# Measuring the Underground Economy with the Currency Demand Approach
## A Reinterpretation of the methodology, with an application to Italy[♠]

Guerino ARDIZZI
(Bank of Italy, guerino.ardizzi@bancaditalia.it)

Carmelo PETRAGLIA
(University of Basilicata, carmelo.petraglia@unibas.it)

Massimiliano PIACENZA
(University of Torino, piacenza@econ.unito.it)

Gilberto TURATI[*]
(University of Torino, turati@econ.unito.it)

**December 2011**

**Abstract**

We contribute to the debate on how to assess the size of the underground (or shadow) economy by proposing a reinterpretation of the traditional Currency Demand Approach (CDA) *à la* Tanzi. In particular, we introduce three main innovations. First, we take a direct measure of the value of cash transactions – the flow of cash withdrawn from bank accounts relative to total noncash payments – as the dependent variable in the money demand equation. This allows us to avoid using the Fisher equation, overcoming two severe critiques to the traditional CDA. Second, in place of the tax burden level, usually intended as the main motivation for non-compliance, we include among the covariates two direct indicators of detected tax evasion. Finally, we control also for the role of illegal production considering crimes like drug dealing and prostitution, which - jointly with the shadow economy - contributes to the larger aggregate of the non-observed economy and represents a significant component of total cash payments. We propose then an application of this 'modified-CDA' to a panel of 91 Italian provinces for the years 2005-2008.

**Keywords:** Underground economy, Currency Demand Approach, Cash transactions, Tax evasion, Illegal production

**JEL classification:** E26, E41, H26, K42, O17

---

[♠] We wish to thank Fabio Bagliano, Salvatore Capasso, Domenico Depalo, Michael Pickhardt, Alessandro Santoro, Paolo Sestito, Jordi Sardà, Brigitte Unger, Roberta Zizza, and all seminar participants at the *52nd Annual Conference of the Italian Economic Association* (Roma Tre University, 2011), the *2011 Conference on Shadow Economy, Tax Evasion and Money Laundering* (Münster University, Germany) and the *Lunch Seminar* held at the Bank of Italy (Roma, 2011), for their helpful comments. Usual disclaimers apply.

[*] *Corresponding author*: University of Torino, Department of Economics and Public Finance "G. Prato", Corso Unione Sovietica 218 bis, 10134 Torino – ITALY. Phone: +39.011.6706046; fax: +39.011.6706062.

## 1. Introduction

The Currency Demand Approach (CDA) is the most popular method to estimate the underground (or shadow) economy among the so-called indirect macroeconomic approaches. Originally suggested by Cagan (1958), the CDA was subsequently refined and applied by Tanzi (1980, 1983) to the U.S. economy, and has been (and still is) widely adopted in the literature (among the more recent contributions, see Ferwerda *et al.*, 2010). The CDA measures the size of the shadow economy in two stages: 1) the econometric estimation of an aggregate money demand equation, with a specific component related to cash transactions in the underground sector; 2) the computation of the value of these shadow transactions via the quantity theory of money. The key assumptions for the first-stage estimation are that shadow transactions are settled in cash to avoid traceability, and that the main cause of the underground economy is a high tax burden. The CDA involves estimating the aggregate cash demand including among the regressors both standard explanatory variables of the preference for liquidity (like the interest rate on deposits) and specific variables identifying the determinants of the shadow economy (like the tax burden level). The demand for cash associated with shadow transactions is then computed as the difference between the estimated demand for cash in the full model and the demand obtained by setting to zero all the determinants of the underground economy (i.e., the demand for cash motivated only by regular transactions).

More precisely, in the Tanzi (1980, 1983) application of the CDA to the U.S. economy, the dependent variable in the money demand equation is the cash to money supply ratio. This ratio is regressed on three variables identifying the determinants of money demand for regular transactions (the share of wages paid in cash on the national income, the interest rate on savings deposits, and the average income per capita), plus the average tax rate on personal income, which is considered to be the sole determinant of the shadow transactions. Since a basic assumption of the CDA is that a higher tax burden stimulates a higher evasion, which in turn causes an increase in the demand for cash, the expected sign on the income tax rate is positive. First stage estimation of the money demand equation confirms this view. In the second stage, the estimate of the underground economy to GDP is obtained by exploiting the Fisher equation. In particular, Tanzi defines a base year in which the contribution of the underground economy to GDP is assumed to be zero, and computes the velocity of money as

the ratio between the official GDP and the stock of liquid assets. Assuming then that this velocity is the same for the regular economy and the shadow sector, the value of the latter is obtained by multiplying $V$ for the estimated 'excess demand' for cash.

Schneider and Enste (2000, 2002) identify and discuss many substantial drawbacks of the CDA, pointing to three main criticisms of the basic assumptions of this methodology[1]: the absence of any transactions in the underground economy in a given base year; the same velocity of money in both the official and the irregular economy; the excessive tax burden as the only determinant of the shadow economy. Our aim here is to contribute to the debate on the measurement of the underground economy by proposing a revision of the CDA that overcome all these three drawbacks. In particular, we propose a 'modified – CDA' introducing three main innovations to the traditional methodology: first, we take a direct measure of cash transactions (the flow of cash withdrawn from bank accounts relative to total noncash payments) as the dependent variable in the money demand equation, which avoid using the Fisher equation; second, in place of the tax burden level, we include among the covariates two direct measures of 'detected' tax evasion, thus overcoming a serious problem of potential misspecification of the model due to the inability of considering all the relevant determinants of the phenomenon; finally, we also control for the influence of illegal production (considering crimes like drug dealing and prostitution), which jointly with shadow economy contributes to the larger aggregate of non-observed economy and represents a significant component of total cash payments (OCSE, 2002). We then propose an original application of this 'modified-CDA' to Italy, a country where the weight of the underground economy is remarkable compared to other Western countries.

The remainder of the paper is structured as follows. Section 2 discusses the innovations we introduce in the CDA, and how these help overcome (most of) the drawbacks highlighted by Schneider and Enste (2000, 2002). In section 3 we present the application of our 'modified-CDA' to Italy, discussing model specification and empirical results; in particular, besides country level estimates, we provide also disaggregated territorial estimates for country macro-areas; we finally include here a comparison with the findings obtained in other studies on Italy. Section 4 provides brief concluding remarks.

[1] Ahumada *et al.* (2007) and Breusch (2005) point to critiques specifically related to econometric issues, partly addressed by Pickhardt and Sarda (2010) within the standard CDA approach.

## 2. Reinterpreting the Currency Demand Approach

Our starting point are the criticisms to most of the assumptions of the traditional CDA advanced by Schneider and Enste (2000, 2002). In particular, we focus here on three main issues: (1) the hypothesis of the absence of any transactions in the underground economy in a given base year, which is rather unrealistic; (2) the assumption of equality in the velocity of money for both the official and the irregular economy, which introduces a restriction in the estimation method not easily justifiable; (3) the hypothesis of the excessive tax burden as the only determinant of the shadow economy, which is also quite restrictive, since other factors – such as market regulation (especially the regulation of labour markets), the trust in political institutions, and the citizens' tax morale – can substantially affect the decision to participate in the underground sector.

