Fraud Detection Under Limited State Capacity: Experimental Evidence From Senegal*

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Abstract

Tax administrations in low-income countries face widespread tax evasion and high enforcement costs. They thus need information to detect where tax evasion is most severe, and allocate scarce resources accordingly. This paper shows that leveraging large firms' trading network to collect information about their suppliers is a cost-efficient way to detect tax evasion and increase future audit returns. We collaborate with the Senegalese tax administration on a vast data collection effort to digitise lists of payments submitted by the largest firms and show that the vast majority of firms, at least 89%, provide incomplete information about their suppliers. This prevents any cross-checking against income declared by the suppliers themselves to detect revenue underreporting. We then randomise a low-cost communication campaign across all 3,487 incomplete reporters, to discourage future misreporting. The intervention increases the reporting of suppliers' identification information by 52%. In aggregate, this allows to uncover $145.5 million in unreported revenue (i.e. 0.5 % of GDP). Most of it accrues to a few tax-registered suppliers, as opposed to informal ones. A simulation exercise shows that exploiting the newly available information to target the largest under-reporting suppliers would increase audit returns by at least 100%.

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1 Introduction

Governments in low-income countries (LICs) lack the resources to sustainably fund public goods and often collect little tax revenue compared to other countries.[1] At the same time, tax evasion is widespread in LICs. At the extensive margin, evidence from household survey data shows that less than 10% of the adult population is subject to personal income tax (Bonnet et al., 2019). Recent evidence also suggests that most households are typically subject to very little indirect tax, as they mainly buy from informal markets (Bachas et al., 2024). Moreover, using administrative micro-data, some studies document very prevalent tax evasion among the tax-registered, i.e. at the intensive margin (Best et al., 2021).[2] Altogether, this evidence suggests that LICs could improve tax collection by strengthening enforcement at both the extensive and intensive margins, without changing existing policy rules that define tax bases or rates.

However, enforcement is costly, especially in LICs where the lack of a systematic address system, imperfect transport infrastructure, lower levels of digitisation, and partial financial inclusion all increase the cost for the administration to reach out to taxpayers (and vice versa). Tax enforcement is also more difficult in more fragile states, where low levels of trust in government institutions can foster tax resistance (Besley, 2020). Faced with widespread tax evasion and high enforcement costs, tax administrations in LICs do not have the resources to register and monitor every non-compliant actor and need to strategically allocate scarce resources. Yet, doing so requires access to reliable information about taxpayers and their tax base, which is particularly difficult to collect in an environment where statistical capacity is weak, institutional procedures are still (partially) paper-based, and national registries may be flawed.[3] This paper provides evidence that in such a multi-constrained setting, leveraging large firms' trading networks to collect information about their suppliers can be a cost-efficient way to detect tax evasion and increase future audit returns.

The context of this study is Senegal, where by law firms must withhold a 5% tax on non tax-registered service suppliers (henceforth *withholding tax on services* - WTS).[4] Similar tax instruments are in place in other sub-Saharan African countries including Mauritania, Côte d'Ivoire, Ghana and Nigeria, with the objective to reach informal actors through formal ones. In Senegal, the WTS accounts for slightly less than 1% of all fiscal revenue in 2019. In practice, firms must collect, declare and remit the tax to the administration on a monthly

[1] Using comparable tax revenue statistics (excluding social contribution) from OECD's Global Revenue Statistics Database, and the most recent World Bank income group classification, we estimate that the average tax-to-GDP ratio was 32.2% among (46) high-income countries, 20.8% among (31) upper-middle-income countries, 17.9 % among (30) lower-middle-income countries and 12.8% among (11) low-income countries - with sub-Saharan African countries accounting for 100% and 36% of the LICs and the LMICs group respectively.

[2] See also: Shimeles et al. (2017) for Ethiopia, Mascagni et al. (2022) for Rwanda, and Almunia et al. (2022) for Uganda, all of which classified as LICs.

[3] See World-Bank (2021), Czajka et al. (2022), Clark et al. (2022), OCDE (2020).

[4] With the exemption of foreign suppliers, transactions below about USD 40 and suppliers operating in the hospitality sector.

basis (henceforth *monthly WTS*) but without providing the details of the transactions. At the end of each calendar year, remitting firms must also declare the list of all their service suppliers (henceforth *suppliers list*), whether tax-registered or not, indicating, for each of them, the amount paid and an identification number (henceforth *ID*). Tax inspectors may use this detailed source to (a) verify whether the 5% tax on informal service suppliers has been duly remitted, (b) check these charges' eligibility for deduction, as well as (c) compare payments received by tax-registered suppliers to the self-declared income tax statement of the latter to potentially detect tax evading suppliers. If performed at all, such verification are always carried out on a case-by-case basis.

We collaborated with the tax administration (TA) on a vast, multi-year, data collection effort to assemble a unique dataset of 6,706 suppliers lists over 2018-2020,[5] covering 75% of the taxpayers of the four largest tax centers.[6] These tax centers monitor all of the country's largest firms; they account for 90% of tax revenue, despite representing only 10% of taxpayers. Our in depth analysis of this new database revealed that the reporting rules for suppliers lists were seldom observed. Indeed, 88.6% of the taxpayers in our sample had misreported their suppliers list at least once during the period. On average, misreporting taxpayers omitted the IDs of 83.5 % of their suppliers. Without IDs, tax inspectors cannot use suppliers lists to perform the above mentioned verification. Other available information (names or addresses) are insufficiently standardised to allow precise and automated matching with other sources such as the tax-registry or other taxpayers' suppliers lists. This implies, for instance, that distinguishing tax-registered suppliers from informal ones, or even simply counting the number of clients by supplier, is exceedingly complex.

We identified 3,487 firms that misreported suppliers lists for at least one year during 2018-2020 and randomised an official communication campaign with the objective of deterring future misreporting. The message, individualised and conveyed through repeated emails and confirmation phone calls by the TA, consisted in (a) reminding firms of reporting rules, (b) notifying them that irregularities had been detected in past declarations and asking for rectifications, and (c) urging them to do better in the future. We expected the intervention to operate through two mechanisms: (1) by providing information to taxpayers potentially unaware of their obligations, (2) by increasing taxpayers' perception of the likelihood of sanction in case they persist in unlawful behaviors. As large firms tend to make more and larger payments to other firms, targeting this group should maximise the expected gains and make the intervention as cost-efficient as possible. In addition, because the administration more frequently interacts with large firms, their email address, phone number and postal address are more likely to be up-to-date, and they are presumably

[5] We digitised 4,797 paper-based suppliers lists, combining OCR technology and manual data entry, while collaborating with the TA to design a platform allowing for online-declaration from 2019/20 onwards.

[6] The remaining 25%, most probably never submitted any suppliers list over that period.

less likely to ignore our message. The first email was sent just before the deadline for the declaration of 2021 suppliers list, in January 2022. Confirmation phone calls and subsequent email reminders ran through the year of 2022. Finally, we collected evidence that the message was received: 60% of the treated group submitted a rectified declaration for the previous years and we were able to confirm message reception for another 33% thanks to follow-up verification calls. Only 7% of the treated remained unreachable.

In this paper, we present three important sets of findings. First, we show that the intervention considerably improves the quantity and quality of information submitted. We analyze the impact on 2022 suppliers lists, submitted soon after the end of the full communication campaign (in January 2023). The proportion of taxpayers misreporting all their suppliers decreases by 19.5 percentage points, while the proportion of taxpayers perfectly complying with declarative rules increases by 10.1 percentage points. This essentially results from a large increase in the prevalence of IDs. The share, per client, of suppliers associated with a formally valid ID increases by 52% on average, while the share of misreported suppliers decreases by 42% on average. Such positive effects on reporting are more pronounced for larger firms. Treated firms were not more likely to report suppliers satisfying the conditions to be exempt from the WTS, nor to fill missing fields with intentionally wrong IDs. Interestingly, the intervention also increased the declaration of suppliers' phone numbers, an element which was not mentioned in the communication campaign nor is mandatory by law. Altogether, these results strongly suggest that firms did try to comply with the message instructions without circumventing the rules. Importantly, the intervention did not affect the number of suppliers, nor the distribution of payments, therefore the large changes observed in the prevalence of IDs seem to reflect modifications of declarative behavior rather than real changes in the service supply network.

Second, we show that the intervention increases the detection of tax evading suppliers. Using suppliers' identification information, we cross-check suppliers lists with the tax registry to split Senegalese suppliers into formal (tax-registered) and informal (unregistered) categories. Next, we create a revenue database for all tax-registered actors by assembling the universe of tax statements that contain information on total gross revenue.[7] By matching formal suppliers to this revenue database, we can check whether the sum of all payments they received is superior to the total gross revenue they self-declared. We then distinguish *compliant* formal suppliers from *under-reporting* ones, according to each intervention group. With these definitions at hand, we show that the intervention increases the share of payments going to identified suppliers classified as formal but under-reporting, by 2.5 percentage points, i.e. 45%, and the share of payments going to identified suppliers classified as informal by 17.5 percentage points, i.e. 76.4%.

[7] This consists of five types of declaration: one is declared every month (the value added tax), others are declared on a yearly basis (the corporate income tax, the personal income tax, the business property tax and the synthetic tax for small business).

Finally, we show that exploiting the newly available information (due to the intervention) to strategically allocate scarce audit resources could raise tax revenue collected upon audit. Aggregating data at the supplier level first allows us to draw further conclusions on the distribution of non-compliant suppliers according to each intervention group. Information declared by taxpayers of the treatment group allows us to identify 2,795 under-reporting formal suppliers and 23,141 informal suppliers. Comparing these figures to those derived from suppliers lists declared by the control group, we estimate that the intervention increased the detection of tax evaders by 60% on the intensive margin (formal but under-reporting suppliers), and by almost 200% on the extensive margin (informal suppliers). In aggregate, the intervention uncovers USD 145.5 million in unreported revenue, i.e. the equivalent of 0.5 % of GDP. Importantly, the information declared by taxpayers in the treatment group helps to identify more non-compliant firms at all levels of unreported income. In a simulation exercise, we compare the tax revenue expected from auditing the largest under-reporting suppliers according to the treatment group, to tax revenue expected when applying four alternative selection methods.[8] Under conservative assumptions on unreported revenue uncovered by audits, our simulations show that selection based on newly available information due to the intervention outperforms all alternative methods. In particular, we estimate that using this information to target audits to the 200 largest under-reporting taxpayers would increase the amount collected by at least 100%. Finally we show that even under very conservative assumptions, implementing our intervention and carrying the follow-up audits would help collect at least USD 5.7 million in tax revenue, inducing a benefit-to-cost ratio superior to 9.

This paper makes three important contributions to the literature on tax compliance and enforcement in LICs. First we show that, even in LICs, communication campaigns can be an efficient deterrent tool to enforce third-party reporting, especially among the largest firms. In line with experimental studies from various context (Kleven et al. (2011), Brockmeyer and Hernandez (2022)), historical and cross-country evidence suggest that the adoption of third-party reporting is instrumental to increase the tax ratio along the development path (Jensen (2022), Besley and Persson (2014)). But the literature also shows that in LICs where such tools are in place, significant improvements are yet to be made to reach full compliance (Almunia et al. (2022), Mascagni et al. (2023)). In this regard, this paper illustrates that the digitisation of third-party reports helps systematic detection of misreporting, which in turn allows the scale-up of individualised communication campaigns via direct mail technology. We demonstrate the effectiveness of such campaigns despite being a relatively mild intervention compared to other deterrent alternatives. These results contrast with those of recent studies which find no (Santoro et al., 2020) or limited (Mascagni and Nell (2022),

[8] Method 1: select the largest under-reporting suppliers according to the control group. Method 2: select a random sample form all the tax-registered. Method 3: select the largest taxpayers only. Method 4: select the largest taxpayers, by center (i.e. same proportion form each tax center)

Almunia et al. (2023)) impact on tax payments following communication interventions in Eswatini, Rwanda and Uganda. A key difference with these studies is that our aim was to collect better information about taxpayers other than those directly targeted: In a context where tax evasion is widespread, communication campaigns may be efficient to collect better third-party information, but insufficiently threatening to induce compliance in those directly targeted.

Second, we show that information reported by a country's largest firms can reveal a significant amount of tax evasion. In that regard, our paper contributes to a recent literature emphasizing the central role of firms for tax collection (Slemrod and Velayudhan, 2018). Previous studies show that firms, especially the largest ones, are efficient withholding agents that tax administrations can rely on to outsource part of the costs related to tax collection (Garriga and Tortarolo (2022), Milanez (2017)). Here we show that large firms can also be used as informants to detect large, non-compliant, actors, both at the intensive (formal) and extensive (informal) margins. This result is especially relevant to LICs where most actors operate in the informal sector and administrations can only rely on a few compliant firms to find the next margin worth expanding to.

Third and last, our results imply that strengthening tax enforcement among already tax-registered actors would help collect more revenue than enrolling new ones. Previous studies on the distribution of tax evasion have focused on tax-registered individuals (Alstadsæter et al. (2019), Londoño-Vélez and Ávila-Mahecha (2021)), or firms (Best et al. (2021), and micro evidence on the informal sector in LICs exclusively derives from surveys. Thanks to our unique administrative data on both tax-registered and informal suppliers, we are able to more precisely determine whether it is strategic for revenue-maximizing administrations to widen their tax base, as can be advocated (Ohnsorge and Yu, 2022).[9] Due to the high concentration of unreported revenue detectable, before audit, among tax-registered suppliers, our results suggest that greater gains should be expected by auditing the largest under-reporting taxpayers, at least in the short-term.

The rest of the paper is structured as follows: section 2 provides a detailed description of the context of the experiment, section 3 explains the design, section 4 presents the data, the econometric model, the balance tests, and results on take-up. Section 5 presents and interprets the results on misreporting and fraud detection. Section 6 discusses the implications for the distribution of tax evasion and audits targeting. Section 7 concludes.

[9] In particular, since 2020, one of the core pillar of Senegal's mid-term revenue strategy for 2020-2025 has been to broaden the tax base. As emphasised in a recent IMF country report communicating about the approval of USD 1.8 billion loan extension (IMF, 2023), this objective is still given very high policy priority: "On the revenue side, the implementation of the medium-term revenue strategy should be accelerated [...] notably through the streamlining of VAT exemptions and broadening the tax base."

2 Institutional Context

Senegal is a low income country in West Africa, with stable democratic institutions, a population of 16.5 million people, and a GDP per capita of about PPP 2011 $ 3,500. In 2019, its tax to GDP ratio was 18.4%.[10], i.e. 2 p.p above the average for the 31 African countries with comparable statistics (OCDE, 2022) The TA collects about 62 % of all fiscal revenue, the rest coming from the Customs Authority and the Treasury.[11] The tax base is small. Overall, the TA directly manages a bit over 30,000 taxpayers, one third of which are legal persons, the remainder being self-employed individuals. Tax registered firms are the cornerstone of tax collection: in addition to the taxes they are directly subject to (e.g the Corporate Income Tax), they also remit to the TA taxes collected through withholding applied to the payments made to employees, shareholders, administrators and informal or foreign service suppliers.[12]

Directly managed taxpayers are distributed across 20 tax centers according to business size, sector, and location. Taxpayers with a turnover exceeding about USD 3,200,000 for three consecutive years are managed by the Large Taxpayer Center (LTC), irrespective of their headquarters' location. Smaller taxpayers operating within the region of Dakar are distributed across two medium-sized taxpayers centers (MTC1, MTC2), one center for firms operating in regulated sectors (RSC) and seven municipal tax centers.[13] The remainder of taxpayers is spread across 11 regional centers. Most importantly, tax collection is heavily concentrated:[14] With approximately 900 taxpayers, the LTC alone accounts for 80% of all tax revenues collected by the TA, while the smallest 16 centers monitor more than 31,000 taxpayers but collect less than 10% of all fiscal revenues. Our intervention focuses on taxpayers from the four most important centers: LTC, MTC1, MTC2 and RSC.

By law, tax registered (henceforth *formal*) firms buying services from other economic actors must withhold the WTS, a 5% presumptive tax on all transactions superior to XOF 25.000 (about USD 40) paid to unregistered (henceforth *informal*) Senegalese service suppliers (except restaurants and hotels). The objective of this policy is to integrate into the tax net all natural persons who provide services to tax-registered firms but are not employed by the latter and not taxed otherwise.[15] This tax represents a little more than 1%

[10] Including social contributions, which are equal to 1.2 % of GDP

[11] The treasury collects taxes on civil servants' wages, as well as local taxes, the Custom Authority collects import duties and import VAT, the TA collects all other taxes (Personal Income Tax, Corporate Income Tax, Value Added Tax etc.

[12] Using personal income tax statements, withholding data on employees, suppliers lists as well as lists of shareholders and administrators, we estimate that about 350,000 natural persons pay tax, either directly or indirectly through withholding, i.e less than 5 % of the adult population.

[13] Regulated sectors are medical and legal professions, accountants, architects, state agencies and NGOs. Firms within the MTC1 (MTC2) have a turnover between USD 1,600,000 and USD 3,200,000 (USD 800,000. USD 1,600,000). Sector prevails over size for fiscal assignment. Darkar's seven municipal centers are Dakar-Plateau, Ngor-Almadies, Parcelles Assainies, Dakar Liberté, Grand Dakar, Pikine-Guédiawaye and Rufisque.

[14] This has been shown also in other contexts like the United States, or India Slemrod and Velayudhan (2018)

[15] Note that, by definition, this does not prevent informal *firms* (i.e with several employees) to be liable to the

of the total tax volume collected by the TA.[16]. The WTS must be collected, declared and remitted on a monthly basis by the clients. On the monthly declaration, remitting firms indicate information on the *total* amount spent on external service provision and the *total* amount withheld to be transferred to the TA.

