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PECUNIA OLET.
CASH USAGE AND THE UNDERGROUND ECONOMY

by Michele Giammatteo*, Stefano Iezzi* and Roberta Zizza§

Abstract

This paper explores the role of cash usage in feeding the underground economy by using a unique dataset that combines, at province level, official estimates of Italian firms' underreporting with data on cash transactions drawn from the aggregate anti-money laundering reports filed to the Italian Financial Intelligence Unit (UIF) by banks. In order to derive causal evidence, we apply two different econometric strategies: an instrumental variable approach and a difference-in-difference approach, which exploits the change in the maximum threshold for cash transactions introduced in 2016, thereby providing a measure of the effect of such policy on tax evasion. We find that an increase in cash usage translates, other things being equal, into a higher level of underreporting by firms, and that raising the cash threshold in 2016 – a measure motivated by the objective of boosting spending – had the side effect of leading to a larger underground economy.

JEL Classification: O17, H26, E26, E42.
Keywords: shadow economy, tax evasion, cash threshold, bank branches, ATM, cashless payments.
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1. Motivation and contribution to the literature[1]

The diffusion of the underground economy is customarily held related to the use of cash, as shadow transactions are settled in cash to avoid traceability and, thereby, compliance with labour and tax laws. The anonymity associated to transactions in cash is a feature that makes it a privileged means of payment for laundering proceeds originating from a number of criminal activities, to which end smurfing techniques are typically used so as to limit the value of individual transactions. Thus, the fact that using cash, especially for large transactions, may be connected to an illegal activity led influential scholars to refer to cash "as a curse" and provides a rationale for phasing out paper money (Rogoff, 2016).

Despite the thesis of a nexus between the use of cash and the proliferation of the shadow economy is widely accepted,[2] very little empirical evidence is available to support it. As argued by Gros (2017), cash holdings are particularly high in Japan and Germany, where one would expect only a small underground economy. Two recent papers at cross-country level attempted to fill this gap. Immordino and Russo (2018) show for a panel of European countries - adopting an instrumental variable approach and relying on a dataset matching information on VAT evasion with Payment Statistics as released by the ECB - that cashless payments hinder tax evasion; they also find that, in this respect, it is not the diffusion of payment cards *per se* that matters, but their actual use: if cards are used to withdraw cash, rather than to make payments, they actually end up in fostering tax evasion. Marmora and Mason (2021) resort to a system GMM framework to account for reverse causality and find for a panel of 37 countries that the existence of a shadow economy - estimated on the basis of a method assuming a close relationship between consumption of electricity and economic activity – mitigates the effect of the diffusion of cashless payment technologies on the demand for cash. While these contributions represent a significant step forward in understanding the relationship between payment habits and the underground economy, estimates of the latter used therein, though cleverly designed, are plagued with uncertainty and limitations. Moreover, exploiting large panels of countries is particularly challenging, as many dimensions of heterogeneity and the role of confounding factors (e.g. due to concomitant changes in other policies) need to be taken into account by the econometrician.

In this paper, we delve into this issue adopting a within-country perspective, with reference to the Italian

[1] Many thanks to Paolo Del Giovane, Mario Gara, Alessandro Mistretta and seminar participants at the UIF for useful suggestions and discussions; to Istat and, in particular, to Alessandra Agostinelli and Federico Sallusti for providing us with data on underreporting, and to Sauro Mocetti for data on judicial proceedings. The views expressed in the article are those of the authors and do not involve the responsibility of UIF and Banca d'Italia.

[2] The validity of this nexus also provides a justification for one of the most popular methods for estimating the underground economy, the so-called 'currency demand approach'. See Slemrod and Yitzhaki (2002) for a review of the estimation methods and Zizza (2002) and Ardizzi *et al.* (2014) for applications of the 'currency demand approach' to Italy.

economy. In doing this, we contribute to the huge literature that employs variations across cities or regions to answer macroeconomic questions, as reviewed in Nakamura and Steinsson (2018).

Comparable, though non-official, estimates place Italy among the European countries where the underground economy is more widespread (CASE-CPB, 2013; Kelmanson *et al.*, 2019); shadow economy is held a serious concern in Italy, as highlighted by the European Commission (2020). According to the Italian National Statistical Institute (Istat), which estimates the value added produced by the underground economy as a way to achieve exhaustiveness of GDP and other aggregates in the National accounts, in 2018 about 11 per cent of total value added was either under-reported or produced by undeclared work (Istat, 2020). Equally, Italy stands above the euro area average as for the preference for cash in payment habits. According to the Study on the Payment Attitudes of Consumers in the Euro area (SPACE) conducted in 2019 by the ECB, in Italy 82 per cent of transactions (corresponding to 58 per cent of the total value) are made in cash, which compares to 73 per cent (48 per cent) for the euro area as a whole (ECB, 2020).

Italy is thus a perfect laboratory to assess the relevance of the nexus between the use of cash and the extent of the underground economy. Actually, promoting the use of electronic means of payments has been in the political agenda of several governments, concerned about the diffusion of tax evasion, irregular work and money laundering. Among the measures approved over the recent years to reduce the scope for tax evasion, most of them based on an extensive use of technology (Prometeia, 2019),[3] a prominent one is the introduction of limits in the use of cash, which in Italy have been in place since 1991. Italy has been a pioneer in this respect; many other European countries followed, putting a ban on cash transactions beyond a certain amount.[4] Over the years and mainly in the last decade, Italian thresholds were subject to several adjustments, though not always in the same direction. Until the beginning of 2010, the threshold in Italy was equal to 12,500 euros; then, regulation became more stringent: the limit was set to 5,000 euros in May 2010, then halved in August 2011 and finally lowered to 1,000 euros as of January 2012. This trend was temporarily reversed with the 2016 Stability Law, which stipulated that from January 2016 cash could be used for payments up to 3,000 euros, with the aim of boosting consumer spending. In the last two years, though, the threshold downward shift has resumed, as it was reduced to 2,000 euros from July 2020 and will be brought back to 1,000 euros in 2022.

[3] Traceability in order to benefit from deductions for property renovations and energy savings expenses is one of the longest-living measures.

[4] Among them, France, Spain, Portugal, Belgium and Greece (see Russo, 2020; Sands *et al.*, 2017) for further details on thresholds enacted in other countries.

