural log of each variable. Enders (1995) has observed that most macroeconomic time series data are usually non-stationary. Therefore, the potential existence of unit roots in the variables could lead to spurious estimates (Harvey, 1991).

According to Dickey and Fuller (1979), using the ADF unit root test helps to determine whether the variables are stationary in log-linear levels and then proceeding to determine their order of integration at which the series become stationary. Furthermore, Phillips and Peron (1988) have argued that the PP test has an advantage over the ADF because it gives robust estimates when the series are serially correlated and suffer from time-dependent heteroskedasticity. Although pre-testing for unit root is not a requirement of the ARDL cointegration model, we conducted the tests to ensure that none of the variables are integrated of I(2). In line with this, our estimation procedure commenced with performing stationarity tests using both the Augmented Dickey–Fuller (ADF) and the Phillip–Peron (PP) tests.

To empirically analyze the long-run equilibrium relationship among the variables and the associated short-run dynamics, we estimated the unrestricted ECM within the ADL model. The ARDL bounds testing for cointegration was developed by Pesaran *et al.* (2001). The model is specified as:

$$\begin{aligned}\Delta\ln(CM2)_t = {} & \alpha_0 + \sum_{i=1}^{p}\phi_i\Delta\ln(CM2)_{t-i} + \sum_{i=0}^{p}\theta_i\Delta\ln(TGDP)_{t-i} + \sum_{i=0}^{p}\theta_i\Delta\ln(GDPP)_{t-i} \\ & + \sum_{i=0}^{p}\varphi_i\Delta\ln(UNEM)_{t-i} + \sum_{i=0}^{p}\varphi_i\Delta\ln(EPCM)_{t-i} + \sum_{i=0}^{p}\varphi_i\Delta\ln(TRAD)_{t-i} \\ & + \delta_1\ln CM2_{t-1} + \delta_2\ln TGDP_{t-1} + \delta_3\ln GDPP_{t-1} + \delta_4\ln UNEM_{t-1} \\ & + \delta_5\ln EPCM_{t-1} + \delta_6\ln TRAD_{t-1} + \psi ECM_{t-1} + \mu_t \qquad (2)\end{aligned}$$

where Δ is the difference operator, p is the optimal lag length, ψ represents the speed of adjustment and ECM_{t-1} is the lagged error correction term measuring the speed of adjustment following a shock to the system, thus, linking the short-run deviations to long-run equilibrium.

The statistical notations α, ϕ and δ are the elasticities of the respective variables, with μ representing the stochastic error term and t the time period from 1990 to 2015. The resulting sign of the ECM_{t-1} must be negative and significant concurrently to ensure convergence of the dynamics to the long-run equilibrium.

Further, the resulting value of the coefficient, ψ, which represents the speed of adjustment to the equilibrium process normally ranges from −1 and 0. The value −1, signifies perfect and instantaneous convergence while 0 shows no adjustment after a shock in process.

The ARDL has some advantages over earlier and traditional cointegration methods such as the Johansen cointegration. The first is that it does not require all the variables under study to be integrated of the same order. It is also applicable irrespective of whether the underlying series are I(0) or I(1) but not I(2). The second advantage is that the ARDL test is relatively more efficient in the case of small and finite sample data sizes (Narayan, 2004). Thus, the ARDL technique accommodates small sample sizes. Finally, in applying the ARDL technique, unbiased estimates of the long-run model are obtained (Harris and Sollis, 2003).

4. Results and discussion

Under this section, we report the results and show how tax evasion was computed from the underground economy.

Table I shows that the absolute ADF and PP *t*-statistic values of the variables are less than the critical values at 5 per cent significance level indicating that all the variables have unit roots.

However, based on the results obtained in Table II, it can be observed that all the variables are stationary at their first difference, an indication that the level is I (1). The

Table I.
Unit root test results at levels

	Critical values**			Level	
Variable	1%	5%	10%	ADF test statistic	PP test statistic
lnCM2	−3.72407	−2.98623	−2.63260	−1.12716	−1.11267
lnTGDP	−3.72407	−2.98623	−2.63260	−2.59157	−2.53469
lnGDPP	−3.72407	−2.98623	−2.63260	−0.073206	−0.83493
lnUNEM	−3.75295	−2.99806	−2.63857	−2.11788	−1.96725
lnEPCM	−3.75295	−2.99806	−2.63857	−2.01353	−1.95656
lnTRAD	−3.72407	−2.98623	−2.63260	−2.07209	−2.05590

Note: **Critical values are obtained from MacKinnon (1996)

