



ESTIMATING THE SIZE OF THE UNDERGROUND ECONOMY IN BARBADOS

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*Presented at the 26th Annual Review Seminar
Research Department
Central Bank of Barbados
July 26-29, 2005*

ABSTRACT

In Barbados, and the Caribbean as a whole, very little research has been done on the topic of the informal economy. This paper estimates the size of the Barbadian informal sector for the period 1972-2003. Our estimates suggest that this sector is quite large and has grown over time to about one-third the size of the official economy. These results are consistent with the stylised fact about the Barbadian economy, in particular the large number of persons employed in small business and trading versus the number tax returns filed on an annual basis and also claiming to have incomes way below taxable levels. The finding of a significant sized informal sector also has implications for the conduct of both monetary and fiscal policy. At the minimum it means that possible spill-over effects between the two sectors must be taken into consideration in the design and execution of policies.

1. Introduction

The informal economy is a phenomenon that spans all income classes and all economic sectors. It consists of various types of activities, ranging from domestic work (maids, mechanics, gardeners) to registered businesses that underestimate their sales and overestimate their expenditure. It is a known fact that the informal economy does exist, however, there have always been problems in trying to estimate its size and value. Informal economy data are not reflected in the national statistics and may lead to not only inaccurate but also unreliable macro indicators. Such data may consequently result in erroneous policy decisions.

This paper is the first stage in a two-stage process in trying to assess the size and relevance of the informal economy in Barbados. In this stage, an attempt was made to measure the size of this sector. The second stage will entail surveying and quantifying the contributions of the sub-sectors to GDP.

The next section attempts to define the informal economy, and identify its main causes. It also discusses the advantages and disadvantages of the shadow economy and looks at the methods used in estimating its size. The following section deals with some of the studies that were conducted in the Caribbean and gives a review of their results. In section 4, estimates for the size of the informal economy in Barbados are made, using the currency demand approach.

2. A Literature Review of the Underground Economy

2.1 Definition of Terms

Several terms are used in defining the unmeasured economy. Terms such as informal, hidden, underground, invisible and shadow are but a few. Many of these concepts are used interchangeably to mean the same thing. However some distinction must be made in order to effectively measure this activity.

Any economic activity that does not appear in the statistics of the national income and GDP is considered to be part of the hidden economy. When asked, many people think of the hidden

economy as being illegal activities; however this is not necessarily so. While it may be true that all illegal activity lie within the hidden economy, there are many legal ones that also contribute. For example, when a carpenter who is employed in the official economy is paid to do work for a friend outside of his working hours, and does not report this income to the tax authorities, he too is participating in the hidden economy. A teacher who gets paid for out-of-class lessons may also be participating in this economy if this income is not reflected on the tax form. This information would normally have been measured if brought to the attention of the relevant authorities. Table 1 shows some of the various ways, both legal and illegal, in which people can participate in the hidden economy.

Table 1 **Types of Underground Economic Activities**

Type of Activity	Monetary Transactions	Nonmonetary Transactions			
ILLEGAL ACTIVITIES	Trade in stolen goods; drug dealing and manufacturing; prostitution; gambling; smuggling; fraud.	Barter of drugs, stolen, or smuggled goods. Producing or growing drugs for own use. Theft for own use.			
LEGAL ACTIVITIES	Unreported income from self-employment. Wages, salaries, and assets from unreported work related to legal services and goods	Employee discounts, fringe benefits.	Barter of legal services and goods.	All do-it-yourself work and neighbour help.	

Source: Lippert and Walker, *The Underground Economy: Global Evidence of its Size and Impact*. Vancouver, B.C., The Frazer Institute, 1997.

2.2 Reasons for the Increase in the Hidden Economy

The growth in hidden economies is creating a problem for governments and policy makers around the world. The rise in hidden economic activity is due to several identifiable reasons. The most important of these being increasing tax burdens and social security contributions, increased regulations in the official economy, especially in the labour markets, poor governance and the presence of significant corruption in government operations.

Taxes and Social Security

High tax rates lead to a low tax morality which in turn leads to individuals becoming more willing to participate in the hidden economy, in order to evade payment of taxes. Studies have shown that in the official economy, as net wages increase, there is a decrease in the work force of the hidden economy. Furthermore, the bigger the difference between input and the after tax earnings from work, the greater the incentive for persons to participate in the hidden economy. As such the tax regime and the social security system will have significant influence on the growth of the shadow economy.

Government Regulations

Research has indicated that countries with more regulations on their economies have larger hidden economies (Johnson, Kaufmann and Shleifer (1997)). Regulations such as licensing requirements, labour market regulations, restrictions for foreigners, and trade barriers, all aid in increasing the cost of labour and consequently cause many people to shift to the hidden economy. It is often the case that employers react to these high costs by transferring them to their employees or even by reducing their labour force. These employees then find other sources of income, often through the hidden economy. Intense regulations can also cause employers to stay in the informal economy to avoid higher and non-transferable legal burdens.

Some countries, such as France, have even implemented restrictions on hours worked in order to reduce unemployment. While this is a commendable attempt to distribute limited working opportunities more fairly, it creates the incentive and the time for people to participate in the hidden economy.

Governance and Corruption

Countries with strong and efficient government institutions have smaller hidden economies. It has been found that there is an increase in the growth of the shadow economies in societies where governments do not effectively and fairly carry out their tax laws and regulations.