Sands *et al.* (2017) critically discuss arguments in favour and against imposing limits to use cash for big purchases, concluding that cash thresholds are an attractive and pragmatic policy option, complementing other actions[5] taken to curb tax evasion, money laundering and financial crime, with limited downsides. Despite its potential relevance for the Italian economy in the fight against tax evasion (OECD, 2019), quantitative evaluations of this policy are scant. As for Italy, to the best of our knowledge, only two very recent papers address this issue, exploiting changes in the threshold enacted in the last decade. Rainone and Valentini (2019) use high-frequency data on payments regulated in the TARGET2 system operated by the Eurosystem to show that the recent increase in the demand for cash in Italy is due to a higher demand for large-denomination banknotes, which in turn can be in part the effect of the increase of the threshold for cash payments (from 1,000 to 3,000 euros) decided in 2016. Russo (2020), exploiting individual data from the Banca d'Italia's Survey of Household income and Wealth in a difference-in-difference exercise, finds that the threshold decrease to 1,000 euros enacted in 2011 induced a higher decrease of cash expenditure among "potential tax evaders" (i.e. households with at least one self-employed member) than in the rest of the population; he also proposes a theoretical model which is used to compute the entailed increase in tax revenues.

Our contribution to the literature on the role of cash usage in feeding the underground economy is threefold. First, we build a unique dataset by merging official estimates on Italian firms' underreporting provided by Istat and data on operations in cash drawn from anti-money laundering reports gathered by the Italian Financial Intelligence Unit (UIF) for years 2015-17, using the province as matching key. Second, we adopt an instrumental variable approach to estimate a causal relationship, as in Immordino and Russo (2018), but we improve on them as reliance on data for a single country makes it less challenging to take into account other potentially affecting factors, such as concomitant institutional changes. Third, we resort to an alternative identification strategy, based on a difference-in-difference approach applied to the change in the cash threshold in force since 2016, which is also meant to provide an empirical assessment of the effect of this policy on tax evasion. Differently from Russo (2020), we focus on the period between 2015 and 2017, and thus assess whether raising the threshold in 2016 had, as a side effect, a positive impact on the irregular economy; more importantly, we are able to provide a *direct* test of the impact of this policy as we can take advantage of an explicit measure of underreporting.

The rest of the paper is organized as follows. Section 2 describes the data sources and variables; Section

[5] These include the elimination of high denomination notes, the imposition of reporting requirements on bulk cash movements or the promotion of electronic alternatives to cash.

3 illustrates strategy adopted and results of the instrumental variable approach; Section 4 presents the exercise based on a difference-in-difference regression and Section 5 concludes.

2. Data description

We build a unique dataset at the provincial level covering the three-year period 2015-17, drawing from several sources.[6] As a measure of the size of the underground economy, we construct the share of undeclared value added over total value added, which is our outcome of interest. Underlying data are estimated by Istat to ensure the exhaustiveness of National account aggregates and refer to the component due to under-reporting of business activities, which proves to be the most relevant one, accounting for half of the total underground economy (Istat, 2020); these data have not previously been used in academic research, to the best of our knowledge.[7] Under-reporting occurs when data provided by a production unit are not consistent or have abnormal characteristic values (i.e. costs/production ratio). In general, this happens because one or more components contributing to make up the production value are under-reported or, vice versa, because cost components are over-reported. In all cases, the final result is an under-reporting of the enterprise's profits, highlighted by an underestimate of the value added (for the methodology adopted by Istat for the estimation of this component see Mantegazza *et al.*, 2014; Curatolo *et al.*, 2016; Cavalli and Sallusti, 2019). The share of undeclared value added is on average equal to 18.9 per cent, but its extent varies widely across provinces, ranging between 6.0 and 32 per cent, being as a whole higher in the Southern part of the country (Table 1 and Figure 1).

The source of data we use for cash is the Aggregate Anti-Money Laundering Reports (S.AR.A. from the Italian acronym): the Italian anti-money laundering law (Legislative Decree no. 231/2007) mandates banks and other financial intermediaries to report on a monthly basis to the UIF all transactions amounting to 15,000 euros or more, after aggregating them according to several criteria.[8] The reports mainly refer to the operations carried out by the customers of the obliged intermediaries. We consider

[6] Italy contains 107 provinces, but here we had to exclude the provinces of the region Sardinia from the analysis because in 2016 a regional law redesigned the administrative borders of three of its provinces and created two brand new ones, thus making impossible a time-consistent analysis over the period 2015-2017 for this region. The provinces considered in our analysis are 102, consequently.

[7] The main components of underground economy are under-reporting of value added and value added produced by undeclared work; in addition it includes off-the-book rents, tips and the results of the reconciliation procedure of independent estimates of supply and demand for goods and services; this integration is to be attributed, in an unidentifiable proportion, to purely statistical effects, or to an underground economy component not fully captured by means of the first two types of adjustments.

[8] Aggregation criteria include the type of transaction, the intermediary's branch where the transaction took place, the client's residence (at municipality level) and his/her economic sector. Each aggregate record includes information on the total amount transacted, the corresponding cash component and the number of underlying individual transactions being aggregated.

transactions in cash recorded by banks[9], thus excluding cash payment transactions between private parties. Even though the threshold floor of 15,000 euros applies to all kinds of transactions, intermediaries also transmit data relating to cash transactions below the threshold and are to be considered as fractional transactions.[10] In 2019, UIF received over 108 million aggregate records, corresponding to about 359 million single transactions worth nearly 62 trillion euro. About 95 per cent of total aggregate records were received by banks; other reporting entities include fiduciary and asset management companies, securities firms and insurers accounting for the residual share. Cash transactions account for 6.8 per cent of the total number of transactions.

For our analysis, we compute the share of cash transactions (both deposits and withdrawals) over total transactions carried out at Italian banks only by firms in the private non-financial sector. Table 1 shows that this share is on average equal to 3.8 per cent, reaching its low in Milan (0.4 per cent) and its maximum in Enna (12.3 per cent). Clearly, as observed for under-reported value added, there is a remarkable North-South gradient (Figure 1). This share cannot be directly compared to that, much higher, related to the overall relevance of cash in economic transactions in Italy: according to Rocco (2019), and based on the Study on the use of cash by households (SUCH) conducted by the ECB on most euro area countries, in Italy in 2016 about 86 per cent of the number of transactions and two thirds of their volume in 2016 was made in cash (see also ECB (2020) for an update of these figures to 2019). Indeed, the measure of cash usage that we rely upon here is drawn from the subset of those exceeding the reporting threshold, and involves only deposits and withdrawals made by firms in the private non-financial sector, consistently with the measure of underground economy which is referred to the under-reporting of business activities.