To avoid these critiques, we introduce three innovations in this study as compared to the traditional CDA *à la* Tanzi. First, instead of using the stock of liquid assets as the dependent variable in the money demand equation, here we take a direct measure of cash transactions: the *flow of cash* withdrawn from bank accounts with respect to total payments settled by instruments other than cash. This is a substantial modification of the model, which eliminates the need to rely on the quantity theory of money and the Fisher equation. In this way, we are able to overcome the critique (1), concerning the need to arbitrarily choose a base year for calculating the velocity of money, and the critique (2), concerning the equality assumption of the velocity of money in both the official economy and the shadow sector. Notice that the cash withdrawals we refer to also help to deal with the problematic measurement of the stock of liquid assets in each country of the EMU zone after the introduction of the euro, which can severely limit the application of the traditional CDA.

Second, in order to reply to critique (3), direct measures of *detected tax evasion* are included among the factors positively correlated with the amount of (irregular) transactions settled in cash. In this way, we remove the need to identify a set of variables that can adequately capture all the relevant determinants of shadow economy besides the level of tax burden, which is the key variable in the classic Tanzi-approach and does not take into account the presence of other possible factors underlying the decisions of noncompliance (e.g., Ferwerda *et al.*, 2010; Schneider, 2010). We look directly at the final outcome of this process – so as to circumvent the problem of incomplete specification of the model – and investigate the

relationship between the number of detected cases of tax evasion and the use of cash in transactions.

Finally, with reference again to criticism (3) and the issue of model misspecification, we argue that shadow economy represents just one component of the total amount of cash payments. Indeed, according to OECD (2002) classification, the activities contributing most to the so-called non-observed (cash-settled) economy in developed countries include both underground and illegal production: the former is defined as «*those activities that are productive and legal but are deliberately concealed from the public authorities to avoid payment of taxes or complying with regulations*», while the latter mainly refers to «*the production of goods and services whose production, sale or mere possession is forbidden by law*». Hence, in order to avoid potential distortions in the estimation of the underground component of non-observed economy, the CDA methodology we propose also controls for the presence of *illegal production*. We consider, in particular, two criminal activities like drug dealing and prostitution, which represent illegal transactions typically regulated in cash and are classified by almost all scholars among the most important activities making up the illegal economy.[2] Notice that the choices of the individuals operating in the two sectors of non-observed economy (underground and illegal production) depend on different motivations and incentive mechanisms, including the role played by deterrence actions. The two components also differ remarkably for their effects on public finances and the implications in terms of law enforcement policies, since it is possible to identify potential revenues to be recovered through tax audits only for shadow economy, while in the case of illegal production the goal is to suppress the criminal activity by relying on policing and imprisonment. Despite these relevant differences, the decomposition of total non-observed economy into underground and illegal production is an issue rarely investigated in the literature, mainly because of the difficulty in delineating the boundaries of the analysis and the lack of reliable information.[3] Here we exploit crime indicators related to drug dealing

[2] See the classification originally proposed by Lippert and Walker (1997), subsequently integrated by Schneider and Enste (2000, 2002) and Schneider (2010), and the discussion in OECD (2002, chapter 9).

[3] For a comprehensive survey of the estimates of non-observed economy in different countries with a discussion of the contribution of the two components, see the study by Thomas (1992). A recent application that takes into account the role of illegal production and relies on the traditional CDA is provided in Ferwerda *et al.* (2010). In particular, in order to reply to criticism (3) raised by Schneider and Enste (2000, 2002), the authors propose some changes to the Tanzi-approach, by including in the model several proxies for the determinants of shadow economy in substitution of the income tax rate. However, the results are judged unsatisfactory, since none of the proxies adopted significantly explains the underground economy as measured by excess demand for cash. The

and prostitution, with the purpose to provide a more precise estimate of the excess demand of cash transactions due to tax evasion, by disentangling the illegal component of non-observed economy and thus introducing a third innovation with respect to the traditional CDA.

## 3. An application of the 'modified–CDA'

### *3.1. Defining the demand for cash payments*

In this section of the paper we provide a first application of the 'modified – CDA' to a balanced panel of 91 Italian provinces observed from 2005 to 2008. We first need to discuss the definition of the demand for cash payments, and then its determinants. As for the demand of cash payments, departing from the standard CDA, we exploit information on the *flow* of cash rather than the *stock* of liquid assets. Hence, we base our assessment of the size of the shadow economy on a *direct* measure of the value of transactions at the provincial level. In particular, the dependent variable in the estimated equation of the demand for cash payments is the ratio of the value of cash withdrawn from bank accounts to the value of total payments settled by instruments other than cash (*CASH*). This represents a measure of the demand for untraced payments per euro of traceable ones (i.e., payments settled by bank transfers, cheques, credit cards).

The transactions theory of money demand relies on liquid assets as such (e.g., M1) rather than on the concept of payment, the latter necessarily implying a cash flow and precise technical and organizational procedures by which these flows circulate in the economy. However, even in the presence of reliable statistics, stock indicators can be highly inaccurate for three reasons: a) quantifying the level of national currency used outside national borders is problematic, and this is particularly true in the Euro area after the euro entered circulation in 2002; b) a certain amount of money can be held for purposes other than transactions: traditional theories of money demand discuss, for instance, the 'speculative motive' for holding money reserves; c) the velocity of money is assumed to be constant with respect to several GDP components, including the informal sector, without taking into account, *inter alia*, trade in intermediate goods and services. Hence, there may be compensatory phenomena within the same stock of banknotes in circulation, both between different purposes for

---

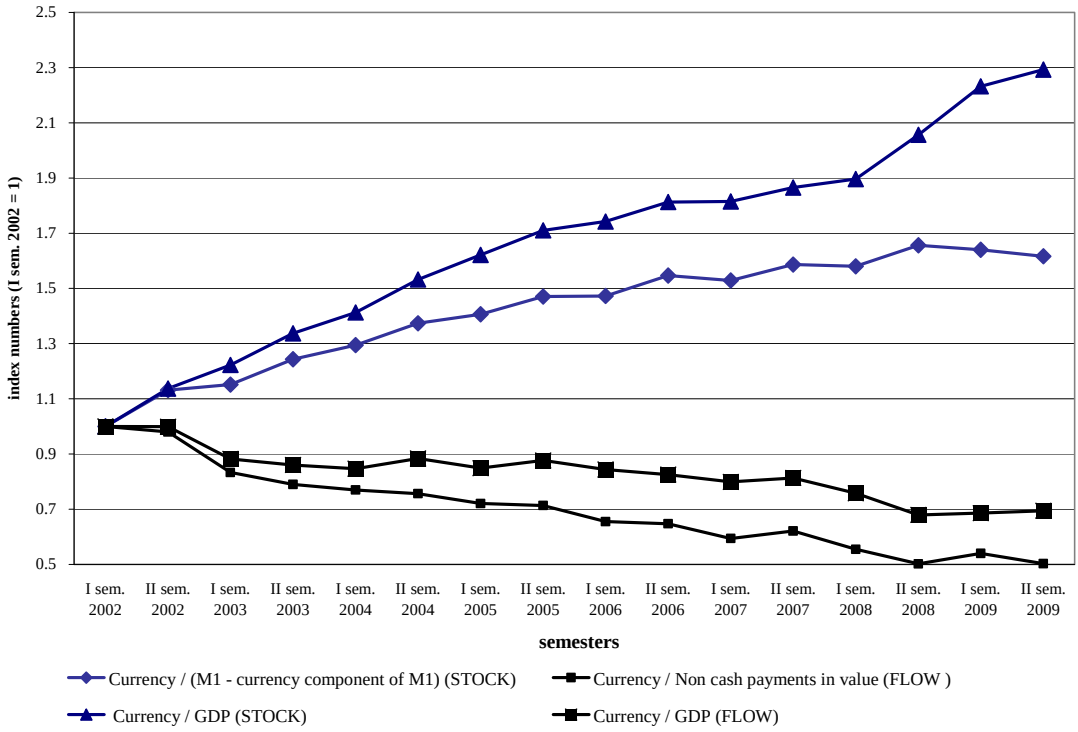
authors conclude therefore by highlighting the need to find other variables more closely related to the decision of operating in the shadow sector.