2.3 Advantages and Disadvantages of the Hidden Economy

Some of the advantages of the hidden economy are that it

- Encourages entrepreneurship and creativity.
- Aids the official economy. Most of the income that is earned in the hidden economy is spent in the official sector.
- Forces prices in the official economy to fall in order to remain competitive. This benefits the consumers, including those who work in the official sector.
- Gives displaced workers the opportunity to generate their own income, rather than relying on government benefits or nothing at all.
- Provides employment, especially in times of scarce work opportunities, and gives families an avenue through which they can meet their needs and improve their way of life.
- Contributes to high productivity and encourages growth if supported.
- Is often used as an outlet for built up frustration and tension in the public system.

Some of the disadvantages are that it:

- Takes away valuable government revenue. This causes increased tax rates in order to sustain revenue levels. The lost revenue results in a decline in the provision of public goods and services that would have otherwise benefited the general public.
- Creates a problem for policy makers by distorting economic information by overstating unemployment and inflation rates, and understating growth rates. Consequently, policies are often erroneous and cause adverse reactions.
- Develops unfair competition against the official economy and thereby effectively lowering the official economy's income.
- Has low income and productivity. Additionally, there is few development strategies implemented in this economy, causing a lack in productive growth.
- Increases corruption and political lobbying.

2.4 Measuring or Estimating the Hidden/ Informal Economy

The process of measuring the informal economy is a difficult one since there is often a lack of information pertaining to the hidden economy, as persons prefer anonymity for fear of the relevant consequences. Nevertheless, there are many techniques used to estimate the size and structure of the hidden economy. These methods can be placed into three main categories: Direct, Indirect, and Model approaches with each having its own strengths and weaknesses. Most of the techniques used are indirect and may provide a wide range of estimates.

2.4.1 Direct Approaches

There are two methods of this approach, the Sample Survey and the Tax Audit procedures. Both techniques provide detailed information about the structure of the hidden economy, however they only provide lower-bound estimates (minimum range which may be considered accurate) for the size of the activity. The direct approaches are sometimes referred to as micro approaches.

The Sample Survey

The survey technique is relatively new, only being actively used in the last two decades. The main benefits from using this method are the in-depth conclusions that can be drawn from its results. Useful information about the size and structure of the hidden economy can be derived from this process. However, the obtained results greatly depend on the structure of the questionnaire. A badly formulated questionnaire does not give persons the incentive to reveal their participation in the hidden economy and cooperate with the survey. This unwillingness can lead to unreliable results, and hence accurate estimations and inferences are unable to be made.

The Tax Audit

Differences between the income submitted for tax purposes and that which is calculated by tax audits lead to information on the hidden economy (Frey and Pommerehne, (1984)). Threats of fines and imprisonment force participants to reveal this hidden income, which would have otherwise provided the government with useful revenue.

The tax audit method leads to a few difficulties. The estimates based on this technique do not provide complete information about the size of the hidden economy and these results tend to be

biased. The data that is used (tax compliance data) may itself be a biased sample of the population. Only persons who complete tax forms are considered for audit but most persons submitting these forms will comply and submit accurate information. However, this bias is somewhat lessened because the selection of those persons to be audited is done based on tax forms that show some possibility of fraud. This procedure only displays the fraction of this economy that the authorities were able to catch.

2.4.2 Indirect Approaches

These techniques allow for estimates to be drawn from seemingly unrelated information. This is useful because, as stated before, many persons do not want the relevant authorities to know of their participation in this economy, and hence try their best to conceal it. These procedures try to deal with this problem. The indirect processes are sometimes called macro approaches since they use macroeconomic indicators to extract information about the development of the informal economy. Accounting statistics, the labour statistics, the monetary balances, and the physical outputs are all types of the indirect approach.

The indirect approaches have many benefits but they also have their shortcomings. They provide information on the size of the economy but are unreliable when it comes to determining its structure. Another problem is that they often require some assumptions to be made, which often cannot be proven.

Accounting Statistics

The accounting statistics approach can be used on both the individual and the national level to derive estimates of the hidden economy. It uses discrepancies between expenditure and income to draw conclusions (Schneider and Enste, (2000)). In the presence of the informal economy, the income (and production) measure of national income will not be the same as the expenditure measure, and in fact, the latter will be much higher. Therefore, the surplus of expenditure over income is an indicator of the size of the shadow economy.

The individual level, rather than a national one, yields better results. Processes like the Family Expenditure Survey in the United Kingdom, separately measure income and expenditure on a

daily basis, using record books and information on credit and hire purchase. It provides more detailed information about the sectors and industries in which work can be obtained. The figures generated are almost identical to those on the national level.

Nationally, this technique is useful and easy when the relevant information on expenditure is available, however it will only capture the lowest range of estimates of the shadow economy that can be considered to be accurate. Expenditure data is difficult to collect because it is almost impossible to keep accurate records of every transaction that takes place. Expenditure information may even be dependent on income information which may lead to inaccurate estimates. In addition the discrepancy used to make these estimates often include errors and omissions in the accounting statistics. In fact, the difference between the two aggregates is almost always attributed to the error and omission terms and as such would make the resulting estimates unreliable.

