Estimating the Size of the Hidden Economy in Peru: A Currency Demand Approach*

Manuel A. Hernandez *

Abstract
It is well established that informal activities are increasing around the world, particularly in developing countries. Quantifying these activities is difficult both from a conceptual and practical perspective. The method that has experienced greatest acceptance in the literature is the currency demand approach which supposes that the hidden economy is a response to changes in the tax burden or government regulation, and as a result there is an excessive use of cash in the economy. The present study follows this approach to estimate the size and evolution of the hidden economy in Peru for the period 1979-2005. Results under a conservative scenario indicate that the share of the hidden economy over total GDP in Peru has fluctuated between 44% and 50% in recent years. The results are robust to alternative econometric techniques and different model specifications. The standard assumption of unitary income-elasticity when imposing the same velocity of circulation in the formal and informal sector is also relaxed.

Resumen
Se sabe que las actividades informales se encuentran creciendo alrededor del mundo, particularmente en países en desarrollo. Cuantificar estas actividades es dificultoso, tanto desde una perspectiva conceptual como práctica. El método que ha experimentado la mayor aceptación en la literatura es el enfoque de la demanda de moneda que supone que la economía oculta es una respuesta a cambios en la carga impositiva o de la regulación del gobierno, y como resultado hay un excesivo uso del efectivo en la economía. El presente estudio sigue este enfoque de modo de estimar el tamaño y la evolución de la economía oculta en Perú para el periodo 1979-2005. Resultados bajo un escenario conservador indican que la participación de la economía oculta sobre el total del PIB en Perú ha fluctuado entre el 44% y el 50% en los años recientes. Los resultados son robustos a técnicas econométricas alternativas y a diferentes especificaciones de modelos. El supuesto standard de elasticidad-ingreso unitaria, cuando se impone la misma velocidad de circulación en los sectores formal e informal, también se relaja.

Key Words: Hidden Economy, Informal Sector, Currency Demand Approach

JEL Codes: E26, C22, E41

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1. Introduction

It is well established that informal activities are increasing around the world, particularly in developing countries. There are several reasons, in turn, why policy makers should be concerned about the rise of the hidden economy: (1) informal activities reduce the tax base, thereby limiting the financing of public goods and social protection (Loayza, 1996); (2) a growing hidden economy may distort official indicators, resulting in inefficient allocation of public resources (Schneider and Enste, 2000); and (3) a prospering hidden economy may attract workers away from the formal sector and create an unfair competition environment for formal firms (Schneider and Enste, 2000).

Attempts to measure the size of informal activities, however, face two potential problems, one conceptual and one practical. First, there is no single definition of the informal sector and it has been referred to by many terms in the literature. Besides hidden economy, it is also referred to as shadow, underground, black, second or parallel economy. A broad definition includes legal and illegal activities as well as money and barter transactions (Mirus and Smith, 1997). According to this definition, hidden economy should include unreported income from the legal production of goods and services. In this line, Feige (2003) distinguishes up to four classes of hidden activities: unreported, unregistered, illegal and informal activities. Overall, a precise definition seems quite difficult, and often varies depending on the focus of the study (Fleming et. al., 2000).

Second, gathering information about informal activities is difficult since nobody engaged in hidden transactions is interested in being identified. There are a number of difficulties then when dealing with direct methods of estimation. Indirect approaches, on the contrary, rely on macroeconomic relationships thought to contain information about the evolution of informal activities.

A method that has been widely used among the indirect approaches is the currency demand approach. This method associates the excessive use of cash in the economy with a greater number of informal activities, and was first proposed by Cagan (1958) in his study about the determinants of the stock of money in the United States. Later, Gutmann (1977) and Tanzi (1983) further developed this approach assuming that the informal economy is a response to the tax burden and is generally channeled through cash. A correctly defined currency demand function should include then fiscal variables as proxies of the tax burden, whose parameters capture the sensitivity of the use of currency to changes in these variables. This allows us to distinguish the fraction of currency demanded for formal and informal activities and convert the latter into income from informal activities using an appropriate measure of income velocity of circulation. More recent studies following this monetary approach include Bhattacharyya (1990), Spiro (1994), Ahumada et al. (2000), Schneider (2002), and Gadea and Serrano-Sanz (2002).

In the currency demand approach, the term informal sector or hidden economy refers then to all activity that adds value but is not taxed or registered, and consequently is beyond official channels of measurement. This definition follows the widely accepted legal approach to informality (De Soto, 1986, and Loayza, 1996). More specifically, economic agents rationally choose to partially or completely engage into informal activities by weighting the costs and benefits that a legal status entails. Formal or informal are then the different activities carried out by individuals, so an economic agent may comply with all the government-imposed taxes and regulations in one market but may not in another.

The currency demand approach, however, has also been subject to several criticisms (Thomas, 1999; Giles, 1999). As pointed by Gadea and Serrano-Sanz (2002), most of the criticisms are related to the sensitivity of the results to the basic assumptions of the model. For example, the assumption that most of the hidden transactions are in cash. Similarly, the monetary aggregate used in the estimation

2. For a detailed survey of the different methods of estimation of the informal economy, see Gerxhani (1999) and Schneider and Enste (2000).
3. Parallel to these authors, Feige (1980) derived an index of informality under his general currency-demand deposit ratio model (GCDRM), where informal transactions are not necessarily in cash.
4. In developing countries, several individuals usually carry out more than one economic activity.
process and the corresponding velocity of circulation, as well as the assumption of a similar velocity of circulation in both formal and informal activities. Finally, the identification of an appropriate fiscal variable that can summarize preferences leading to the use of currency may also be difficult.