As a complement of information, remitting firms are required to submit suppliers lists on a yearly basis, i.e. third-party reporting statement listing *each* of their service providers – including both tax registered and unregistered service suppliers, exempt or liable to the WTS, Senegalese or foreign – with their names, ID, contact information, the amount of transaction (summed up over the year) and the WTS amount withheld. Suppliers lists have three functions for tax enforcement. First they should allow to verify that the total WTS remitted on a monthly basis throughout the year corresponds to the sum of expected withholdings from informal suppliers. Second they are used by tax inspectors to assess whether payments to service suppliers can rightfully be claimed by the clients as deductible charges. Third, and most importantly, tax inspectors also exploit it by cross checking amounts with the tax statements submitted by (identifiable) formal suppliers to detect under-declaration by the latter. For either function to be performed, tax inspectors must be able to distinguish tax-registered actors from unregistered ones, hence the requirement for reporting IDs.

There are two types of IDs: *firm-IDs* and *national-IDs*. All tax-registered actors, irrespective of their legal form, have a *firm-ID*. This ID is used by the TA as the central tax identification number. Conversely, the vast majority of unregistered actors are self-employed individuals with only a *national-ID* for numerical identification purposes (even though some may also have a *firm-ID*).[17] As a result, in the suppliers lists tax-registered clients are expected to provide the *firm-IDs* of their tax-registered suppliers and mostly the *national-ID* (occasionally the *firm-ID*) of their informal suppliers. Overall, if suppliers lists were duly filed we would only find two types of Senegalese suppliers:

- *formal (tax-registered) suppliers*: no WTS and a *firm-ID* matching the tax registry
- *informal (non tax-registered) suppliers*: some WTS (unless exemption rules apply) and a valid *national-ID* (or a *firm-ID* matching the national registry of firms and associations

WTS as long as they satisfy the above conditions.

[16]The tax volume is principally composed of the value added tax (26%), the personal income tax (23%) the corporate income tax (15%) and special taxes on telecommunication and petroleum products (13%). The remainder is constituted by capital income taxes (3.5%), revenue stamp and registration fees (5%), and a tax on financial operations (4%). Authors' calculations based administrative reports.

[17]This is due to the fact that *firm-IDs* are not produced by the TA itself but by the National Agency for Statistics and Demographics (NASD) in charge of maintaining the national registry of firms and associations. As such, *firm-IDs* are not only used for tax purposes but also in interactions with Immigration Services, Customs, Banks, the Treasury or local governments. Economic actors can derive short-term benefits from interacting with these institutions (namely a visa, access to foreign markets, a loan or a public contract) and may ask the NASD for a *firm-IDs* for these purposes. On the other hand, they probably expect only disadvantages in the short run from interacting with the TA. In fact, over 90% of the entities in the national registry of firms and associations are not tax-registered.

but not the tax registry)

Yet our inspection of suppliers lists revealed very prevalent reporting issues. Out of the 6,706 suppliers lists we collected from the largest tax centers over the 2018-2020 period, 6,170 (i.e 92%) had been misreported. Table 1 classifies and illustrates each type of issue, all of which result from missing information. We indicate average prevalence of misreporting issues over the 2018-2020 period (pooled and per client). Overall, well reported lines (i.e. client-supplier pairs) represent only 15.5 % of all observed lines (type (a)+(d)+(f)+(g)), while 83.2% are misreported because neither the *Firm ID* nor the *national-ID* have been filled (type (c)+(e)+(h)). This prevents us from distinguishing formal versus informal suppliers, or those liable for the WTS versus those exempt from it (see Figure H.10). Complementary information such as the economic sector of the supplier are also very poorly filled (see Figure H.11). This provides evidence that reporting rules of suppliers lists were barely enforced before our intervention (see appendices B for a discussion on what could explain such low level of enforcement).

3 Intervention and Experimental Design

Following hypotheses underlying classic frameworks developed by Allingham and Sandmo (1972) to model decisions related to tax evasion, we assume that, for each supplier, tax-registered firms take a binary decision - to comply or not with reporting rules - simply by comparing compliance and non-compliance expected costs. Compliance costs typically capture everything related to bookkeeping past transactions, collecting reliable and up-to-date identification and contact information from suppliers, staying up-to-date with reporting rules, and finally filling suppliers lists. To the extent that misreporting suppliers lists can also be a strategy for tax-registered firms to hide transactions with informal suppliers, compliance costs also include losses from reduced opportunities to evade the WTS. On the other hand, non-compliance costs will incorporate all penalties prescribed by law for misreporting suppliers lists and, possibly, evading the WTS, weighted by the perceived probability for these sanctions to materialise. To account for the possibility that taxpayers may be ignorant about fiscal and reporting rules, we further assume that the taxpayer's decision is based on beliefs, whether true or not, about compliance and non-compliance costs.

The intervention we test consists of a communication campaign by the TA spanning over a year and targeting taxpayers that we had identified as having recently submitted incomplete suppliers lists. Building from the communication experiment literature which emphasises the prominent role of deterrence (Hallsworth (2014), Slemrod (2019), Antinyan and Asatryan (2019)), this campaign was designed with the primary objective to induce firms to submit more complete information in the future and explicitly conveys the following

messages:

1. The TA has checked recent suppliers list, detected misreporting issues and demands rectifications of the incomplete reports within 20 days, otherwise the taxpayers may be subject to sanctions as set by the fiscal code[18] The TA invites the taxpayers to submit complete suppliers list in the future.

2. Reminder of the fiscal rules related to the withholding tax on service suppliers and of the declarative obligations for suppliers lists, citing precise elements of the fiscal code.

A taxpayer fully complying with the message's instructions would: *(a)* submit a new, corrected, suppliers list for each year highlighted in our message; and *(b)* submit future suppliers lists free of misreporting issues. Given our above assumptions on taxpayers' reporting choice, we expect our intervention to increase taxpayers' probability to comply via two mechanisms. The first message should on average increase the perceived probability of sanctions for the highlighted past declaration(s) but also future ones: It demonstrates the administration's ability to detect misreporting issues and includes an explicit warning for future declarative behavior. According to the law, taxpayers may be subject to a fine of 200,000 XOF (about USD 320) for not submitting suppliers lists, or submitting incorrect information. This fine is arguably small but there may also be risks (real or perceived) associated with having being detected as not compliant. The second message may improve taxpayers' knowledge and understanding of reporting obligations. In this regard, following De Neve et al. (2021) on the role of simplified, actionable communication for tax compliance, we endeavoured to express in the clearest possible way the steps taxpayers would have to take to comply with the reporting rules for suppliers lists.

We randomized this intervention among taxpayers identified as having mis-reported suppliers lists over 2018-2020. The randomization was stratified according to tax center, a mis-reporting incidence indicator, and number of suppliers (split in 4 quantile groups). This led to 32 strata with the smallest cell accounting for 14 taxpayers. Appendix A provides more detail on the definition of the intervention sample and the randomization.

Figure 1 displays the general timeline of the intervention, together with the tax calendar for the relevant ex-post tax declarations. The message was first sent by email during January 2022, right before 2021 suppliers list were due. We worked with the TA to use automated direct mail technology to send individualised emails by batch. The TA then made follow-up calls to each taxpayers to verify that the email had been received, read and understood. In May-June 2022 additional calls were made to taxpayers who had not yet submitted rectifications - in accordance with what the TA would typically do in such situations. In July 2022, the TA sent another email to the treatment group, simply reminding them of

[18]The years for which misreporting has been detected are individualised.

their declarative obligations related to the suppliers lists and inviting them to duly comply in the future (but without again highlighting past non-compliance). A final email was sent in December 2022 similar to that of July but with two additions: A final reminder to those who had still not submitted any rectifications and a paragraph emphasising that yearly suppliers lists should be consistent with (the sum of) monthly declarations and remittances of the WTS.

Within the time frame of the intervention, no sanctions were applied for failure to submit a rectification. Relative to a pure communication intervention, applying systematic sanctions would have imposed a significant burden on the TA. Indeed, the administration considered checking the accuracy of future suppliers lists a more strategic use of its resources than verifying improved versions of past declarations. Therefore, the objective of the individualised reminders the TA sent in May-June 2022, and then in December 2022, to the gradually decreasing subset of firms which had not yet submitted any rectifications was to limit as much as possible any sentiment in recalcitrant taxpayers that threats were not credible.

We did not send any message to the control group. Front office staff did not know about the existence of the control group and taxpayers could not have known they were part of an experiment. Each communication was made by the TA through its usual communication channels, in strict accordance with the tax code. As such, the TA has full ownership over all tools used for the implementation of the experiment, allowing for replication or scale-up of the intervention.

4 Data, Estimation and Baseline Statistics

4.1 Data

Our experiment relies on a long-term extensive collaboration with the Senegalese tax administration (TA) to collect, understand and assemble a vast amount of administrative records and improve data management systems (Czajka et al., 2022). We produced four databases, three of which result form the consolidation of administrative sources. Our first database gathers suppliers lists submitted by taxpayers registered at the four most important tax centers. We digitise all paper-based suppliers lists submitted since 2018, and combine them with the universe of suppliers lists declared online since 2019/20 via a platform we contributed to design. We use this database at baseline for sample selection (Section 4.3) and to measure our outcomes of interest when estimating the impact on misreporting and fraud detection (Section 5). Our second database consists of all monthly declarations submitted for the Withholding Tax on informal Service suppliers (WTS) together with detailed information recording actual remittances of the WTS to the TA (all of which are stored in the TA's central database). We use this source to analyse the impact on withholding

(see Section C). We build a third database by extracting, for all 20 tax centers, all five types of declarations where total gross revenues are reported: value added tax (monthly), corporate income tax, personal income tax, business property tax and the synthetic tax for small businesses. This is the database we exploit to measure self-declared revenues by tax-registered suppliers. Comparing this source with information from the suppliers lists database mentioned above allows us to measure the impact on fraud detection capacity (Section 5.3) and its implications for tax evasion (Section 6). Finally, as part of intervention implementation we collected information on immediate responses by taxpayers in the treatment group. This database allows us to documentthe effective reception of the message (Section 4.4, Table 7).

4.2 Estimation

Our main model estimates the average treatment impact at the taxpayer (client) level i, the statistical unit with respect to which randomisation was executed. $Treat_i$ is the treatment dummy, δ_s are fixed effects for each randomisation stratum s, and $\boldsymbol{X_i}$ is a vector of potential additional control variables. The outcomes y_i may take various forms, e.g. the total number of suppliers reported by taxpayer (client) i, the probability to perfectly comply to reporting rules, the share of foreign suppliers, or the total amount paid to formal suppliers.

$$y_i = \alpha + \beta Treat_i + \boldsymbol{\gamma X_i} + \delta_s + \epsilon_i \tag{1}$$

Note that we cannot estimate models at the supplier level as this would require using information from post-intervention suppliers lists that may have been affected by the intervention. In particular, as our intervention increases the prevalence of IDs (Section 5.1), ex-post identifiable suppliers of the treatment group are very likely to be different from identifiable suppliers of the control group. Therefore, in the absence of alternative sources to identify suppliers ex-post equally for both groups, any estimation at the supplier level is likely to suffer from selection bias. For the same reason, the data does not allow us to test hypotheses at the level of the client-supplier pair, such as whether the intervention affects contracting relationships or clients' choice among potential suppliers. Nevertheless we can explore certain impacts at the supplier level, notably by restricting the analysis to the sample of suppliers that were identified ex-ante. We do so to test whether suppliers of the treatment group tend to self-declare higher incomes after the intervention induced their clients to more thoroughly report their spending to the administration (see Appendix D)

4.3 Sample and Baseline Statistics

Based on our analysis of the 6,706 suppliers lists submitted by taxpayers from the four largest tax centers over the period 2018-2020, we include in our intervention sample all

firms that misreported for at least one of these years, as per the definition of misreporting provided in Table 1.[19] Our sample consists of 3,487 taxpayers; 799 from LTC, 439 from MTC1, 1,000 from MTC2 and 1,249 from RSC. This corresponds to, respectively, 91.4%, 77.4%, 88.6% and 91.4% of the center's taxpayer population (Table 3). On average, we observe 1.7 annual suppliers lists per sample taxpayer at baseline (over 2018-2020).

Table 6 displays summary statistics for key covariates and outcomes, together with β coefficients and standard errors of balance tests. With the exception of the number of employees, treatment and control group do not differ significantly from one another. Overall, 70 % of the sample are registered as legal persons, the majority has been interacting with the TA for 13 years or more, 32.6% had started declaring suppliers list online before the intervention, and we observe at least 2 suppliers lists at baseline for the 2018-2020 period for more than half of the sample. Even though our sample only includes the country's largest firms, it is still very heterogeneous in economic terms, which reflects vast disparities across taxpayers in Senegal (Czajka and Sarr, 2023): The average turnover is USD 5.48 million, with a standard deviation of USD 30.68 million and a median at USD 407,000. Some firms have no formally registered employees, while a few have more than 100,000. The average number of suppliers is about 40 but the standard deviation is 152 and the median is 10. At the same time, the sample is more homogeneous in terms of misreporting patterns: On average about about 86% of lines from suppliers list are misreported. The vast majority of suppliers (98.9%) are Senegalese.

4.4 Assessing the Take-up

In this section, we discuss results from a descriptive analysis of direct responses from the treatment group to assess to what extent treated firms actually received and understood the message conveyed by the communication campaign. This analysis draws on *(a)* email tracking technology to verify whether emails sent in bulk had been received and opened, *(b)* responses received by email, *(c)* follow-up calls to treated taxpayers after each email campaign to verify whether the email had been read and understood, and, finally *(d)* meta-data on rectified suppliers lists submitted after the start of the 2022 intervention for the years 2018, 2019 and/or 2020. Submitting a rectification strongly suggest not only message reception and comprehension, but also willingness to comply.

Table 7 decomposes immediate response rates overall and by center. Overall, 60.8 % of all treated taxpayers did submit a rectified declaration. About 32% did not, but we were nevertheless able to confirm the message had been well received. Interestingly, when last asked why they had still not submitted any rectifications: 16.4% claimed they needed more time, 7.1 % explained they could not retrieve the requested information and 3.5 % asked for assistance on the online platform. Finally, we have no proof of reception for only 125

[19] Appendix A provides more detail on the construction of the intervention sample.

taxpayers, i.e 7.1% of the treatment group.

5 Results on Misreporting and Fraud Detection

5.1 Misreporting of Suppliers Lists Significantly Decreases

In this subsection, we estimate and interpret the intervention's impact on reporting behavior for 2022 suppliers lists, which were due in January 2023, i.e after the full communication campaign. The intervention did not affect the choice to declare a 2022 suppliers list (Table 8).[20]

The intervention was very successful in deterring misreporting in follow-up suppliers lists (Table 8, Panel (A)). The share of misreported suppliers decreased by 23.3 percentage points, i.e. 42% compared to the control group average. The proportion of taxpayers fully complying with reporting rules increased by 10.1 percentage points, while that of taxpayers misreporting all their suppliers decreased by 19.5 percentage points. This impact is essentially driven by a large increase in the presence of ID. Indeed, the share of suppliers with a formally valid ID increased by 24.7 percentage points on average (+52%). Importantly, the intervention had no significant impact on the prevalence of intentionally misreported ID[21], so the intervention not only increased the *quantity* but also the average *quality* of the available information. Interestingly, we also estimate a strong impact on the presence of suppliers' phone numbers (+9.2 p.p, +22%), despite this neither featuring in the campaign, nor being legally mandatory. Last, suppliers of treated firms are not more likely to be eligible for WTS exemptions. Altogether, these results strongly suggests that treated firms did attempt to comply with the law and collaborate with the administration without circumventing the rules. These positive effects on reporting are more pronounced for larger firms (Figure 2), a result that is consistent across measures of firm size (turnover, number of employees, number of suppliers and number of years since creation).

Yet, the intervention did not induce perfect reporting compliance. Indeed, results form Table 8, Panel (A) imply that part of the treatment group shifted from full non-compliance to partial compliance (which increased by 9.3 pp). As a result, 71% of treated firms still misreport at least one supplier after the intervention. This is consistent with the possibility that compliance costs depend on suppliers willingness to share information with their client. This interpretation is also supported by direct feedback received from treated firms complaining about the difficulty to collect the information from reluctant suppliers (see

[20] The remainder of this section discusses impacts relying on information provided within the lists. Hence, the analysis is restricted to taxpayers having declared a 2022 suppliers list, that is, about 78% of the full sample. Summary statistics and balance Table H.13 for this sub-sample shows that it is balanced on tax payer and suppliers list characteristics. Section xxx discusses whether taxpayers may have xxx

[21] An ID is considered as intentionally misreported if its structure is obviously wrong (e.g. 999999999) or if it is provided for many different suppliers by the same clients for the same year

Table 7).

5.2 The supplier network does not seem to be affected

So far we have shown that treated firms reported more information about their suppliers. However, the identity of these suppliers could have been affected by the intervention. The first email was sent in early 2022 and the 2022 suppliers lists were due by end of January 2023, hence giving treated firms a year to possibly adapt their trading relations to facilitate reporting compliance. The result that firms reported more information about suppliers could then be due to a change in suppliers rather than increased compliance with reporting rules as such.

The intervention could have led to real changes in the supplier network for two reasons. First, firms trading at baseline with informal suppliers without complying with the WTS rules may choose to trade less with informal suppliers and more with formal ones (exempt from the WTS). This might not only affect the composition of suppliers but also their number, e.g. a firm could replace several individually contracted informal security guards with a single formal firm specialised in security services. Second, firms could change trading partners to better comply with the information requirement, looking for suppliers that agree to share a correct ID. Obviously, several other factors will affect this decision such as search and matching costs, or differences in prices, quality and risk across supplier types (formal/informal). In some cases, a substitution may be hard to operate, at least in the short run, and the clients may as well decide to end contracts without replacement.

We explore this question using two approaches. First, we test for impacts on the overall structure of 2022 service suppliers.[22] Second, we repeat the analysis of section 5.1 using *2021* suppliers lists which, due to their timing, cannot reflect changes in supplier numbers and composition.