Labour Force Statistics

The labour force statistics method assumes that the participation in the official labor force remains constant. Hence any decline in the participation in the official work force can be assumed to be an estimate for growth in the shadow economy, *ceteris paribus*, (O'Neill, (1983)). More specifically, this approach assumes increasing underground economic activity when the ratio of employment to population is decreasing with the ratio of labour supply to population relatively constant.

However, although it is relatively simple in its calculations, this method is flawed in its major assumption, the constancy of the participation rate as individuals may leave the official economy for reasons other than to participate in the hidden economy. Furthermore, it is compounded by the fact that persons can work in both the official and hidden economies. Such persons go undetected, and are not considered as part of the hidden economy's work force. To use this assumption leads to unreliable results and gives weak estimates of the size of the hidden economy.

Monetary Balances

The monetary balances approach seems to be the most commonly used system to estimate the hidden economy. The three procedures that fall under the monetary balances approach, involve assumptions about the volume of monetary transactions, and the use of currency.

(a) Currency Demand

Cagan (1958) was the first to use the currency demand method followed by Gutmann in 1977. The approach was very simple, using only the ratio between currency and demand deposits. Tanzi (1980, 1983) further developed the original model. Under the assumption that all hidden economic activity takes place, using cash as means of exchange, it is further assumed that the increase in demand for cash indicates an increase in the shadow economy. He included in his equation the factor that is identified as the main reason for participation in the hidden economy, tax burdens.

The basic equation that Tanzi proposed is:

$$\ln(C/M_2)_t = \beta_0 + \beta_1 \ln(1+TW)_t + \beta_2 \ln(WS/Y)_t + \beta_3 \ln R_t + \beta_4 \ln(Y/N)_t + u_t$$

Where $\beta_1 > 0$, $\beta_2 > 0$, $\beta_3 < 0$ and $\beta_4 > 0$ and, $\ln$ denotes the natural logarithm, C/M_2 is the ratio of the cash holdings to current plus deposit accounts, TW is a weighted average tax rate (to proxy changes in the size of the hidden economy), WS/Y is the proportion of wages and salaries in national income (to capture changing payment and money holding patterns), R is the interest rate paid on savings deposits (to capture the opportunity cost of holding cash), and Y/N is the per capita income.

The unexplained value u_t , which is the excessive increase in currency, is then attributed to factors leading individuals to participate in the hidden economy. The model is estimated twice: once in its current state and again by imposing zero tax rate values. The difference between these two estimates represents the volume of currency in circulation in the underground economy. Multiplying this difference by the velocity of money yields the nominal aggregates of the underground economy.

This procedure may provide an underestimate for the size of the economy, because not all of the transactions take place-using cash as means of exchange. This method assumes that there is a base year of no hidden economic activity.

(b) *Transactions*

Feige developed the transaction method in 1979. The size of the shadow economy is estimated by utilising information on the overall volume of transactions in the total economy. Information is generated by the equation:

$$MV = pT$$

Where M = money supply
 V = velocity of money
 p = price level of transactions
 T = volume of transactions

It is assumed that there is a constant relationship between the volume of transactions and the total official GDP over time (Feige, (1979, 1989, and 1996). Assumptions are also made about the velocity of the money and also, that there is a base year of no hidden economic activity. From this data the total GDP can be calculated. The difference between the total GDP and the official GDP is the GDP of the hidden economy.

The assumption that there is a base year of no hidden economy is problematic. This is compounded by assuming (i) a fixed transaction ratio over time and (ii) that the hidden economy is the only factor affecting a change in the transaction ratio. These are strong assumptions and raises questions about the reliability of the results.

Physical Outputs - (Electricity Consumption)

The physical outputs method assumes that electricity consumption is the best indicator for overall economic activity (official and hidden) (Kaufman and Kaliberda, (1996)). Because the electricity/GDP elasticity has been observed to be close to one, the growth rate of the official GDP can be subtracted from the growth rate of electricity consumption. This resultant value is attributed to the growth of the hidden economy.

This method is easy to use because of the availability of the information required. However, there are problems that have arisen with its application. First, not all of the hidden economic activity requires electricity, other sources of energy are used. Second, due to technological advances, electricity consumption has become more efficient. Third, the electricity/ GDP elasticity may vary over time.

2.4.3 The Model Approach

This technique considers both the causes and the effects of the hidden economy over time. It is based on the dynamic multiple-indicators multiple causes (DYMIMIC) model. It consists of two parts: a measurement model linking the observed indicators to the size of the informal economy; and a structural-equations model specifying causal relationships among the observed indicators.

The three main causes identified are tax burdens, government regulations and tax morality. The three main indicators are (i) development of monetary indicators, (ii) labour markets, and (iii) production market. The method is in-depth and comprehensive. However, it requires a lot of data which is often not available thus making this technique inapplicable.

3. The Hidden Economy in the Caribbean

Research on the hidden economy in the Caribbean has not been given as much attention as its importance merits. In the Caribbean, studies have been carried out in Jamaica, Trinidad and Tobago, Guyana and Barbados.

3.1 Jamaica

The information generated from the Jamaican informal economy was mainly done as case studies of sidewalk vendors and higgler. However, the higgler aspect was given more attention (Smikle and Taylor, (1977)), (LeFranc, MacFarlene-Gregory and Taylor, (1987)).

Investigations were done in the form of surveys. One of these targeted informal commercial importers, while the others sought to collect data on the traditional higgler, who traded in parochial and kerbside markets. These studies did not provide information on the size of the

economy. They only generated information on the kinds of activities that were taking place, giving the profile of the typical higgler and a breakdown of their average weekly costs.