holding money reserves, and between the use of cash in the formal and the informal sector. This is confirmed by the recent trend of the currency-to-GDP ratio in the countries belonging to the G10 and to the Eurosystem: the ratio has remained stable or even increased since 2004 in those countries that should have been more affected by the replacement of banknotes with digital money. Similar considerations hold for other stock-based indicators of currency demand, such as the stocks of M1 (currency and deposits repayable on demand). Notice that – although being a signal of a higher preference for liquidity – an increase in a stock-based monetary aggregate is not informative about the underlying reasons, including for instance the rebalancing of portfolio assets, the adjustment in liquidity buffers, the need to hide transactions (whether for evading taxes or because they are illegal). The European Central Bank has noted that, on the occasion of the so-called cash changeover, the stock of euro banknotes in circulation has increased (even compared to M1 or M2) more than the previous circulation of national currencies would have suggested (ECB, 2008). According to he ECB, «*this is reasonable, in particular, in an environment of low interest rates and low inflation expectations*», not to mention that an estimate up to 20% percent of banknotes in circulation is held outside of the Euro area. It then becomes difficult – if not impossible – to estimate the component of cash held to settle payments within the underground economy using stock infomation. This is the reason why researchers need to select monetary indicators more directly related to the transaction motive.

In order to better clarify this issue, Figure 1 shows the recent trends of the currency-to-GDP and the currency-to-M1 ratios as compared to their respective flows in Italy. Two diverging trends can be observed: the stocks show a rising trend, while the flows are declining. An explanation of the increasing trend of stocks is given by the above mentioned explanation provided by the ECB. The decreasing trend of flows is instead consistent with the diffusion of electronic payment instruments in commercial transactions, which allow some substitution between alternative instruments, at least in the formal economy. Furthermore, the common trend of the two flow-based indicators confirms the higher coherence of these indicators with the transaction motive of the demand for cash. The combined evidence of such a 'substitution effect' of cash flows and the growing trend of the stock of banknotes suggests a slowing down of the overall velocity of circulation of legal money in order to meet liquidity needs other than

purely transactional ones. All these considerations seem to support the criticisms raised to the traditional CDA based on the quantity theory of money.

**Figure 1. Monetary aggregates in Italy: stocks vs. flows (index numbers, first semester 2002 = 1)**




*Source: own elaboration on Bank of Italy and ISTAT data.*

The direct link between flow-based indicators of currency demand and the transaction motive of the demand for cash can also be highlighted by looking at micro-data on cash purchases collected by the Bank of Italy through the *Survey on Household Income and Wealth*. Table 1 illustrates the correlation matrix of two different (macro) currency ratios (based on bank cash withdrawals flows divided by other payments transactions) and the percentage of cash purchases on total expenditures declared by the Italian households sample in the period 2006-2008 (nearly the period considered in this study). The correlation coefficients are positive and significant in all cases. As one would expect, the 'ATM cash withdrawals on POS card transactions' ratio shows a higher correlation with the 'Cash expenditure share by Italian households' than the 'Total cash withdrawals value flows to total non cash payments' ratio. In other words, the closer is the monetary indicator to the 'point of sales', the higher is the

correlation with the household cash expenditures.[4] Nevertheless, the wider indicator of cash usage 'Total cash withdrawals value flows to total non cash payments' better accounts for the behaviour of all the economic agents (including also private firms and the public sector, besides the household sector), which makes it more appropriate for our purposes.

**Table 1. Pearson, Spearman and Kendall tau-b correlation coefficients on different cash usage indicators** [a]

| Cash usage indicator | Total cash withdrawals value flows on total non cash payments [b] | ATM cash withdrawals on POS card transactions [c] | Cash expenditure share by Italian households [d] |
|---|---|---|---|
| | | ***Pearson correlation*** | |
| Total cash withdrawals value flows on total non cash payments | 1 | | |
| ATM cash withdrawals on POS card transactions | 0.663 | 1 | |
| Cash expenditure share by Italian households | 0.717 | 0.848 | 1 |
| | | ***Spearman correlation*** | |
| Total cash withdrawals value flows on total non cash payments | 1 | | |
| ATM cash withdrawals on POS card transactions | 0.695 | 1 | |
| Cash expenditure share by Italian households | 0.690 | 0.793 | 1 |
| | | ***Kendall tau-b correlation*** | |
| Total cash withdrawals value flows on total non cash payments | 1 | | |
| ATM cash withdrawals on POS card transactions | 0.490 | 1 | |
| Cash expenditure share by Italian households | 0.490 | 0.590 | 1 |

[a] Each correlation index is based on data for the 20 Italian Regions. All correlation indexes are statistically significant at 1%.
[b] Bank of Italy, banking statistics 2006-2008 (average annual value).
[c] Bank of Italy, banking statistics 2009.
[d] Bank of Italy, *Survey on Household Income and Wealth*, 2006-2008 (average annual value).

### *3.2. Defining the determinants of cash payments*

In line with the discussion in Section 2, we classify the determinants of *CASH* in three groups, thus identifying three components of the demand for cash payments: the *structural* component, the *underground* (or tax evasion) component, and the *illegal* (or crime) component.

[4] Exhaustive data on ATM cash withdrawals and POS transactions at regional level are fully available from 2009. Nevertheless, the stability of payment behaviours over time makes the correlation analysis consistent even in the presence of a different period covered by data on cash expenditures.

A description of the variables affecting each of the three components is provided below. The Appendix reports descriptive statistics for all covariates and information on data sources (see Tables A1 and A2).