Considering that most of the denominated informal micro-entrepreneurs in Peru carry out their transactions in cash (Robles et al., 2001), the present study follows a currency demand approach to estimate the size and evolution of the hidden economy in this country during the period 1979-2005. The study is closely related to the work of Ahumada et al. (2000) and Gadea and Serrano-Sanz (2002). It can be distinguished from conventional monetary models by analyzing the sensitivity of the results using two different econometric techniques, considering two alternative fiscal variables that could be associated with the evolution of informal activities, testing the relationship of these fiscal variables with monetary aggregates other than currency, and allowing for different income velocities of circulation. The standard restriction of unitary income-elasticity (when assuming the same velocity of circulation in the formal and informal sector) is also relaxed.

The results obtained indicate that after a decline in the share of the hidden economy over total GDP in the 80’s, the share of informal activities have shown an upward trend in recent years in Peru. Under a conservative scenario, this share has ranged between 44% and 50% in the period 2000-2005.

The reminder of the paper is organized as follows. Section 2 describes in detail the currency demand approach and the conditions for consistency of the estimations. Section 3 discusses the implementation of the model for the Peruvian case and reports the estimation results. Section 4 concludes.

2. The Currency Demand Model

The currency demand approach can be summarized into two basic assumptions, a behavioral and an observational assumption. The former assumes that informal transactions are usually undertaken in the form of cash payments in order to leave no traces for authorities. Therefore, an increase in the number of informal activities will result in an excessive use of cash in the economy. The latter assumes that there is a set of identifiable variables which approximate the preference for currency of the agents to carry out hidden activities. In that sense, it is assumed that informal activities are a direct consequence of government regulation, complexity of the tax system, taxpayers’ attitude towards the state, and, in particular, of the tax burden.5

To isolate then the resulting excessive demand for currency, an econometric specification of the currency demand is estimated over time with conventional economic variables, such as Gross Domestic Product (GDP), interest and inflation rate, as well as with variables related to the evolution of the informal activity. The increase in the amount of currency in the economy unexplained by conventional factors is attributed to the rising tax burden and other factors leading people to work in the hidden economy.

Formally, the estimation of the size and evolution of the informal sector consists of two steps. The first step involves estimating the demand for currency, both for formal transactions and for motives associated with the cover up of income. The former is calculated by considering the case when taxes and government regulations are at their lowest values (i.e. lowest tax burden), and the latter is just the difference between the observed demand for currency and the estimated amount for formal transactions. The second step converts the amount of currency associated with the hidden economy into income through the income velocity of circulation. The most common procedure is to assume the same income velocity of circulation for currency in both formal and informal transactions.6

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5. As pointed by Schneider and Enste (2000), besides direct and indirect tax burden, reliable data is not necessarily available in all the other cases and these variables are usually constructed in a quite arbitrary manner.

6. In the literature, there is great uncertainty on how to determine the income velocity that must be applied when calculating the size of the informal economy. The velocity in the informal sector could be either greater than the one in the official sector due to its productive structure (more service activities) or lower due to a higher level of accumulation. As a result, it is usual to allow for different options and capture the sensitivity of the hidden income to each of them. Feige (1986), for example, proposes a very simple analysis consisting of adding or subtracting 10% to or from the velocity derived from a reference monetary aggregate. But Hill and Kabir (1996) argue that it is more reasonable to assume the same velocity for both official and hidden transactions given this uncertainty.
The estimated magnitude of the hidden economy is finally compared with the registered or official GDP.\footnote{Since currency is not the exclusive medium of exchange for informal transactions, the size of the total informal economy may be even larger. As stated by Tanzi (1986), estimates under this approach attempt to measure the income generated through the excessive use of currency and that presumably was not reported to the tax authorities or registered.}

## 2.1 Methodology

This section follows Ahumada et al. (2000). Consider the following multiplicative demand function for currency,

\[ C_o = a(1 + F)^\alpha Y_o^\beta e^\gamma \]  \hspace{1cm} (1)

where \( C_o \) is the observed currency in real terms, \( F \) is a fiscal variable related to the evolution of informal activities (e.g. total taxes over GDP or government expenditure over GDP); \( Y_o \) is a variable associated with the level of transactions in the economy such as observed real GDP; \( e \) represents the opportunity cost of holding currency (e.g. nominal interest rate or inflation rate), and \( a \) is a constant term.\footnote{As revealed by Gadea and Serrano-Sanz (2002), this specification has been criticized, among others, by Feige (1986) and Bhattacharyya (1990) since it supposes the loss of the initial additive form of the observed currency demand in both the formal and informal sector. However, it is standard in the majority of applied work to use a log-linear approximation of this specification and to assume, as Tanzi (1986) suggests, that the demand for currency cannot be divided into two separate functions, i.e. one for formal and another for informal transactions, since economic agents use all their income (both legal and hidden) for their savings and consumption decisions which are jointly affected, for example, by the interest rate.} The expected sign of the parameters \( \alpha \) and \( \beta \) is positive and of \( \gamma \) is negative. In the case of the fiscal variable \( F \), it is assumed that as the level of taxation or government intervention raises, individuals are encouraged (or have greater incentives) to engage in informal activities which are facilitated with the use of currency.