Smikle and Taylor (1977) estimated that 115,006 members of the higgler population traded in the markets and their environs, while another 1,046 existed in curbside markets. The surveys were unable to provide reliable data on the financial activities of these members of the informal economy.

3.2 Trinidad & Tobago

Mootoo, Sookram and Watson (2002) obtained preliminary estimates for the hidden economy in Trinidad and Tobago utilizing the Tanzi currency demand approach, applied to data spanning the period 1970-1999. Firstly, least squares regression was applied to the equation. The interest rates and wages and salaries variables were found to be insignificant; hence the equation was re-estimated with these variables omitted. The resultant model was deemed optimal and under the assumption that the velocity of “illegal” money is the same as that of legal money, the researchers concluded that the hidden economy represented 2.6-6.8% of the measured GDP. However they felt that this was a gross underestimation of the actual value based on their knowledge of the Trinidadian economy. They suggested that the use of a direct survey would yield more meaningful results.

3.3 Barbados

An extensive Informal Sector Survey was conducted by the Statistical Service Department in 1997-1998. The survey sought to improve the social and economic statistics on the informal sector in the island, analyze the situation of the workers and better design support policies to increase productivity of this sector.

The survey was designed using a two stage stratified sampling method, the first stage being Enumeration Districts and the second being the households of informal economy business operators. The island was divided into 458 EDs. These EDs were then divided into four distinct groups, called Strata. Fifty-two enumeration districts were chosen from across the strata in numbers proportionate to the relative size of each stratum. Then the actual districts to be

surveyed were selected within each stratum using a probability proportionate to size method. Larger Eds had a greater chance of being chosen.

From the 52 districts 522 informal sector operators were interviewed. The information gathered from this survey showed various forms of informal economic activity - agriculture, construction, distribution and tourism, to name a few. Distribution and agriculture were identified as being the most populous of these sectors with 2,313 and 1,562 persons respectively. It was estimated that there were 5,720 informal business operators, compared to 14,172 in the formal economy. The total employment calculated in the informal economy numbered 6,904, as opposed to 117,575 in the formal economy.

Detailed information was gathered on the backgrounds of informal economy operators, such as, level of education, starting capital, credit information, input costs, and the duration of their informal business lives, but no indication of the size of the informal economy was provided. However, care must be taken when using this technique, because most interviewees tend to understate income and overstate expenses, thus obscuring results.

3.4 Guyana

Faal (2003) utilized a parsimonious and stable error-correction-based currency demand model to estimate the underground economy in Guyana. His findings indicate the existence of large underground economy ranging from 27% of GDP in 1970 to as high as 101% in 1989. Thereafter as macroeconomic reforms were implemented the size of the hidden economy declined to 35% in 2000.

He concluded that a long-run strategy based on market based reforms including fiscal reforms, improved governance and stronger institutions are effective in reducing the underground economy.

Thomas (1989)¹ also investigated the informal economy in Guyana with emphasis on the foreign currency market.

4. Estimates for Barbados

We chose the currency demand approach to estimate the size of the informal economy in Barbados because of the availability of reliable time series data is available for the monetary sector as well as the tax burden and also because it is the most widely used indirect method in the literature. In this regard, we have modified the Tanzi equation following along the lines taken by Bajada (1999) and Faal (2003). Also, as in Bajada (1999 and 2005) we utilised a general unrestricted error correction model but, instead of simply estimating the model with a set number of lags (for example, testing 1 lag against 2 and using the selected length across all variables in the model), we used the general-to-specific (Gets) approach to eliminate statistically irrelevant variables thus reducing this ‘general’ model to a more parsimonious, congruent one, allowing for more efficient estimation and inference.

The currency demand model specifies that:

$$C = f(YD, R, \pi, E, Tr, T) \quad (1)$$

Where C is real currency per capita, YD is real disposable per capita, R is the interest rate, π represents the rate of inflation, E denotes private consumption expenditure as a ratio of GDP, Tr is a technological trend variable, and T is the tax rate.

Currency demand is expressed in real per capita terms to eliminate the impact of inflation and population growth on the demand for currency.

Real disposable income and interest rates are expected to have similar impacts on the demand for currency as they would have on the demand for money. Disposable income is substituted for income since we are examining the excess sensitivity of taxes on currency (see Bajada 1999). Inflation becomes relevant since increasing prices will either cause individuals to (a) hold more cash to meet daily demand or (b) induce them to hold less as its value may be eroded. As stated earlier, real currency demand is used to compensate for (a) above. Thus, we expect a negative relationship.

Like Bajada, “private consumption expenditure to GDP is added to capture currency demand arising as a result of spending on goods and services (desired demand) in the official economy by underground participants which would not normally be captured by the measure utilised for disposable income.”

Technological developments (ATMs, point of sale cards, etc.), which are currency substitutes and will have an impact on the demand for currency is represented by a trend variable. Our key assumption, as was Tanzi’s, is that the underground economy is more cash intensive than the official economy. As such, increases in taxes lead to an expansion of the underground economy and consequently to greater use of cash.