First, the estimates reported in Table 8, Panel (D) show that the communication campaign had no significant impact on the overall structure of the service supply. The average number of suppliers remained unchanged, so did the total, the average, and the standard deviation of the payments. The median may have slightly decreased but this coefficient is only marginally significant. We still cannot discard that some real changes in the supplier network may have occurred during 2022, but this would have had to have taken place mostly by replacing one supplier by another, for a transaction of similar size. Contrasting this with the widespread changes in information availability documented above, it seems reasonable to conclude that the impacts we observe essentially reflect improvements in information sharing rather than real changes in supplier composition.

[22] We can only analyze the general structure of the service supply because it is impossible to disentangle real changes in supplier networks from reporting behavior when the measurement of these changes requires information that is itself affected by improved reporting (see Section 4.2).

Second, we reinforce this conclusion using 2021 suppliers lists. Results on these lists - which had to be declared by the 31st of January 2022 - cannot be due to real changes in the service supply structure, because treated firms received the first intervention email in early January 2022, i.e. after all reported transactions had already been completed. However, going out a few weeks before the reporting deadline, our message seems to have served as a reminder: The intervention increased the probability to submit 2021 suppliers lists, thus potentially introducing selection bias due to differential attrition.[23] To account for this, we follow Lee et al. (2009) and estimate treatment-effect bounds for non-random sample selection. Results are very consistent across 2021 and 2022 suppliers lists, both in terms of sign and significance level (Appendix Table H.15). They differ only in magnitude, with average impacts slightly larger for 2022.

5.3 New Information Increases the Detection of Tax Evading Suppliers

In the short run, access to new information on suppliers may be valuable to a tax revenue-maximising administration only if it allows to better identify non-compliant suppliers. Yet this is not necessarily the case. Indeed, the additional information might only help track transactions going to firms that already duly declare all their revenue to the TA. In this section, we show that the newly available information helps uncover tax evading suppliers, both at the extensive (informal) and intensive (tax-registered) margin. Throughout this analysis, we assume that discrepancies are always due to under-reporting suppliers, yet *a priori*, clients could also be strategic. In appendix F, we discuss why this is less likely.

First, among all suppliers with a formally valid ID we distinguish tax-registered and informal suppliers. We identify formal suppliers either directly - when their firm-ID matches the tax registry - or indirectly - in case their national-ID matches the national registry of firms and associations where it can then be linked to a firm-ID that in turn matches the tax registry.[24] We consider informal all other suppliers with a formally valid national-ID,[25] or with a firm-ID that matches the national registry of firms and associations but not the tax registry. Using these definitions, the intervention increases the share of suppliers identified as formal (informal) by 6.9 (17.5) percentage points, which translates into a 30% (76%) increase (Table 8, Panel (C)).

Given that informal suppliers are not tax-registered, we consider them as tax evaders.[26]

[23] Recall that for the 2022 suppliers lists, this issue was not present; presumably the reminder-effect had worn off a year after the first message.

[24] The rationale here is that suppliers may have duly declared (under their firm-ID) revenues from transactions recorded with their national-ID by their clients.

[25] To be considered formally valid, national-IDs must respect a strict structure. As the suppliers' age can be inferred from the national-IDs, we also invalidate national-IDs implying an age below 15.

[26] The Senegalese tax code requires that xxx. Informal suppliers are therefore non-compliant, irrespective of whether their client(s) withheld the 5% WTS or not. See Appendix C for a discussion on the detection of under-withholding clients).

Formal suppliers, on the other hand, may be perfectly compliant. To verify this, we compare the sum of payments they received - according to their clients' suppliers list - to the total revenue they have indicated for the same period in their self-declared annual income tax declarations. More specifically, we define a binary outcome classifying each transaction t^T (t^C) paid by a client from the treatment (control) group as going to an *under-reporting* formal suppliers S if and only if the sum of all transactions t^T (t^C) going to S is superior or equal to the total revenue self-declared by S in its annual income tax statement.[27] Under this definition, the same supplier may therefore be considered as under-reporting according to the information provided by the treatment group but not the control group or vice versa. This definition prevents capturing externalities outside of the treatment group due to network effects. Most importantly, it better reflects what to expect if we were to scale up our intervention to all firms. With this definition at hand, we estimate that the intervention increases the share of payments going to under-reporting formal suppliers by 2.5 percentages points on average, i.e 45% (Table 8, Panel (C)).

6 Implications for the Distribution of Tax Avoidance and the Targeting of Future Deterrent Measures

We now explore the implications regarding tax avoiding suppliers. Results from Section 5 and Appendix C aggregate client-supplier pair data at the *client* level to make statistical inference on average treatment impact. But, as suppliers may have several clients, within and/or across experimental groups, this perspective is not sufficient to discuss implications at the *supplier* level. In this section, we thus turn to the descriptive analysis of the ex-post distributions of supplier-level data. As was the case for section 5.3, this analysis assumes that discrepancies are always due to under-reporting suppliers, not over-claiming clients.[28]

6.1 How Many and How Large are Newly Identified Suppliers?

Detecting tax evasion is only valuable for tax collection if newly detected non-compliant suppliers (formal or informal) are not too small and are thus worth targeting with follow-up deterrence interventions. To assess the fiscal potential of fraud detection, we therefore need to estimate its implications for the ex-post distribution of tax evading suppliers. As discussed above, all suppliers identified as informal are classified as non-compliant, while for formal firms this is the case if and only if the sum of payments received from clients (according to their suppliers lists) is larger than the revenues self-declared in the income tax statement. As in section 5.3, we define tax evasion *relative* to each experimental group:

[27] See Table 2 for detailed examples).
[28] See appendix F for a discussion on strategic clients).

a formal supplier can thus be under-reporting according to information provided by one group and not the other.[29]

Table 9 compares the population of suppliers identified as tax evaders according to treatment and control groups. Information retrieved from the treatment group's 2022 suppliers lists allows to identify 29,317 suppliers, or 2.4 times more than for the control group. The sum of all payments declared by treatment group clients and going to identified suppliers (formal or informal) totals USD 1.56 billion, or 5.63% of Senegal's GDP for that year (Table 9, columns (4) and (5)). Comparing this to the control's group equivalent figure, we estimate that our intervention allowed to identify more than USD 1 billion worth of transactions, i.e. 3.8 % of GDP.

Further disaggregating suppliers, we observe that information coming from the treatment group flags 2,795 under-reporting formal suppliers and 23,141 informal ones, compared to 1,742 and 7,750, respectively, for the control group. In terms of tax evaders' population size, fraud detection thus increased by 60% at the intensive margin and by almost 200% at the extensive margin. Further, information from the treatment group also detects larger amounts *per formal evader*: Under-reporting formal suppliers of the treatment group are detected to have received on average USD 118,823 in 2022 from their (treated) clients, compared to USD 61,951 for the control group. Regarding informal evaders, however, the substantial increase in the number detected comes with a decrease by 40% in average amounts received. Thus, at the intensive margin , the informational gains induced by the intervention pinpoint large evaders, while at the extensive margin they shed more light on the bottom of the distribution comparatively. Bringing all these figures together, we establish that our intervention revealed USD 145.5 million in additional unreported revenue, i.e. 0.5% of GDP.

To better assess the distribution of these informational gains, we compute the number of tax evading suppliers identified by the treatment group, the control group or both, by decile of *unreported amounts* (Figure 3). For informal suppliers, all payments received that we detect go unreported by definition. For formal but under-reporting suppliers we define unreported amounts relative to treatment (control) as the sum of payments received from clients of the treatment (control) group, minus total revenue declared to the TA. We find that information from treated clients allows to identify more tax evading suppliers across all levels of unreported income, both at the intensive and extensive margin, even though the difference in detection rate tends to decrease with unreported income.

6.2 What Do We Learn about the Distribution of Tax Evasion?

On average, more than 50% of the suppliers of the control group have no valid ID (see Table 8 and Figure 4.A), therefore preventing any match with the tax registry, which in

[29] See Table 2 for detailed examples).

turn implies that we cannot determine whether they are formal or informal, tax-avoiding or compliant suppliers. With so much information missing, any attempt to describe the distribution of tax evasion is likely to suffer from sampling biases. But because treated firms did submit much more complete reports about their suppliers (see Figure 4.A and 4.B for a graphical illustration), restricting our analysis to suppliers of the treatment group allows to more confidently explore this question. We document three stylised facts about tax evasion which the prevalence of unidentified suppliers was previously hiding (Tables 9 and 10).

First, the average number of clients of tax evading suppliers is rarely superior to 2, which strongly suggests that detected under-reporting is only a fraction of real total income, despite the prevalence and magnitude of tax evasion already observed here. Second, conditional on being identified as formal, under-reporting is highly prevalent: 45% of the treatment group's formal suppliers have been detected as under-reporting. They represent a bit less than 10% of all tax-registered actors identified as active in 2022 (see Table 11). Third, the observed distribution of unreported revenue by tax evading suppliers is extremely skewed. Most are very small: 90 % have a yearly observable net unreported income lower than USD 11,000. But unreported amounts among the largest 1% of tax evaders reach USD 639,570 on average. Overall, net under-reported amounts among formal suppliers are significantly larger than amounts received by informal ones. Below the 96th percentile (USD 31,798) tax evading suppliers are mostly informal, while above, tax evading suppliers are mostly formal. Under-reporting formal suppliers within the top 1% of the distribution of tax evaders account for 52% of all unreported income.

Considering this and the fact that auditing already tax-registered suppliers is likely to be much less costly than going after fully non-compliant actors, our results suggest that, in the short run at least, an administration maximizing fiscal revenue should target under-reporting formal firms rather than informal ones, at least above a certain threshold. It is worth stressing, however, that, in the longer run, this strategy will reinforce inequities between those who contribute and those who do not. To avoid this, we believe tax administrations facing large informal sectors should always invest resources also to enrol new economic actors even if they do not have the resources to go after *all* informal actors. Our results speak to this issue as information in supplier lists allow to identify large informal suppliers worth registering.

6.3 How Much Additional Tax Revenue Can Be Expected from Exploiting the New Information to Target Future Audits?

We run a simulation exercise to estimate the expected *additional* tax revenue collected would the administration exploit the new information retrieved from suppliers lists submitted by the treatment group. To do so, we compare tax revenue expected when using this information to select firms to be audited, with tax revenue expected based on alternative

selection methods that the TA could use. Following the conclusion of Section 6.2, we concentrate exclusively on the formal sector, and define our benchmark selection method (S_0) as the audit of the largest under-reporting formal suppliers according to information reported by the treatment group. Ideally, we would like to compare tax revenue collected with our benchmark selection method to those collected when using the method that the TA currently applies to select taxpayers to be audited. Current audit selection procedure is very decentralised. Executed mostly at the tax center level, it mixes discretionary decisions made by individual tax inspectors based on elements of suspicion with more rule-based decisions validated by a college of higher ranked administrators (Bachas et al. (2021), Czajka et al. (2022)).[30] Given this, we decide to confront S_0 to four, very different, alternatives:

> S_0: audit the largest under-reporting formal suppliers according to information reported by the *treatment* group (benchmark selection method)
> S_1: audit the largest under-reporting formal suppliers according to information reported by the *control* group
> S_2: audit randomly selected taxpayers
> S_3: audit the largest taxpayers (based on declared income)
> S_4: audit the largest taxpayers, by center (based on declared income)[31]

Let n be the number of firms to be audited and r the effective audit rate of return, i.e. tax revenue collected upon audit as a percentage of unreported amounts. For each selection procedure S_k (with $k \in [0,4]$) listed above, we define $T_k^{nr} = \sum_{i=1}^{n}(r \cdot u_i^k)$, where $(u_i^k)_{0\leq i\leq n}$ are unreported incomes of the n selected taxpayers. T_k^{nr} represents the total expected tax revenue collected by auditing the n taxpayers selected though the procedure S_k, assuming an effective audit rate of return of r. For some n, r and selection S_k (with $k \in [1,4]$), we are interested in estimating $\Delta_k^{nr} = (T_0^{nr} - T_k^{nr})/T_k^{nr}$. For simplicity, we can assume that r does not vary with selection method, hence it can be removed from the equation which thus simplifies into $\Delta_k^n = (U_0^n - U_k^n)/U_k^n$ where, for any $k \in [0,4]$, $U_k^n = \sum_{i=1}^{n} u_i^k$, i.e the sum of all revenue unreported by the n selected taxpayers.

For any k, i, we have: $u_i^k = c_i^k + a_i^k$ where c_i^k, is unreported income revealed by cross-checking suppliers list against self-declared income tax *before audit*, and a_i^k is unreported income revealed by the audit (via any method applicable during an audit). By definition, $c_i^0 > 0$ ($c_i^1 > 0$) for any taxpayer i who has been identified as under-reporting payments received from the treatment (control) group. But, when $k \in [2,4]$, $c_i^k = 0$, and thus $u_i^k = a_i^k$. In other words, for selection methods 2, 3, 4, the only unreported income detected is what is uncovered by the audit. To estimate U_k^n for all k, we thus need to estimate a_i^k for each taxpayer i. Unfortunately, information about a_i^k is not collected by the administration.

[30] Exhaustive and reliable data and information on audit selection and execution is not systematically collected and consolidated into standardised format. Our description here derives from qualitative and observational evidence.

[31] This is the same as S_3 but selecting the same proportion of taxpayers from each tax center.

To approximate a_i^k, we thus exploit amounts unreported by the 2,792 tax evading formal suppliers of the treatment group.[32] For each of them, we compute an under-reporting rate by taking the ratio between unreported income detected thanks to information declared by the treatment group, and total *real* revenue (the sum of both declared and unreported revenue). Building from Best et al. (2021), who show that in Pakistan firm size is by far the best predictor of audit-based evasion rates, we then rank the full population of taxpayers according to their declared revenue (including those 2,792 known tax evaders) and compute average under-reporting rates by decile. Column (5) of Table 11 displays average under-reporting rates *conditional on under-reporting*. As audits do not systematically detect tax evasion,[33] extrapolating observed conditional under-reporting rates to all taxpayers to estimate unreported income revealed by the audits, would greatly overestimate evasion.[34] Instead, we use *unconditional* average under-reporting rates by decile of declared income. Before computing these rates, we discard the largest 1% firms of the sample, may they be under-reporting or not. Indeed, we detect only 3 under-reporting taxpayers among the largest 1% taxpayers, while these account for almost 75% of all (declared) revenue (Figure 6). Considering this, it seems reasonable to assume that the population of detected under-reporting suppliers provides too little information about this extremely different sub-group to allow any extrapolation, as a result, we prefer to discard them from the analysis. Finally, we obtain the coefficients displayed in column (6) of Table 11 and apply these to taxpayers' declared revenue to estimate a_i^k, and therefore u_i^k for each taxpayer i and scenario $k \in [0,4]$. This way we can compute Δ_k^n in all scenarios. We bootstrap the estimation procedure to account for potential measurement errors. Overall, the validity of our estimation will rely on the following two assumptions:

1. The audit rate of return is constant across all scenarios.
2. Unconditional under-reporting rates based on cross-checking are at least as high as unconditional under-reporting rates based on audits.

Hypothesis 1 is at worst harmless, at best conservative. Indeed, it seems plausible that, conditional on some unreported revenue detected, the selection method would not impact the share of unreported revenue recovered by the administration. Also, in case third-party evidence is perceived by under-reporting taxpayers as a sign that the tax administration is more competent then they thought it was (as evidenced by Brockmeyer and Hernandez (2022)), then they might be more likely to collaborate, possibly giving away some additional

[32] As further discussed below, we discard the largest 1% firms from our analysis, including the 3 under-reporting firms detected in that group.

[33] This can happen not only in cases where taxpayers do not under-report, but also if the audit procedure is not able to uncover some forms of evasion.

[34] Indeed, we estimate that assuming audits would systematically reveal evasion rates as large as conditional under-reporting rates uncovered through cross-checking, would make aggregate unreported income almost ten times greater than Senegal's GDP

information that would increase the recovery rate (e.g. the bank account number). Relaxing hypothesis 1 to allow higher r in our benchmark scenario would lead to even more significant results.

Assessing the plausibility of Hypothesis 2 requires making sure that we do not underestimate a_i^k. As explained above, the TA in Senegal does not collect information on such parameters. Yet, there exists one study that measures unbiased tax evasion rate discovered upon audits in a LIC. Comparing the unconditional under-reporting rates we use in our estimation, to those found by Best et al. (2021), our estimates clearly stand out as upper bounds. Indeed, above the median declared revenue, the average unconditional under-reporting rates they find are equal, or inferior, to 1.75, while ours are systematically above 2.5. Importantly also, under our assumption, the implied total estimated unreported income for the entire sample of taxpayers is USD277 millions, i.e 51% more than total unreported income detected through cross-checking information declared by the treatment group (see Table 9, column (7)).

Figure 7 displays Δ_k^n for any $k \in [1,4]$ and $n \in [100,1000]$. Selection method S_0 outperforms method S_1 by at least 80%, and up to 115% if we consider the top 100 tax evaders. It outperforms method S_2 by at least 1000%, which derives from the fact that S_2 selects too many small taxpayers. Our benchmark method also does better than method S_3 which is, to our knowledge, the closest to what the TA actually does. Finally S_0 even outperforms selection method S_4 for the top 350-400 under-reporting formal firms - beyond, under-reporting levels based on suppliers list decrease faster than estimated unreported income for the next largest firms. Overall, these results strongly suggest that newly available information would increase short-term audit returns by improving the targeting of firms to be audited.