Furthermore, we include a large number of control variables, which should account for the most important factors fostering the hidden economy (see, *inter alia*, Gërxhani, 2004; Goel and Nelson, 2016; Schneider and Enste, 2000). Table 1 summarizes this list of control variables together with some descriptive statistics. The first relevant determinant of the shadow economy is tax burden. The higher the tax burden, the greater the costs for employers and employees in the formal economic sector, and the greater incentive for capital and labour to transfer to the shadow economic sector (Schneider and Enste, 2000; Schneider *et al.*, 2010). This result holds regardless of the type of taxes.[11] In our paper, we

[9] Deposits also include the amount settled in cash of various types of transactions, carried out over the counter, to which the customer has delivered cash (e.g. purchase of securities); withdrawals include the settled amount in cash of similar transactions in which the customer has withdrawn cash (e.g. closing of certificates of deposit).

[10] Fractional transactions are operations which pile altogether to more than 15,000 euros, but they are carried out through several single operations for an amount of less than 15,000 euros over a seven-day period.

[11] In this respect, the most important studies that can be referred to are Schneider *et al.* (2010) for direct taxes and Schneider and Hametner (2014) for total indirect taxes.

measure tax burden at the province level by computing the provincial average of top municipal marginal rates on income weighted according to municipal population.

The deterrence role exerted by a system of controls and administrative proceedings that make effective application of the penalty is relevant in determining the observed level of tax evasion. Indeed, where the probability of being caught and, consequently, of incurring a sanction, is higher, illicit behavior is reduced. Accordingly, we use the average length in days of civil proceedings in ordinary courts, provided by Istat only at regional level, as a proxy for the efficiency of the judicial system.

The willingness to pay taxes is also viewed by some scholars as a cultural norm or the result of a set of values specific to a particular region or territory. Frey and Torgler (2007) view the payment of taxes as an example of "pro-social" behavior. They relate the level of tax morale to a number of variables, including the extent to which trust, solidarity and crime are spread out. Following the authors' view, here we use a measure of trust in institutions, computed as the average score of trust in the Italian Parliament (on a scale from 0 to 10) expressed by people aged 14 and over. As a proxy of solidarity we employ an indicator provided by Istat built as the percentage of people aged at least 14 who in the previous 12 months have carried out gratuitous and unpaid activity for charities or similar associations. The incidence of crime is proxied by the number of reported petty crimes (theft and residential burglary) per 1,000 inhabitants at provincial level.

The standard of living of the economy is another key factor in the shadow economy. The incentive to work in the informal economy is higher the lower the overall economic well-being, that we approximate with the per capita value added (Bajada and Schneider, 2009; Feld and Schneider, 2010).

We also include a proxy for the diffusion of small enterprises in the local productive system, as the provincial share of local units with 0-9 employees. As a matter of facts, small business is considered to be highly vulnerable to tight regulation, high taxation, and bureaucratic burdens and, thus, it is believed to be more prone to shifting into the shadow economy. Roma (2001) shows there is a strong correlation between the average size of business and the incidence of the underground economy: in economies featuring a small number of large enterprises, underground economy is almost absent; conversely, underground economy thrives in productive systems made up of a large number of small businesses, because detection by institutions is more difficult.

In addition to these variables, we also include the unemployment rate and the share of foreign population. Since these are potentially endogenous - people working underground typically tend to declare themselves

as unemployed in the surveys which the official statistics on unemployment are based on; also a huge underground economy attracts immigrants and not only the other way round - we will consider regressions both excluding and including them.

3. Does the use of cash foster the underground economy? An instrumental variable approach

Our first empirical test is based on the following specification of a linear regression:

$$U_{pt} = \alpha + \beta C_{pt} + \Gamma \boldsymbol{X}_{pt} + \pi_p + \tau_t + \varepsilon_{pt} \qquad (1)$$

where U_{pt} is the size of the underground economy in province *p* in the year *t*, C_{pt} is our measure of cash usage at the same unit of analysis, and $\boldsymbol{X}_{pt}$ is a vector of controls, including the main economic determinants of the diffusion of the underground economy. Fixed effects by year (τ_t) and province (π_p) are added, the latter accounting for structural differences in the economies at the local level and other characteristics that are persistent over time (for example, cultural differences or initial conditions). Our main interest lies in the estimate of parameter $\boldsymbol{\beta}$ which accounts for the effect of cash usage on the size of the underground economy.

When assessing the relationship between the choice of the payment method and the scale of the informal sector there is an issue of reverse causality which must be addressed: merchants or artisans might offer a discount on the price of the good/service provided to the buyer paying in cash, thereby sparing them any tax that may be applied; but it is also the case that tax dodgers – as they are paid in cash - would use cash for their expenses. Thus, cash may be used more in provinces where the underground economy is more widespread, with an inversion of the direction of causality.

To address the potential simultaneity bias deriving from reverse causation, we resort to an instrumental variable approach. Candidate instruments must have an effect on cash usage without being a direct determinant of the hidden economy and, at the same time, must affect the latter only through its effect on cash usage. In particular, we propose three alternative instruments: the number of automated teller machines (ATMs) and the number of broadband internet connections – as in Immordino and Russo (2018) –, and the number of bank branches (all listed variables are considered per capita). The statistics drawn from ECB (2020) show a diffuse need of accessing a bank branch or an ATM to deposit or withdraw cash. Considering bank branches and ATMs separately lies in that the diffusion of the latter

does not necessarily go hand-in-hand with that of the former[12], as there are ATM devices that are located elsewhere, for example in shopping centers, railway and fuel stations, or airports[13].

The proximity (or density) of either bank branches or ATMs affects the cost of cash payments[14] and, therefore, their frequency, and in this regard could serve as a relevant instrument. At the same time, for our instrument to be also valid we have to postulate that the the localization of branches/ATMs does not affect the share of the hidden economy unless through the cash ratio; in other words, the per capita number of bank branches or ATMs must not be correlated with omitted variables in the second stage. Density of branches and ATMs are set to depend on factors such as the standard of living (proxied with per capita value added, the unemployment rate and the share of foreign population), the characteristics of the productive system (fragmentation) and the institutional quality (such as crime and social capital), which are all variables we control for in our specification. Additional important determinants may be the level of competition and change of control (e.g. in case of mergers and acquisitions) in the banking sector which are plausibly unrelated to firms' underreporting.[15] Thus, we can hold per capita branches and ATMs as valid instruments and credibly identify the causal impact of cash ratio on the shadow economy. Likewise, the penetration of broadband connection is beneficial to the growth of e-commerce and to the diffusion of electronic payments, thus to the detriment of cash usage. Since its outreach on the territory strongly depends on the investment strategies of the internet providers, it is not believed to be a determinant of underground economy.