Data and Estimation of Currency Demand Function

The data is sourced from the Central Bank of Barbados and is of annual frequency covering the period 1972-2003. Real currency per capita is measured as the stock of notes and coins in the hands of the public deflated by the GDP deflator and further expressed as a ratio of the population. Real disposable income per capita is calculated as nominal GDP less direct taxes on incomes, also deflated by the GDP deflator and divided by the population. The interest rate is represented by the commercial banks’ weighted average deposit rate. The tax rate is direct taxes on incomes expressed as a percentage of GDP. The inflation rate is the change in the consumer price index. Private consumption expenditure is taken from the national accounts and expressed as a percentage of GDP. All variables are expressed in natural logarithm.

We begin by investigating the stationary properties of the data, as this can influence the estimation procedure we choose. In this regard, a number of stationarity tests are applied to the levels and first differences of the variables. The results are presented in Table 2.

Table 2 **Results of Tests for Stationarity**

		C	YD	R	π	E	T
Level	ADF	-1.891	-1.782	-3.212**	-2.759**	-2.387	-1.512
	PP	-1.665	-1.522	-2.255	-2.652*	-2.444	-1.545
	KPSS	0.777***	0.628**	0.217	0.253	0.729**	0.181
	ERS	19.79	11.191	1.500***	2.544**	27.761	4.867
	MZ _a	1.073	-3.777	-19.21***	-10.34**	-1.436	-5.130
	MZ _t	0.949	-1.259	-2.948***	-2.267**	-0.742	-1.465
	MSB	0.884	0.333	-0.153***	-0.219**	0.516	0.286
	MP _T	56.58	6.533	1.804**	2.397**	14.667	5.102
Δ	ADF	-4.684***	-3.515**			-8.382***	-5.276***
	PP	-3.761**	-3.376***			-8.904***	-5.276***
	KPSS	0.061	0.070			0.396*	0.131
	ERS	0.192***	1.801***			2.707**	1.556***
	MZ _a	-140.91***	-12.74**			-20.63***	-14.99***
	MZ _t	-8.374***	-2.524**			-3.129***	-2.736***
	MSB	0.059***	0.198**			0.152***	0.183**
	MP _T	0.205***	1.922**			1.415***	1.640***

*, ** and *** are the critical values for rejection of the null hypothesis at the 10%, 5%, and 1% levels, respectively. Δ denotes the first difference of the original series.

The first test is that of augmented Dickey-Fuller (ADF) test for unit root based on the regression:

$$\Delta x_t = \alpha_1 + \beta_1 x_{t-1} + \sum_{j=1}^J \alpha_j \Delta x_{t-j} + \varepsilon_t$$

where J in the regression is chosen so that it is sufficiently large to ensure that the error term is free of significant serial dependence. The null hypothesis of non-stationarity is rejected if δ_1 is significantly negative. The next test is the Phillips-Perron, PP, (1988) which, instead of adding differenced terms as explanatory variables to correct for higher order serial correlation, makes the correction on the t-statistic of the δ coefficient. However, the PP test, as originally defined, suffers from severe size distortions when there are negative-moving average errors (see Schwert 1989, and Perron and Ng, 1996). Although the ADF test is more accurate under such

conditions, its power is still affected. In lieu of this, we used both the Elliot, Rothenberg, and Stock (ERS) Point Optimal test (1996), which has improved power characteristics over the ADF test, and the Ng and Perron (2001) testing procedure (NP) which exhibits less size distortions compared to the PP test. Both tests are well documented in the literature and are therefore only summarised here.

The ERS based on a quasi-differencing regression of the form:

$$d(y_i | a) = d(x_i | a)' \delta(a) + \eta_i$$

where yt is the series in question, xt may contain a constant only or both a constant and a time trend, and a is proxied by $\bar{a}$ which is computed as $\bar{a} = 1 - 7/T$ and $\bar{a} = 1 - 13.5/T$ in the presence of a constant and a constant and time trend respectively. The ERS point optimal test statistic of the null that $\alpha = 1$ against the alternative that $\alpha = \bar{a}$ is given by $P_T = [SSR(\bar{a}) - \bar{a}SSR(1)] / f_0$ where SSR is the sum of squared residuals and f_0 is an estimator for the residual spectrum at frequency zero. In making inferences, the test statistic calculated is compared with the simulation based critical values of ERS.

The NP procedure involves four test statistics. The first calculates the ERS point optimal statistic

for the GLS detrended data ($y_t^d = y_t - x_t' \hat{\delta}(\bar{a})$) as:

$$MP_T^d = \begin{cases} \left(\bar{c}^2 T^{-2} \sum_{t=1}^T (y_{t-1}^d)^2 - \bar{c} T^{-1} (y_T^d)^2 / f_0 \right) & \text{if } x_t = \{cons \tan t\} \\ \left(\bar{c}^2 T^{-2} \sum_{t=1}^T (y_{t-1}^d)^2 + (1 - \bar{c}) T^{-1} (y_T^d)^2 / f_0 \right) & \text{if } x_t = \{cons \tan t, trend\} \end{cases}$$

The other three are modifications of the PP statistics (the Z_a and Z_t statistics of Phillips and Perron and the Bhargava statistic) with corrections for size distortions in the case of negatively correlated residuals. There are given as:

$$MZ_{\alpha}^d = (T^{-1}(y_T^d)^2 - f_0) / \left(2 \sum_{t=2}^T (y_{t-1}^d)^2 / T^2 \right)$$

$$MZ_t^d = MZ_{\alpha} \times MSB$$

$$MSB^d = \left(\sum_{t=2}^T (y_{t-1}^d)^2 / T^2 f_0 \right)^{1/2}$$

However, all the above tests take a unit root as the null hypothesis, which means that they have a high probability of falsely rejecting the null of non-stationarity when the data generation process is close to a stationary process (Blough, 1992; and Harris, 1995). Therefore, we also utilised the KPSS test described in Kwiatkowski *et al.* (1992) where the null hypothesis is specified as a stationary process.