Table II.
Unit root test results at first difference

ADF and PP unit root test results

	Critical values**			First difference		
Variable	1%	5%	10%	ADF test statistic	PP test statistic	Order of integration
ΔlnCM2	−3.73785	−2.99188	−2.63554	−4.33229	−5.17912	I(1)
ΔlnGTGDP	−3.73785	−2.99188	−2.63554	−5.71423	−7.07064	I(1)
ΔlnGGDPP	−3.73785	−2.99188	−2.63554	−4.94594	−4.95554	I(1)
ΔlnUNEM	−3.76956	−3.00486	−2.64224	−7.55128	−7.89605	I(1)
ΔlnEPCM	−3.76956	−3.00486	−2.64224	−5.78512	−5.79301	I(1)
ΔlnTRAD	−3.73785	−2.99188	−2.63554	−4.45060	−4.43708	I(1)

Note: **Critical values are obtained from MacKinnon (1996)

study, therefore, proceeds to test whether there is a linear relationship between the variables of the same order of integration by using bounds test for cointegration.

Before testing for cointegration we conducted the lag order selection process to select the number of lags to include in the ARDL model. The results of the final prediction error, Akaike information criterion, Schwarz information criterion and Hannan–Quinn information criteria indicate a lag order of equation (2). We, therefore, proceed to further tests with two lags. Table III reports the ARDL bounds tests for cointegration.

The bounds test is based on the joint *F*-statistic whose asymptotic distribution is non-standard under the null hypothesis of no cointegration. The null hypothesis of no long-run relationship is rejected when the value of the test statistic exceeds the upper critical bounds value. From Table III, the *F*-statistic of 14.716 is greater than the upper bounds at all significance levels, thereby confirming the existence of long-run relationship among the variables.

Table IV reports long-run elasticities of the variables, indicating their standard errors, *t*-statistics and p-values. The cointegrating equation produced from Table IV is given as:

$$\text{Cointeq} = \text{lnCM2} - (-1.1821^{*}\text{lnTGDP} - 0.1075^{*}\text{lnGDPP} - 0.1931^{*}\text{lnUNEM} - 0.3696^{*}\text{lnEPCM} + 1.1439^{*}\text{lnTRAD} - 0.0275 \quad (3)$$

where Cointeq is the ECM.

However, as the results are normalized on the lnCM2 because of the normalization process, the long-run elasticities signs are reversed to enable proper interpretation. Thus, the long-run estimated equation for further analysis becomes:

		ARDL bounds test		
	Test statistic		Critical values	
	Value	Significance (%)	Lower bound	Upper bound
F-statistic	14.71620**			
		10	2.26	3.35
		5	2.62	3.79
		2.5	2.96	4.18
		1	3.41	4.68

Note: **Critical values are obtained from Narayan (2004)

Table III.
ARDL Bounds tests for cointegration

	Dependent variable: lnCM2			
	Selected model: ARDL(2, 2, 2, 2, 2 and 2)			
Variable	Coefficient	Std. error	*t*-statistic	Prob.
lnTGDP	−1.182110	0.507696	−2.328382	0.0804
lnGDPP	−0.107494	0.011422	−9.410827	0.0007
lnUNEM	−0.193110	0.078299	−2.466325	0.0692
lnEPCM	−0.369607	0.170335	−2.169886	0.0958
lnTRAD	1.143941	0.223550	5.117168	0.0069
C	−0.027495	1.502953	−0.018294	0.9863

Table IV.
Estimated long-run elasticities using ARDL

$$\ln CM2 = 1.1821\ln TGDP + 0.1075\ln GDPP + 0.1931\ln UNEM + 0.3696\ln EPCM - 1.1439\ln TRAD + 0.0275 \quad (4)$$

From Table IV, all the variables apart from lnGDPP posted the expected elasticities signs and are also significant determinants of currency in circulation as a ratio of broad money supply, and hence, tax evasion.

Table V reports results of the short-run dynamics. It shows that there are significant effects of the lags of some of the independent variables on dependent variable. All the explanatory variables with the exception of lnGDPP at lag 1, lnUNEM at lag 1 and lnEPCM at lag 1 are statistically significant. The cointegrating equation as expected is negative and significant at 10 per cent.

A negative sign implies that any shock that occurs in the short-run would be rectified in the long-run. The results show that mathematically the ratio of the money in currency to broad money supply adjusts partially by about 114.06 per cent in the short-run towards its long-run equilibrium. This confirms the long-run equilibrium relationship running from currency in circulation to money broad money supply ratio to lnTGDP, lnGDPP, lnUNEM, lnEPCM and lnTRAD.