We first estimate a very simple version of equation (1) linking the share of underground economy to our main regressor, i.e. the cash ratio, as well as to per capita GDP and the share of firms with less than nine employees, using ordinary least squares (OLS). Table 2 (column (1)) shows that the coefficient for the cash ratio is slightly negative and, most notably, not statistically significant; the introduction of additional

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[12] Campbell and Frei (2009) show the existence of a substitution effect between customers' adoption of online banking and self-service technologies (such as ATMs and voice response units); at the same time, the former can reduce the importance of banks physical presence (bank branches). Hasan *at al.* (2012) observe that in the European Union during the period 2000-2007 a higher degree of adoption of retail payment technology (such as ATMs and POS terminals) was used to replace traditional retail branches. Stix (2020a, 2020b) find that in Austria the number of ATMs has increased from about 7,400 in 2005 to about 9,000 in 2019, while the number of retail bank branches declined by about 1,000 over the same period. Based on data available in Banca d'Italia (2020), in Italy the number of ATMs fell by about 5 per cent between 2015 and 2017, while that of branches by about 10 per cent. Finally, Carmignani *et al.* (2020) estimate for Italy a negative relationship between the use of online services and the geographical distribution of bank branches.

[13] Based on data available in Banca d'Italia (2020), on average in 2015-17 about 13 per cent of the ATMs were located outside bank branches. In 2017 the ratio between the number of ATM devices and bank branches was about 1.51, reaching its minimum of 1.17 in the province of Benevento (Campania), and its maximum of 2.56 in Siena (Tuscany). The correlation across provinces between the two variables, expressed in per capita terms, is 0.90 on average.

[14] Angelini and Lippi (2008) show that a greater diffusion of ATMs increases the probability of a successful ATM withdrawal, reducing its expected cost.

[15] Hester, Calcagnini and De Bonis (2001); Alamá *et al.* (2015).

controls (Table 2, columns (2) and (3)), though bringing the coefficient into positive territory, leaves it statistically indistinguishable from zero. These results support our intention to use instruments to identify the role of cash in a proper way.

In our benchmark specification the share of cash is instrumented with the per capita number of bank branches. As a result, the coefficient of the latter turns positive and statistically significant (Table 3, column (1)), implying also a far from negligible effect on the size of the underground economy: our result implies that an increase by 1 percentage point of the cash ratio translates, other things being equal, into a rise of the share of shadow value added by almost 2 percentage points.

As for the other regressors, per capita value added has a negative and statistically significant coefficient, meaning that better economic conditions are associated with a lower share of underground economy, in line with the consensus. Also the proxies of social capital, such as trust in the Parliament and volunteering activity, exhibit negative and statistically significant coefficients, in line with our expectations. Conversely, tax pressure at the local level, the share of small firms, the diffusion of petty crime and the duration of judicial processes prove not to be significant, plausibly because their degree of variation over time is quite limited and thus it is accounted for by the province fixed effects.[16] As for the first stage, the number of per capita bank branches emerges as a relevant instrument for the cash ratio, with a coefficient that is close to 5 (Table 4, column (1)).

We have estimated alternative instrumental variable specifications involving other instruments – namely per capita ATM and broadband connections – featuring either one by one or jointly in the first stage. These two further instruments are never significant at standard confidence levels, either singularly considered (Table 4, columns (2) and (3)) or together with per capita branches (Table 4, columns (4)-(7)), hence their inclusion leaves the estimates obtained with per capita branches as an instrument basically unaffected: the coefficient gets only smaller (1.3 or 0.8 instead of 1.8, depending on the set of controls included; Table 4, columns (4)-(7)). The bottom lines of Table 3 report the result of different specification tests. On the basis of the latter, we can reject all tests of under-identification and weak instruments for all the specifications except when broadband connections and per capita ATM are used as instruments on their own (Table 3, columns (2) and (3)). Thus, the two alternative instruments tend to weaken the overall instrument strength, although the under-identification and weak instrument tests viewed all

[16] We also control for a number of other variables, such as the average of municipal tax rates on income, the ratio between local taxes and provincial taxable income, an indicator of civil and political participation of citizens and alternative measures of civil judicial proceedings duration; the coefficients for the main variables are left unchanged. Estimates are not reported for the sake of brevity but are available from the authors upon request.

together still remain positive.

Finally, we performed some robustness exercises.[17] First, we estimated the same model using logarithms on both sides of the specification, and the results are confirmed. Second, following Chodorow-Reich (2020), regressions were weighted by population (Table 5, column (1)) and highly influential observations possibly driving the results (both outliers and biggest provinces) were excluded (Table 5, columns (2) and (3) respectively). Third, province fixed effects were omitted. Our baseline results hold in all cases.

4. Does raising cash thresholds matter for underreporting? A difference-in-difference exercise

As an additional way to test what is the impact of cash usage on value-added underreporting we perform a difference-in-difference exercise, exploiting the increase of the maximum threshold for cash transactions, which rose from 1,000 euros to 3,000 euros in 2016 in order to boost consumer spending. For the purpose of our study it would be interesting to investigate the effect of the new limit in different areas across Italy, but, since it was introduced by the 2016 Budget law, the new threshold was enforced over the whole national territory, which means that it is not possible to distinguish between 'treated' and 'untreated' provinces, as customary in difference-in-difference analysis.

However, it can be observed that traditionally the level of cash usage is not uniform across the country[18] and that held true also in the period *before* the reform. Hence, following Duflo (2001), Italian provinces can be classified into high- and low-treatment ones on the basis of the results of an ancillary regression of cash over its fundamental determinants, estimated in a period preceding the change in regulation. More precisely, a province is defined as highly (lowly) treated if the sign of its residual in the ancillary regression is positive (negative). The rationale underlying this approach is that in the province where the observed level of cash use is higher than the estimated one it can be reasonably argued that any policy intervention on cash can be expected to have a significant impact. Conversely, if the observed use of cash is lower than the estimated level a lower effect should arise.

In our case this regression was estimated on the cross-section of provinces in 2010;[19] determinants of cash include income (see Table 1 for summary statistics) and the number of self-employed and

[17] Estimates which are not reported for the sake of brevity are available from the authors upon request.

[18] See Figure 1 for the distribution of cash operations across provinces in the period of analysis.

[19] We present estimates limited to the period January-May 2010, as in June a change in the threshold for cash transactions (from 12,500 to 5,000) occurred. Results including the whole 2010 are very similar and available from the authors upon request.

entrepreneurs aged more than 50 years or, alternatively, the number of self-employed on its own. The assumption behind the choice of the latter variable is a relatively stronger preference for cash among the oldest people, which should apply also to entrepreneurs/self-employed whose underreporting is under exam. We also consider a continuous treatment approach by using the residual of this latter regression as a measure of the extent of the treatment without classifying the provinces into high and low-treatment groups.