The results indicated that both R and π are both integrated of order zero, $I(0)$, while the other series are non-stationary in levels and stationary in their first differences, hence $I(1)$. Note that the various tests are in agreement except in the case of the tax rate. Here the KPSS suggested that it is stationary, while the others pointed to an $I(1)$ process. A graphical inspection showed a sharp dip in the tax rate in 1988 and when we allowed for a blip in the unit root test (using the procedure in procedure in Saikkonen and Lütkepohl, 2002; and Lanne *et al.*, 2002) it confirmed that the series is stationary¹.

Since we have a mixture of $I(0)$ and $I(1)$ variables we opted to use the Gets procedure since it is still an open debate on how to appropriately handle combinations of stationary and non-stationary variables in standard cointegration frameworks like that of Johansen. In addition, Monte Carlo studies have shown that the Gets procedure is as good as, if not more appropriate than, other cointegration techniques in dealing with small data samples, even in the presence of $I(1)$ variables². With the Gets procedure we can minimise the possibility of estimating spurious relations while retaining long-run information and at the same time derive a currency demand model that is suitable for economic interpretation.

¹ These results are available from the authors upon request.
² See Krolzig (2000) for a further discussion.

To apply the Gets procedure we estimate equation 1 in an unrestricted model with 2 lags (2 lags are considered appropriate when dealing with annual data) and progressively reduce it by eliminating statistically insignificant coefficients and reformulating the lag structure where appropriate in terms of levels and differences to achieve orthogonality. The final parsimonious representation of the model is presented below along with some standard diagnostic statistics and long-run elasticities.

$$\Delta \ln C_t = -7.755 + 0.881 \Delta \ln YD_t + 0.872 \ln YD_{t-1} + 0.136 \Delta \ln T_t + 0.148 \ln T_{t-1} - 0.086 \Delta \ln R_t$$

(-2.88 **)
(4.102 ***)
(2.917 **)
(2.157 **)
(1.987 **)
(-2.143 **)

$$- 0.126 \ln R_{t-1} - 0.011 \Delta \ln \pi_t - 0.450 \ln C_{t-1} - 0.005 Tr$$

(-3.385 **)
(-1.880*)
(-3.129 **)
(-1.974*)

Diagnostics

$$\bar{R}^2 = 0.76 \quad DW = 1.915 \quad Norm = 0.108 \quad ADF(r) = -5.447$$

(0.589)
(0.614)
(0.947)
(0.000)

$$LM = 0.292 \quad RR = 0.254 \quad HET = 0.125$$

(0.589)
(0.614)
(0.911)

Long-run elasticities (Long-run response of the real currency per capita with respect to):

Real Disposable Income	1.94
Interest Rate	-0.28
Average Tax rate	0.33

Notes: T-statistics are shown in parentheses. For the diagnostics the F-statistic for the respective test are shown (unless indicated otherwise) and the associated P-value in square brackets. *DW* is the Durbin-Watson statistic. *SC* is the Lagrange multiplier test of residual serial correlation (Chi-square of degree 1). *FF* is the Ramsey's RESET test for incorrect functional form using the square of the fitted values (Chi-square of degree 1). *Norm* is the test for normality of the residuals based on the Jarque-Bera test statistic (Chi-square of degree 1). *HET* is the Heteroskedasticity test based on the regression of squared residuals on squared fitted values. *ADF(r)* is the Augmented Dickey-Fuller unit root test

The model is well-behaved in terms of the diagnostic tests. The residuals do not suffer from non-normality, serial correlation or heteroskedasticity. In addition, the Ramsey's RESET test suggests that the model is well specified. However, before accepting the model we also checked for possible endogeneity between real currency per capita, real disposable income, private consumption expenditure and taxes, which if present will render our estimates biased and inconsistent. To do this we ran an auxiliary regression of the form

$\Delta \ln X = \alpha_0 + \sum_{i=1}^p \Delta \ln X_{t-i} + \sum_{i=1}^p \Delta \ln C_{t-i}$ for each of the four variables of interest. The predicted values are then included in our unrestricted model. An insignificant t-statistic would suggest endogeneity is not a problem and our estimates are consistent. The results are shown below and indicate no evidence of endogeneity between the variables.

Endogeneity Tests			
	ρ		
	1	2	3
ΔT	-0.2567 [0.801]	1.243 [0.233]	1.355 [0.197]
ΔYD	0.348 [0.732]	1.071 [0.299]	0.1378 [0.893]
ΔE	1.239 [0.232]	-1.688 [0.110]	-0.2278 [0.822]

P-values are in square brackets.