Let the observed currency \( C_o \) be equal to the total currency \( C_t \). Hence, it includes both the currency demanded for formal or legal transactions \( C_f \) and for informal transactions \( C_i \),

\[ C_o = C_t = C_f + C_i \] \hspace{1cm} (2a)

Similarly, let the observed income \( Y_o \) be equal to the registered or legal income \( Y_l \). Then the total income \( Y_t \) is defined as,

\[ Y_t = Y_o + Y_i = Y_f + Y_i \] \hspace{1cm} (2b)

where \( Y_i \) is the income from informal activities. It follows that an econometric estimation of (1) will result in biased coefficient estimators given that the observed currency includes \( C_f \) but the observed income excludes \( Y_i \). However, setting \( F \) to a level closer to its lowest historical value (i.e. when the incentive to engage in hidden activities is minimum), it is possible to obtain an unbiased estimation of \( C_f \) since \( Y_o = Y_l \),

\[ C_f = a(1 + F_{\text{min}})^\alpha Y_o^\beta e^\gamma \] \hspace{1cm} (3)

From (2a) and (3), the amount of currency demanded for informal transactions is given by,

\[ C_i = C_f - C_t \] \hspace{1cm} (4)

Besides, the income velocity of circulation in the legal economy is obtained by,

\[ v = \frac{Y}{C_f} \] \hspace{1cm} (5a)
Assuming then the same velocity of circulation in both the formal and informal economy, the amount of income that results from informal transactions is equal to,

\[ Y_i = \nu C_i \] (6)

Gadea and Serrano-Sanz (2002) suggest an alternative estimation for the income velocity of circulation in the formal economy. They recommend taking as reference a monetary aggregate \( M \) that is frequently used in the formal sector to carry out transactions which could reflect, in turn, other methods of payment (i.e. \( M1, M2, M3 \)) Then, subtracting \( C_i \) from \( M \),

\[ \tilde{\nu} = \frac{Y_i}{M - C_i} \] (5b)

It follows that a broader aggregate will result in a decrease in the velocity of circulation, and consequently in a smaller hidden income according to (6).

### 2.2 Condition for consistency of the estimations\(^9\)

The assumption of the same income velocity of currency in both the formal and informal sector is consistent with the estimation of (1) and the assumption of (2a) only when \( \beta = 1 \). A positive value for \( Y_i \) implies that total income \( Y_i \) is greater than the observed income \( Y_i \) and results in a decrease (increase) in the velocity \( \nu \) if \( \beta > 1 \) (\( \beta < 1 \)). This result can be easily shown by deriving the condition under which \( \nu \) does not respond to changes in income. Replacing (3) in (5a),

\[ \nu = \frac{Y_i}{C_i} = \frac{Y_i}{a(1 + F_{min})^\alpha Y_i^\beta e^{\nu t}} = \frac{Y_i^{1-\beta}}{a(1 + F_{min})^\alpha e^{\nu t}} \] (7)

Taking logarithms and deriving with respect to the log of total income,

\[ \frac{\partial L\nu}{\partial LnY_i} = \frac{\partial L\nu}{\partial LnY_i} - \frac{\partial LnY_i}{\partial LnY_i} = (1 - \beta) \frac{Y_i}{Y_i} \] (8)

Estimating the demand for currency with an income-elasticity \( \beta \) different from 1 is not consistent then with the assumption of equal velocity of circulation in both sectors. Nevertheless, this inconsistency can be overcome by defining the amount of currency for informal transactions as a fraction of the amount of currency for legal transactions, that is, \( C_i = \lambda C_i \), where \( \lambda \) can vary over time. Then, from (2a),

\[ C_i = (1 + \lambda)C_i \] (9)

Replacing \( C_i \) by (3) and recalling that \( Y_o = Y_i \),

\[ C_i = (1 + \lambda)a(1 + F_{min})^\alpha Y_i^\beta e^{\nu t} \] (10)

which can be econometrically estimated as (1) since \( C_i \) and \( Y_i \) are observed. Thus,

\[ (1 + F)^\alpha = (1 + \lambda)(1 + F_{min})^\alpha \] (11)

Assuming that parameters \( a, \alpha, \beta \) and \( \gamma \) do not vary in the demand for currency in the formal and informal sector\(^10\),

\[ \frac{C_i}{C_i} = \frac{a(1 + F_{min})^\alpha Y_i^\beta e^{\nu t}}{a(1 + F)^\alpha Y_i^\beta e^{\nu t}} \]

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9. This section is also based on Ahumada et al. (2000) with the exception that \( F \) is set to a level closer to its lowest historical level (and not to zero) when calculating the amount of currency demanded for formal transactions.

10. This restriction is also implicit in the derivation of \( C_i \) in the previous section.
or equivalently,

\[
\frac{C_i}{C_i} = \left(\frac{Y_i}{Y_i}\right)^{\beta} = \left(\frac{1 + F_{\text{min}}}{1 + F}\right)^{\alpha}
\]  

(12)

where \(C_i\) and \(Y_i\) are obtained from the econometric estimation of the demand for currency and from the observed values of \(Y_i\) and \(C_i\).

Note that when \(\beta = 1\) the standard estimation of the hidden income under this monetary approach will not be biased. In particular, if \(\beta = 1\), equation (12) reduces to,

\[
\frac{C_i}{C_i} = \frac{Y_i}{Y_i}
\]

(13)

Using \(\frac{Y_i}{C_i} = v_i\),

\[
Y_i = Y_i - Y_i = C_i + Y_i - Y_i = vC_i + Y_i - Y_i = vC_i
\]

(14)

which is equal to (6). Equation (12) allows us then to adjust the estimations when the income-elasticity is different from 1. More specifically, let

\[
\frac{C_i}{C_i} = \frac{Y_i}{Y_i}
\]

(15)

be the relationship derived under \(\beta = 1\), then

\[
\frac{Y_i}{Y_i} = \left(\frac{C_i}{C_i}\right)^{1/\beta} = \left(\frac{Y_i}{Y_i}\right)^{1/\beta}
\]

(16)

3. Estimation and Results

The data used for the analysis is quarterly and covers the period 1979:2 through 2005:2, with the aim of having a sufficiently broad sample period which is usual under this approach.\(^{11}\) As shown in Figure A.1 in Appendix 1, the currency \(c\) held by the public in Peru (hereinafter currency) has behaved some way different from what could have been expected, particularly during recent years. After a period of moderate decline (in terms of GDP) until the early 90’s, with the exception of the expansive monetary policy period during the second half of the 80’s, in more recent years it started to show a slight upward trend while other monetary aggregates, such as demand deposits \(d\) and savings deposits and other deposits \(qm\), started to decrease in recent years. This turns out to be of particularly interest considering the financial innovation process in Peru during the last decade and the increase in the use of other monetary aggregates as payment methods (specifically savings deposits).