Eventually, one could argue that if audits do not yield any return, then a relative increase of 100%, will still produce null results. This however is very unlikely. Every year, the tax administration carries out audits based on similar cross-checking exercise (although not automatised) and recovers some positive total, part of which is going to tax inspectors themselves as a form of bonus (Bachas et al., 2021). These returns might be small. Best et al. (2021) find for instance that, in Pakistan, only 2% of the uncovered evasion gets recovered upon audit. Nevertheless, it is very unlikely that, despite proof of under-reporting, results of audits based on our information would *always* be null. What is more subject to debate in the literature is the quantification of the long term impact of audits. Indeed, **?** highlight that, because of the combination of learning and "crater" effects, audits can in theory have both negative or positive impact on compliance. Best et al. (2021) find that random audit have no effect in the long-run, while **?** find *some* types of audits can increase compliance the following three years.

6.4 Cost-Benefit Analysis for the Tax Administration

In this last section, we estimate the cost-benefit ratio of implementing our intervention and auditing the largest under-reporting formal firms detected thanks to information declared by the treatment group in their 2022 suppliers list. The total intervention costs about USD 102,720[35]. Tax inspectors get paid an average salary of XOF 668,085 (USD 1,068) per month and, based on administrative reports, we estimate it takes them about 1.2 months to complete an audit.[36] For each $r \in [3,30]$ and $n \in [100,1000]$, we compute T_0^{nr} (see Figure 8.A) and T_0^{nr} / C_0^n (see Figure 8.B), where C_0^n stands for the full cost of running our intervention plus auditing the n largest under-reporting formal firms according to the treatment group.

Unfortunately, the TA does not systematically collect data on r. By law, unreported revenue should be considered as net profits and thus subject to the corporate income tax, whose statutory rate is 30%. In addition, the detection of unreported income may lead to the upward revision of the tax base for other fiscal instruments,[37] and thus further increase total liability. Last, financial sanctions for having committing tax fraud may also be added. Yet, during the audit process, taxpayers are often given the opportunity to revise upward deductible charges, therefore lowering net profit. Eventually, the effective r will depend on several factors that we cannot observe. To account for this uncertainty, we vary our estimates for any $r \in [3,30]$. The 30% upper bound corresponds to a scenario where no taxpayer manages to claim new deductible charges, but also where no fine would be applied, nor any adjustment of other tax liabilities. We take 3% as a lower bound as it corresponds to the average effective tax rate (considering all taxes) with respect to total gross revenue for the full taxpayer population.

Final estimates are very sensitive to the input parameters. The nominal amount of total tax collected upon audit varies from USD 5.8 million to USD 52.2 million (see Figure 8.A), and the benefit-to-cost ratio goes from 9.8 to 175. (see Figure 8.B). Importantly also, due to the extreme skewness of the distribution of unreported amounts (see Table 10), benefit-to-cost ratio sharply decreases with the number of audited firms. Nevertheless, our simulation strongly suggests that, even under very conservative assumptions, implementing the intervention followed by the audits is highly cost-effective.

[35] This includes USD 30,720 for two years of data collection (although suppliers list are now declared online, making this amount unnecessary in the future) USD 33,600 for the one-year communication campaign, and USD 38,400 for all coordination and data analysis related costs.

[36] On average a tax inspector does about 10 audits per year. In practice audit run over a long period of time (between 3 months to a year) and inspector always work simultaneously on several cases at the time. All these figures are exclusively derived form reports produced by the Large Taxpayers Center.

[37] In particular: VAT, local business tax (which is based on value added), excise duties and other special taxes.

7 Conclusion

In the context of Senegal, this paper provides evidence that leveraging large firms' trading network to collect information about their suppliers can be a cost-efficient way for tax administrations in LICs to detect tax evasion and increase future audit returns. We first digitise and consolidate 6,706 lists of suppliers filled by the country's largest firms. We document that misreporting is highly prevalent, preventing any systematic use of the lists for audit-related tasks. Building on the communication experiment literature, we then randomise a low-cost individualised communication campaign across all 3,487 firms identified as misreporting, to discourage future misreporting.

Our intervention dramatically increases the quantity of information available in follow-up suppliers lists, without reinforcing strategically manipulative declarative behaviors. The newly available information allows to better track USD 1 billions worth of transactions, i.e. 3.8% of GDP. By cross-checking these transactions with the universe of self-declared income tax statements, we show that intervention allows to uncover 145.5 million in unreported revenue, i.e. 0.5% of GDP. The distribution of unreported revenue reveals extreme concentration of tax evasion, mostly accruing to the largest under-reporting formal firms. A simulation exercise shows that by strategically allocating audit resources based on the newly available information, tax revenue collected upon audit could be increased by at least 100%.

This study illustrates that well-targeted communication campaigns are highly cost-effective tools to induce better reporting even among the largest taxpayers, despite being relatively mild interventions compared to costlier deterrent methods. This may be due to the fact they are asked to report on the revenues of others, rather than their own. Our results also show that large firms can be used as informants to detect large, non-compliant, actors, both at the intensive (formal) and extensive (informal) margins. This result has wide-ranging policy implications in LICs where most actors operate in the informal sector and where administrations can only rely on a few compliant firms to find the next margin worth expanding enforcement to. In the case of Senegal, our estimation suggests that, at least in the short term, greater gains should be expected from strengthening tax enforcement among the tax-registered rather than widening the tax base.

Future research should aim at more precisely quantifying (the distribution of) audit returns in the short and long term, and deepening our understanding of their determinants in the specific context of LICs. Building on our results, additional research should also attempt to gather more complete information on the size and distribution of tax evasion at the extensive and intensive margins to better understand the trade-off for tax administrations between revenue-maximizing strategies and fiscal equity across the population.

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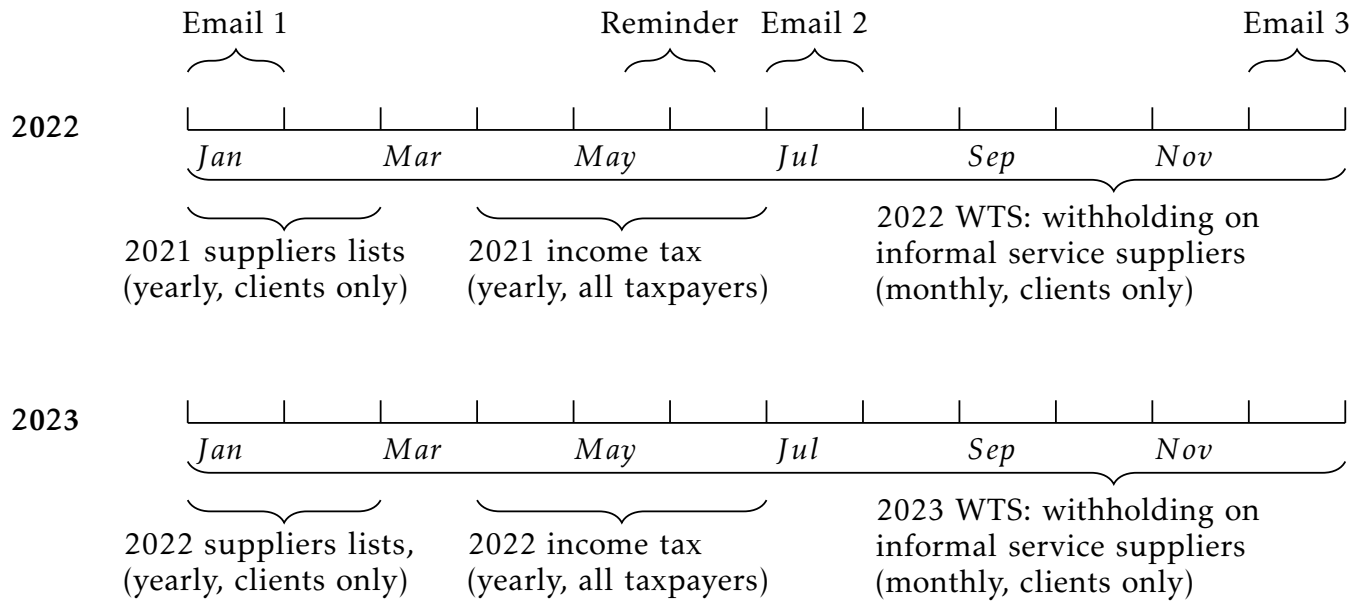
8 Figures

Figure 1: Timeline - Intervention and Main Declarations



Intervention: Our communication campaign consists of three waves of emails and systematic verification calls in January, July and December 2022.

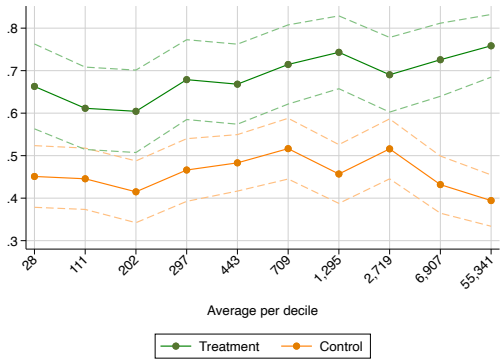
Suppliers lists: For each year of activity y, a detailed list of all service suppliers (tax-registered or not) must be declared by their clients before the 31st of January in year $y+1$. The statistical unit of this data is the client-supplier pair. See Table 1 for a detailed review of suppliers lists reporting rules.

Income tax: For each year of activity y, all tax-registered individual or firms must declare their personal or corporate income tax statement (PIT or CIT) by mid-April of $y+1$. This is the main source we use to measure self-declared gross revenue of tax-registered suppliers.

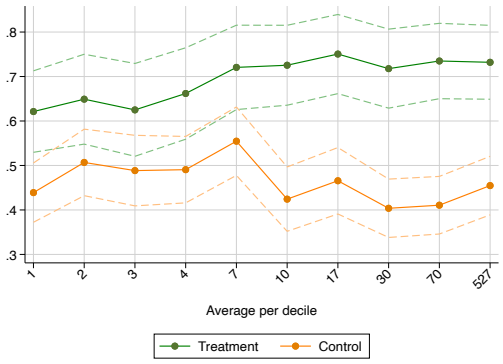
WTS: In this monthly declaration, clients of informal service suppliers indicate the total spent on such services and remit the corresponding 5% withholding tax to the administration. The statistical unit of this data is the client.

Figure 2: Impact on the Share of Correctly Reported Suppliers - 2022 Suppliers Lists - Heterogeneity by Firm Size and Age

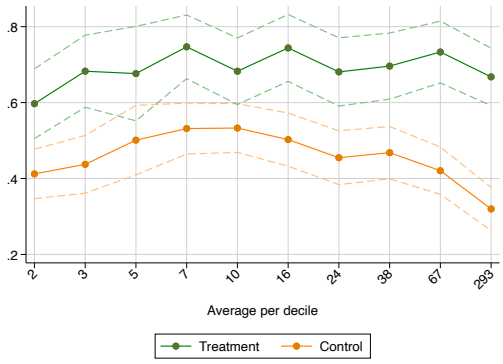
(A) By Revenue (USD'000)



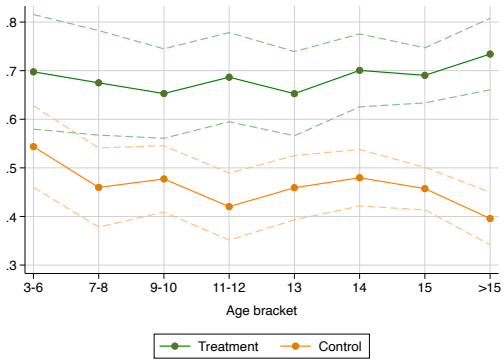
(B) By Number of Employees



(C) By Number of Service Suppliers



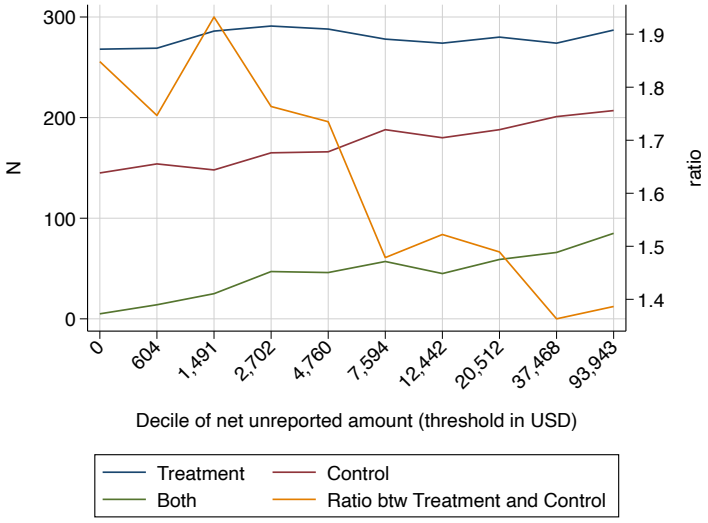
(D) By Age (years since creation)



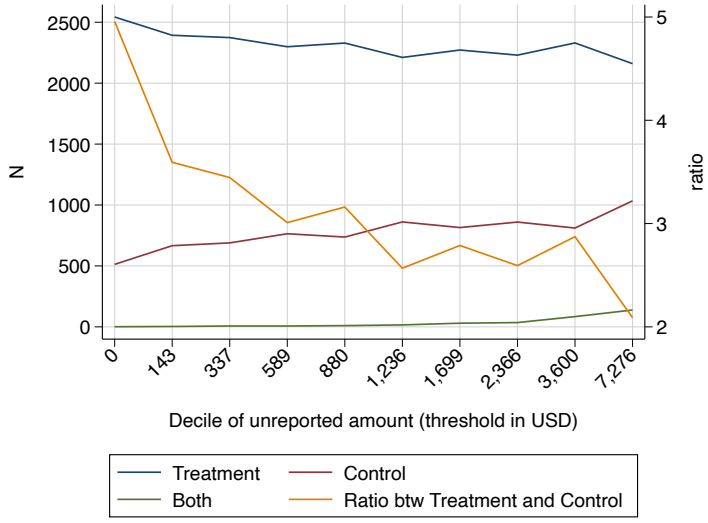
Notes: These figures display the average shares of correctly reported suppliers declared by firms in the treatment and control group, across deciles of four different covariates. For each decile, averages for the control group are the sample mean, averages for the treatment group are obtained by adding our average treatment estimates (using OLS and the model specified in 4.2, and variables displayed in Table 6 as controls) to the control group's average. Dashed lines indicate 95% intervals. Figure 2.(A) exploits the average Revenue declared ex-ante during the 2018-2020 period. Figure 2.(B) (resp. 2.(C)) use average number of employees (resp. service suppliers), over the same period. Labels of the x-axis for the three figure indicate the decile average of each covariate. Finally 2.(D) splits the sample into age groups of similar size. Age measures the number of years since the creation of the firms / start of the activity.

Figure 3: Number of Detected Tax Evading Suppliers - by Quantiles of Unreported Amounts

(A) Formal Under-reporting Suppliers

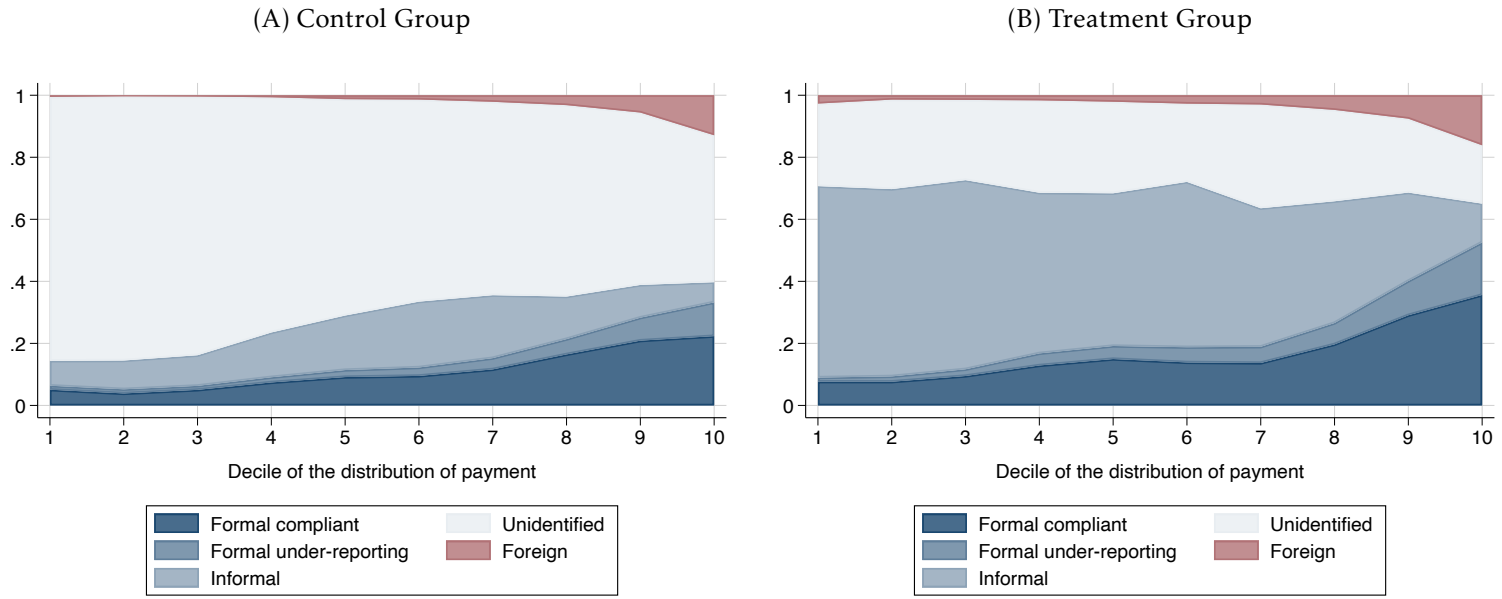


(B) Informal Suppliers



Notes: Figure 3.(A) and figure 3.(B) display the number of tax evading suppliers by decile of unreported amounts on the intensive (formal) and extensive (informal) margin respectively. By definition suppliers are classified as formal if they are tax-registered, informal otherwise. The blue (red) line represent the number of tax evading suppliers detected thanks to information coming from the treatment (control) group. The yellow line is the ratio between the two. The green line is for suppliers flagged as tax evaders by both groups.