The ARDL regression for the underlying ARDL equation (3) fits very well and the selected model ARDL (2, 2, 2, 2, 2 and 2) is also very significant. The model satisfies other specification and diagnostic tests. Finally, the overall statistical properties of the regression are good as indicated by adjusted R^2 of 97.59 per cent and the values of t-statistics displayed

Table V.
Results of short-run dynamic model using ARDL

Dependent variable: lnCM2 Selected model: ARDL(2, 2, 2, 2, 2 and 2)				
Variable	Coefficient	Std. error	t-statistic	Prob.
Δ(lnCM2(−1))	−0.251859	0.136646	−1.843145	0.1391
Δ(lnTGDP)	−0.771956	0.151369	−5.099817	0.0070
Δ(lnTGDP(−1))	0.427405	0.117207	3.646581	0.0218
Δ(lnGDPP)	1.138466	0.172517	6.599142	0.0027
Δ(lnGDPP(−1))	0.338734	0.194538	1.741218	0.1566
Δ(lnUNEM)	0.029060	0.027896	1.041735	0.3564
Δ(lnUNEM(−1))	0.019463	0.041068	0.473933	0.6603
Δ(lnEPCM)	−0.250137	0.094414	−2.649361	0.0570
Δ(lnEPCM(−1))	−0.161743	0.089011	−1.817113	0.1434
Δ(lnTRAD)	1.392404	0.171278	8.129520	0.0012
Δ(lnTRAD(−1))	−0.546697	0.104398	−5.236645	0.0064
CointEq(−1)	−1.140643	0.350438	−3.254907	0.0312
R^2	0.995415	Mean dependent var		−1.083952
Adjusted R^2	0.975930	S.D. dependent var		0.180992
S.E. of regression	0.028080	Akaike info criterion		−4.375921
Sum squared resid	0.003154	Schwarz criterion		−3.483250
Log likelihood	66.13513	Hannan–Quinn criter.		−4.165634
F-statistic	51.08637	Durbin–Watson stat		1.638848
Prob (F-statistic)	0.000829	Jarque–Bera		0.40478
Breusch–Godfrey test	0.4670	Ramsey RESET test		0.0799
White heteroskedasticity	0.4190			

Source: Authors' calculations

in Table V. Therefore, the model could be accepted as approximating the relationship being tested.

4.1 Calculating the size of underground economy and tax evasion in Ghana

The basic justification for the CDA to calculate the size of the hidden economy is that all incomes will be reported as long as the tax rate is zero. However, illegal economic activities would remain hidden even if the tax rate were nil.

Furthermore, because cash is the preferred means of financing hidden transactions, when the tax rate increases, there will be a corresponding increase in currency holdings reflecting an increase in hidden economic activity.

Finally, the model pivots on the assumption that the velocity of money in circulation in the hidden economy is the same as that in the legal economy.

Relying on the long-run elasticities of the variables in equation (4) and following the Tanzi (1980, 1983) procedure, the hidden economy and tax evasion were calculated. We proceed to calculate the size of the hidden economy and tax evasion using the following steps:

(1) The elasticities of equation (4) are used to derive predicted values for currency demand with tax rate as a variable in the model, $\ln CM2_{wt}$.

(2) The predicted currency holdings, $\ln CM2_{nt}$ in the event of a zero tax rate are obtained by setting $\ln TGDP_t = 0$ in the estimated equation (4), keeping all other variables constant.

(3) The difference ($\ln CM2_{wt} - \ln CM2_{nt}$) provides an estimate of illegal currency in the economy.

(4) The computed value of illegal currency step (3) is subtracted from the value of' narrow money, M1 to obtain a value of' legal money used for transaction purposes.

(5) Compute the velocity of money in circulation by dividing nominal GDP by the value of legal money as obtained in step (4).

(6) Calculate the size of the underground economy by multiplying the illegal currency step (3) by the velocity of money step (5).

(7) Calculate evasion by multiplying the size of the underground economy by the tax rate (lnTGDP).

Table VI displays estimates of the size of the hidden economy and level of tax evasion from 1990 to 2015, as well as estimates of illegal money.

According to the results by 1990, tax evasion was 14.86 per cent [Ghanaian Cedis (GHS) 28.54 m] of the GDP but increased to 20.35 per cent (GHS 552.64 m) in 2000 before settling at 23.32 per cent (GHS 32,629.9 m) in 2015. Thus, the results in Table VI validated the existence of a large underground economy and high tax evasion in Ghana.

5. Conclusion

This paper attempts to estimate tax evasion from the size of the underground economy by using a modification of Tanzi's currency demand model. The factors that trigger tax evasion were also discussed. The following key results emerged.