The $ADF(r)$ statistic confirms that the variables in the currency demand equation form an equilibrium (cointegrated) relationship, while the coefficient on $\ln C_{t-1}$ suggests an adjustment speed of 0.55. Thus, it takes approximately 2 years for holders of currency to fully adjust to shocks affecting their demand. All the variables of our final model are correctly signed. The coefficient on disposable income indicates that increases in income increases the use of currency with a long-run elasticity of 1.9 percent. Interest rate has a negative affect on real currency demand which is consistent with the idea that it represents the opportunity cost of holding money. A 1 percentage point rise in the nominal interest rate brings about 0.09 percentage point decline in real currency demand in the short run, with a steady state effect of -0.29 percentage point. The coefficient on the average tax rate is positive indicating that an increase in the tax rate induces higher currency demand, consistent with the notion that there is an incentive to conceal income from being taxed by demanding currency for payments of goods and services. The extent of this is that a 1 percentage point increase in the average tax rate leads to roughly a 0.14 percentage point rise in currency demand in the short-run and over time currency demand

expands to 0.33 percentage points. As expected, the increasing use of technology significantly reduces the need to use cash for transactional purposes.

The Size of the Informal Economy

In order to derive estimates of the underground economy we first rearranged our model and expressed it in terms of nominal currency holdings:

$$C_t^* = \exp(A + \delta_1 \Delta \ln T_t + \phi_1 \ln T_{t-1} + \ln C_{t-1}^* + \Delta \ln P_t + \Delta \ln N_t)$$

where C_t^* is estimated nominal currency in the hands of the public, A is all the explanatory variables of our model excluding the two tax variables, P is the GDP deflator and N is population. Now if $\delta_1 = \phi_1 = 0$ then there is no excess sensitivity of taxes and thus no longer an incentive for persons to participate in the underground economy as there is no need to demand cash for payments of goods and services in order to evade taxes. Thus, in the absence of an underground economy currency holdings will settle at its natural rate, which will be lower than C_t^* . We referred to this level as C_t^{**} where:

$$C_t^{**} = \exp(A + \ln C_{t-1}^* + \Delta \ln P_t + \Delta \ln N_t)$$

Therefore, the amount of currency in the hands of persons conducting business in the underground economy, illegal currency, is given as $H_t = C_t^* - C_t^{**}$. Assuming that the velocity of money in the informal economy is the same as that of the formal economy, then the size of the informal economy is estimated by $GDP_{IE} = H_t \times V_t$, where V , the velocity of money, is obtained by dividing GDP at market prices less consumption of fixed capital and net income paid overseas by C_t^{**} . The results of these calculations along with the size of the underground economy expressed as a ratio to GDP are presented in Table 3.

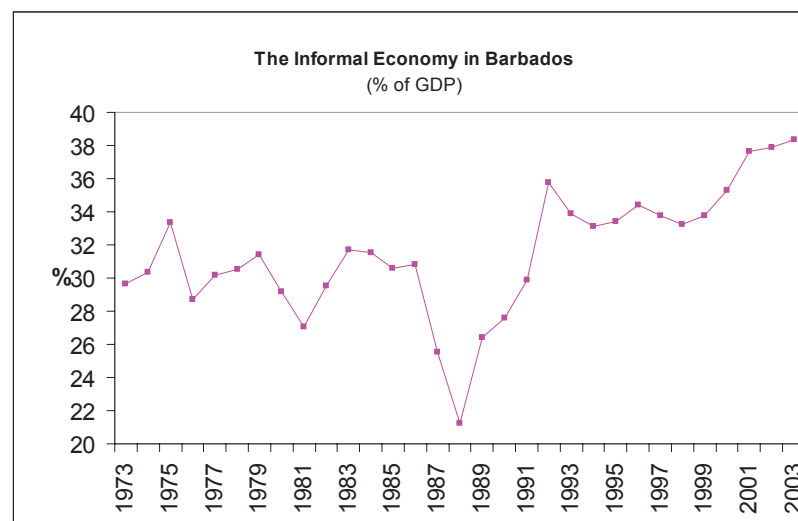
The first point we can perhaps note from Table 3 is that our estimates of nominal currency holdings are very close to the actual, which gives further credence to our model. The second point is that the informal economy has been and continues to be a large and significant part of

overall economic activity. Figure 1 plots the size of the informal economy as a percentage of GDP, from which three episodes can be distinguished in the evolution of the informal economy. The first is from 1973 to 1986 where it fluctuated around 30 percent of official GDP. It then declined sharply to roughly 21 percent over the next 2 years before rising rapidly to reach nearly 36 years in 1992. It remained within that vicinity for the remainder of the sample; though displaying a downwards trend until 1998 and then expanding again.