*3.2.1. The structural component of the demand for cash payments*

Drawing from the literature on the demand for cash (e.g., Goodhart and Krueger, 2001), we identify four conventional determinants of the structural demand for cash payments: the level of economic development; the degree of spatial diffusion of banking activities; the technology of payments; the interest rate. The level of development of the economy is measured by per capita GDP at the provincial level (*YPC*). As suggested by several authors (e.g., Schneider and Enste, 2000; Schneider, 2010), *YPC* has a negative expected sign: the higher the living standard, the lower the use of cash (and the higher the demand for alternative payment instruments). Income is highly correlated to education (both general education and 'financial literacy'), and more education usually leads to a lower use of cash, since more educated individuals show greater confidence in alternative payment instruments (World Bank, 2005; Ferwerda *et al.*, 2010).

We use the number of per capita bank accounts (*BANK*) as a proxy of the spatial diffusion of banking activities, thus controlling for the structural impact of the degree of bank branches diffusion in provincial economies on the demand for cash payments. The expected sign of *BANK* coefficient is negative, as a higher diffusion of current accounts reduces the need to withdraw cash from ATMs for payments.

Several studies (e.g., Drehmann and Goodhart, 2000; Goodhart and Krueger, 2001; Schneider, 2009) emphasize the importance of the technology of payments, with a particular reference to the supply of electronic instruments. We account for available technology by including the variable *ELECTRO* among the structural determinants of *CASH*. *ELECTRO* measures the ratio of the value of transactions settled by electronic payments to provincial GDP. Since a higher share of electronic transactions (via POS and internet banking) implies a lower number of cash transactions, the expected sign of the *ELECTRO* coefficient is negative.

The interest rate on bank deposits *INT* is the fourth determinant of the structural component of *CASH*. Based on standard economic theory, the interest rate is expected to have a negative effect on the demand for money, via its role of opportunity cost of holding

cash in alternative to interest-bearing assets. Notice, however, that our model deals with cash flows rather than stocks of liquid assets, which implies an ambiguous effect of the interest rate.[5] Higher interest rates might even have a positive impact on flows, for instance, by pushing towards forms of cash raising alternative to the banking channel. However, due to the usual 'speculative' motive, we can not exclude that the interest rate on bank deposits may also negatively affect the propensity to withdraw cash in alternative to the use of other payment instruments. Thus, the expected sign of the $INT$ coefficient is *a priori* unclear.

*3.2.2. The underground component of the demand for cash payments*

We innovate the traditional CDA by considering measures of detected tax evasion instead of the variables usually adopted as proxies for the tax burden level, like the average income tax rate. Information on detected tax evasion are retrieved from a dataset concerning inspection activities with law enforcement purposes by the *Guardia di Finanza* (the Italian tax police). The availability of such information is particularly relevant for two reasons. First, as already discussed above, many factors – beyond the burden of taxes and social security contributions – are likely to influence the decision to escape Tax Authorities (market regulation, tax morale of citizens, efficiency of public administration, etc.), and each of these factors would need a proper proxy.[6] Second, since we aim at providing disaggregated territorial estimates of the shadow economy, there are no data on the actual tax rate at the provincial level in Italy, and the calculation of some measures of fiscal pressure for Italian provinces is not a trivial task, since taxes are levied by four different levels of government. In order to overcome these problems, we selected two variables that provide a direct measure of the diffusion of the productive activities (partially or totally) unknown to Tax Authorities at the provincial level. $EVAS1$ is defined by the number of *specific* tax audits[7] in a given province divided by its sample mean value (this is a measure of tax evasion intensity at the provincial level) and then

[5] Several studies investigating the role of innovative payment systems in cash demand of Italian families (e.g., Ardizzi and Tresoldi, 2003; Lippi and Secchi, 2008; Alvarez and Lippi, 2009) point out that the progress in transaction technology may substantially reduce (or even eliminate) the impact of the interest rate on the cash demand of buyers.

[6] For a discussion on the determinants of the decision to participate in the shadow economy, besides the fiscal burden, see, among others, Friedman *et al.* (2000), Schneider and Enste (2000, 2002), Feld and Frey (2007), Dreher *et al.* (2009), Torgler and Schneider (2009), and Dreher and Schneider (2010).

[7] These audits are *specific* in the sense that they imply inspections to firms based on ex-ante information about frauds that occurred within a particular operation (e.g., payment of salaries) and/or are related to a single item of the tax base (e.g., income taxes or social security contributions).

weighed by a GDP concentration index.[8] This latter standardization allows us to compare provinces characterized by remarkable differences in the level of economic development, thus avoiding attaching automatically higher levels of tax evasion to provinces with a number of audits above the sample mean. The second variable ($EVAS2$) accounts for irregularities detected by the *Guardia di Finanza* during inspections to retailers. $EVAS2$ is given by the ratio of the number of positive audits on cash registers and tax receipts to the number of existing POS in the province.[9] The standardization for the number of POS is made necessary by the high variability in the presence of POS across provinces, which is likely to affect the opportunity to evade (lower where the number of POS is higher). The inclusion of both $EVAS1$ and $EVAS2$ in our model is motivated by the fact that the former refers to inspections which may relate to any *assumed* fiscal irregularity (evasion of income and indirect taxes or social security contributions) in any type of business, while the latter *certainly* detects only tax frauds in sales by retailers (VAT and income tax evasion). Thus, $EVAS1$ and $EVAS2$ are expected to jointly provide a more comprehensive evaluation of underground component of the demand for cash payments.

*3.2.3. The illegal component of the demand for cash payments*

An index of crime diffusion ($CRIME$) is included as a further innovation compared to the traditional CDA, in order to separate the illegal component of non-observed (cash-settled) economy from shadow production. $CRIME$ is defined as the share of crimes violating the laws on drugs and prostitution over the total number of reported crimes in each province. In analogy with tax evasion variables, also this indicator has been weighed by a GDP concentration index. The selection of the variables to estimate the size of the illegal production deserves a brief explanation. Our choice of drug- and prostitution-related offenses is motivated by the focus on criminal activities that – in line with the OECD (2002) definition of illegal economy discussed above – imply an exchange between a seller and a buyer relying on a mutual agreement and a voluntary cash payment. Therefore, we excluded all those crimes which, to some extent, are based on the use of violence made to persons or properties (burglary, extortion, etc), and then imply 'payments' which do not follow an 'agreement'

[8] The GDP concentration index is defined as the ratio of provincial GDP to its sample mean value.

[9] Here *positive* stands for audits with detected evasion. The ratio is weighed for the GDP concentration index for the same reasons discussed above.

between the thief, for instance, and the victim.[10] We also excluded those offences with possible ambiguous effects on the size of cash withdrawals. This is, for instance, the case of thefts, which could also have a negative impact on *CASH* due to the fact that – in zones where more robberies occur – individuals will find too dangerous to hold money in cash. In essence, our choice is consistent with the model to be estimated, which exploits information on cash withdrawals from bank accounts due to a voluntary transactional motive.

### *3.3. Estimating the demand for cash payments*

Equation [1] provides the complete model of the demand for cash payments to be estimated, which consider the structural demand reflecting the ordinary preference for liquidity augmented by the two components related to the underground economy and the illegal production:

$$CASH_{it} = \alpha_0 + \alpha_1 YPC_{it} + \alpha_2 BANK_{it} + \alpha_3 ELECTRO_{it} + \alpha_4 INT_{it} + \alpha_5 EVAS1_{it} + \alpha_6 EVAS2_{it} + \alpha_7 CRIME_{it} + \varepsilon_{it} \quad [1]$$

We depart from the existing CDA literature on Italy, which has so far dealt with country-level data, and apply model [1] to a balanced panel of 91 Italian provinces observed from 2005 to 2008. The units included in the sample represent about 90% of all the Italian provinces (103), and are those for which complete information were available for all the variables included in Equation [1].