This exercise gives the opportunity to assess the effect of a cash threshold on tax evasion; as our sample covers the period between 2015 and 2017, we can evaluate if raising the threshold increased the scope for underreporting. Since our analysis is focused on a very short time span, it is reasonable to hold constant other policies or shocks affecting the whole economy around the policy change. Our empirical specification is the following:

$$U_{pt} = \gamma * treat_p * reform_t + \Gamma X_{pt} + \pi_p + \tau_t + \varepsilon_{pt} \qquad (2)$$

where U_{pt} is the share of undeclared value added in province p and year t; $treat_p * reform_t$ is the interaction term between the dummy variable $treat_p$, equal to 1 if the province is 'high-program' and 0 elsewhere (alternatively the residual of the ancillary regression is used so as to account for a continuous treatment), and the dummy variable $reform_t$, equal to 1 in 2016 and 2017 (post-policy period); X_{pt} are the control variables listed above; $\pi_p, \tau_t, \varepsilon_{pt}$ are respectively province fixed effects, year time dummies and an error term. Our main coefficient of interest is thus γ, which captures the differential impact of the change in the threshold on most affected provinces.

With reference to our ancillary regressions meant to discriminate between high- and low-treatment provinces, results are quite reassuring as a substantial part of the variation across provinces can be explained by income and self-employment/entrepreneurship, as the R-squared is equal to 0.85 (see Table 6 where in column (1) we included as a regressor the number of self-employed and entrepreneurs aged more than 50 years while in column (2) only the number of self-employed was considered).[20] Figure 2 shows the dynamics of the share of unreported value added in the period under exam, separately for treated and untreated provinces. A visual inspection of this chart supports the hypothesis whereby the extent of underreporting started diverging between treated and untreated provinces as the change of the threshold became effective, shrinking in the latter.

[20] For the sake of robustness, the latter variable was alternatively replaced by the average age of the population in the province and, assuming a relatively stronger preference for cash among the oldest people, by the number of inhabitants aged at least 50 years old. The partition of provinces in the two groups is barely the same according to all these specifications.

Table 7 illustrates the results of the difference-in-difference exercise. Estimates include fixed effects by province and year and, in columns (1b) and (2b), the control variables already exploited in the instrumental variable regressions. In columns (1a) and (1b) the variable *reform* has a negative and significant coefficient, which accounts for the gradual decrease of the share of hidden value added in the period under exam. The coefficient of the interaction between reform and treatment, however, is positive and significant, signaling that the increase of the threshold increased tax evasion. In columns (1b) and (2b) the variable reform is no longer significant, possibly because crowded out by the control variables, while the interaction remains positive and significant, corroborating our previous conclusion. Estimates in Table 8, in which the treatment is held continuous, provide a consistent picture. Moreover, for both treatments, results turn out to be confirmed or even strengthened when robustness exercises - namely weighing regressions by population and omitting either outliers or biggest provinces – are conducted (Tables 9 and 10).

The main take-away message is that the reform in the threshold had the side effect of widening the underground economy: our estimates in all specifications show that in treated provinces under-reported value added rose by around half percentage point (with a range between 0.4 and 0.8) following the loosening in the constraints to cash usage, and compares with an average share of hidden value added of 19 per cent. While possible sources of asymmetry could not be disregarded - for example, Russo (2020) shows that the gains in terms of VAT and income tax are non-linear with the size of the threshold - this evidence tends to support the effectiveness of implementing limits in the use of cash to the end of tackling tax evasion.

5. Conclusions

We have investigated the role of cash usage in feeding the underground economy, by relying upon a unique dataset which merges by province official estimates on Italian firms' underreporting with cash transactions drawn from the aggregated anti-money laundering reports filed to the Italian Financial Intelligence Unit (UIF) by banks. In order to derive causal evidence, we have both adopted an instrumental variable approach and resorted to a difference-in-difference strategy, which exploits the change in the maximum threshold for cash transactions introduced in 2016. We find that an increase by 1 percentage point in the use of cash translates, other things being equal, into an increase of the share of shadow value added by between 0.8 and 1.8 percentage points, and that the decision to raise the cash threshold from 1,000 to 3,000 euros to boost spending had the side effect of shifting the same share upwards by about 0.5 percentage points. While we are aware of some limitations affecting our exercise –

in particular, the difficulty of controlling for all the factors that can affect the propensity to evade taxes and the fact that we had to classify the provinces according to the intensity of the treatment, as the ban on cash usage was enacted at the national level – this evidence indicates that stricter limits in the use of cash are an effective instrument to tackle tax evasion.

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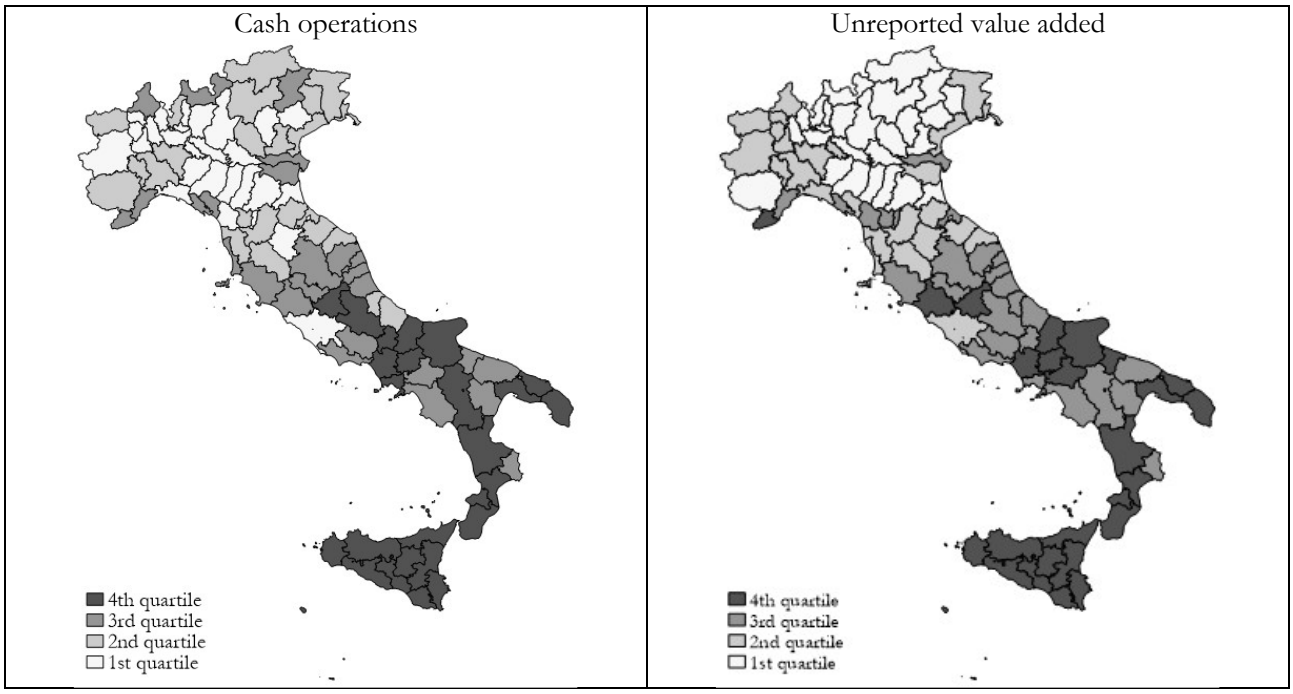
Figures and Tables

