

The analysis of the informal economy at the province level through cash usage indicators from the Aggregate Anti-Money Laundering Reports

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1. Introduction

The relation between the use of cash and the underground economy is based on the evidence that irregular transactions or transactions aimed at laundering money deriving from illegal activities are mainly settled in cash to avoid tracing and subjection to tax obligations, or protect them from investigative activities for criminal aspects; this is mainly due to the guarantee of anonymity that characterizes this payment instrument. Despite the consensus on this relationship, empirical evidence is limited, especially for lack of comprehensive data at the sub-national level (Immordino e Russo, 2018; Marmora and Mason, 2021).

In Italy, recent studies have explored this issue in light of changes to cash usage limits. Russo (2022) found that reducing the threshold to €1,000 in 2011 led to a more significant decrease in cash usage among potential tax evaders compared to the general population. Giammatteo et al. (2022) analysed the causal relationship between cash use and undeclared work at the provincial level, showing that a higher ratio of cash transactions was associated with an increase in the share of undeclared value added. Additionally, an increase in the cash usage threshold to €3,000 in 2016 resulted in a slight rise in undeclared value added. Rainone (2023), exploiting high-frequency data on cash transactions by denomination of banknote, showed that the 2016 threshold modification and the access to bank data by the Revenue Agency led to a contraction in cash circulation in Italy, with the latter policy having a more significant impact on regions prone to tax evasion.

The aim of this paper is to contribute to the literature along two lines. On one hand, it has been built a unique dataset, which allows to associate comprehensive measures of underground economy with indicators of the propensity to use cash for the years 2016-2020, both at the province and economic sector level, for the first time in Italy. On the other hand, two sets of indicators for the shadow economy and the cash usage are analysed via canonical correlation analysis for each economic sector separately in order to extract information regarding the correlation structure between the two phenomena. This exploratory analysis does not aim to establish causal relationships between the phenomena, but to reveal the potential interconnection between cash and shadow economy across the sectors.

The statistical relationship between cash usage and the shadow economy holds significance as it could underscore the value of using cash transaction data to improve estimations of the informal economy. Furthermore, this potential connection could strengthen the capabilities of anti-money laundering (AML) authorities in identifying anomalies in cash transactions.

2. The data

Non-Observed Economy (NOE) includes economic activities that escape to direct statistical observation. In Italy, it represents a relevant part of the economy; NOE amounts to about 174 billion euro, accounting for 9.5% of the GDP and 10.5% of the value added generated by the business system in 2020 (ISTAT, 2022). Underground production represents the largest component of NOE – in Italy it accounts for 90% in 2020 (157 billion euro). It is mainly composed

of under-reporting of value added – which is connected with the false declarations aimed at under-reporting production and/or over-reporting costs in order to reduce tax payments on profits (slightly less than 80 billion euro in Italy) – and the value added generated by the employment of un-registered workforce (about 62 billion euro in Italy).

This study focuses on the three main determinants of the underground economy: under-reporting of value added by business units, the value added produced by employing unregistered employees and self-employed individuals. Under-reporting of value added occurs when business units intentionally conceal a portion of their income by providing incorrect declarations of turnover and/or costs. Specifically, under-reporting takes place when one or more components of production are inaccurately reported, or conversely, when certain components are over-reported. In either case, the end result is an underestimation of profits, which corresponds to a underestimation of value added. The estimation of under-reporting of value added also encompasses the amount of VAT fraud without complicity, wherein the buyer pays VAT to the seller, while the latter does not declare it.¹

The un-registered workforce component of NOE refers to the value added generated through the employment of un-registered labour input. In particular, the component relating to self-employment measures the value added generated by un-registered self-employed, both in their operating surplus and in the mark-up over the remuneration of un-registered employees. The un-registered employee component, on the other hand, measures the value added generated by the employment of un-registered employees measured by their remuneration.

The estimation of these components, for the use proposed here, was carried out with a mixed approach in successive steps. A bottom-up approach was used for the under-reporting component, in which the territorial and sectoral intersections were estimated by aggregation of micro-data referring to business units. A top-down approach was used, instead, for the un-registered workforce component, in which, starting from the domain, the estimates at territorial and sectoral level were obtained by successive breakdowns, consistently with the proposed analysis. This allowed the construction of a dataset by province and economic sector.

For the purposes of this analysis, the three dimensions of the shadow economy are used to construct seven indicators, which differ according to the variable used for normalization, which can be the provincial total value added², the total value of underground economy (as sum of the three components), or the gross value added at the province and sector level, which includes only the under-declaration component (Table 1).

Indicators S1, S2 and S5 measure the extent of under-declared value added, respectively, in comparison to the total provincial economic output, in comparison to the gross provincial economic output, including under-declaration, and as a ratio of the total value of the shadow economy. Indicators S3 and S6 measure the contribution of irregular independent work, respectively, to the province's overall economic activity, and to the total shadow economy. Finally, indicators S4 and S7 are similar to S3 and S6 but related to the irregular dependent work.