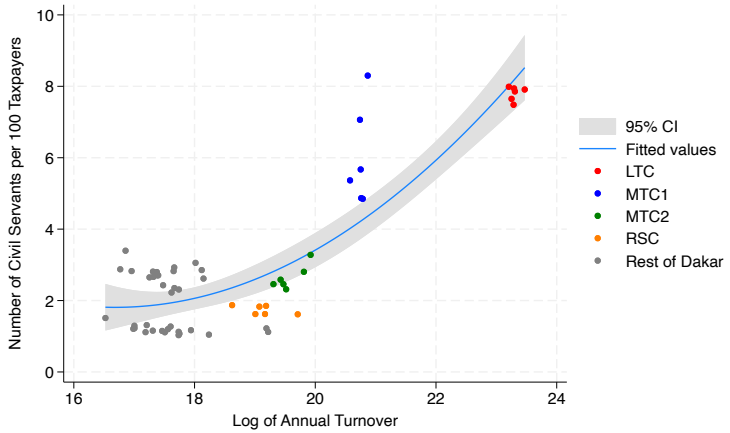
Figure 4: Decomposition of 2022 Payments to Suppliers by Experiment Group, Suppliers' Type and Decile of the Distribution of Payments



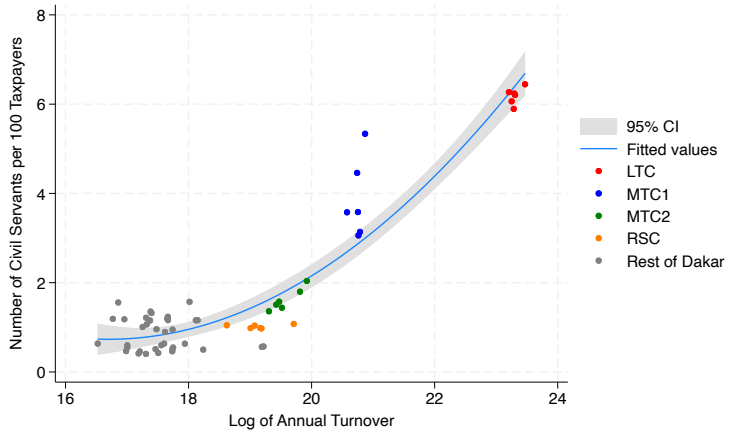
Notes: The statistical unit is the client-supplier pair as declared, by clients (control or treatment), in their 2022 suppliers list, after the full communication campaign. For both Figures, deciles are based on the within-group distribution of yearly payments for each client-supplier pair. The classification of each payment is based on the client (control or treatment) and the suppliers' type. Suppliers are classified across 5 types, according to information available in 2022 suppliers lists and cross-checks with the tax registry and suppliers' own tax declarations for 2022. Suppliers of the control (treatment) group are classified as "Formal compliant" if they are tax-registered and have self-declared total revenue at least as large as the sum of payments received by client of the control (treatment) group. They are classified as "Formal under-reporting" in case that sum is superior to self-declared revenue, or "Informal" if they are not tax-registered. By construction, the rest of Senegalese suppliers are reported with no valid ID in their clients suppliers lists, and are thus considered "unidentified". Foreign suppliers form a separate group because we cannot cross-check payment received against their self-declaration.

Figure 5: Number of Civil Servants per Taxpayer - by Tax Center and Civil Servant Category : 2016-2021

(A) All Civil Servants

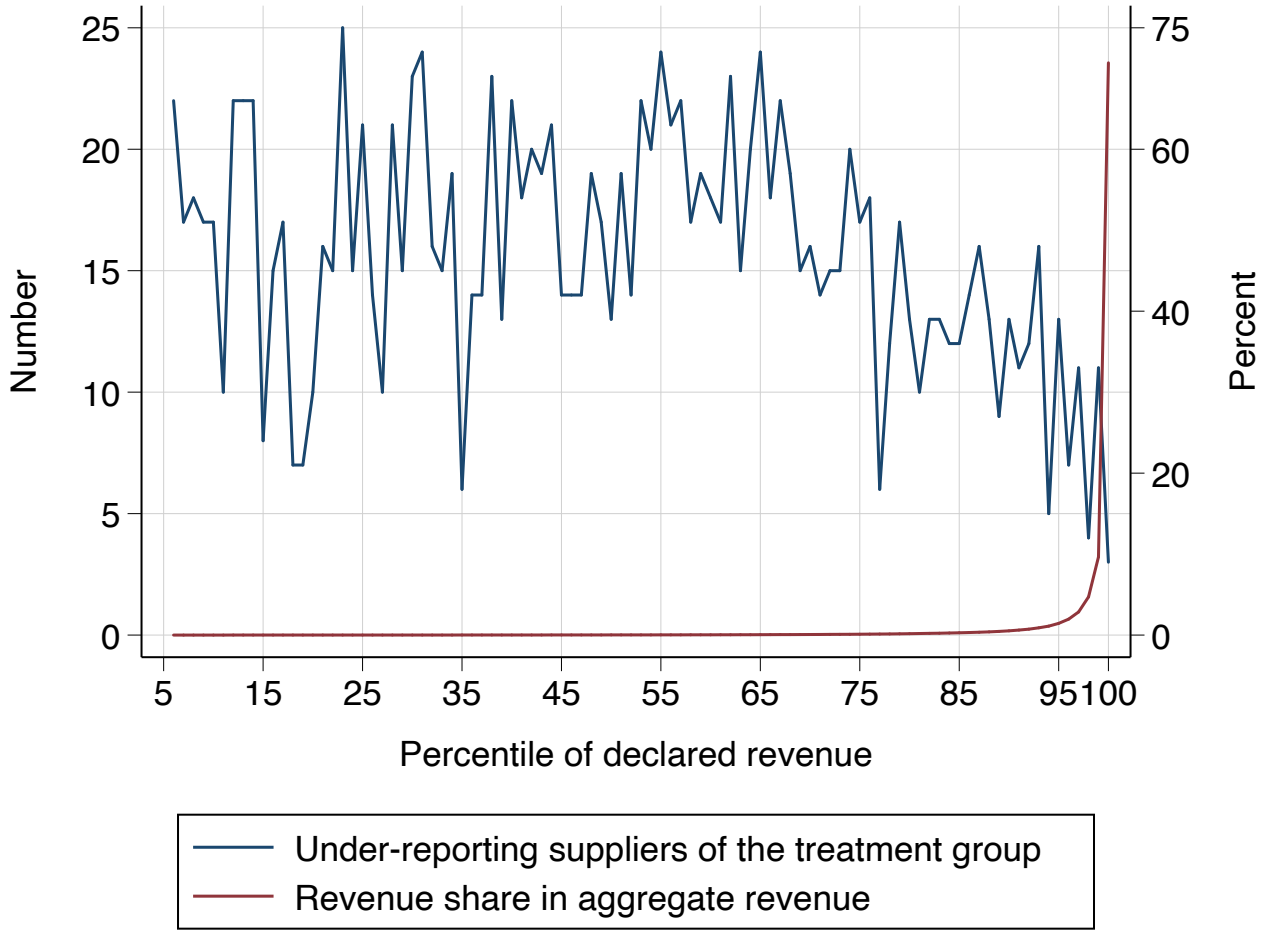


(B) Civil servants of Category A or B only



Notes: The statistical unit is the year-center. We exploit data from 2016 to 2021 and 10 tax centers : the Large Taxpayers Center (LTC), the Middle-sized Taxpayers Center 1 (MTC1) the Middle-sized Taxpayers Center 2 (MTC2), the Regulated Sectors Center (RSC) and all other centers of Dakar (excluding *Rufisque* - the most off-center unit the agglomeration, due to unreliable data). The x-axis indicates the log of the average annual turnover declared by taxpayers. The y-axis indicates the number of civil servant per 100 taxpayers within each tax center. Civil servants at the tax administration are split across four categories : A, B, C or D. Only agents of category A or B are required to have a training in fiscal law and administration, and only them can perform audits, establish fines and force tax recovery. Panel (A) considers civil servants of all four categories, while panel (B) restrict the analysis to most qualified civil servants. Example : over 2016-2021, there was consistently more civil servants of category A or B per taxpayers in the Large Taxpayers Center than in any other centers.

Figure 6: Distribution of the 2,975 Under-reporting Suppliers of the Treatment Group and Revenue Share

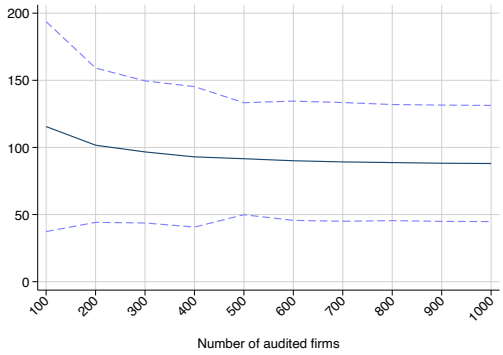


Notes: The population for this figure is the full sample of taxpayers active in 2022. On the x-axis are percentiles of the distribution of declared revenue. The blue line (left y-axis), displays the number of under-reporting suppliers of firms from the treatment group in each percentile. The red line (right y-axis) displays the revenue share (in %) of each percentile in aggregate revenue declared. We observe only 3 under-reporting taxpayers within the top 1%, yet that sub-group alone accounts for almost 75% of all revenue. We decide to discard these extremely large taxpayers from all selection methods in our simulations, including our benchmark method.

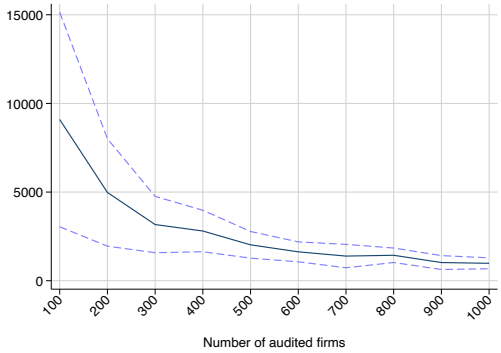
Figure 7: Hypothetical Audit Returns, four Scenarios

Returns expected from auditing the largest under-reporting formal suppliers according to the treatment group, compared to estimated returns when targeting ...

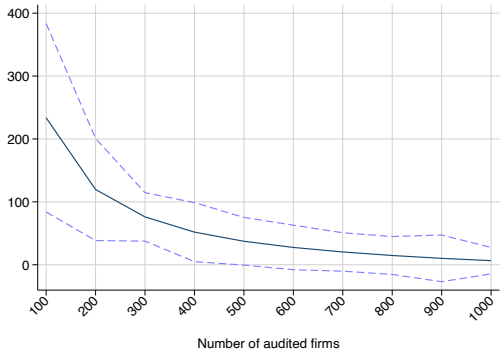
(A) ... under-reporting formal suppliers of the control group



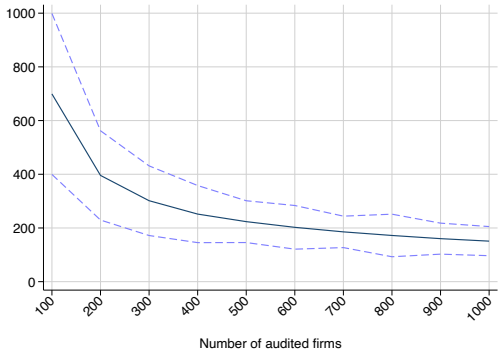
(B) ... randomly selected taxpayers



(C) ... the largest taxpayers



(D) ... the largest taxpayers by tax center

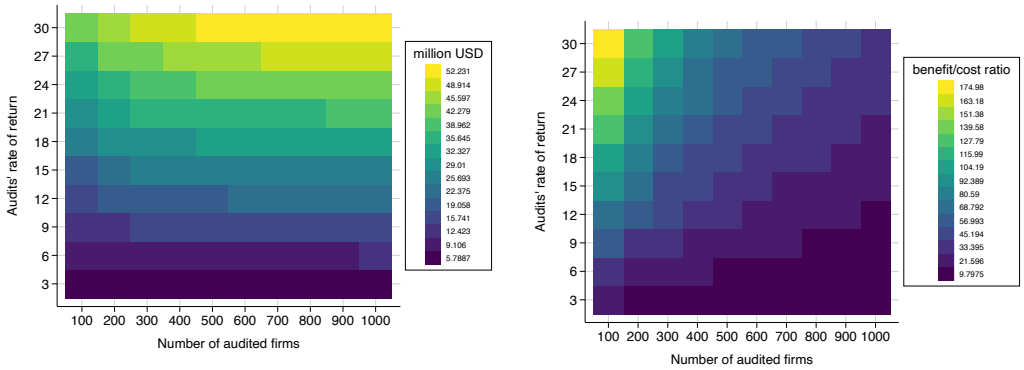


Notes: This Figure plots the *percentage difference* in expected audit returns (tax collected upon hypothetical audits) obtained when comparing audits of the largest under-reporting formal suppliers (according to information declared by the treated group in their 2022 suppliers list), to audits of other formal firms, selected through four alternative methods. In Figure 7.(A), the alternative method consists in selecting the largest under-reporting firms according to the *control* group. In Figure 7.(B) the alternative method is a random draw from the (active) tax-registry. In Figure 7.(C) the alternative method consists in selecting the largest taxpayers (in terms of gross revenue), and for Figure 7.(D) we do the same but by tax center, selecting the same proportion of taxpayers in each tax center. Dashed lines represent 95% confidence interval estimated by bootstrapping our calculation to allow for some potential measurement errors. *Example:* We estimate that auditing the 200 largest under-reporting suppliers according to the treatment group would multiply audit returns by 4, compared to auditing the largest 200 firms by tax centers. See Section 6.3 for a detailed explanation.

Figure 8: Hypothetical Audit Returns and Short-Term Cost-Benefit Analysis

(A) Tax Revenue Collected upon Audits

(B)... and Compared to Costs (Intervention + Audits)



Notes: Figure 8.(A) displays the difference, in nominal amounts, in expected audit returns (tax collected upon hypothetical audits) obtained when comparing audits of the largest under-reporting formal suppliers according to the *treatment* group, versus audits of the largest under-reporting formal suppliers according to the *control* group (see Figure 7 for a comparison with alternative selection procedure). We estimate 10x10 scenarios by varying the number of taxpayers to be audited and the hypothetical rate of return per audit. Figure 8.(B) displays the ratio between the audit surplus and the total cost of our intervention plus the estimated cost of carrying out the follow-up audits.

9 Tables

Table 1: Reporting Rules for Suppliers Lists - Examples for Each Type of Line

WTS Exemption based on information from (1), (6), (7)	Is the line correct?	Suppliers' type		(1) *Amount ('000 XOF)*	(2) *Name of supplier*	(3) *Firm-ID*	(4) *5% WTS*	(5) *National-ID*	(6) *nature*	(7) *country*	Mean Prevalence at baseline (%) *in total*	*av. per client*
(A) Not Exempt	Yes	Formal	(a)	78,000	Securitek SA	000987518			surveillance	Senegal	12.3	14.0
	No	Informal	(b)	8,500	Legal Terranga			1385196500..	Service	Senegal	0.7	0.5
	No	Unidentified	(c)	9,000	Dieye Pharmacie					Senegal	54.9	71.5
	Yes	Informal	(d)	200	Abdoulaye Diop		10	1267199080...	consulting	Senegal	2.6	1.6
	No	Unidentified	(e)	8,000	Mouhamed Faye		400			Senegal	19.8	9.5
(B) Exempt	Yes	Informal	(f)	20	Dieynaba Sall			2648200187...		Senegal	0.2	0.1
	Yes	Foreign	(g)	750	S&Q200			BE08.9689.97...		Belgium	0.4	0.1
	No	Unidentified	(h)	24,000	Dakar Beach Hotel				Hotel	Senegal	8.5	2.5

On misreporting: This table illustrates in full details how we proceed to detect misreporting. A taxpayers having submitted at baseline a suppliers list which contains at least one of the error listed here, will be considered as misreporting and thus eligible for the intervention. We also explain bellow how we use the available information to classify suppliers themselves as "Formal", "Informal", "Foreign" or "Unidentified".

WTS Exemption definition: The supplier of a given line is considered "Exempt" if information present in column (1), (6) or (7) is sufficient to grant exemption, i.e if the amount is lower than XOF 25,000 (see cell (f)(1)), or if the supplier operates in the Hospitality sector (see cells (g)(6) and (i)(6)), or if the supplier is foreign (see cell (h)(7)).

Panel A - "Not Exempt":
(a) A formally correct *Firm-ID* is indicated in column (3), hence suggesting the supplier is tax-registered therefore that, as far as the client could tell, no withholding was due. This is how transaction with tax-registered suppliers should typically be declared. This *Firm-ID* is then what can be used to check whether this supplier is effectively tax-registered and has declared revenue at least as large as the sum of payments third-party reported here. This supplier will be classified as formal only if the *Firm-ID* matches the tax-registry.
(b) Some information is missing: either a formally correct *Firm-ID* if the supplier is tax-registered (column (3)), or some positive WTS amount if it is not (column (4)).
(c) Some information is missing: either a formally correct *Firm-ID* if the supplier is tax-registered (column (3)) or some positive WTS amount and a formally correct *National-ID* if it is not (column (4) and (5)). Pooling all suppliers lists for 2018-2020 we estimate that 54.9% of the suppliers reported at baseline are of that type.
(d) A positive WTS is declared, together with a formally correct *National-ID*. This is how transaction with informal suppliers (not tax-registered) should typically be declared. Note that in some rare case, a *Firm-ID* may be present together with, or instead of, the *National-ID*. In that case the line is still considered correct.
(e) Some information is missing: A positive WTS is declared but some identifier, typically a *National-ID* (column (5)), or more rarely, a *Firm-ID* (column (3)) is missing.