Given the panel structure of the database, we use a random-effects Tobit model to account for unobservable residual heterogeneity across provinces (Wooldridge, 2002). This model has the advantage – as compared to a standard panel regression with individual random effects – to accommodate for the particular distribution of the dependent variable, which is censored and has a concentrated mass of positive values very close to zero.[11] In particular, we specify the

[10] We do not account for money laundering in our analysis, since this is a criminal offense which results from other underlying criminal activities that amplifies in a cumulative way the impact of organized crime on both regular and irregular economies. The definition of recycling implies that the income stemming from a crime needs to be 'cleaned up' through the legal channel (e.g., bank transactions) in order to lower the likelihood for the criminal agent of being caught. After this, the 'cleaned up' money can be reinvested in legal activities.

[11] The sample mean of *CASH* is 0.11 (median = 0.10), with a minimum of 0.01 and a maximum of 0.24. Furthermore, 75% of the observations show values below 0.14. Before considering the censored nature of *CASH* and adopting the Tobit specification, we estimated our model by both LSDV and GLS panel tecniques. The Hausman test did not reject the GLS model. Indeed, Cameron and Trivedi (2005) argue that one of the weaknesses of the LSDV model is the high degree of inaccuracy of the estimates when the *within* variability is

error structure of Equation [1] as $\varepsilon_{it} = u_i + e_{it}$, where $u$ and $e$ are individual effects and the standard disturbance term, respectively.[12]

**Table 2. Estimated demand for cash payments (random-effects Tobit model – Italian provinces, 2005-2008)** [a]

| **Regressors** [b] | **MODEL A** | **MODEL B** |
|---|---|---|
| *YPC* | -0.030*** | -0.026*** |
| | (0.003) | (0.004) |
| *BANK* | -0.037*** | -0.061*** |
| | (0.011) | (0.013) |
| *ELECTRO* | -0.005*** | -0.005*** |
| | (0.001) | (0.001) |
| *INT* | -0.011*** | -0.010*** |
| | (0.002) | (0.002) |
| *EVAS*1 | 0.006*** | 0.006*** |
| | (0.002) | (0.002) |
| *EVAS*2 | 0.027*** | 0.010* |
| | (0.005) | (0.006) |
| *CRIME* | - | 0.286*** |
| | | (0.063) |
| Constant | 0.220*** | 0.222*** |
| | (0.006) | (0.006) |
| Observations | 364 | 364 |
| Log-likelihood | 959.08 | 963.96 |
| Wald statistic ($\chi^2$) | 1969.51*** | 2563.29*** |
| $\sigma_u$ | 0.022*** | 0.023*** |
| | (0.001) | (0.001) |
| $\sigma_e$ | 0.012*** | 0.012*** |
| | (0.000) | (0.000) |
| $\rho$ | 0.772 | 0.784 |
| | (0.019) | (0.017) |

[a] Dependent variable: *CASH*; MODEL A: equation [1] without crime indicator ($\alpha_7 = 0$); MODEL B: equation [1] including crime indicator.
[b] Standard errors in round brackets; *** statistically significant at 1%; ** statistically significant at 5%; * statistically significant at 10%.

dominated by the *between* variability of the panel. Looking at table A2 in the Appendix, it is clear that this is the case for all variables of our model (except *INT*). In light of this, we decided to adopt a random-effects Tobit specification.

[12] We also experimented with a model including time fixed effects in addition to provincial individual effects. However, apart from the year 2007, for which the estimated coefficient resulted negative and significant, no other time effect was statistically significant, while leaving virtually unaffected the estimates for the other variables.

Once obtained the parameter estimates of the model, we adapt and apply the original procedure proposed by Tanzi (1983) for the assessment of the underground economy. The size of the total (shadow plus illegal) non-observed production is given by the 'excess demand' for cash payments unexplained by structural factors. This excess demand is obtained as the difference between the fitted values of *CASH* from the full model [1], and predicted values obtained from a restricted version of Equation [1] setting $EVAS1 = EVAS2 = CRIME = 0$. To evaluate separately the size of the two components of the non-observed economy, we then proceed in a similar manner, by imposing alternatively the restrictions $EVAS1 = EVAS2 = 0$ and $CRIME = 0$, and calculating the excess demand for cash payments due to tax evasion (underground production) and criminal activities (illegal production), respectively. Given our definition of *CASH*, the estimates obtained in this way are expressed in relation to total payments settled by instruments other than cash. In order to have measures comparable with previous studies, we then rescale our estimates of shadow and illegal economy, and express our results in terms of provincial GDP.

Table 2 reports the estimation results. The first column show the estimates for a reduced version of Equation [1], accounting only for underground production as a component of the non-observed economy (MODEL A). The second column report results for a complete model considering both tax evasion and criminal activities (MODEL B). All the estimated coefficients have the expected sign, and are statistically significant at the 1% level in all cases except one. Moreover, the LR test ($H_0$: MODEL A = MODEL B) confirms the importance of controlling for the presence of illegal activities (drug dealing and prostitution) in order to correctly assess the extent of the underground economy: the inclusion of *CRIME* significantly improves the goodness of fit of the model ($\chi^2_{(1)} = 9.76$, p-value = 0.002) and also reduces from 0.027 to 0.010 the magnitude of the coefficient associated to $EVAS2$, thus lowering the total impact of tax evasion on the demand for cash and, eventually, the estimated size of the shadow production. Finally, for both specifications the coefficient $\rho$ – which measures the proportion of total residual variance explained by individual effects ($u$) in relation to the proportion explained by noise ($e$) – is close to 0.80, highlighting the importance of using panel techniques, in order to control for the presence of unobserved heterogeneity due to provincial-specific idiosyncratic random shocks.

### *3.4. Assessing the non-observed economy*

The size of the total non-observed economy for each province in each year has been assessed relying on the most comprehensive specification of MODEL B, which allows us to obtain separate measures for the underground economy and the illegal production. Before computing average values (reported in Table 3), we discarded 26 outliers identified using the Hadi (1992, 1994) method.

**Table 3. Size of non-observed economy as % of GDP (Italian provinces, 2005-2008)**[a]

| | Underground economy | Illegal production | Total non-observed economy |
|---|---|---|---|
| 2005 | 14.5% | 10.2% | 24.7% |
| 2006 | 15.0% | 9.6% | 24.6% |
| 2007 | 18.0% | 11.3% | 29.3% |
| 2008 | 18.5% | 12.6% | 31.1% |
| *Average 2005-2008* | *16.5%* | *10.9%* | *27.4%* |

[a] 26 outliers were dropped using the Hadi (1992, 1994) method.