The source of data we use for cash is the Aggregate Anti-Money Laundering Reports (S.A.R.A. is the Italian acronym) which the Financial Intelligence Unit for Italy (UIF) collects from the obliged intermediaries. The Italian anti-money laundering law (Legislative Decree 231/2007) mandates banks and other financial intermediaries to report on a monthly basis to the UIF all

¹ For further information on the methods for estimating the sub-declaration of value added and the calculation of VAT with and without complicity see Sallusti and Cavalli (2019).

² The estimate of total value added both at the province and sector level is not available.

transactions amounting to €15,000 or more,³ after aggregation according to given criteria⁴, regardless of any money laundering suspect.

The reports refer to the operations carried out by the customers of the obliged intermediaries and, as the data are aggregated, they are reported in an anonymous format. We have constructed seven indicators of cash usage propensity based on S.A.R.A. data (Table 1). The first four indicators, C1 to C4, serve as general metrics for cash usage, as they quantify the total value or number of cash transactions, encompassing both incoming and outgoing flows. The remaining three indicators, on the other hand, are more specific in nature, as they focus on the interplay of cash with other transaction types. Specifically, C5 assesses the portion of total cash value used in conjunction with wire transfers in relation to the total value of wire transfers. Indicator C6 pertains to the role of cash in loan repayment and provision operations, while indicator C7 concerns transaction cash involving the sale or purchase of securities.

Table 1: Description of the indicators

Indicator	Description
<i>Shadow economy</i>	
S1	Ratio between the under-declaration of value added and the total provincial value added
S2	Ratio between the under-declaration of value added and the gross provincial value added which includes only the under-declaration component
S3	Ratio between the value of irregular independent work and the total provincial value added
S4	Ratio between the value of irregular dependent work and the total provincial value added
S5	Share of the under-declaration of value added on the total value of the shadow economy
S6	Share of the value of irregular independent work on the total value of the shadow economy
S7	Share of the value of irregular dependent work on the total value of the shadow economy
<i>Use of cash</i>	
C1	Share of value of incoming cash transactions on total incoming transactions
C2	Share of value of outgoing cash transactions on total outgoing transactions
C3	Share of the number of incoming cash transactions on the total number of incoming transactions
C4	Share of the number of outgoing cash transactions on the total number of outgoing transactions
C5	Share of value of cash (incoming and outgoing) used in combination with wire transfers on the total value of wire transfers
C6	Share of value of cash (incoming and outgoing) used in combination with operations of re-payment or provision of loans on the total value of operations of re-payment or provision of loans
C7	Share of value of cash (incoming and outgoing) used in combination with operations for selling or purchasing securities on the total value of operations for selling or purchasing securities

For our analysis, shadow economy and cash indicators are computed only for the private non-financial sectors. The customer's economic sector, together with the province⁵ in which the branch of the intermediary where the operation took place is located, are the two criteria used to associate ISTAT indicators on the underground economy with S.A.R.A. indicators on cash.

3. The canonical correlation analysis

This study employs canonical correlation analysis to assess the concurrent relationship between shadow economy and cash usage across the provinces. The analysis is conducted

³ The presence of a reporting threshold for cash payments does not automatically exclude transactions below that threshold. For instance, a retailer may receive multiple smaller cash payments throughout the day and eventually deposit the total amount at the end of the day or week. If the total deposited amount exceeds the €15,000 threshold, the retailer's bank will record these transactions for anti-money laundering reporting purposes. Financial intermediaries are also required to report data on fractional operations, which are unitary operations with a total amount equal to or higher than €15,000 but conducted through several smaller operations within a seven-day period. Starting from 2021, the reporting threshold has been lowered to 5,000 euros and fractional operations are no longer reported.

⁴ Aggregation criteria include the type of transaction, the intermediary's branch where the transaction took place, the client's residence (at municipality level) and economic sector. Each aggregate record includes information on the total amount transacted, the corresponding cash component and the number of individual transactions being aggregated.

⁵ Italy comprises a total of 107 provinces; however, the provinces within the region of Sardinia have undergone numerous changes over the past decade. As a result, conducting a consistent analysis across all regions has become challenging. To overcome this issue, we opted to consider all provinces in Sardinia as a single entity, reducing our cross-sectional dimension to 103 provinces.

separately for each economic sector on an annual basis. For brevity, we present the results of the canonical correlation analysis for the year 2019. Notably, the analysis for 2020 is heavily influenced by the pandemic crisis.