Panel B - "Exempt":
(f) The transaction is exempt because the amount is inferior to XOF25,000, the WTS amount (column (4)) is thus rightly missing. Some formally correct *National-ID* is provided (it could have been a *Firm-ID*), making the line correct.
(g) The transaction is exempt because the supplier is foreign (column (7)). Some ID has been provided, hence the line is correct. Note that is that case, the ID needs not even to be formally valid (as we would not know which rule to apply) for the line to be considered correct.
(h) The transaction is exempt because the supplier is a hotel (column (6)). Yet some identifier is missing either a formally correct *Firm-ID* if the supplier is tax-registered (column (3)) or a formally correct *National-ID* if it is not.

Note on IDs: Every individual, tax-registered or not, has a *National-ID*. In addition, all tax-registered actors have a *Firm-ID* as the tax administration requires it for all operations. But the reverse is not true. *Firm-IDs* are produced by the National Agency for Statistics and Demographics and used by many institutions other than the tax administration. For simplification and unless specified, throughout the paper whenever we use the term "ID", it refers to either a *National-ID* or a *Firm-ID*. Unidentified suppliers are those for which no valid ID has been indicated. As we can see from the last two columns of the table, more than 80% of the suppliers are unidentified at baseline.

Note on names: All names are fictional and made precise only to illustrate the diversity of patterns.

Table 2: Rules and Examples for the Definition of Under-reporting (Formal) Suppliers

Experimental Group	Transaction Index	Data from suppliers list			Data form self-declared income tax statements	Our classification
		client	suppliers ID	transaction amount	Annual total turnover of the supplier	According to information provided by all treated (resp. control) firms, the supplier is considered:
		(1)	(2)	(3)	(4)	(5)
Treatment	(a)	A	firm-ID-1	300	1000	under-reporting
	(b)	A	firm-ID-2	700	2000	not under-reporting
	(c)	A		2300	impossible to cross-check	indeterminate
	(d)	B	firm-ID-3	700	400	under-reporting
	(e)	B	firm-ID-1	800	1000	under-reporting
	(f)	B	firm-ID-2	1200	2000	not under-reporting
Control	(g)	C	firm-ID-1	500	1000	not under-reporting
	(h)	C		200	impossible to cross-check	indeterminate
	(i)	D		400	impossible to cross-check	indeterminate
	(j)	D	firm-ID-2	900	2000	not under-reporting
	(k)	D		600	impossible to cross-check	indeterminate
	(l)	D		100	impossible to cross-check	indeterminate

Notes This table displays fictional data to illustrate how we define under-reporting relative to information declared by the treatment (resp. control) group. Columns (1) to (3) are information provided by two treatment firms (A and B) and two control firms (C and D). Columns (4) display (hypothetical) information on revenue self-declared to the tax administration by suppliers for which a firm-ID has be declared. Finally column (5) indicates the result of our classification method. In green, we display information, which, in that example, has been declared *as a response* to the intervention by treated firms.

Type 1: firm-ID-1 is an identified supplier of client A, B and C. According to self-declared income statement submitted to the tax administration its revenue equal 1000. Thanks to the intervention client, B reveals that transaction (e) goes to *firm-ID-1*. Summing all transactions from treatment clients going to *firm-ID-1*, we have the 300+800 > 1000, hence *firm-ID-1* is classified as under-reporting relative to the treatment group. It is not, however, classified as under-reporting relative to the control group, as the sum of transactions going from control clients to *firm-ID-1* equal 500 < 1000.

Type 2: firm-ID-2 is an identified supplier of client A, B and D. According to self-declared income statement submitted to the tax administration its revenue equal 2000. Thanks to the intervention client, A reveals that transaction (b) goes to *firm-ID-2*. Summing all transactions from treatment clients going to *firm-ID-2*, we have the 700+1200 < 2000, hence *firm-ID-2* is classified as *not* under-reporting relative to the treatment group (idem for the control group). This is despite the fact that if we were to sum all transactions going to *firm-ID-2*, form both treatment and control clients, we would have 700+1200+900>2000.

Other cases: firm-ID-3 is an identified supplier of client B only. It's under-reporting status is unequivocal. Transactions (c), (h), (i), (k) and (l) benefit unidentified suppliers which prevents any cross-checking against self-declared income tax statement, and forces us to leave their under-reporting status as "indeterminate".

Justification: With our definition, the average share of transaction, per client, going to under-reporting taxpayers is (1/3+2/3)/2 = 50% in the treatment group, and 0 in the control group. But if under-reporting was defined relative to *all* transactions, the average treatment impact on the share of transaction going to under-reporting taxpayers, would be (2/3+3/3)/2 - (1/2+1/4)/2 = 45.8%. Our definition of *relative* under-reporting prevents externalities outside of the treatment group due to network effects. Most importantly, it better captures what to expect if we were to scale up our intervention to all firms, as, by definition, under-reporting firms of type 2 are only detectable when some clients are not treated.

Table 3: Suppliers Lists Declaration and Intervention Sample by Tax Units

	Number of Taxpayers for which we observe Suppliers Lists					Selected Taxpayers		
	2018	2019	2020	2018-2020				av. number of years observed
				N	as % of all	N	as % of (4)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Large Taxpayers Centre	684	709	760	874	86.5	799	91.4	2.5
Middle Taxpayers Centre - 1	515	191	154	567	83.5	439	77.4	1.5
Middle Taxpayers Centre - 2	1104	145	57	1127	69.6	1000	88.6	1.20
Regulator Sectors Centre	930	1121	336	1366	68.8	1249	91.4	1.79
Total	3233	2166	1307	3934	74.4	3487	88.5	1.70

Notes. This table provides information on the distribution of the baseline data we used to select our experimental groups. In total we got access to 6706 suppliers lists, spanning over three years, reported by 3934 different taxpayers, i.e. 74.4% of the total taxpayers population of the four largest taxpayers units. We identified 3,487 taxpayers having misreported at least once over the period, i.e 88.5% of the initial sample. On average, for that selected sub-sample, we observe about 1.7 suppliers list over 2018-2020

Table 4: Sectoral Decomposition of the Intervention Sample

	N	Total Sales		Total Employment	
		mean	% in total	mean	% in total
	(1)	(2)	(3)	(4)	(5)
Accommodation and food service activities	64	3557	1.23	78	2.85
Activities of extraterritorial organisations and bodies	4	255	0.00	129	0.28
Administrative and support service activities	424	3962	9.05	85	20.62
Agriculture, forestry and fishing	77	5877	2.44	81	3.54
Arts, entertainment and recreation	9	7240	0.34	92	0.46
Construction	206	6233	6.92	80	9.35
Education	48	918	0.23	21	0.56
Electricity, gas, steam and air conditioning supply	23	43874	5.44	144	1.88
Financial and insurance activities	104	13657	7.65	98	5.80
General public administration activities	18	380	0.03	23	0.23
Human health and social work activities	390	220	0.46	10	2.25
Information and communication	103	9470	5.26	39	2.27
Manufacturing	243	14432	18.88	144	19.96
Mining and quarrying	20	55962	6.03	64	0.73
Other business support service activities n.e.c.	28	2936	0.43	24	0.38
Professional, scientific and technical activities	323	1425	2.48	10	1.88
Real estate activities	85	2325	1.05	14	0.66
Retail sale via stalls and markets	1099	4232	25.05	31	19.73
Transportation and storage	160	5203	4.48	42	3.83
Water supply; sewerage; waste management and remediation activities	5	49040	1.32	309	0.87
unassigned	54	3944	1.14	55	1.70
Total	3487	18560124	100	175265	100

Notes. The classification used is the official NAEMA classification, used by countries the UEMOA, which, for that level of analysis, is consistent with the NACE classification used by European countries. Total sales and total employment are averaged over 2018-2020 per firm, then averaged per sector to obtain figures in column (2) and (4). Example : 206 firms of our selected sample operate in the Construction sector, their average yearly turnover during 2018-2020 was equal to USD 6,233,000, and they employed 80 individuals on average. This sector represents 6.92% of all sales and 9.35% of all employment in our sample.

Table 5: Baseline Patterns of WTS Declarations and Payments

	Conditional on declaring a suppliers list:				Does not declare a suppliers list
	pays 0 and declares 0	pays > 0 and declares 0	pays 0 and declares > 0	pays > 0 and declares > 0	but pay > 0
	%	%	%	%	%
	(1)	(2)	(3)	(4)	(5)
Large Taxpayers Unit	14.1	47.2	2.0	36.5	6.6
Middle Taxpayers Unit - 1	16.3	59.2	1.5	22.8	4.5
Middle Taxpayers Unit - 2	25.5	63.9	0.6	9.8	1
Regulator Sectors Unit	25.2	61.5	0.6	12.3	11.3
Total	20.6	57	1.2	21.1	6.4

Notes. This table compares total amounts of the WTS tax that clients declare having withheld from their suppliers in a given year (according to yearly supplier lists) to the total amount of the monthly remitted WTS they have effectively paid to the administration for that same period. For column 1-4 we exploit all collected supplier lists - figures add to 100% for each centre. In column 5 we restrict our sample to the years that are best covered by our data collection of the supplier lists, (i.e 2020 for LTC, 2018 for MTC-1 and MTC-2 and 2019 for RSC) and compute the percentage of firms that have remitted a positive amount and yet did not submit any supplier list. Example: in column (2) we can read that in the , 47.2 % of the supplier list we collected from the Large Taxpayers Centre have no information about any withheld amount, although some positive amount has been remitted during the year. Figures of column (3) suggest the contrary is much more rare.

Table 6: Summary Statistics and Balance Tests - Full Sample (N = 3,487)

Source	Covariates/Outcomes	Summary Statistics			Balance tests	
		Mean	Std. dev.	Median	β	Std. err.
(A) Suppliers lists	Number of suppliers	39.663	152.777	10	-6.773	4.635
	Share of suppliers without any ID	0.867	0.215	1	-0.008	0.006
	... with a positive WTS	0.115	0.239	0	-0.002	0.007
	... in the Hospitality sector	0.001	0.013	0	-0.000	0.000
	... Senegalese	0.989	0.047	1	0.001	0.001
	... with transaction bellow taxable threshold	0.017	0.067	0	-0.000	0.002
	N. of y. for which we observe a suppliers list	1.705	0.775	2	-0.001	0.019
	Declares suppliers list online	0.326	0.468	0	0.004	0.011
(B) Other Declarations	Av. Sum of WTS remitted - 2018-2020 (USD'000)	4.142	22.982	0.620	-0.894	0.784
	Av. turnover - 2018-2020 (USD'000)	5480.939	30678.406	407.394	-1213.954	981.129
	Av. number of employees - 2018-2020	56.564	319.884	6.699	-22.606**	11.135
(C) Tax Registry	Large Taxpayers Centre (binary)	0.229	0.420	0	-1.810	1.277
	Upper-Middle Taxpayers Centre (binary)	0.126	0.332	0	-6.950	5.998
	Upper-Middle Taxpayers Centre (binary)	0.286	0.452	0	-1.209	3.065
	Regulated Sector Centre (binary)	0.358	0.479	0	-1.054	1.777
	Legal person (binary)	0.708	0.454	1	-0.006	0.011
	Number of years since first digital admin. record	11.345	3.275	13	-0.016	0.109
	Firm created before 1990 (binary)	0.299	0.457	0	0.005	0.015
	... btw 1990 and 2000 (binary)	0.076	0.266	0	0.000	0.009
	... btw 2000 and 2010 (binary)	0.274	0.446	0	-0.005	0.014
	... after 2010 (binary)	0.349	0.476	0	0.000	0.016

Notes. The first three columns provide summary statistics about covariates and outcomes we use throughout the study for the entire sample. The last two columns summarize results from OLS estimation of equation (1) (see Section 4.2) without covariates, with each variable as the outcome. Variables of panel (A) are measured using suppliers lists collected at baseline (average over the period 2018-2020. Panel (B) exploits information reported in other declarations such as monthly Withholding Tax on Services (line 1), or Personal Income Tax, Corporate Income Tax, Value Added Tax, Business Property Tax, and the Synthetic Tax for small Businesses (line 2), or Withholding on employees (line 3). Panel (C) exploits all relevant information we could retrieve from the tax registry.

Table 7: Direct Responses - Decomposition by Tax Centre

	by tax centre				Full Sample	
	LTC	MTC-1	MTC-2	RSC	N	%
Rectification submitted for 2018-2020 suppliers list(s)	247	128	285	401	1061	60.8
No rectification submitted but message reception confirmed	144	82	154	177	557	31.9
... ask for more time	95	38	52	101	286	16.4
... cannot get the required information	26	20	48	30	124	7.1
... ask for assistance	16	15	14	17	62	3.5
... ceased activity	3	6	7	2	18	1.0
... other explanations	4	3	33	27	67	3.8
No rectification submitted, no confirmation	10	9	61	45	125	7.1
Total	401	219	500	623	1743	100

Notes: This table decomposes the treatment group by type of direct responses and tax centre in order to assess treatment take-up. Out of the 1,743 treated firms, 60.8% have submitted a rectifying declaration for 2018-2020 suppliers list pinned down by our communication campaign, 31.9% did not but have acknowledged reception of the message, and 7.1% have remained unreachable. Among those who received the message but did not submit a rectifying declaration, 286 (i.e half of that sub-group) have asked for more time in the last communication we had with them. *LTC*: Large Taxpayers Centre - *MTC-1*: Middle Taxpayers Centre 1 - *MTC-2*: Middle Taxpayers Centre 2 - *RSU*: Regulated Sectors Centre

Table 8: Key Intervention Impacts

			β	Std. err.	μ_c	N	Bonferroni p	Rand. inf. p
Conditional on declaring 2022 suppliers list	(A) Misreporting	Misreport no supplier (binary)	0.101***	0.015	0.182	2633	0.00	0
		Misreport all suppliers (binary)	-0.195***	0.014	0.289	2633	0.00	0
		Misreport some suppliers (binary)	0.093***	0.018	0.527	2633	0.00	0
		Share of misreported suppliers	-0.233***	0.014	0.543	2633	0.00	0
	(B) Information Prevalence	Share of suppliers ...						
		... with a formally valid ID	0.247***	0.014	0.469	2633	0.00	0
		... with intentionally wrong ID	-0.003	0.005	0.026	2633	1	0.43
		... with positive WTS declared	0.036***	0.014	0.508	2633	0.20	0.01
		... satisfying cond. to be exempt of WTS	0.001	0.003	0.033	2633	1	0.60
		... with a telephone number	0.092***	0.016	0.410	2633	0.00	0
	(C) Fraud Detection	Share of suppliers identified as ...						
		... informal	0.175***	0.012	0.229	2633	0.00	0
		... formal	0.069***	0.012	0.232	2633	0.00	0
		... formal and compliant	0.043***	0.010	0.175	2633	0.00	0
		... formal and under-reporting	0.025***	0.005	0.056	2633	0.00	0
	(D) Structure of Service Supply	Number of suppliers	4.590	7.203	49.903	2633	1	0.53
		Total (ihs)	0.036	0.056	17.934	2633	1	0.52
		Average (ihs)	-0.021	0.043	15.472	2633	1	0.63
		Median (ihs)	-0.079*	0.043	14.765	2633	1	0.06
		Standard Deviation (ihs)	0.105	0.171	13.928	2633	1	0.54
Full Sample		Declare 2022 suppliers list (binary)	0.017	0.013	0.772	3487	1	0.20
	(E) Remittance of the WTS	Remitted a positive WTS in 2022 (binary)	0.018	0.014	0.671	3487	1	0.23
		WTS amount remitted in 2022 (ihs)	0.236	0.205	9.521	3487	1	0.56
		Remitted a positive WTS in 2023 (binary)	0.008	0.015	0.605	3487	1	0.24
		WTS amount remitted in 2023 (ihs)	0.091	0.210	8.258	3487	1	0.67

Notes. This table displays all main results. We use OLS method to estimate the model specified in 4.2, with variables displayed in Table 6 as controls. Panels (A) to (D) are restricted to taxpayers that have submitted a 2022 suppliers list, after the full communication campaign (hence N=2633). The Statistical unit is always the taxpayer declaring suppliers list (i.e. the client). The last outcome of Panel (A) as well as outcome variables for panels (B) and (C) all measure the share, at the taxpayer level, of some specific type of suppliers. Outcome variables of panel (D) measure properties of the distribution of payments to suppliers, reported by each taxpayers. Outcome variables of panel (E) aggregate information from 2022, or 2023, monthly WTS remittances to assess the impact of the intervention on WTS remittances at the year level. These variables are measured without using 2022 suppliers lists, and thus estimations can exploit the full sample (N=3487)

Table 9: Identified Suppliers in 2022 - Summary Statistics by Intervention Group and Suppliers' Compliance Status

Clients' Group	Suppliers' Compliance Status	Number of Suppliers	Av. N. of clients	Income received from this group of clients					
				Total			Net unreported		
				Mean	Aggregate		Mean	Aggregate	
				USD	M. of USD	% of GDP	USD	M. of USD	% of GDP
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(A) Treatment group	Formal	6,176	2.086	237,040	1463.9	5.28	29,666	183.2	0.66
	... and compliant	3,381	2.648	334,767	1131.8	4.08	0	0	0
	... and under-reporting	2,795	1.405	118,823	332.1	1.19	65,552	183.2	0.66
	Informal	23,141	1.021	4,178	96.6	0.34	4,178	96.6	0.34
	All	29,317	1.245	53,233	1560.6	5.63	9,547	279.9	1.01
(B) Control group	Formal	4,610	1.832	96,387	444.3	1.60	17,232	79.4	0.28
	... and compliant	2,868	2.146	117,303	336.4	1.21	0	0	0
	... and under-reporting	1,742	1.316	61,951	107.9	0.38	45,603	79.4	0.28
	Informal	7,750	1.018	7,100	55.0	0.19	7,100	55.0	0.19
	All	12,360	1.322	40,402	499.3	1.80	10,879	134.4	0.48
(C) % variation	Formal	33.96	13.81	145.92	229.46	229.46	72.15	130.63	130.63
	... and compliant	17.88	23.38	185.38	236.43	236.43	0.	0.	0.
	... and under-reporting	60.44	6.76	91.80	207.73	207.74	43.74	130.63	130.63
	Informal	198.59	0.24	-41.15	75.70	75.70	-41.15	75.70	75.70
	All	137.19	-5.81	31.75	212.52	212.52	-12.24	108.15	108.15