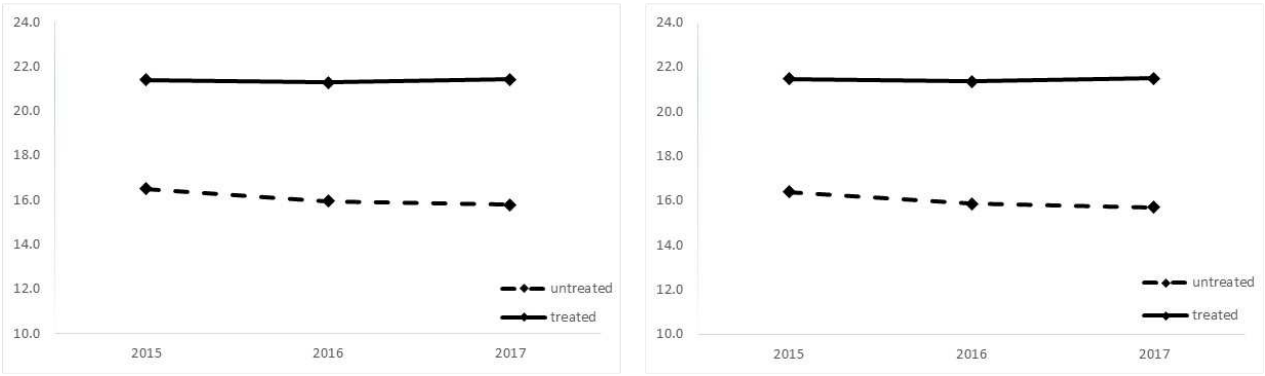
Figure 1. Share of cash operations and share of unreported value added (quartiles)



Source: our calculations based on S.AR.A data.

Figure 2. Share of unreported value added, treated and untreated provinces (annual means)

(1) (2)



Notes: calculations are based on the estimates of an ancillary regression of cash ratio on: (1) income and the number of self-employed and entrepreneurs aged more than 50 years; (2) income and the number of self-employed aged more than 50 years. *Source*: our calculations on UIF and Istat.

Table 1. Summary statistics

Variables	Sources	mean	median	standard deviation	min	max
Share of hidden value added (%)	Istat - National accounts	18.9	18.8	5.5	6.0	32.0
Share of cash operations (%)	UIF - Anti-Money Laundering Aggregate Reports	3.8	2.9	2.7	0.4	12.3
Bank branches (per 1,000 inhabitants)	Banca d'Italia	0.51	0.53	0.17	0.18	0.94
ATMs (per 1,000 inhabitants)	Banca d'Italia	0.72	0.75	0.24	0.27	1.75
Broadband connections (per 1,000 inhabitants)	Istat - Elaboration on AGCOM[$] data	33.73	26.03	28.63	0.06	175.87
Value added (€ per capita)	Istat - National accounts	6,699	6,639	2,858	2,183	17,286
Share of local units with 0-9 persons employed (%)	Istat - Business register	95.0	95.0	1.2	92.0	97.5
Municipal taxes (%)	Italian Revenue Agency	0.68	0.44	0.83	0.00	6.17
Trust in Parliament (score)	Istat - Multipurpose survey on households: aspects of daily life	3.5	3.5	0.3	2.8	4.2
Voluntary activity (% of inhabitants)	Istat - Multipurpose survey on households: aspects of daily life	10.7	11.0	3.4	5.7	24.0
Crimes (per 1,000 inhabitants)	Istat - Elaboration on data collected by police forces	18.8	17.3	8.0	6.0	52.2
Duration of civil judicial proceedings (average days)	Italian Ministry of Justice	1,129	977	336	612	1,926
Share of foreign population (%)	Istat	8.0	8.5	3.3	1.8	16.6
Unemployment rate (%)	Istat	11.9	9.6	5.8	3.1	31.5
Income (millions €)	Italian Revenue Agency 2010	6,850	4,276	8,760	813	60,704
No. of self-employed aged 50+ partnerships incl.	Istat - Business register 2012	16,948	11,744	16,754	2,226	104,681
No. of self-employed aged 50+	Istat - Population census 2011	18,431	12,700	17,544	2,793	115,703

Notes: Pooled sample statistics. Share of cash operations: include both deposits and withdrawals. Municipal taxes: provincial weighted mean (weights: municipal population). Trust in Parliament: score between 1 and 10. Voluntary activity: share of population aged 14 years or more having carried out voluntary activity in the last 12 months.

[$] Authority for Communications Guarantees.