Several interesting results emerge from the table. First, the estimated size of the non-observed economy due to tax evasion (16.5% of GDP over the entire period 2005-2008) is very close to the official figures provided by the Italian National Institute of Statistics (Istat, 2010), while Schneider and Enste (2000, 2002) report much higher values (above 25% from mid-90s until 2000). As already suggested by Zizza (2002), this discrepancy is likely to be attributable to the role played by criminal activities. Indeed, the ratio of the illegal production 'value added' to GDP in 2007 is in line with the only available estimates provided by Eurispes (2008) for the same year (about 11% of GDP). The estimates of MODEL A – where the crime indicator is not included – confirms that neglecting the component of illegal economy in the application of the CDA leads to overestimate the underground production: MODEL A implies higher values of the underground economy than MODEL B, 21.4% on average in 2005-2008, not far from the estimates presented by Schneider (2010), but lower than the sum of the shadow economy and the illegal production estimated in MODEL B (27.4%).[13] Hence, ignoring crime as a component

[13] The average incidence of the underground economy estimated by Schneider (2010) in the years 2005-2007 amounted to 23.3% of GDP. However, it is worth remarking that – since the estimates for the more recent years

of total cash payments brings about two possible measurement errors: muddling up tax evasion and illegal production, on the one side, and under-estimating the total size of the non-observed economy, on the other.

**Table 4. Size of the non-observed economy as % of GDP in Southern and Central-Northern Italian provinces (2005-2008)**[a]

| | Underground economy | Illegal production | Total non-observed economy |
|---|---|---|---|
| **CENTRE-NORTH** | | | |
| 2005 | 16.6% | 11.5% | 28.1% |
| 2006 | 16.6% | 11.0% | 27.6% |
| 2007 | 19.9% | 13.0% | 32.9% |
| 2008 | 20.8% | 14.6% | 35.4% |
| *Average 2005-2008* | *18.5%* | *12.5%* | *31.0%* |
| **SOUTH** | | | |
| 2005 | 9.7% | 7.2% | 16.9% |
| 2006 | 11.3% | 6.3% | 17.6% |
| 2007 | 13.6% | 7.4% | 21.0% |
| 2008 | 13.6% | 8.2% | 21.8% |
| *Average 2005-2008* | *12.0%* | *7.3%* | *19.3%* |

[a] 26 outliers were dropped using the Hadi (1992, 1994) method.

As for the temporal dynamics, one can observe an increasing trend from 2005 to 2008 for both components, although the increase appears more marked for tax evasion (+4%) than for the criminal economy (+2.4%), with a sharp jump in the transition from 2006 to 2007 (+3% and +1.7%, respectively). Such evidence may be, at least in part, due to the fact that the Italian economy in 2007, like other countries in the euro zone, began to suffer the cyclical downturn caused by the severe world financial crisis, with a sharp slowdown in consumptions and investments and a strong deterioration in firms' trust indicators (Bank of Italy, 2007). The negative expectations of the operators may then have led to an increased subtraction of

were derived from a combination of the MIMIC method with the CDA – the comparison in this case is more difficult than for the values computed up to 2000 and presented in Schneider and Enste (2000, 2002). For additional details, see Schneider (2010).

taxable income to Fiscal Authorities, and a more marked use of the black labour market, and/or even to turn to illegal sectors of the economy (e.g., prostitution, drug dealing).[14]

Finally, the separate assessment of the two components of the non-observed economy is of particular interest in the Italian case. In the light of the marked regional differentials in the distribution of tax bases and in the concentration of the organized crime, at least two questions deserve to be explored. First, given the higher degree of economic and industrial development of the Central-Northern regions with respect to Southern ones, does the size of the underground production differ between the North and the South of the country? Second, does the prevalent localization of the 'headquarters' of criminal organizations in the South of Italy imply a higher contribution of the Southern regions to the formation of the illegal component of the non-observed economy? Or, instead, is it reasonable to expect minor territorial differences, due to the high mobility of criminal resources?

According to results reported in Table 4, compared to Southern provinces, those in the Centre-North seem to exhibit a higher incidence of the non-observed economy on GDP, both for tax evasion (18.5% vs. 12%) and for criminal activities (12.5% vs. 7.3%). Despite being against the widespread opinion about the presence of a higher shadow economy and illegal production in the South of the country[15], such an evidence of a significant gap between Centre-North and South supports the results obtained by the few previous studies based on alternative estimation methodologies. Relying on time series data from the early '80s to the late '90s, Bovi *et al.* (2002) estimate a higher tax evasion in the North than in the South in several years. More recently, looking at more specific taxes (the Personal Income Tax IRPEF, and a tax on productive activities IRAP), Marino and Zizza (2008) and Pisani and Polito (2006) both conclude that in many cases tax evasion is higher in the Centre-North than in the rest of the country. The results delivered in 2011 by the Working Group *Economia non osservata e flussi finanziari* (literally, 'Non-observed economy and financial flows') –

[14] Note that these changes in the economic cycle involve likely variations in the velocity of money, which presumably fell in the official economy and increased in the irregular sectors. This further supports the adoption of an estimation approach – such as the 'revised – CDA' proposed here – that overcomes the restriction of the velocity of money constant over time and identical between regular and non-observed economy.

[15] This opinion largely relies on the fact that in Southern regions payments are settled by instruments other than cash to a lower extent than in the Centre-North. The descriptive statistics reported in Table A2 in the Appendix clearly show that the use of cash is higher in the South than in the rest of the country (the mean values of *CASH* are 0.09 and 0.15 in the Centre-North and in the South, respectively). However, far from being in contrast with our results, these statistics provide evidence that in less advanced regions, because of the lower degree of financial development, a higher share of transactions in the official economy are settled in cash.

established by the Ministry of Economy and chaired by the President of the Italian Statistical Office – go in the same direction. Finally, a recent survey by one of the three biggest unions shows the significant increase in the diffusion of irregular workers in the Northern regions (UIL, 2011). As for the illegal component of the non-observed economy, the higher incidence observed for the Centre-North is probably justified by the fact that the use of cash for transactions related to criminal activities is higher where the 'retail markets' for goods and services such as drug and prostitution are more lucrative. Hence, despite criminal organizations having their 'headquarters' predominantly localized in the South, our evidence seems to suggest their ability to export illegal activities in the richest areas of the country.[16]

## 4. Conclusions

In this paper we contribute to the debate on assessing the size of the underground economy by providing a reinterpretation of the CDA *à la* Tanzi, which aims at overcoming its most relevant weaknesses as remarked in Scheider and Enste (2000, 2002). Our main contributions can be summarized as follows. First, we introduce a *direct* measure of the value of cash transactions as the dependent variable in the money demand equation. In particular, we use the flow of cash withdrawn from bank accounts with respect to total noncash payments in substitution of the traditional money stock variable. This departure from the standard CDA makes it possible to avoid using the Fisher equation and the implied unrealistic assumptions of the absence of underground production in a given base year and of a common velocity of money in the official economy and the irregular sector. Second, instead of considering the tax burden as the main determinant of the decision to operate in the underground economy, we capture the 'excess demand' for cash payments due to tax evasion by exploiting direct information on *detected* non-compliance, thus overcoming the problem of finding suitable proxies able to capture all the relevant causes of the phenomenon. Third, we control also for the role played by illegal production (considering crimes like drug dealing and prostitution), which - jointly with the shadow economy - contributes to the larger aggregate of the non-observed economy and represents a significant component of total cash payments.