Additionally, during the period of study, both the tax burden (i.e. total taxes over GDP) and the government expenditure over GDP increased, specially the former as shown in Figure A.2. This is in line with the fiscal reform of 1993 in Peru which restructured the tax system and resulted in the strengthening of regulation procedures. According to the discussion in the previous section, the environment for economic agents went from one that was permissive in fiscal matters and which did not offer many incentives to cheat to one with strict rules and with higher potential benefits from informal transactions.

\(^{11}\) Despite the fact that with a longer sample period it is also more difficult to achieve a stable relationship between money and its principal determinants.
Taking logs to both sides of (1), the estimated equation of the demand for currency is given by,

\[ \ln C_t = a + \alpha \ln (1 + F_t) + \beta \ln Y_t + \gamma_1 i_t + \gamma_2 \pi_t + \epsilon_t \]  \hspace{1cm} (17)

where \( C_t \) is total currency in real terms at time \( t \), \( F_t \) is the fiscal variable, either total taxes over GDP (denoted by \( T \)) or government expenditure over GDP (denoted by \( G \)); \( Y_t \) is the GDP in real terms; \( i_t \) is the nominal deposit rate; and \( \pi_t \) is the GDP deflator – based inflation rate.\(^\text{12}\)

The reason for using either total tax burden or government expenditure over GDP is to account for two alternative fiscal components in the currency demand function. The idea is to compare the estimates of the magnitude of informal transactions, derived from the excessive use of currency, using two different fiscal variables. The inclusion of the inflation rate as an additional control results from the fact that Peru was a high-inflation country during the second half of the 80’s and the beginning of the 90’s, so both the nominal interest rate and the inflation rate may be used to measure the (real) opportunity cost of holding money.\(^\text{13}\)

Equation (17) is estimated using the Johansen Cointegration Method in a multivariate context since all the variables are integrated of order 1 at a 5% level (see Appendix 2). The estimation results confirm the existence of one long-term relationship between currency and all the other variables either when including total taxes or government expenditure over GDP.\(^\text{14}\) The estimated equations for the currency demand function are presented below.

Table 1
Estimated models for currency demand

<table>
<thead>
<tr>
<th>Using Total taxes over GDP (st. errors in parenthesis)</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>[ \ln C_t = 10.881 + 19.046 \ln (1 + T) + 1.562 \ln gdp - 5.106 interest + 7.245 inflation ]</td>
<td>(5.791) \hspace{1cm} (0.534) \hspace{1cm} (0.866) \hspace{1cm} (1.039)</td>
</tr>
<tr>
<td>Test of excluding the long run relation of the fiscal variable: ( H_0: \beta_1, \beta_2 = 0 ) (p-value in parenthesis)</td>
<td>LR test ( \chi^2 (1) ) \hspace{1cm} 6.265 \hspace{1cm} (0.012)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Using Government expenditure over GDP (st. errors in parenthesis)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>[ \ln C_t = 8.650 + 16.551 \ln (1 + G) + 1.434 \ln gdp - 4.231 interest + 4.901 inflation ]</td>
<td>(4.837) \hspace{1cm} (0.296) \hspace{1cm} (0.532) \hspace{1cm} (0.613)</td>
</tr>
<tr>
<td>Test of excluding the long run relation of the fiscal variable: ( H_0: \beta_1, \beta_2 = 0 ) (p-value in parenthesis)</td>
<td>LR test ( \chi^2 (1) ) \hspace{1cm} 4.165 \hspace{1cm} (0.041)</td>
</tr>
</tbody>
</table>

As can be seen, the fiscal variables have an important and significant impact on currency in both specifications. The income-elasticity is greater than 1 (1.562 in the first case and 1.434 in the second one). Similarly, all the variables are statistically significant and have the expected signs, except for inflation which does not seem to reflect the opportunity cost of holding currency. As stated by Gadea and Serrano-Sanz (2002), inflation could also have a positive effect on currency by accelerating transactions, particularly during high inflation periods, and the opportunity cost, measured through this variable, would only appear in broader monetary aggregates that include savings. Crane and Nourzad (1986) also argue that inflation can have a positive effect on informal transactions by

12. Most of the data was obtained from the International Monetary Fund (IMF) Financial Statistics (web access). Total tax revenue was obtained from the Instituto Nacional de Estadistica e Informatica (INEI), and nominal deposit rate from the Banco Central de Reserva del Peru (BCRP). Currency, GDP, tax revenue and government expenditure were also seasonally adjusted.

13. Since the inflation rate is quarterly and the interest rate is in annual terms, the latter was adjusted as follows: quarterly interest rate \( i = (1+x)^{1/4} - 1 \), where \( x \) = annual interest rate.

14. Both the trace and the maximum eigenvalue test indicate the existence of one cointegration equation at a 5% significance level. See Appendix 3 for further details, including the adjustment coefficients of the Vector Error Correction estimates.
agitating the social climate and relaxing the acceptance of tax regulations.

In line with the work of Gadea and Serrano-Sanz (2002), the likelihood ratio (LR) test for weak exogeneity proposed by Johansen and Juselius (1992) was also carried out to derive a single-equation model for the demand for currency, and estimate it as an Autoregressive Distributive Lags (ADL) model. Given the concerns regarding the sensitivity of the results under the currency demand approach, the idea is to perform a second estimation technique to compare the results obtained under each procedure. As shown in Appendix 3, the test for weak exogeneity of all variables but currency cannot be rejected at a 95% confidence level. The results for the estimation of the ADL model are detailed in Appendix 4. Note that the signs of the derived static long-run equation are similar to those under the Johansen’s method. However, the tax burden does not seem significant in this case.