Table 2 showcases the 2019 results, featuring eigenvalues, canonical correlations, and the cumulative proportion of explained variability for the first two canonical variables in each sector. Canonical variables beyond the second are disregarded due to their eigenvalues not significantly differing from zero across the analysed economic sectors. The first canonical correlation varies between 0.387 and 0.887, which would appear to be substantially larger than any of the between-set correlations. Strong and significant canonical correlation can be found in most of the economic sectors, especially in producer households and retail trade, capturing a cumulative proportion of explained variability between 0.525 and 0.883. The second and remaining canonical correlations are significant at 1 per cent level only for food industry.

Table 2: First and second canonical variables by economic sector (year 2019)

	First canonical variable			Second canonical variable		
	Eigenvalues	Canonical correlation	Cumulative proportion of explained variability	Eigenvalues	Canonical correlation	Cumulative proportion of explained variability
Mining, energy, petrochemicals, iron and Construction	0.683	0.637 ***	0.566	0.257	0.452 **	0.779
Manufacture of machinery and equipment	0.739	0.652 ***	0.566	0.263	0.456 **	0.768
Food industry	0.455	0.559 **	0.593	0.192	0.401	0.842
Textile industry	1.310	0.753 ***	0.680	0.391	0.530 ***	0.883
Other manufactured products	0.371	0.520 **	0.525	0.209	0.416	0.821
Wholesale trade services	0.257	0.452	0.592	0.126	0.335	0.882
Retail trade services	0.560	0.599 ***	0.636	0.159	0.370	0.816
Accommodation and food services	1.255	0.746 ***	0.721	0.318	0.491 *	0.904
Transportation and storage	0.697	0.641 ***	0.568	0.459	0.561 *	0.941
Real estate and financial auxiliaries	0.658	0.630 ***	0.606	0.190	0.400	0.781
Waste treatment	0.526	0.587 **	0.762	0.104	0.307	0.912
Health services	0.176	0.387	0.534	0.087	0.283	0.798
Other services	0.176	0.387	0.570	0.083	0.277	0.838
Producer households	0.904	0.689 ***	0.813	0.098	0.299	0.901
Others	3.690	0.887 ***	0.883	0.197	0.406 *	0.931
Others	0.273	0.463	0.736	0.070	0.255	0.923

Asterisks refer to the likelihood ratio chi-squared statistics test that the first/second canonical correlation and all the other are zero; *: significant at 10 per cent; **: significant at 5 per cent; ***: significant at 1 per cent.

The standardized canonical score of the underground economy indicators have been summed up along the three dimensions of the shadow economy: in particular, we compute a cumulative standardized canonical score for all indicators regarding the under-declaration of value added (indicators S1, S2 and S5); one for the irregular independent work (indicators S3 and S6); and one for the irregular dependent work (indicators S4 and S7). The results indicate that all three dimensions play a crucial role in explaining the canonical correlation with the cash use indicators. However, noticeable variations in the impact of underground economy indicators can be observed across different sectors. Specifically, under-declaration of value added holds greater significance for the transportation sector, health services, food industry, and construction. Irregular independent work demonstrates higher relevance for the food industry, textile industry, and construction. Meanwhile, irregular dependent work undeniably exhibits greater relevance for producer households (Figure 1 – panel a).

When considering the impact of cash use indicators, it is evident that deposits hold the highest level of importance across most sectors, except for the manufacture of machinery and equipment, and waste treatment sectors. In particular, for the former, withdrawal indicators appear to be very relevant in explaining the overall correlation between underground economy and cash use. The three specific indicators of anomalous cash use generally exert a lesser influence on the overall correlation. However, there is an exception in the case of cash used in combination with wire

transfers, which appears to be strongly associated with the informal economy in the food and textile industries. Additionally, it is worth noting that the indicator of cash use in combination with operations for selling/purchasing securities has a relatively significant impact on correlation for the construction and transportation sectors (Figure 1 – panel b).

Figure 1: Cumulative standardized canonical scores by economic sector (year 2019)