We present an application of this 'modified–CDA' exploiting original data on monetary variables, tax evasion and reported illegal activities for the Italian Provinces over the period

[16] The ability of criminal organizations to 'export' their businesses is discussed, e.g., in Varese (2011).

2005-2008. Our results show an average value of the shadow economy of 16.5% of GDP, which is consistent with the recent estimates available from official statistical sources relying on microeconomic methods of measurement, but appears lower than the values obtained for Italy in the international literature (e.g., Schneider and Enste, 2000, 2002 and Schneider, 2010). We show that this discrepancy is likely to be due to the omission of illegal activities in the application of the traditional CDA *à la* Tanzi. Not surprisingly, when the model does not accounts for the role played by criminal transactions, which amount, on average, to about 11% of GDP, our estimate of underground economy increases up to 21.4% of GDP. This evidence points out that, ignoring illegal production, one could not only mistakenly attribute to shadow economy a part of cash payments due to criminal transactions – for which it is not possible to implement law enforcement policies in order to recover lost tax revenues – but also underestimate the total incidence of the non-observed economy (i.e., underground plus illegal production).

Given the availability of relevant information at a disaggregated territorial level, we also provide estimates of the shadow and illegal economy by macro-areas. This is an important step in the understanding of the non-observed economy and its size, because of the marked North-South divide in the level of economic development, institutional quality and social capital in Italy. The evidence we provide suggests that, compared to Southern provinces, those in the Centre-North exhibit a higher incidence of both underground economy and illegal production relative to GDP. While the result on crime provides fresh insights on the ability of criminal organizations to 'export' illegal activities in the richest areas of the country, where demand is presumably higher, the findings concerning tax compliance stimulate future research on the determinants of this higher propensity to evade in the North of the country.

**References**


Ahumada, H., Alvaredo, F. and Canavese, A. (2007), "The Monetary Method and the Size of the Shadow Economy: A Critical Assessment", *Review of Income and Wealth*, 53(2), 363-371.

Alvarez, F. and Lippi, F. (2009), "Financial Innovation and the Transactions Demand for Cash", *Econometrica*, 77(2), 363-402.

Ardizzi, G. and Tresoldi, C. (2003), "Spunti di riflessione sull'uso del contante nei pagamenti", *Banca Impresa Società*, 2, 153-188.

Bank of Italy (2007), *Relazione Annuale*, Rome.

Bank of Italy (various years), *Survey on Household Income and Wealth*, Rome.

Bovi, M., Hermann, A., Pappalardo, C. and Sica, F. (2002), "Il sommerso: cause, intensità territoriali, politiche di regolarizzazione", in ISAE (a cura di), *Rapporto Trimestrale – Priorità nazionali: trasparenza, flessibilità, opportunità*, n. 9, 55-100.

Breusch, T. (2005), *Fragility of Tanzi's Method of Estimating the Underground Economy*, Working Paper, School of Economics, Australian National University: Canberra.

Cagan, P. (1958), "The Demand for Currency Relative to Total Money Supply", *Journal of Political Economy*, 66, 303-328.

Cameron, A.C., and Trivedi, P.K. (2005), *Microeconometrics: Methods and Applications*, Cambridge University Press, New York.

Dreher, A. and Schneider, F. (2010), "Corruption and the Shadow Economy: An Empirical Analysis", 144(2), *Public Choice*, 215-238.

Dreher, A., Kotsogiannis, C. and McCorriston, S. (2009), "How Do Institutions Affect Corruption and the Shadow Economy?", *International Tax and Public Finance*, 16(4), 773-796.

Drehmann, M. and Goodhart, C.A.E. (2000), *Is Cash Becoming Technologically Outmoded? Or Does it Remain Necessary to Facilitate Bad Behaviour? An Empirical Investigation into the Determinants of Cash Holdings*, Financial Markets Group Research Centre, Discussion Paper 358, LSE.

Eurispes (2008), *Rapporto Italia 2008*, Istituto di Studi Politici Economici e Sociali, Rome.

European Central Bank (2008), *Economic Bulletin*, special edition, May.

Feld, L. and Frey, B.S. (2007), "Tax Compliance as the Result of a Psychological Tax Contract: The Role of Incentives and Responsive Regulation", *Law and Policy*, 29(1), 102-120.

Ferwerda, J, Deleanu, I. and Unger, B. (2010), *Revaluating the Tanzi-Model to Estimate the Underground Economy*, Tjalling C. Koopmans Research Institute, Discussion Paper 10-04, Utrecht School of Economics, February.

Friedman, E., Johnson, S., Kaufmann, D. and Zoido-Lobatón, P. (2000), "Dodging the Grabbing Hand: The Determinants of Unofficial Activity in 69 Countries", 76(3), *Journal of Public Economics*, 459-493.

Goodhart, C. and Krueger, M (2001), *The Impact of Technology on Cash Usage*, Financial Markets Group Research Centre, Discussion Paper 374, LSE.

Hadi, A.S. (1992), "Identifying Multiple Outliers in Multivariate Data", *Journal of the Royal Statistical Society*, Series B, 54, 761-771.

Hadi, A.S. (1994), "A Modification of a Method for the Detection of Outliers in Multivariate Samples", *Journal of the Royal Statistical Society*, Series B, 56, 393-396.

Istat (2010), "La misura dell'economia sommersa secondo le statistiche ufficiali. Anni 2000-2008", *Conti Nazionali – Statistiche in Breve*, Istituto Nazionale di Statistica, Rome.

Lippert, O. and Walker M. (1997), *The Underground Economy: Global Evidences of its Size and Impact*, Vancouver: The Frazer Institute.

Lippi., F. and Secchi, A. (2008), *Technological Change and the Demand for Currency: An Analysis with Household Data*, Bank of Italy, Temi di Discussione, Nr. 697, Roma.

Marino, M.R. and Zizza, R. (2008), *L'evasione dell'Irpef: una stima per tipologia di contribuente*, mimeo, Bank of Italy, Rome.

OECD (2002), *Measuring the Non-Observed Economy – A Handbook*, Paris.

Pickhardt, M. and Sarda J. (2010), *The Size of the Underground Economy in Germany: A Correction of the Record and New Evidence from the Modified-Cash-Deposit-Ratio Approach*, Institute of Spatial and Housing Economics, Working Paper 201036, University of Münster.

Pisani, S. and Polito C. (2006), *Analisi dell'evasione fondata sui dati IRAP – Anni 1998-2002*, Ministero dell'Economia e delle Finanze, Agenzia dell'Entrate, Documenti di lavoro dell'Ufficio Studi.

Schneider, F (2010), "The Influence of Public Institutions on the Shadow Economy: An Empirical Investigation for OECD Countries", *Review of Law and Economics*, 6(3), 441-468.