Besides, with the aim of further examining the sensitivity of the demand for currency to fiscal variables, additional econometric estimations were performed using broader monetary aggregates (\(M_1\) and \(M_3\)). The results, reported in Table 2, indicate that in most cases both the tax burden and government expenditure over GDP do not have a significant relationship with other monetary aggregates, at least for the Peruvian case. It appears then that only currency reacts to changes in fiscal variables, supporting the argument that informal transactions are usually undertaken in the form of cash payments.

**Table 2**

<table>
<thead>
<tr>
<th>Fiscal variables and other monetary aggregates (Johansen method)</th>
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<tbody>
<tr>
<td><strong>Est.</strong></td>
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<tr>
<td><strong>With (M_1)</strong></td>
</tr>
<tr>
<td>Tax burden (T)</td>
</tr>
<tr>
<td>Government expenditure over GDP (G)</td>
</tr>
<tr>
<td><strong>With (M_3)</strong></td>
</tr>
<tr>
<td>Tax burden (T)</td>
</tr>
<tr>
<td>Government expenditure over GDP (G)</td>
</tr>
</tbody>
</table>

*significant at 5% level, and ** at 1% level.

(1) LR test \(\chi^2(1)\) of exclusion of fiscal variable in the long-run relationship (\(H_0: \beta_{1,2} = 0\)).

(2) Maximum eigenvalue statistic of no cointegration equation.

Next, with the estimated parameters, the amount of currency demanded solely for formal transactions was calculated by setting the tax burden and the government expenditure over GDP just below their lowest historical levels. For both fiscal variables, this value was close to 5% (although in different years), so \(\ln(1+F_{\text{min}}) = \ln(1+0.05) = 0.04879\).

Assuming then the same income velocity of circulation between formal and informal transactions and allowing for an income-elasticity different from one according to equation (16), the demand for currency for hidden transactions, and, consequently, the size of the hidden economy is estimated. Table 3 reports the results of the estimation of the size of the informal sector in Peru for different time
periods while the whole evolution is presented in Figure 1.

Table 3

<table>
<thead>
<tr>
<th>Estimations of the hidden economy as % of total GDP</th>
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<tbody>
<tr>
<td>79-84</td>
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<tr>
<td>-------</td>
</tr>
<tr>
<td>Johansen Cointegration Method</td>
</tr>
<tr>
<td>Tax burden (T)</td>
</tr>
<tr>
<td>Government expenditure over GDP (G)</td>
</tr>
<tr>
<td>ADL Method</td>
</tr>
<tr>
<td>Tax burden (T)</td>
</tr>
<tr>
<td>Government expenditure over GDP (G)</td>
</tr>
</tbody>
</table>

It follows that the results following Johansen’s methodology are more conservative than those obtained under the ADL method. In the former method, the size of the informal sector in Peru, derived from the excessive use of cash, varied on average between 33% and 52% of the total GDP. In the latter method, this magnitude fluctuated between 55% and 76%. Note also that the estimated share for recent years is much higher than in the early 90s but only slightly higher than 25 years ago when the country was under a military dictatorship with numerous government regulations.

Figure 1

Evolution of the hidden economy as % of total GDP

With respect to the evolution of hidden activities, they showed a downward trend during the 80’s, followed by a period of moderate expansion with stronger regulations procedures and stricter rules, as previously stated. The sharp, but volatile, decline at the end of the 80’s coincides with the high inflation period in the country. Although the estimations suggest a positive impact of inflation over the use of currency (which will in turn imply a higher number of informal transactions), the reduction in the velocity of circulation due to a considerable increase in the monetary base during that period, offsets this initial effect.

Finally, for illustration purposes, the same estimations following Johansen’s methodology were carried out using alternative income velocity measures. Instead of using the velocity of circulation for currency, the velocity corresponding to M1 and M3 aggregates were calculated using equation (5b).
As expected, the broader the aggregate used to estimate the income velocity, the lower the size of the hidden economy.\textsuperscript{21} In countries like Peru, however, it is reasonable to assume a high velocity of circulation in the informal sector since most of the hidden activities are related to service activities which require, in turn, a smaller number of transactions.\textsuperscript{22} A narrower aggregate seems to be more appropriate in this case.

### Table 4

Estimations of the hidden economy as % of total GDP (assuming different income velocities of circulation)

<table>
<thead>
<tr>
<th></th>
<th>79-84</th>
<th>85-89</th>
<th>90-94</th>
<th>95-99</th>
<th>00-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using M\textsubscript{1}</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tax burden (T)</td>
<td>18.7</td>
<td>18.1</td>
<td>18.6</td>
<td>16.8</td>
<td>15.7</td>
</tr>
<tr>
<td>Government expenditure over GDP (G)</td>
<td>16.7</td>
<td>15.7</td>
<td>12.8</td>
<td>13.7</td>
<td>15.2</td>
</tr>
<tr>
<td>Using M\textsubscript{3}</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tax burden (T)</td>
<td>8.9</td>
<td>11.7</td>
<td>7.7</td>
<td>4.7</td>
<td>4.0</td>
</tr>
<tr>
<td>Government expenditure over GDP (G)</td>
<td>7.6</td>
<td>9.6</td>
<td>4.9</td>
<td>3.8</td>
<td>4.0</td>
</tr>
</tbody>
</table>

It is important to emphasize that the estimates, following Johansen’s method, are somewhere above the range of results of previous studies for the Peruvian case. ILD (1989), using Feige’s GCDRM with an econometric specification for the currency-demand deposit ratio, finds that the size of the informal sector, as a percentage of total GDP, increased from 16.6% in 1952 to 34.6% in 1986. In particular, for the period 1979-1986, the average size was around 39%. Similarly, Loayza (1996) and Schneider (2002), using a Multiple Indicators Multiple Causes (MIMIC) model, report an estimate of 57.4% of the official GDP for the period 1990-1993 and of 59.4% for the period 2000-2001, respectively.