Firstly, the results of the bounds test confirmed that all the variables are cointegrated and have long-run relationships. The empirical findings show that the ratio of the currency

Year	Illegal money (GHS'M)	Size of hidden economy (GHS'M)	Tax evasion (GHS'M)	GDP (GHS'M)	Tax evasion as a % of GDP
1990	79.63	264.02	28.54	192.08	14.86
1991	99.32	315.50	41.52	242.75	17.10
1992	145.82	372.51	40.12	280.29	14.31
1993	201.62	501.99	66.01	387.21	17.05
1994	318.07	665.76	107.59	520.50	20.67
1995	422.47	992.47	145.79	775.17	18.81
1996	572.67	1,444.66	218.00	1,133.87	19.23
1997	822.30	1,797.35	263.67	1,411.34	18.68
1998	1,053.66	2,152.47	339.66	1,729.60	19.64
1999	1,273.43	2,571.50	385.98	2,057.98	18.76
2000	1,748.81	3,398.77	552.64	2,715.25	20.35
2001	2,650.70	4,718.91	814.01	3,807.07	21.38
2002	4,054.57	6,128.32	1,117.19	4,886.20	22.86
2003	5,975.37	8,170.93	1,717.53	6,615.77	25.96
2004	7,646.60	9,871.54	2,152.98	7,988.79	26.95
2005	8,558.21	11,878.78	2,466.04	9,726.08	25.35
2006	11,833.46	22,728.58	4,602.54	18,705.08	24.61
2007	17,397.03	27,845.95	6,140.03	23,154.45	26.52
2008	20,638.37	37,140.38	5,905.32	30,178.60	19.57
2009	24,458.45	44,071.32	6,786.98	36,597.59	18.54
2010	36,393.02	55,870.05	9,330.30	46,042.10	20.26
2011	51,090.08	72,117.34	15,000.41	59,816.32	25.08
2012	58,742.37	92,973.49	15,898.47	75,315.37	21.11
2013	66,399.52	115,946.13	17,507.87	93,415.89	18.74
2014	91,622.69	139,646.36	23,320.94	113,343.40	20.58
2015	121,983.17	169,066.82	32,629.90	139,935.86	23.32

Table VI.
Estimates of the hidden economy and tax evasion in Ghana, 1990-2015

in circulation to broad money supply adjusts towards the long-run equilibrium at the speed of about 114.06 per cent.

Secondly, this study unlike prior studies, introduced the electric power consumption (a proxy for mobile money activities), as a new variable in the CDA. After establishing the relationships in the currency demand equation, we estimated tax evasion from the underground economy computations.

Thirdly, the empirical results indicate that in the long-run the underground economy and tax evasion in Ghana are triggered by tax burden, GDP per capita, unemployment, trade as a per cent of GDP and electric power consumption. All the elasticities carry their expected signs apart from GDP per capita. The results are consistent with Annan *et al.* (2014), who established that tax burden triggers tax evasion in Ghana.

Fourthly, the results show that the Ghanaian economy is characterized by a high underground economy and tax evasion levels, with tax evasion averaging 20.78 per cent of GDP over the period. The results are consistent with Asante (2012), who estimated that tax evasion ranges from 4 per cent to about 14 per cent of GDP.

Fifthly, we accept the hypotheses that as the tax burden and unemployment rates rise, the greater the incentives are to work in the underground economy, thereby motivating the incidence of tax evasion.

Finally, the study identified the underground economy-triggering factor of mobile money activities, which in its current form poses a threat to the traditional forms of money transfer system.

5.1 Contribution and policy recommendations

Methodologically, the study extended literature by introducing a new variable in the currency demand model to estimate tax evasion from the underground economy.

To reduce tax evasion, the government and policymakers need a reliable estimate of the underground economy and the level of tax evasion in Ghana. While the government has argued that it is addressing the tax evasion menace, the results show that it is rather worsening.

Therefore, the research provides a basis for the government to evaluate its tax evasion reduction strategies and embrace new methodologies to ensure that it deals effectively with the issue to ensure the realization of sustainability development goals. We posit that the current tax evasion reduction strategies of emerging economies such as Ghana require a relook as evidenced by our research findings.

From the foregoing, we propose new tax evasion reduction strategies such as improving tax morale to ensure compliance, curtailment of multiplicity of taxes with its inimical effects on overall tax revenue, minimizing tax compliance costs, dealing with corruption and changing the tax culture of citizens.

Further, we propose the introduction of compulsory tax education into the curricula at the basic school level of emerging economies instead of the current tertiary level (which is even optional depending on the choice of the student's degree programme) to revolutionize the tax culture and ensure an appreciation of taxation as a tool for the development of such national economies.

Finally, we propose that formalising and regulating the activities of mobile money operators and vendors through the central bank would help reduce tax evasion and significantly boost tax revenues to improve the development of such economies and the welfare of the citizenry.

Notes

1. Illicit financial flows are monies that are earned, transferred or used unlawfully, hence, tax evasion.
2. Ghana's external debt jumped from US$7,653m in 2011 to US$15,718.8m in 2015, which is 42.8 per cent of GDP.
3. The modelling approaches make use of structural econometric model pertaining to the particular economic phenomenon under study.
4. BOG reports that it has increased by 190.5 per cent from GHS 2,927.2m in 2010 to GHS 8,503.71m in 2015.

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