Schneider, F. (2009), *The Shadow Economy in Europe. Using Payment Systems to Combat the Shadow Economy*, A.T. Kearney Research Report, September.

Schneider, F. and Enste D.H. (2000), "Shadow Economies: Size, Causes and Consequences", *Journal of Economic Literature*, 38(1), 77-114.

Schneider, F. and Enste, D.H. (2002), *The Shadow Economy: Theoretical Approaches, Empirical Studies, and Political Implications*, Cambridge University Press, UK.

Smith, P. (1994), "Assessing the Size of the Underground Economy: The Canadian Statistical Perspectives", *Canadian Economic Observer*, 7(5), May.

Tanzi, V. (1980), "The Underground Economy in the United States: Estimates and Implications", *Banca Nazionale del Lavoro Quarterly Review*, 135(4), 427-453.

Tanzi, V. (1983), "The Underground Economy in the United States: Annual Estimates 1930-1980", *IMF Staff Papers*, 30(2), 283-305.

Thomas, J.J. (1992), *Informal Economic Activity*, LSE Handbooks in Economics, London: Harvester Wheatsheaf.

Torgler, B. and Schneider F. (2009) "The Impact of Tax Morale and Institutional Quality on the Shadow Economy", *Journal of Economic Psychology*, 30(2), 228-245.

UIL (2011), *2° Rapporto UIL sul lavoro sommerso*, Servizio Politiche del Lavoro e della Formazione, Rome.

Varese, F. (2011), *Mafias on the Move: How Organized Crime Conquers New Territories*, Princeton, Princeton University Press.

Wooldridge, J.M. (2002), *Econometric Analysis of Cross Section and Panel Data*, MIT Press, Cambridge, Massachusetts.

World Bank (2005), *International Migration, Remittances, and the Brain Drain*, M. Schiff and C. Ozden (eds.), Washington, D.C.

Zizza, R. (2002), *Metodologie di stima dell'economia sommersa: un'applicazione al caso italiano*, Bank of Italy, Temi di Discussione, Nr. 463, December.

## Appendix. The data

This study uses an original dataset on a balanced panel of 91 Italian provinces observed over the period 2005-2008. This dataset merges information of four different sources: Bank of Italy (BdI), *Guardia di Finanza* (GdF, the Italian Tax Police), Istat (the Italian National Statistical Office), and Eurostat (the Statistical Office of the European Union). All monetary variables are provided by BdI. Data on provincial GDP are provided by Eurostat. The proxies for tax evasion are computed using data on GdF fiscal inspections for the period 2005-2008. The crime index uses information on criminal offences downloaded from Istat website http://giustiziaincifre.istat.it.

**Table A1. Data description (definition of variables and data sources)**

| Variable | Definition | Source |
|---|---|---|
| *CASH* | Ratio of the value of cash withdrawn from bank accounts to the value of total payments settled by instruments other than cash | BdI |
| *Structural factors* | | |
| *YPC* | Provincial GDP per capita | Eurostat |
| *BANK* | Per capita number of banking accounts | BdI |
| *ELECTRO* | Ratio of the value of transactions settled by electronic payments to GDP | BdI and Eurostat |
| *INT* | Rate of interest on bank deposits | BdI |
| *Tax evasion* | | |
| *EVAS*1 | Number of specific tax audits in a province divided by its sample mean value (weighted by a GDP concentration index) | GdF and Eurostat |
| *EVAS*2 | Ratio of the number of positive audits on cash registers and tax receipts to the number of existing POS in the province (weighted by a GDP concentration index) | GdF and Eurostat |
| *Criminal economy* | | |
| *CRIME* | Share of crimes violating laws on drugs and prostitution over the total number of reported crimes (weighted by a GDP concentration index) | Istat and Eurostat |

**Table A2. Descriptive statistics**

| Variable | Mean | Standard Deviation | | | Min | Max |
|---|---|---|---|---|---|---|
| | | Total | *Between* | *Within* | | |
| | | | ***ITALY*** [a] | | | |
| *CASH* | 0.108 | 0.048 | 0.046 | 0.013 | 0.010 | 0.236 |
| *YPC* (×10⁴ €) | 2.491 | 0.596 | 0.590 | 0.099 | 1.235 | 3.908 |
| *BANK* | 0.584 | 0.193 | 0.189 | 0.042 | 0.236 | 1.177 |
| *ELECTRO* | 2.100 | 1.728 | 1.598 | 0.672 | 0.538 | 16.638 |
| *INT* | 1.247 | 0.488 | 0.265 | 0.410 | 0.472 | 2.909 |
| *EVAS1* | 1.151 | 0.594 | 0.575 | 0.159 | 0.222 | 3.839 |
| *EVAS2* | 0.204 | 0.215 | 0.207 | 0.063 | 0.001 | 1.233 |
| *CRIME* | 0.023 | 0.020 | 0.019 | 0.004 | 0.001 | 0.116 |
| | | | ***CENTRE-NORTH*** [b] | | | |
| *CASH* | 0.090 | 0.041 | 0.039 | 0.012 | 0.010 | 0.204 |
| *YPC* (×10⁴ €) | 2.823 | 0.335 | 0.318 | 0.110 | 2.061 | 3.908 |
| *BANK* | 0.684 | 0.129 | 0.125 | 0.036 | 0.304 | 1.177 |
| *ELECTRO* | 2.399 | 1.962 | 1.802 | 0.800 | 0.538 | 16.638 |
| *INT* | 1.299 | 0.504 | 0.261 | 0.432 | 0.472 | 2.909 |
| *EVAS1* | 1.067 | 0.522 | 0.507 | 0.136 | 0.221 | 2.746 |
| *EVAS2* | 0.149 | 0.186 | 0.178 | 0.059 | 0.001 | 1.233 |
| *CRIME* | 0.022 | 0.021 | 0.021 | 0.003 | 0.001 | 0.115 |
| | | | ***SOUTH*** [c] | | | |
| *CASH* | 0.148 | 0.038 | 0.036 | 0.016 | 0.063 | 0.236 |
| *YPC* (×10⁴ €) | 1.703 | 0.216 | 0.210 | 0.062 | 1.234 | 2.218 |
| *BANK* | 0.347 | 0.077 | 0.057 | 0.053 | 0.236 | 0.581 |
| *ELECTRO* | 1.390 | 0.478 | 0.479 | 0.077 | 0.806 | 2.723 |
| *INT* | 1.122 | 0.423 | 0.235 | 0.355 | 0.474 | 2.480 |
| *EVAS1* | 1.350 | 0.699 | 0.678 | 0.205 | 0.387 | 3.839 |
| *EVAS2* | 0.335 | 0.224 | 0.215 | 0.0718 | 0.037 | 0.983 |
| *CRIME* | 0.025 | 0.016 | 0.015 | 0.006 | 0.003 | 0.095 |

[a] Figures based on a balanced panel of 91 provinces observed in 2005-2008 (364 total observations).

[b] Figures based on a balanced panel of 64 provinces observed in 2005-2008 (256 total observations).

[c] Figures based on a balanced panel of 27 provinces observed in 2005-2008 (108 total observations).