Other studies in the region using a monetary approach include CIEN (2001) for Guatemala and Ahumada et al. (2000) for Argentina. The former study finds an increase in the size of the hidden economy from 7.7% in 1960 to 34.5% in 2000 (as percentage of the official GDP). The latter study estimates the size of the informal economy between 21% and 27% of the total GDP for the period 1993-1999. But when they relax the assumption of unitary income-elasticity, these shares increase to 50% and 60%.

### 4 Conclusions

Given the nature of informal activities, it is difficult to rely on direct methods of estimation of the hidden economy. The currency demand approach, which relates the excessive use of cash in the economy with the extent of informal activities, is an appealing alternative which has been widely applied in the literature. The main advantage of this model is that it is possible to characterize the size and evolution of informal activities during a longer period of analysis.

In order to account for the sensitivity of this type of models, two different econometric techniques were applied (Johansen Cointegration method and ADL model), two fiscal variables were used in the econometric specification (tax burden and government expenditure over GDP), the relationship between the fiscal variables and monetary aggregates other than currency (\(M\textsubscript{1}\) and \(M\textsubscript{3}\)) was tested, and different measures of income velocity were considered in the estimations (currency, \(M\textsubscript{1}\) and \(M\textsubscript{3}\)).

Additionally, the estimates were adjusted by relaxing the assumption of unitary income-elasticity. The results, under a conservative scenario, indicate that after a decline in the share of the hidden economy over total GDP in the 80’s, the share of informal activities have shown an upward trend in recent years, ranging between 44% and 50% in the period 2000-2005.

\textsuperscript{21} As in Gadea and Serrano-Sanz (2002).
\textsuperscript{22} INEI (1995).
However, it is important to stress that this model attempts to measure the income generated only through the excessive use of currency, which presumably was not reported to the tax authorities or registered. It follows that the size of the informal sector may be even larger if, for example, illegal activities are included.

Natural extensions of this study are the inclusion of other variables related to the evolution of hidden activities in the econometric specification, such as the degree of government regulation or complexity of the tax system. Similarly, allowing for a different income velocity of circulation between the formal and informal sector. Provided that this model does not characterize the structure of the hidden sector, it would also be interesting to match these results with other eventual studies that could focus on the characterization of the informal sector on a cross-sectional basis. This could help, in turn, to better direct policy efforts to reduce informal transactions.
References


Appendix 1

Figure A.1
Monetary Aggregates as % of GDP

Source: International Monetary Fund (IMF) Financial Statistics (web access).

Figure A.2
Total taxes and Government Expenditure over GDP

Source: International Monetary Fund (IMF) Financial Statistics (web access), and Instituto Nacional de Estadistica e Informatica (INEI).
Appendix 2

Augmented Dickey-Fuller Unit Root Test
(H0: variable has a unit root)

<table>
<thead>
<tr>
<th>Variable</th>
<th>t statistic</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln currency</td>
<td>-147.737</td>
<td>0.8313</td>
</tr>
<tr>
<td>ln (1+T)</td>
<td>-2.492.916</td>
<td>0.3310</td>
</tr>
<tr>
<td>ln (1+G)</td>
<td>-2.418.091</td>
<td>0.3682</td>
</tr>
<tr>
<td>ln gdp</td>
<td>-178.507</td>
<td>0.7050</td>
</tr>
<tr>
<td>interest</td>
<td>-3.243.041</td>
<td>0.0819</td>
</tr>
<tr>
<td>inflation</td>
<td>-2.379.925</td>
<td>0.1499</td>
</tr>
</tbody>
</table>

*MacKinnon one-sided p-values.
Appendix 3

Estimation on the basis of the Johansen Cointegration Method

Trend assumption: Linear deterministic trend

A. Using Total taxes over GDP as the Fiscal variable

Lags interval (in first differences): 1 to 2

<table>
<thead>
<tr>
<th>Hypothesized No. of CE(s)</th>
<th>Trace Statistic</th>
<th>5% Crit. Val.</th>
<th>P**</th>
<th>Maximum Eigenvalue Statistic</th>
<th>5% Crit. Val.</th>
<th>P**</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>0.315</td>
<td>84.352*</td>
<td>69.819</td>
<td>0.002</td>
<td>38.620*</td>
<td>33.877</td>
</tr>
<tr>
<td>At most 1</td>
<td>0.206</td>
<td>45.732</td>
<td>47.856</td>
<td>0.078</td>
<td>23.559</td>
<td>27.584</td>
</tr>
<tr>
<td>At most 2</td>
<td>0.105</td>
<td>22.173</td>
<td>29.797</td>
<td>0.289</td>
<td>11.360</td>
<td>21.132</td>
</tr>
<tr>
<td>At most 3</td>
<td>0.097</td>
<td>10.813</td>
<td>15.495</td>
<td>0.223</td>
<td>10.381</td>
<td>14.265</td>
</tr>
<tr>
<td>At most 4</td>
<td>0.004</td>
<td>0.431</td>
<td>3.841</td>
<td>0.511</td>
<td>0.431</td>
<td>3.841</td>
</tr>
</tbody>
</table>

* denotes rejection of the hypothesis at the 5% level

** MacKinnon-Haug-Michelis p-values

1 Cointegrating Equation:

Log likelihood 871.990

Normalized cointegrating coefficients (st. error in parenthesis)