Notes. This table provides basic statistics by type of identified suppliers (i.e reported with a valid ID in 2022 suppliers list), according to intervention groups. Example: information submitted by clients of the treatment group in their 2022 suppliers list help identify 29,317 suppliers in total. Out of this group, 23,141 are informal, 6,176 are formal, and 2,795 are flagged as under-reporting when comparing the sum of payments they received from clients of the treatment group to the total revenue they self-declared in their 2022 income tax statement. On average, these under-reporting formal suppliers have 1.405 from the treatment group, receive a total of USD 118,823 but under-report 65,552. In aggregate, this implies that about USD 183 millions have been under-reported by identified formal suppliers of the treatment group, i.e. 0.66 % of GDP. Note that by definition formal compliant suppliers do not under-report, hence their unreported income is 0. Also, as compliance status are defined *relative* to information reported by each intervention group, the same supplier can appear in both panel (A) and (B)

Table 10: Distribution of Unreported Amounts - Suppliers of the Treatment Group - 2022

Quantile	Unreported amount (USD)		Underreporting Formal Suppliers			Informal Suppliers		
	threshold	average	Population		% in tot.	Population		% in tot.
			N	%	unreported	N	%	unreported
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D-0	40	66	84	3.24	0.002	2509	96.76	0.059
D-10	140	241	89	3.43	0.008	2505	96.56	0.216
D-20	346	474	97	3.74	0.016	2496	96.26	0.424
D-30	607	763	118	4.55	0.031	2476	95.44	0.675
D-40	946	1,125	113	4.36	0.044	2480	95.63	0.998
D-50	1,344	1,599	147	5.67	0.083	2447	94.33	1.399
D-60	1,920	2,248	181	6.98	0.14	2413	93.01	1.943
D-70	2,764	3,449	259	9.98	0.302	2334	90.01	2.893
D-80	4,547	6,642	532	20.51	1.22	2062	79.48	4.935
P-90	10,881	11,137	62	23.94	0.238	197	76.05	0.793
P-91	12,480	12,887	83	31.92	0.36	177	68.08	0.837
P-92	14,382	14,702	83	32.04	0.433	176	67.94	0.927
P-93	16,800	17,373	94	36.29	0.56	165	63.70	1.048
P-94	20,056	20,638	120	46.15	0.838	140	53.84	1.079
P-95	24,397	25,770	95	36.68	0.832	164	63.31	1.552
P-96	31,798	34,033	139	53.66	1.611	120	46.33	1.538
P-97	43,301	47,201	137	52.68	2.196	123	47.31	2.188
P-98	65,974	88,300	154	59.45	4.719	105	40.54	3.451
P-99	140,400	639,570	208	80	51.823	52	20	7.586
All		10,777	2795	10.77	65.458	23141	89.22	34.542

Notes. Suppliers of this sample satisfy the following conditions: a) they supply at least one treated taxpayers, b) at least one of their treated clients has provided their ID in the 2022 supplier list c) they have omitted to report some positive amount. If the ID matches the tax-registry they are classified as "Under-reporting", otherwise they are classified as "Informal". The statistical unit is the supplier.

Table 11: Underreporting Rates in 2022 by Decile of Declared Revenue

Decile	Threshold (USD)	Average Declared Revenue (USD)	Under-reporting Taxpayers		Average under-reporting rate as a % of declared revenue	
			N	%	*conditional on under-reporting*	*unconditional*
1	0	330	1,395	49.56	99.37	49.27
2	1,120	1,970	138	4.90	88.63	4.34
3	2,734	3,916	171	6.07	82.20	5
4	5,402	7,465	169	6.01	81.27	4.88
5	9,920	13,666	163	5.78	81.91	4.73
6	18,164	25,245	195	6.92	77.84	5.38
7	34,359	49,986	189	6.71	72.22	4.84
8	71,246	112,452	145	5.15	78.51	4.05
9	170,928	301,713	125	4.44	82.66	3.67
10	513,231	26,687,004	102	3.61	74.54	2.70
All		320,375	2,792	9.92	81.91	8.89

Notes. The population consists of all the 28,141 active taxpayers of the tax registry, minus the largest 1% (measured in terms of gross revenue). For 2,792 of them, information coming from the treatment group's 2022 suppliers lists indicate that they have under-reported their revenue in 2022. For each of these under-reporting taxpayers, we measure under-reporting rate as the ratio between net unreported income and total *real* income (declared + unreported). Column (2) displays average revenue declared, by decile of income declared. Column (5) and (6) display average under-reporting rates, conditional and unconditional on under-reporting. We use unconditional under-reporting rates to estimate unreported amounts detected upon hypothetical audits in the alternative scenario of Figure 7.B, 7.C, 7.D

Appendices

A Baseline data, Intervention Sample and Randomisation

Our intervention targets taxpayers having misreported suppliers lists at baseline. To identify these taxpayers, we exploited our **suppliers list baseline data**, an unbalanced panel of suppliers lists we created from paper-based and online declarations over the period 2018-2020. First, we digitised the hard copies of suppliers lists stored by the most important centers (LTC, MTC1, MTC2, RSC) for the years 2018-2020. We prioritized digitisation at the LTC and managed to obtain full coverage of paper-based declarations at this center; the LTC is by far the most strategic center for the experiment, because it accounts for a large share of both suppliers and payment amounts to suppliers. Due to unexpected complexities of this data collection, at the remaining three centers we were unable to systematically track down and digitize *all* suppliers lists by the start of the experiment. The coverage for the following center-years is therefore imperfect: MTU-1 (2019 and 2020) MTU-2 (2019 and 2020) and RSC (2020 and, to a lesser extent, 2018).[38] Second, we integrated the digitised database with all suppliers lists for 2019 and 2020 submitted through a newly created online platform. This platform was operational from 2019 onwards but first made available only to a small subset of LTC firms. In 2020, most firms from the LTC declared online, while most firms from the other three centers still submitted paper declarations. Thus, our suppliers lists baseline data covers LTC firms for 3 years (the last of which typically submitted online) while our panel from the other centers has been mostly digitised and typically ends in 2019.

Next, we established our **intervention sample** by exploiting the suppliers lists baseline data to detect taxpayers that misreported suppliers lists over 2018-2020. For each taxpayer in the data, we identified misreported lines of type (c), (e) or (h) (Table 1) and computed the share of misreported lines. Taxpayers with no or very few mis-reporting issues were removed from the sample, as well as those that could not unambiguously be matched to the tax registry. We obtained an intervention sample of 3,487 taxpayers.[39]

Using this intervention sample, we implemented our **randomization** stratified across tax centers, mis-reporting incidence and number of suppliers. We created an indicator of mis-reporting incidence by splitting the sample into high/low proportion of misreported lines (above/below median share misreported). We further computed for each taxpayer the average number of suppliers per year reported in suppliers lists and used the 45th and 90th quantiles of the distribution of this variable to split the sample into 3 groups. For about 15

[38] At the time of this data collection, tax centers did not systematically record which taxpayers did or did not submit supplier lists. A small number of additional lists may therefore be missing from the database because we did not find them in taxpayers' physical folders; we expect this phenomenon to be marginal.

[39] This sample stems from an unbalanced panel and the presence of certain years in the panel is correlated with a taxpayer's center (as described above). As the randomization is stratified by center, this should not affect our intervention. Indeed, balance tests show that suppliers lists of treated firms are not more or less likely to be present at baseline.

% of the sample we could only collect *quarterly* (rather than yearly) suppliers lists and thus could not satisfyingly estimate the average number of suppliers per year; we assigned these taxpayers to a fourth group within the "number of suppliers" measure. Finally we assigned intervention sample taxpayers to treatment and control groups through randomisation stratified by center, the mis-reporting incidence indicator and the measure of number of suppliers. This approach implied 32 strata (4 x 2 x 4), with the smallest cell accounting for 14 firms.

B Baseline enforcement of supplier lists' declarative rules

Our intervention is rather inexpensive, simple, and yet yields significant changes in a very short period of time. In that regard, one may ask: what was the administration doing before to enforce declarative rules of the supplier lists? and why hadn't it implemented a protocol similar to our intervention before?

According to the information we gathered before the intervention, tax centers did invest some resources to make sure taxpayers would declare the lists, but rarely to enforce completeness, accuracy or consistency of the information they contained. Our interpretation is that this initial state is the result of several constraints.

First, before 2020, the vast majority of the firms submitted hard copy version of the lists (the online platform was made available only to a small percentage of large firms in 2019). This implies that tax inspectors could not run a code to simultaneously detect all anomalies of all submitted supplier lists in a couple of seconds. Detecting misreporting on a comparable scale without computer assistance would have been extremely costly. Now that online declaration of supplier lists has become the norm, this should be less of a constraint. Nevertheless, human resources trained to perform the data analysis necessary to rigorously detect misreporting is still scarce at the tax administration (Czajka et al., 2022).

Second, inspectors may have given priorities to other enforcement strategies. While supplier lists are a valuable source of information, especially when it is complete and accurate, their submission is not directly tight to a payment, as it is simply a recap of all transactions to service suppliers over the past year. In a situation where over 5% of taxpayers can still avoid submitting both their VAT and PAYE declarations (which are the most significant tax instruments), tax inspectors might have deemed too high the opportunity cost of enforcing better reporting of supplier list.

Third, such a low level of enforcement is probably also due to the fact that the inspectors in charge of monitoring the clients who declare the supplier lists work in a tax centers which are different from the ones to which are assigned the possibly under-reporting suppliers. In other words, by enforcing a better declaration of the supplier lists, tax inspectors of the LTC, MTC-1, MTC-2 and RSC are contributing to the collection of information which will mostly benefit tax collection by other centers. This hypothesis is confirmed by our analysis

of the distribution of formal yet under-reporting taxpayers suppliers across tax centers. Out of the 2795 suppliers identified as under-reporting according to information declared by the treatment group, 1.54% are registered in the LTC, 0.5% in the MTC-1, 2.4% in the MTC-2 and 6 % in the RSC. As for the control group, the figures are 1%, 0.7%, 3% and 7.4% respectively.

Finally, our intervention generalized the use of mail merge technology - to send multiple personalised emails at once - which only one tax center had started using before, and still at a relatively small scale. In that regard, the intervention contributed to speed up the adoption of a digital tool which the administration would have most probably generalised in the following years.

C Results on the Withholding Tax on Service (WTS)

Our intervention does not specifically alert taxpayers about unlawful past behaviors related to the monthly declaration and/or remittance of the WTS. Yet, by singling out misreported suppliers lists on a case by case basis, the message demonstrates to taxpayers that the TA scrutinises declarations whose content should be consistent with monthly declarations and remittance of the WTS. In addition, the message explicitly recalls all fiscal rules related to the WTS, thus possibly informing some taxpayers about those rules.[40] Considering this, and keeping everything else constant,[41] we should expect a positive impact on WTS declarations and remittances on the sub-sample of under-withholding taxpayers, may they be strategic or ignorant.

Unfortunately, the information available in 2018-2020 suppliers list does not allow to identify under-withholding firms ex-ante, due to the widespread misreporting our intervention precisely helps correcting. Because of this, we also cannot assess the prevalence of under-withholding, hence the relative size of the group of taxpayers whose withholding behavior should be affected. Nevertheless, we can proxy under-withholding by *low levels* of withholding ex-ante. We compute the share of remitted WTS in total revenue, before the intervention, and use this variable to split our sample into four quartiles. By construction,

[40] We did collect anecdotal evidence from a few treated taxpayers which seemed to ignore the necessity for them to withhold 5% on transactions made to informal service providers.

[41] Other factors could also play a role but cannot be explored in our setting. First the expected cost of non-complying to the WTS rules may exceed its expected returns. Our intervention essentially consists in reminding firms about a few fiscal and declarative rules and warning them to do better in the future but no audit was conducted on the basis of past misreporting. In this regard, the increase in expected non-compliance cost may be too mild to elicit a significant change in firms behavior, especially for firms not duly withholding the WTS. Also, even though it does not capture entirely the expected cost of non-compliance, the fine for misreporting suppliers lists might be too small (XOF200,000, i.e USD 330) for our intervention to be sufficiently deterrent on that margin. Second, firms previously under-withholding may avoid remitting additional WTS by simply ending contracts with informal suppliers, and possibly replacing them by formal ones. This unfortunately is impossible to verify with our data since identifying formal and informal suppliers requires information whose presence is affected by our intervention. For instance, we are not able to determine whether the ex-post appearance of a new ID among suppliers of the treated group indicates a new trading relationship or simply results from the incomplete information ex-ante.

lower quartiles will capture two types of taxpayers: *(a)* those who duly comply with WTS rules but resort to few informal suppliers (relative to their total revenue), and *(b)* those that have a large informal service supply but withhold less than what they ought to. As a result, exploring treatment heterogeneity by quartile allows to better isolate the group of taxpayers most likely to evade the WTS. Table H.17 displays estimates of average treatment impact on monthly WTS declaration and remittances, aggregated at the year level, both at the extensive margin (whether some positive amount is declared and/or remitted at least once during the year) and intensive margin (how much is declared and/or remitted in total). We find no significant effect for the full sample and significant effects only for the lowest quartile. Firms of this group are indeed more likely to submit at least one monthly WTS declaration during the year (+6.0 p.p in 2022) and remit some positive amount (+4.6 p.p in 2022). At the intensive margin, they also declare a greater WTS tax base and remit larger WTS amounts on average (Table H.17 column (3) and (4)). The magnitude of the impacts at the intensive margin is however difficult to interpret given significant response at the extensive margin and large share of zeros (Chen and Roth, 2023).All effects are more pronounced for 2023, most likely because the full communication campaign extends, and thus reinforces treatment, until December 2022. Our interpretation is that, given that the intervention is unlikely to have such effects on firms that duly comply with WTS rules but have a small informal service supply, these results must derive from the subgroup of firms previously under-withholding.

Additional evidence shows that the intervention contributed to increase the consistency between yearly suppliers lists and monthly remittances of the WTS. The absence of results, for the full sample, on total WTS remitted contrasts with the fact that the share of suppliers for which a positive WTS is declared in 2022 suppliers list increases by 3.6 percentage points (i.e 7%). Table H.16 further highlights the fact that total WTS (ihs) declared in 2022 suppliers list also increases on average. If, according to results of the full sample specification of Table 8, firms overall did not declare nor remit more on a monthly basis during 2022, they have at least declared more WTS on average in the 2022 yearly suppliers list. The question is whether these newly declared amounts correspond to remittances that have already been processed or that are still pending. Evidence from Table H.16 suggests that the first option is more likely. Indeed, conditional on declaring 2022 suppliers list, the proportion of firms that declare some positive WTS amount in their in suppliers list increases by 6.1 percentage points but the proportion of firms actually remitting some during 2022 is not significantly affected. At the same time, the proportion of firms that remit some, but declare none, decreases by 4.4 percentage points and the proportion of firms that declare *and* remit some increases by 5.4 percentage points, while the share of those that declare without remitting remains stable. Overall, the vast majority firms newly declaring WTS in the their 2022 suppliers list had already remitted the tax throughout the

year.

D Impact on suppliers

In a second model, we estimate the average (indirect) impact for suppliers j on outcome y_j of being a supplier of some treated client ($IndirectTreat_j$). We restrict our estimation to firms that could be identified with a *firm-ID* as suppliers of a treated client *before* the intervention (in 2018, 2019 and/or 2020).

$$y_j = \alpha + \beta IndirectTreat_j + \boldsymbol{\gamma X_j} + \delta_s + \epsilon_j \tag{2}$$

Outcome y_j must be measured without using any element of ex-post suppliers list data which otherwise could lead to intervention-induced selection of suppliers. $\boldsymbol{X_j}$ are control variables defined at the suppliers level. A complication here comes from the fact that some suppliers might have made some transactions with clients from both the treatment and control group. Larger, more connected, firms will typically fall into that class. To estimate equation 2, a first solution consists in simply removing those suppliers. Unless "more connected" firms are on average more connected to one of the intervention group specifically (which should have been avoided via the randomisation) this selection should not bias our estimation, yet it would imply that our results do not apply to all suppliers. An alternative method would be to measure the share of supplier's j revenue paid by treated clients as a proportion of j's total profit according to the all transactions in suppliers lists, and then either use a 50% cut-off to assign suppliers to the indirect treatment group.

We test both selection strategies to estimate the impact on revenue declared in 2022 and 2023 by indirectly treated suppliers. Table D.12 displays results from OLS estimation of equation (2). We do not find any significant impact neither at the extensive margin, nor at the intensive margin. We further segment our estimation by decile of average revenue declared over 2018-2020, and still find no significant impact (D.9. On outcome measuring the extensive margin (whether a supplier declares or not), our standard error are reasonably low, which suggest the absence of detected effect is not a matter of statistical power. Overall this strongly suggests that tax registered suppliers of treated firms did not become more compliant by fear being targeted by follow-up deterrent measures. This contrasts with results obtained in high income countries, where third-party reporting is considered an efficient enforcement tool (Kleven et al., 2011).