Table 3: Estimates of the Informal Economy in Barbados, 1973-2003

Year	Currency with the Public (\$ millions)				Informal Economy	
	Actual C_t	Estimate C_t^*	Legal C_t^{**}	Illegal H_t	Size in \$mil	% of official GDP
1973	26.85	28.85	20.94	7.91	165.27	29.62
1974	33.88	34.11	24.42	9.69	212.05	30.33
1975	39.75	40.17	28.46	11.71	271.04	33.36
1976	46.74	45.90	32.87	13.03	250.90	28.73
1977	55.22	53.63	38.49	15.14	299.63	30.16
1978	65.85	61.99	44.41	17.59	339.17	30.50
1979	80.16	79.06	56.37	22.68	423.34	31.40
1980	101.55	101.81	74.56	27.25	505.39	29.20
1981	111.23	108.23	78.91	29.32	515.23	27.05
1982	110.57	110.28	79.82	30.46	587.92	29.54
1983	114.10	113.69	81.92	31.76	670.00	31.71
1984	118.12	120.65	87.88	32.78	725.59	31.51
1985	123.47	126.06	92.89	33.18	736.97	30.58
1986	137.36	142.81	105.51	37.30	815.09	30.80
1987	156.64	158.75	122.83	35.93	743.83	25.53
1988	171.34	164.49	131.83	32.65	657.97	21.23
1989	182.72	188.16	142.86	45.31	904.72	26.40
1990	192.85	191.80	143.39	48.40	948.54	27.57
1991	178.68	184.35	137.24	47.12	1014.75	29.90
1992	176.85	171.27	123.57	47.70	1135.68	35.75
1993	176.99	182.93	132.96	49.97	1118.29	33.88
1994	189.60	187.97	136.99	50.98	1149.89	33.11
1995	200.33	194.89	141.06	53.83	1249.21	33.41
1996	220.05	212.50	152.51	59.99	1373.43	34.44
1997	239.60	240.34	172.22	68.12	1488.50	33.76
1998	268.16	270.70	194.04	76.66	1579.90	33.22
1999	302.69	290.19	206.29	83.90	1676.65	33.77
2000	310.66	311.03	220.62	90.41	1828.53	35.28
2001	312.36	317.07	220.53	96.54	1919.61	37.65
2002	337.47	337.32	234.96	102.37	1930.72	37.87
2003	328.97	342.19	237.47	104.72	2025.74	38.33

Figure 1



With estimates of the size of the informal economy in hand some interesting questions can be asked. One such question is the relationship between growth rates in the formal and informal sectors. We plotted real growth rates for the 2 sectors in Figure 2. There is a positive correlation between the growth rates (which we confirmed to be 0.29 for the full sample), indicating that the informal economy moves procyclically to the official economy. Thus, if the official economy is experiencing good times so would the informal economy, and in times of hardship for the official economy there are spillovers to the informal economy. However, this may not always be the case and especially so for the hardship periods. Figure 3 shows GDP for both sectors and coming in to the recession of the early 1990s, as real economic activity in the official sector began to contract around 1989 that of the informal economy started to expand rapidly.

Figure 2

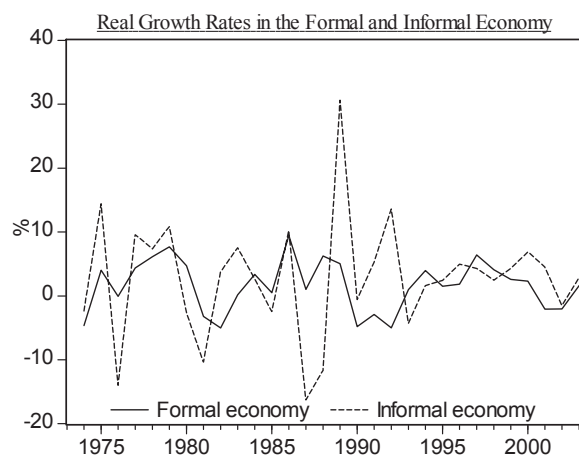
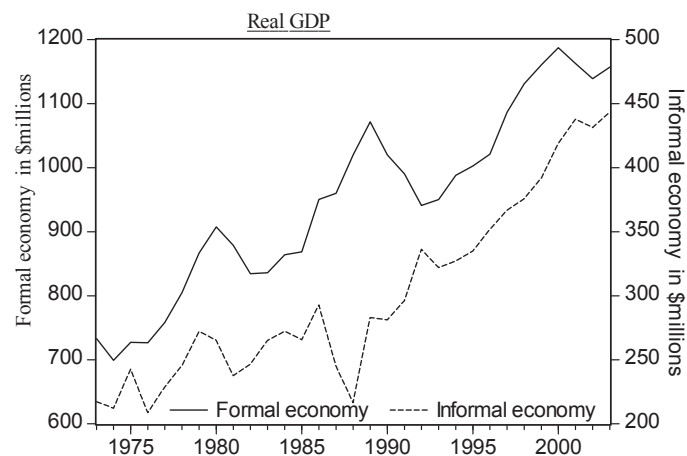


Figure 3



5. Concluding Remarks and Policy Implications

In this study, we estimate the size of the informal economy in Barbados using a currency demand equation and a general to specific modeling approach. Our findings suggest that a significantly large informal economy exist in Barbados; it is at least a third of the official economy. Its mere size implies that it cannot be ignored, especially when it comes to policy planning and execution. In this regard, we recommend moving to the “second stage” of the investigation and employ a direct method (preferably a sample survey) to gather information on the structure (composition, content, etc.), distribution of employment and the relationship between its sub-sectors and the official economy.

Our analysis also suggests a relatively high degree of complementarity between the official and unofficial economy. Thus, care must be taken in designing policies to deal with the existence of the informal economy. It clear that there is a significant loss of direct tax revenues because of the existence of the informal economy. However, its existence also means higher indirect tax revenues (VAT, etc) and less reliance on social welfare. Thus, it may not be advisable to implement policies (compliance policies) to force the informal sector out of existence but remove the incentives for participants to engage in informal sector activities (lower the tax burden, eliminate unnecessary regulations, etc.). Thereby, gradually integrating the informal economy into the formal economy.

Finally, it would also be interesting to extend our approach to other Caribbean countries and thus be able to make direct comparisons with the findings of other studies and, more importantly, undertake cross-country analysis.

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