<table>
<thead>
<tr>
<th>ln currency</th>
<th>ln (1 + T)</th>
<th>ln gdp</th>
<th>interest</th>
<th>inflation</th>
<th>constant</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-19.046</td>
<td>-1.562</td>
<td>5.106</td>
<td>-7.245</td>
<td>10.881</td>
</tr>
<tr>
<td>(5.791)</td>
<td>(0.534)</td>
<td>(0.866)</td>
<td>(1.039)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adjustment coefficients (st. error in parentheses)

<table>
<thead>
<tr>
<th>ln currency</th>
<th>ln (1 + T)</th>
<th>ln gdp</th>
<th>interest</th>
<th>inflation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.009</td>
<td>0.002</td>
<td>-0.005</td>
<td>0.032</td>
<td>0.124</td>
</tr>
<tr>
<td>(0.021)</td>
<td>(0.002)</td>
<td>(0.009)</td>
<td>(0.025)</td>
<td></td>
</tr>
</tbody>
</table>

Serial Correlation LM Test

LM Stat. $\chi^2$ (25): 34.409 (0.099)

Test of excluding the long run relation of the fiscal variable, $H_0: \beta_{1,2} = 0$

LR test $\chi^2$ (1): 6.265 (0.012)

Weak exogeneity test, $H_0: \alpha_i = 0$, $i = 2, \ldots, 5$

LR test $\chi^2$ (4): 8.940 (0.063)

p-value in parentheses when not specified.
B. Using Government expenditure over GDP as the Fiscal variable

Lags interval (in first differences): 1 to 3

<table>
<thead>
<tr>
<th>Hypothesized No. of CE(s)</th>
<th>Eigenvalue Statistic</th>
<th>5% Crit. Val.</th>
<th>P**</th>
<th>Trace Statistic</th>
<th>5% Crit. Val.</th>
<th>P**</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>0.305</td>
<td>71.756*</td>
<td>69.819</td>
<td>0.035</td>
<td>36.814*</td>
<td>33.877</td>
</tr>
<tr>
<td>At most 1</td>
<td>0.189</td>
<td>34.942</td>
<td>47.856</td>
<td>0.451</td>
<td>21.187</td>
<td>27.584</td>
</tr>
<tr>
<td>At most 2</td>
<td>0.071</td>
<td>13.755</td>
<td>29.797</td>
<td>0.854</td>
<td>7.387</td>
<td>21.132</td>
</tr>
<tr>
<td>At most 3</td>
<td>0.054</td>
<td>6.368</td>
<td>15.495</td>
<td>0.652</td>
<td>5.651</td>
<td>14.265</td>
</tr>
<tr>
<td>At most 4</td>
<td>0.007</td>
<td>0.718</td>
<td>3.841</td>
<td>0.397</td>
<td>0.718</td>
<td>3.841</td>
</tr>
</tbody>
</table>

* denotes rejection of the hypothesis at the 5% level

**MacKinnon-Haug-Michelis p-values

1 Cointegrating Equation:
Log likelihood 902.185

Normalized cointegrating coefficients (st. error in parenthesis)

<table>
<thead>
<tr>
<th>ln currency</th>
<th>ln (1+G)</th>
<th>ln gdp</th>
<th>interest</th>
<th>inflation</th>
<th>constant</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-16.551</td>
<td>-1.434</td>
<td>4.231</td>
<td>-4.901</td>
<td>8.650</td>
</tr>
</tbody>
</table>

Adjusted coefficients (st. error in parentheses)

<table>
<thead>
<tr>
<th>ln currency</th>
<th>ln (1+G)</th>
<th>ln gdp</th>
<th>interest</th>
<th>inflation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.000</td>
<td>0.010</td>
<td>0.003</td>
<td>-0.022</td>
<td>0.135</td>
</tr>
</tbody>
</table>

Serial Correlation LM Test

LM Stat. $\chi^2$ (25) 36.395 (0.066)

Test of excluding the long run relation of the fiscal variable, $H_0: \beta_{1,2} = 0$
LR test $\chi^2$ (1) 4.165 (0.041)

Weak exogeneity test, $H_0: \alpha_i = 0, i = 2, ..., 5$
LR test $\chi^2$ (4) 92.140 (0.056)

p-value in parentheses when not specified.

Notes:

(1) The choice of the number of lags of the unrestricted VAR previous to the application of the Johansen Cointegration Test was based on the Akaike Information Criteria.

(2) The weak exogeneity test was carried out using the likelihood ratio (LR) test proposed by Johansen and Juselius (1992).
Appendix 4

Estimation on the basis of the Autoregressive Distributive Lag (ADL) Method
Dependent variable: Ln currency

A. Using Total taxes over GDP as the Fiscal variable
ADL (1 lag)

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>constant</td>
<td>0.269</td>
<td>0.540</td>
<td>0.591</td>
</tr>
<tr>
<td>ln currency(-1)</td>
<td>1.023</td>
<td>31.208</td>
<td>0.000</td>
</tr>
<tr>
<td>ln 1+T</td>
<td>0.139</td>
<td>0.193</td>
<td>0.848</td>
</tr>
<tr>
<td>ln 1+T(-1)</td>
<td>-0.911</td>
<td>-1.180</td>
<td>0.241</td>
</tr>
<tr>
<td>ln gdp</td>
<td>0.708</td>
<td>3.720</td>
<td>0.000</td>
</tr>
<tr>
<td>ln gdp(-1)</td>
<td>-0.741</td>
<td>-3.954</td>
<td>0.000</td>
</tr>
<tr>
<td>interest</td>
<td>0.138</td>
<td>1.836</td>
<td>0.070</td>
</tr>
<tr>
<td>interest(-1)</td>
<td>0.174</td>
<td>2.129</td>
<td>0.036</td>
</tr>
<tr>
<td>inflation</td>
<td>-0.382</td>
<td>-5.603</td>
<td>0.000</td>
</tr>
<tr>
<td>inflation(-1)</td>
<td>-0.055</td>
<td>-0.877</td>
<td>0.383</td>
</tr>
</tbody>
</table>