Table 2. Effect of cash on hidden value added. OLS estimates

	(1)	(2)	(3)
Share of cash operations (%)	-0.076	0.014	0.072
	(0.103)	(0.090)	(0.085)
Value added (thousands of € per capita)		-1.487***	-1.085***
		(0.206)	(0.209)
Share of local units with 0-9 p. employees (%)		-0.163	-0.045
		(0.311)	(0.292)
Municipal taxes (%)		3.075	0.487
		(3.926)	(3.716)
Trust in Parliament (score)		-0.413	-0.418
		(0.277)	(0.263)
Voluntary activity (%)		-0.048	-0.064*
		(0.038)	(0.036)
Crimes (per capita)		27.284	-4.176
		(26.763)	(25.795)
Duration of civil judicial procedures (years)		-0.070	-0.205
		(0.169)	(0.161)
Share of foreign population (%)			0.758***
			(0.148)
Unemployment rate (%)			-0.037*
			(0.022)
Observations	306	306	306
Number of provinces	102	102	102
Province FE and year dummies	Yes	Yes	Yes
R^2	0.468	0.538	0.199

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 3. Effect of cash on hidden value added. Instrumental variable estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Share of cash operations (%)	1.849**	1.063	-4.629	1.809**	1.303**	1.301**	0.752**
	(0.830)	(1.350)	(5.365)	(0.813)	(0.648)	(0.646)	(0.373)
Value added (thousands of € per capita)	-1.433***	-1.456***	-1.624**	-1.434***	-1.449***	-1.449***	-0.998***
	(0.357)	(0.265)	(0.786)	(0.351)	(0.289)	(0.288)	(0.239)
Share of local units with 0-9 p. empl. (%)	-0.141	-0.150	-0.219	-0.141	-0.147	-0.148	-0.016
	(0.536)	(0.395)	(1.162)	(0.528)	(0.434)	(0.434)	(0.327)
Municipal taxes (%)	-2.201	0.060	16.428	-2.087	-0.632	-0.625	-1.944
	(7.172)	(6.312)	(21.266)	(7.063)	(5.784)	(5.777)	(4.354)
Trust in Parliament (score)	-1.389**	-0.971	2.058	-1.368**	-1.099**	-1.098**	-0.787**
	(0.646)	(0.798)	(3.032)	(0.635)	(0.514)	(0.513)	(0.353)
Voluntary activity (%)	-0.182**	-0.125	0.293	-0.179**	-0.142**	-0.142**	-0.116**
	(0.089)	(0.110)	(0.418)	(0.087)	(0.071)	(0.070)	(0.049)
Crimes (per capita)	39.586	34.314	-3.851	39.321	35.927	35.911	-5.867
	(46.526)	(35.174)	(106.213)	(45.842)	(37.641)	(37.606)	(28.881)
Duration of civil judicial proc. (years)	0.149	0.055	-0.623	0.144	0.084	0.084	-0.149
	(0.308)	(0.268)	(0.899)	(0.304)	(0.249)	(0.248)	(0.183)
Share of foreign population (%)							0.888***
							(0.179)
Unemployment rate (%)							-0.052**
							(0.026)
Observations	306	306	306	306	306	306	306
Number of provinces	102	102	102	102	102	102	102
Province FE and year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Instruments	1) bank branches	2) ATMs	3) broadband connections	1) & 2)	1) & 3)	1) & 2) & 3)	1) bank branches
F[†]	7.08***	1.41	0.77	3.56**	3.79**	2.52*	13.44***
LM test[□]	7.18***	1.47	0.80	7.26**	7.71**	7.74*	13.34***
Endogeneity[$]	15.89***	1.03	11.03***	15.39***	8.44***	8.44***	4.72**
Sargan test[§]	-	-	-	0.21	9.75***	9.77***	-

[†] Sanderson-Windmeijer test of weak identification (H0: weak instrument).
[□] Test of identification - relevant instrument (H0: equation not identified).
[$] Exogenous vs endogenous model specification (H0: cash exogenous).
[§]Sargan-Hansen test of over-identifying restrictions (H0: all the instruments are valid). Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4. First-stage regressions (dependent variable: *Share of cash operations (%)*)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bank branches (per 1,000 inhabitants)	4.742***			4.553**	4.658***	4.538**	7.010***
	(1.782)			(1.910)	(1.788)	(1.913)	(1.912)
ATMs (per 1,000 inh.)		0.612		0.152		0.099	
		(0.516)		(0.545)		(0.552)	
Broadband connections (per 1,000 inh.)			-0.003		-0.002	-0.002	
			(0.003)		(0.003)	(0.003)	
Value added (thousands of € per capita)	0.092	0.011	-0.016	0.097	0.101	0.104	-0.054
	(0.168)	(0.167)	(0.164)	(0.169)	(0.168)	(0.169)	(0.172)
Share of local units with 0-9 p. empl. (%)	-0.096	0.005	-0.028	-0.088	-0.107	-0.102	-0.196
	(0.245)	(0.247)	(0.247)	(0.247)	(0.246)	(0.248)	(0.242)
Municipal taxes (%)	2.562	2.875	3.404	2.574	2.994	2.986	3.665
	(3.067)	(3.109)	(3.171)	(3.074)	(3.129)	(3.137)	(3.027)
Trust in Parliament (score)	0.584***	0.540**	0.519**	0.584***	0.573***	0.573***	0.599***
	(0.214)	(0.217)	(0.217)	(0.215)	(0.215)	(0.216)	(0.212)
Voluntary activity (%)	0.079***	0.076**	0.075**	0.079***	0.080***	0.081***	0.087***
	(0.029)	(0.030)	(0.030)	(0.029)	(0.029)	(0.030)	(0.029)
Crimes (per capita)	-20.536	-6.764	-8.763	-20.000	-21.954	-21.554	-10.673
	(21.563)	(21.229)	(21.393)	(21.700)	(21.681)	(21.849)	(21.388)
Duration of civil judicial proc. (years)	-0.110	-0.125	-0.122	-0.112	-0.113	-0.114	-0.033
	(0.132)	(0.134)	(0.134)	(0.133)	(0.132)	(0.133)	(0.132)
Share of foreign population (%)							-0.387***
							(0.132)
Unemployment rate (%)							0.021
							(0.018)
Observations	306	306	306	306	306	306	306
Number of provinces	102	102	102	102	102	102	102
Province FE and year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2 (overall)	0.329	0.077	0.042	0.329	0.283	0.285	0.029
F	3.22***	2.58***	2.51***	2.92***	2.97***	2.71***	3.62***

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5. Effect of cash on hidden value added. Instrumental variable estimates. Robustness

	(1) *Weighted*[I]	(2) *Outliers excluded*[II]	(3) *Biggest provinces excluded*[III]
Share of cash operations (%)	2.427**	2.017**	1.748**
	(1.059)	(0.959)	(0.786)
Value added (thousands of € per capita)	-1.124***	-1.772***	-1.605***
	(0.321)	(0.426)	(0.357)
Share of local units with 0-9 p. empl. (%)	-0.447	-0.135	-0.232
	(0.603)	(0.619)	(0.523)
Municipal taxes (%)	6.194	-3.924	-7.853
	(3.928)	(9.588)	(8.502)
Trust in Parliament (score)	-1.287**	-1.525**	-1.383**
	(0.595)	(0.753)	(0.630)
Voluntary activity (%)	-0.182**	-0.206*	-0.168**
	(0.081)	(0.109)	(0.084)
Crimes (per capita)	103.915**	24.618	35.217
	(47.717)	(51.266)	(45.665)
Duration of civil judicial proc. (years)	0.065	0.273	0.166
	(0.342)	(0.375)	(0.300)
Observations	306	276	297
Number of provinces	102	92	99
Province FE and year dummies	Yes	Yes	Yes
Instruments	bank branches	bank branches	bank branches
F[†]	7.10***	5.71**	7.15***
LM test[□]	7.21***	5.85**	7.26***
Endogeneity[$]	18.36***	16.98***	14.76***

[†] Sanderson-Windmeijer test of weak identification (H0: weak instrument). [□] Test of identification - relevant instrument (H0: equation not identified). [$] Exogenous vs endogenous model specification (H0: cash exogenous).