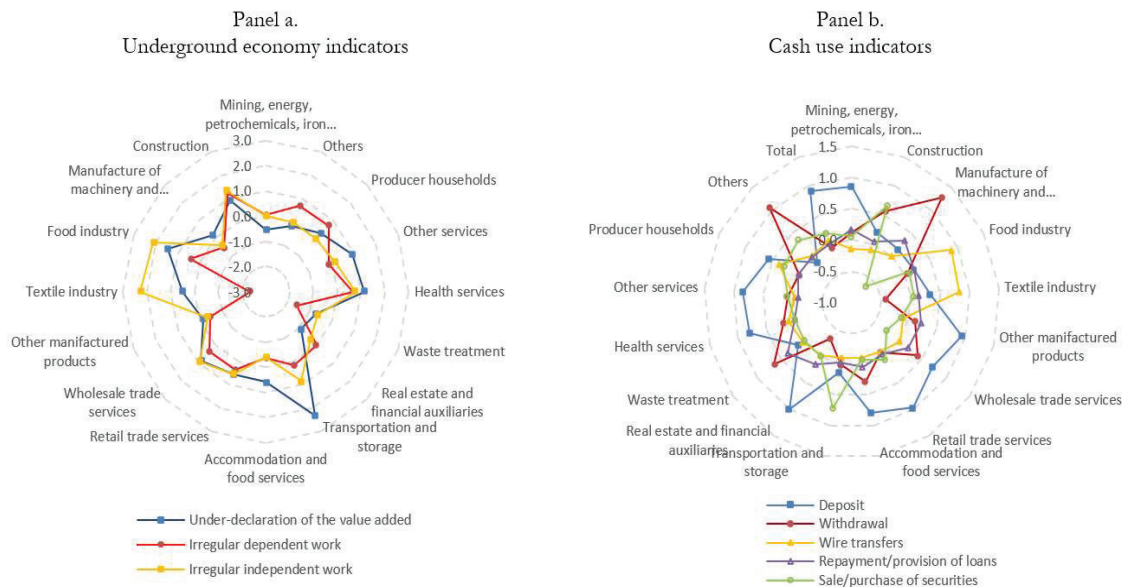


Figure 2: Per cent change of first canonical correlation by economic sector

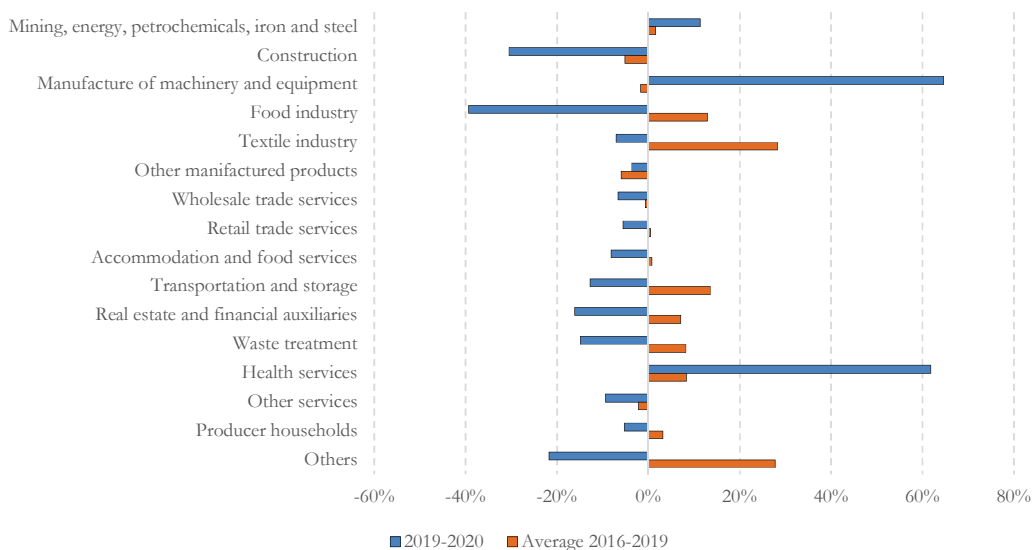


Figure 2 compares the average percentage change in the first canonical correlation between 2016 and 2019 with the percentage change between 2019 and 2020. Canonical correlation shows a general stability in the period 2016-2019, with the exception of the increase recorded in the textile industry. On the contrary, between 2019 and 2020, correlation between underground economy and cash use shows marked negative variations in many sector, presumably attributable

to the detrimental impact of the COVID pandemic on the Italian economy.⁶ Note, in particular, the decrease of correlation for food industry and construction by more than 30 per cent, and in transportation, real estate and waste treatment by more than 10 per cent. Note, however, that health sector and the manufacture of machinery and equipment recorded a sharp increase in canonical correlation by more than 60 per cent during the first year of pandemic. The strong increase of correlation in health sector, in particular, seems to be a confirmation of the marked proliferation of cases of financial crimes linked to the health emergency (UIF, 2021).

4. Conclusions

The aim of this work was to build a dataset allowing to associate comprehensive indicators of underground economy with indicators of cash usage for the years 2016-2020, both at the province and economic sector level, for the first time in Italy. The canonical correlation analysis of the two sets of indicators has highlighted the strong statistical association between the two phenomena across various sectors. Notably, this relationship is particularly pronounced in producer households and the retail trade sector.

The purpose of this analysis is twofold. On one hand, since cash data are available only with a three-month delay, the signalling power of indicators of cash might provide valuable information on the underground economy for specific economic sectors ahead of its estimate release. On the other hand, such potential association could enhance the tools employed to highlight anomalies in cash usage for AML purposes.

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⁶ The economic crisis fueled by the COVID pandemic has determined a decrease in both the total amount of cash operations recorded in S.A.R.A. database and the level of unobserved economy (UIF, 2021; ISTAT, 2022).