R-squared: 0.958
Log likelihood: 140.541
Durbin-Watson statistic: 1.925

Residual tests:
- Serial Correlation LM test: 0.236, p-value: 0.790
- ARCH test: 4.429, p-value: 0.015
- Jarque-Bera (Normality test): 72.673, p-value: 0.000
- Reset (Functional form test): 0.736, p-value: 0.482

Static Long Run Equation:
In currency = -11.73 + 33.69ln(1+T) + 1.41lngdp - 13.60interest + 19.09inflation

Test of significance:
- constant: F(1,94) = 0.291
- In currency: F(1,94) = 973.943**, p-value = 0.000
- ln (1+T): F(2,94) = 1.480
- ln gdp: F(2,94) = 7.829**, p-value = 0.000
- interest: F(2,94) = 9.708**, p-value = 0.000
- inflation: F(2,94) = 20.808**, p-value = 0.000

Error-correction mechanism (ECM) test for cointegration:
t-ratio test: -0.012

*significant at 5% level, and ** at 1% level.
B. Using Government expenditure over GDP as the Fiscal variable
ADL (1 lag)

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>constant</td>
<td>0.131</td>
<td>0.276</td>
<td>0.783</td>
</tr>
<tr>
<td>ln currency(-1)</td>
<td>1.043</td>
<td>28.957</td>
<td>0.000</td>
</tr>
<tr>
<td>ln 1+G</td>
<td>1.251</td>
<td>1.885</td>
<td>0.063</td>
</tr>
<tr>
<td>ln 1+G(-1)</td>
<td>-2.310</td>
<td>-3.431</td>
<td>0.001</td>
</tr>
<tr>
<td>ln gdp</td>
<td>0.613</td>
<td>3.384</td>
<td>0.001</td>
</tr>
<tr>
<td>ln gdp(-1)</td>
<td>-0.648</td>
<td>-3.670</td>
<td>0.000</td>
</tr>
<tr>
<td>interest</td>
<td>0.085</td>
<td>1.168</td>
<td>0.246</td>
</tr>
<tr>
<td>interest(-1)</td>
<td>0.229</td>
<td>2.774</td>
<td>0.007</td>
</tr>
<tr>
<td>inflation</td>
<td>-0.317</td>
<td>-4.529</td>
<td>0.000</td>
</tr>
<tr>
<td>inflation(-1)</td>
<td>-0.098</td>
<td>-1.518</td>
<td>0.132</td>
</tr>
</tbody>
</table>

R-squared 0.962
Log likelihood 145.398
Durbin-Watson statistic 1.929

Residual tests:

<table>
<thead>
<tr>
<th>Residual test</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serial Correlation LM test</td>
<td>0.214</td>
</tr>
<tr>
<td>ARCH test</td>
<td>0.020</td>
</tr>
<tr>
<td>Jarque-Bera (Normality test)</td>
<td>0.000</td>
</tr>
<tr>
<td>Reset (Functional form test)</td>
<td>0.468</td>
</tr>
</tbody>
</table>

Static Long Run Equation:
ln currency = -3.01 + 24.35ln(1+G) + 0.80lngdp - 7.23interest + 9.53inflation

Test of significance:

<table>
<thead>
<tr>
<th>Variable</th>
<th>F(1,94)</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>constant</td>
<td></td>
<td>0.076</td>
</tr>
<tr>
<td>ln currency</td>
<td>838.514**</td>
<td></td>
</tr>
<tr>
<td>ln (1+G)</td>
<td>6.227**</td>
<td></td>
</tr>
<tr>
<td>ln gdp</td>
<td>6.800**</td>
<td></td>
</tr>
<tr>
<td>interest</td>
<td>9.695**</td>
<td></td>
</tr>
<tr>
<td>inflation</td>
<td>15.237**</td>
<td></td>
</tr>
</tbody>
</table>

Error-correction mechanism (ECM) test for cointegration:

t-ratio test 0.043

*significant at 5% level, and ** at 1% level.
Notes:

(1) Given the following ADL(k,k) model for two variables:

\[ Y_t = \mu + \sum_{i=1}^{k} \alpha_i Y_{t-i} + \sum_{i=0}^{k} \beta_i X_{t-i} + U_t \]

the static long-run equation is given by,

\[ Y = \frac{\mu}{1 - \sum_{i=1}^{k} \alpha_i} + \frac{\sum_{i=0}^{k} \beta_i}{1 - \sum_{i=1}^{k} \alpha_i} X + \varepsilon, \quad \text{where} \quad \beta = \frac{\sum_{i=0}^{k} \beta_i}{1 - \sum_{i=1}^{k} \alpha_i} \]

Furthermore, the ADL model has its equivalent in the form of the Error Correction Mechanism (ECM) through a simple transformation. For the particular case (1,1), the ECM is given by,

\[ \Delta Y_t = \mu + \beta_0 \Delta X_t + (\alpha_1 - 1)(Y_{t-1} - \beta_1 X_{t-1}) + U_t \]

(2) The significance test for the long-term effect of each explanatory variable is given by \( \sum_{i=0}^{k} \beta_i = 0 \)

(3) The null hypothesis of the ECM test is defined as \( H_0: \sum_{i=1}^{k} \alpha_i - 1 = 0 \) [\( \alpha_i - 1 = 0 \) in the case ADL(1,1)]

In case of rejection, it is possible to assume that there is cointegration between the variables in levels. The critical values of this t-ratio test are reported in Banerjee et al. (1998).

(4) The choice of the lags of the ADL model were made according to the Akaike Information Criteria.