[I] Weights defined by provincial population in 2017. [II] Provinces below the 5th percentile and above the 95th percentile of the hidden value added distribution in 2017 are excluded from the sample. [III] Provinces with more than 3 million of inhabitants (Rome, Milan and Naples) are excluded from the sample.

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 6. Regression for selecting high- and low-program provinces
(Dependent variable: total cash transactions, Jan-May 2010)

	(1)	(2)
Income	0.630***	0.538***
	(0.193)	(0.187)
No. of self-employed aged 50+ partnerships incl.	0.424**	
	(0.206)	
No. of self-employed aged 50+		0.544***
		(0.207)
Constant	2.027	2.893
	(2.447)	(2.298)
Observations	102	102
R^2	0.848	0.852
Overall significance (F test): p-value	0.00	0.00

Notes: All variables are in logs. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 7. Effect of the change of the threshold for cash transactions on hidden value added

	(1a)	(2a)	(1b)	(2b)
Reform	-0.619***	-0.609***	0.049	0.079
	(0.091)	(0.092)	(0.165)	(0.159)
Treated province*reform	0.570***	0.552***	0.376***	0.406***
	(0.116)	(0.116)	(0.108)	(0.108)
Constant	19.138***	19.138***	40.973	32.307
	(0.047)	(0.047)	(29.301)	(29.301)
Observations	306	306	306	306
Number of provinces	102	102	102	102
Province FE and year dummies	Yes	Yes	Yes	Yes
F	17.84***	17.21***	14.50***	14.84***

Notes: in columns (1a) and (1b) the treatment is obtained from the regression presented in Table 6, column (1); in columns (2a) and (2b) the treatment is obtained from the regression presented in Table 6, column (2). Fixed-effects estimates: models (1b) and (2b) include the control variables used in the IV regressions of Table 3.
Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 8. Effect of the change of the threshold for cash transactions on hidden value added.
'Continuous treatment'

	(1a)	(2a)	(1b)	(2b)
Reform	-0.311***	-0.311***	0.287*	0.290*
	(0.068)	(0.068)	(0.147)	(0.148)
Treated province*reform	0.680***	0.666***	0.521***	0.517***
	(0.175)	(0.178)	(0.155)	(0.157)
Constant	19.138***	19.138***	38.220	39.409
	(0.048)	(0.048)	(29.405)	(29.417)
Observations	306	306	306	306
Number of provinces	102	102	102	102
Province FE and year dummies	Yes	Yes	Yes	Yes
F	14.36***	13.97***	14.34***	14.28***

Notes: in columns (1a) and (1b) the treatment is obtained from the regression presented in Table 6, column (1); in columns (2a) and (2b) the treatment is obtained from the regression presented in Table 6, column (2). Fixed-effects estimates: models (1b) and (2b) include the control variables used in the IV regressions of Table 3.
Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 9. Effect of the change of the threshold for cash transactions on hidden value added. Robustness

	Weighted[I]	*Outliers excluded*[II]	*Biggest provinces excluded*[III]	*Weighted*[I]	*Outliers excluded*[II]	*Biggest provinces excluded*[III]
Reform	-0.679***	-0.608***	-0.607***	0.209	0.073	0.076
	(0.084)	(0.094)	(0.095)	(0.135)	(0.163)	(0.160)
Treated province*reform	0.729***	0.531***	0.518***	0.600***	0.369***	0.394***
	(0.101)	(0.122)	(0.120)	(0.089)	(0.111)	(0.108)
Constant	17.863***	19.150***	19.263***	-24.611	45.447	44.342
	(0.040)	(0.050)	(0.049)	(26.715)	(30.760)	(29.645)
Observations	306	276	297	306	276	297
Number of provinces	102	92	99	102	92	99
Province FE and year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Control variables	No	No	No	Yes	Yes	Yes
F	26.04***	16.55***	15.86***	23.77***	14.56***	15.41***

Notes: fixed-effects estimates; for each estimate, the treatment is obtained from a regression corresponding to the appropriate version of the column (2) presented in Table 6; the control variables are those used in the IV regressions of Table 3.
[I] Weights defined by provincial population in 2017. [II] Provinces below the 5th percentile and above the 95th percentile of the hidden value added distribution in 2017 are excluded from the sample. [III] Provinces with more than 3 million of inhabitants (Rome, Milan and Naples) are excluded from the sample.
Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 10. Effect of the change of the threshold for cash transactions on hidden value added. *'Continuous treatment'*. Robustness

	Weighted[I]	*Outliers excluded*[II]	*Biggest provinces excluded*[III]	*Weighted*[I]	*Outliers excluded*[II]	*Biggest provinces excluded*[III]
Reform	-0.235***	-0.337***	-0.325***	0.528***	0.255*	0.275*
	(0.061)	(0.071)	(0.070)	(0.134)	(0.151)	(0.149)
Treated province*reform	0.777***	0.656***	0.637***	0.617***	0.520***	0.485***
	(0.169)	(0.184)	(0.184)	(0.146)	(0.159)	(0.160)
Constant	17.863***	19.150***	19.263***	-10.487	50.117	51.305*
	(0.043)	(0.051)	(0.050)	(28.246)	(30.673)	(29.852)
Observations	306	276	297	306	276	297
Number of provinces	102	92	99	102	92	99
Province FE and year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Control variables	No	No	No	Yes	Yes	Yes
F	14.75***	14.14***	13.33***	18.86***	14.50***	14.71***

Notes: fixed-effects estimates; for each estimate, the treatment is obtained from a regression corresponding to the appropriate version of the column (2) presented in Table 6; the control variables are those used in the IV regressions of Table 3.
[I] Weights defined by provincial population in 2017. [II] Provinces below the 5th percentile and above the 95th percentile of the hidden value added distribution in 2017 are excluded from the sample. [III] Provinces with more than 3 million of inhabitants (Rome, Milan and Naples) are excluded from the sample.
Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.