Table D.12: Impact on Revenue Declared by Suppliers Identified Ex-ate

	2022		2023	
	Submits a declaration	Revenue declared	Submits a declaration	Revenue declared
	(binary)	(ihs)	(binary)	(ihs)
	(1)	(2)	(3)	(4)
Restricted Sample	0.006	0.056	0.004	0.086
	(0.013)	(0.256)	(0.011)	(0.195)
	[0.594]	[9.849]	[0.226]	[3.559]
	5645	5645	5645	5645
Full Sample	0.005	0.014	0.007	0.094
	(0.011)	(0.235)	(0.010)	(0.194)
	[0.631]	[10.822]	[0.272]	[4.478]
	6853	6853	6853	6853

Notes. This table displays the average treatment impact, at the suppliers level, on the probability to declare revenue ((1) and (3)) and total revenue declared ((2) and (4)) after the intervention. Outcome of column (1) and (2) are measured based on self-declared 2022 income tax (PIT or CIT) due in April 2023. For 2023, such statements will be submitted in April 2024, hence we measure total revenue until June 2023 by taking the sum of revenue declared in monthly value added tax statements. The statistical unit here is the supplier level. Our sample consists of taxpayers that have been identified as formal suppliers of clients over the period 2018-2020, based on information reported in suppliers lists submitted by clients from the control or the treatment group. For the restricted sample we keep only suppliers that have traded either exclusively with the treatment group, or exclusively with the control group. For the full sample specification, we add suppliers that have traded with both group by assigning each of them to the intervention group form which they received the largest amount. For each quadruplets after the intervention, the first figure is the coefficient of interest, the last one is the number of observations, standard errors are in parenthesis and control group averages between brackets.

E The Senegalese Tax System

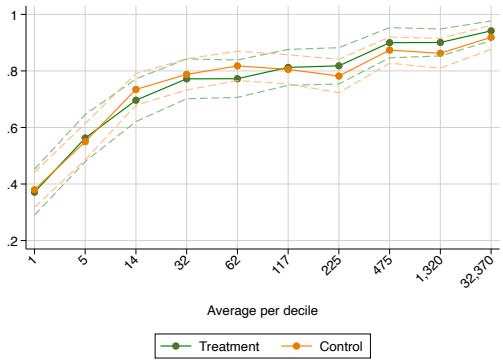
Senegal has three types of income tax: the corporate income tax (CIT), the personal income tax (PIT) and a presumptive tax on small business ("Contribution Global Unique" - CGU). The corporate tax is a 30% tax on business net profit - it applies only to legal persons.

The PIT has a progressive schedule with marginal rates ranging from 18% to 40% and that, in theory, should apply to the sum of all types of personal income (business income, rents, dividends, wages etc.). In practice however, most taxpayers submitting a PIT only declare either business or rental income. Wages, dividends and other source of personal income are never declared directly by their recipients but subject to withholding taxes collected and remitted by firms. Individuals with total taxable income bellow XOF 630,000 (USD 1008) are exempt from PIT. A strict interpretation of the tax code would imply that all natural persons, including those with taxable income below the threshold, should submit a yearly PIT statement with all their income. But the administration dos not enforce that rule as it would not have the capacity to absorb that many declarations. Therefore, in practice, the default rule as a natural person in Senegal is not to declare (**?**). Also, even though one needs to be classified as a natural person to be subject to the personal income tax, several taxpayers falling into this category are firms in the economic sense, with employees, registered under the identify of their owner.

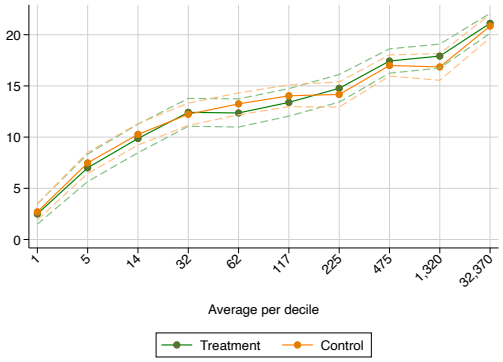
Taxpayers contributing to the PIT or the CIT, must also declare the VAT and two local business taxes. The CGU is a simplified tax regime that allows firms with total turnover bellow USD 80,000 to be discharged of income tax, VAT and local business taxes all at once. It is equal to 5% of total sales if the taxpayers is a service provider, or 2% if she is doing trade or manufacturing. At first, the withholding tax on service supplier declared in the yearly supplier lists does seem to correspond to the CGU for service supplier. But it is not labelled this way, and there is no corresponding withholding tax on suppliers operating in trade or manufacturing. Interestingly also, service providers operating in the hospitality sector are exempt from the withholding tax on services, but not from the CGU. Transaction below XOF 25,000 are exempt from the WTS, yet there is no exemption threshold for the CGU. The WTS was introduced as way to tax unregistered individuals working for firms without being employed by them. The CGU was introduced after the WTS, to simplify administrative procedures.

Figure D.9: Spillover Effects on Suppliers' Fiscal Behavior - Heterogeneity by Decile of Average Revenue over 2018-2020

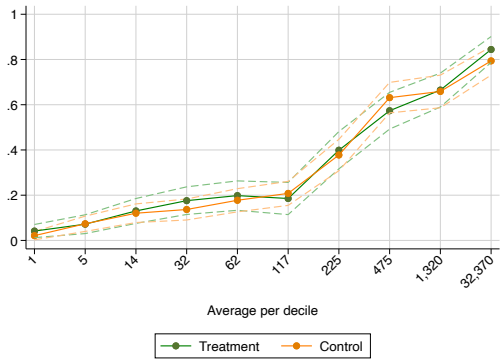
(A) Submits a 2022 Income Tax Declaration



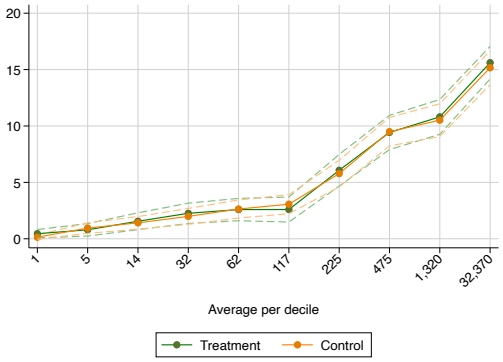
(B) Revenue Declared in 2022 Income Tax Declaration (ihs)



(C) Submits a 2023 VAT Declaration



(D) Revenue Declared in 2023 VAT Declaration (ihs)



Notes: This Figure decompose estimates of Table D.12 by experimental group and decile of revenue declared. The statistical unit is the supplier. Treatment assignment of suppliers is based on treatment assignment of their client(s). Here we opt for the restricted sample, i.e. removing suppliers of both the treatment and the control group (see panel (A) of Table D.12). For each decile, averages for the control group are the sample mean, averages for the treatment group are obtained by adding our average treatment estimates (using model specified in Appendix D) to the control group's average. Dashed lines indicate 95% intervals. Outcome for Figures D.9.(A) and D.9.(B) are measured based on self-declared 2022 income tax (PIT or CIT) due in April 2023. Outcomes for Figures D.9.(C) and D.9.(D), are measured using value added tax statements declared in the first six months of 2023.

F On strategic clients

Throughout the paper, we assume that if the sum of all payments received by a supplier is superior to the total sales she has declared, it must be that the supplier has under-reported. Yet, it could be that clients are also strategic, either by giving wrong identification information or by intentionally over-declaring expenses.

Giving wrong information on the ID could happen accidentally, by making a mistake in one digit for instance. However firm-IDs must follow a strict structure which a random mistake is unlikely to catch. Therefore such mistakes will only make us classify some formal firms as *unidentified* because their firm-ID will most probably not match any of the registries. A more common source of misinformation is when clients simply indicate the *same* firm-ID for many of their suppliers - probably to simplify themselves the task of filling the list while hoping the administration would not bother look into the details. We systematically inspect those cases, which fortunately remain very rare, and classify them as "intentionally wrong ID". Interestingly, the intervention has no significant impact, neither positive nor negative, on the probability to adopt this reporting behavior. Finally, we could also imagine that clients claim to have traded with some formal firms, while in fact they have traded with another one (formal or informal). We cannot detect such cases. By doing so, the client takes the risk that the administration uncovers the fraud when auditing the supplier. If so, then this expenses would not be deductible anymore in the calculation of the CIT, therefore the client would have to pay 30% of that amount. Tax inspectors report never having encountered such cases, and believe they should be very rare in any case as it would be much simpler and safer for a client to provide a wrong ID, and later plead absent-mindedness. We can also imagine that some of the mismatch comes from mistakes made in the numbers (adding one digit for instance). It is unlikely however that our intervention increase the prevalence of such mistakes, if anything we would expect the contrary. To limit this as much as possible we could explore how our results vary when restricting our analysis to payments not exceeding a certain percentage of client's total sales.

Now, clients could also be strategic by over-claiming expenses, this way reducing their liability both for the VAT and the CIT. By doing so, they would expose themselves to the above mentioned risk of non-deductible charges. Yet, if they believe the probability to be detected is low enough, they might still take that risk. While we must acknowledge that this could happen, we believe it should be less frequent than under-reporting by the supplier. In fact, tax inspectors report that as they find a discrepancy themselves, they systematically assume that the fraud comes from the supplier. The main justification for this is that the largest firms tend to be much more scrutinized by the administration (while the majority of detected formal under-reporting suppliers are registered in "small" tax centers, cf. appendix B). We document this by showing that the number of civil servants per taxpayers is significantly higher for the largest centers (see Figure 5). This pattern is

even more pronounced when restricting to civil servants of category A or B - the only ones entitled to perform audits and apply legal sanctions: over the period 2016-2021, small tax centers had less than two high-skilled civil servants per 100 taxpayers, while the Large Taxpayers Center had 6 or more. Based on this, we choose to systematically assume that the fraud is caused by the supplier. Eventually, it is crucial to keep in mind that even if in some cases the fraud may come from the client, this would still count as fraud detected thanks to the intervention, not as under-reported revenue but as over-claimed expenditures. Therefore it would not decrease the total fraud detected. If anything, the amount of the fraud would increase. Indeed, assume client A pays supplier B 200, but claims it paid 1000 - while supplier B declares total sales equal to 500. The discrepancy we observe is (1000−500), that is how we compute under-reported amounts, but if a follow-up audit would reveal that supplier B received only 200 from A, then the over-claimed amount would become (1000−200).

G Detailed Message Content

English Translation

Subject: Request for information: rectification of summary statements

Dear Sir or Madam,

After systematic verification by our information teams, it has been established that the summary statements (annual and/or quarterly) of sums paid to Third Parties and as Rents that your company named COMPANY NAME, and registered under firm-ID n°XXXXXXXXXfiled for the financial years XXXX, XXXX, XXXX, XXXX, do not comply with the provisions of articles 200 and 201 of law 2012-31 of 31-12-2012, as amended, relating to the General Tax Code (GTC).

Indeed, for some of your service providers or lessors, no withholding tax has been declared and the identification information provided (national-ID and/or firm-ID) does not allow their fiscal status to be verified.

Therefore, under penalty of the sanctions provided for by the GTC, we invite you, in accordance with the provisions of article 626 of the aforementioned code, to submit, **within twenty (20) days, rectifying declarations of the summary statements** (annual and/or quarterly) for the aforementioned financial years, indicating in particular the amount of the withholding tax (put "0" if nil) and providing **reliable information** (firm-ID and/or national-ID) which will enable our services to verify their fiscal status.

We would ask you to take account of these shortcomings and omissions so that you do not make the same mistakes again, particularly with regard to the next deadline (the declaration of summary statements of sums paid to third parties/as rents for the 2021 financial year, due on 31 January 2022).

You will find more details on the legislation and reporting procedures in the appendix to this e-mail.

Yours faithfully

***** ADDITIONAL INFORMATION *****

Legislation :

- Under article 200 of the General Tax Code (GTC), a 5% withholding tax must be levied on all sums paid by a debtor established in Senegal to *natural persons* residing in Senegal as remuneration for the provision of services.
- As a reminder, the term "natural persons" is used here to refer to any individual carrying on an economic activity who is not effectively subject to a system of taxation based on actual profits (personal income tax), as well as any legal entity or group that has not opted for corporate income tax (article 200, paragraph 3 of the GTC).
- Under the provisions of article 201 of the GTC, the withholding tax is also applicable to rental income from premises leased by a debtor as defined in point 2 of article 200, to rental income paid by an individual tenant, and to rental income collected on behalf of third parties who are natural persons, by estate agencies, property managers and non-trading property companies.
- In addition, the summary statements of sums paid to third parties must include, among other information, the **firm-ID** or, failing that, the **national-ID** of each service provider (article 200, paragraph 8.b of the CGI). Please note that all persons (legal entities or individuals) actually subject to income tax have a firm-ID.

Submitting your amending tax returns:

- To make things easier for you, you can **use the e-services portal** to submit your corrective declaration:
  - If you have already submitted a declaration via e-services for the financial year in question: ask your tax center for assistance so that you can be authorised to resubmit a declaration for the same financial year.
  - If you only filed a paper declaration for the financial year in question, you can now submit an amended declaration via e-services.
- As far as possible, we invite you to **use your old declaration** (already completed) **and to make the necessary changes** to bring it into line with the above-mentioned tax aspects. Please note that any declaration indicating a false or incorrectly allocated identifier (firm-ID/national-ID) will be systematically detected and a new corrective declaration will be requested.

Finally, we would like to draw your attention to the fact that, as part of the Yataal programme for a broader and fairer distribution of the tax burden, it is crucial that companies such as your service providers contribute in line with their income. As the client of these service providers, your company has a role to play, not only by deducting and declaring the withholding tax when it is due and by completing its summary statements correctly, but also by reminding its service providers that if they are liable to pay tax on their actual income, they are exempt from the 5% withholding tax.

REPUBLIQUE DU SENEGAL
Un Peuple – Un But – Une Foi

MINISTERE DES FINANCES ET DU BUDGET

DIRECTION GENERALE
DES IMPOTS ET DES DOMAINES

DIRECTION DES MOYENNES ENTREPRISES

CENTRE DES MOYENNES ENTREPRISES DAKAR 1

BUREAU DE GESTION ET DES SERVICES AUX CONTRIBUABLES

Dakar, le 04/Janvier/2022

Le Chef de Centre

A

[illegible]

Objet : Demande de renseignements : rectifications d'états récapitulatifs

Madame, Monsieur,

Après vérification systématique par nos équipes du renseignement, il a été établi que les états récapitulatifs (annuels et/ou trimestriels) des sommes versées à des Tiers et/ou au titre des Loyers que votre société dénommée [illegible] **et immatriculée sous le NINEA n°** [illegible] a déposé pour les exercices 2018 ne sont pas conformes aux dispositions des articles 200 et 201 de la loi 2012-31 du 31-12-2012, modifiée, portant Code Général des Impôts (CGI).

En effet, pour certains de vos prestataires ou bailleurs, aucune retenue à la source n'a été déclarée et les informations d'identification fournies (CNI et/ou NINEA) ne permettent pas de vérifier leur régime fiscal.

Aussi, sous peine des sanctions prévues par le CGI, nous vous invitons, conformément aux dispositions de l'article 626 du code sus visé, à soumettre, dans un délai de **vingt (20) jours, des déclarations rectificatives des états récapitulatifs** (annuels et/ou trimestriels) pour les exercices sus visés, en indiquant notamment, le montant de la retenue à la source (mettre « 0 » si nulle) et en fournissant des **informations fiables** (NINEA et/ou CNI) qui permettront à nos services de vérifier leur régime fiscal.

Nous vous invitons à prendre en compte ces manquements et omissions pour ne plus reproduire les mêmes erreurs. Notamment en ce qui concerne l'échéance actuelle (la déclaration des états récapitulatifs des sommes versées à des Tiers/ au titre des loyers pour l'exercice 2021, due le 31 janvier 2022), nous vous invitons à soumettre une déclaration rectificative, le cas échéant.

Vous trouverez en annexe de ce mail plus de détails sur la législation et les modalités déclaratives.

Nous vous prions d'agréer, Madame, Monsieur, l'expression de mes salutations distinguées

Direction Générale des Impôts et des Domaines – Rue de Thiong x Vincens
BP : 1561 Dakar Sénégal Téléphone : (+221) 33 889 20 02 . Fax: (+221) 33 823 21 29
www.impotsetdomaines.gouv.sn

***** INFORMATIONS COMPLEMENTAIRES *****

Éléments de législation :

- En vertu de l'article 200 du Code Général des Impôts (CGI), une retenue de 5% doit être prélevée sur toutes les sommes versées par un débiteur établi au Sénégal, à des *personnes physiques* résidant au Sénégal en rémunération de prestations de service.
- Pour rappel, on désigne par « personnes physiques » ici tout exploitant individuel exerçant une activité économique non effectivement soumis à un régime d'imposition d'après les bénéfices réels réalisés (l'impôt sur le revenu des personnes physiques), ainsi que toutes les personnes morales ou groupement n'ayant pas opté pour l'Impôt sur les Sociétés (article 200, alinéa 3 du CGI).
- Aux termes des dispositions de l'articles 201 du CGI, la retenue est également applicable aux loyers des locaux pris à bail par un débiteur tel que défini au point 2 de l'article 200, aux loyers payés par un locataire individuel, ainsi qu'aux loyers encaissés pour le compte de tiers personnes physiques, par des agences immobilières, des gérants de biens et des sociétés civiles immobilières.
- Par ailleurs, les états récapitulatifs des sommes versées à des Tiers doivent mentionner, entre autres informations, le **NINEA**, ou à défaut le **numéro de la pièce d'identité** de chaque prestataire (article 200, alinéa 8.b du CGI). Notez à ce titre que toutes les personnes (morales ou physiques) effectivement assujetties au régime du réel ont un NINEA.

Soumettre vos déclarations rectificatives :

- Afin de vous faciliter la démarche, vous pouvez **utiliser le portail eservices** pour soumettre vos déclarations rectificatives :
    - Si vous avez déjà soumis une déclaration via eservices pour l'exercice en question : demandez de l'aide à votre centre fiscal pour être autorisé à soumettre de nouveau une déclaration pour le *même* exercice.
    - Si pour l'exercice en question n'aviez fait la déclaration que sur papier, vous pouvez dès à présent soumettre une déclaration rectificative via eservices.
- Nous vous invitons autant que possible à **utiliser votre ancienne déclaration** (déjà remplie) **et d'y ajouter les modifications nécessaires** afin de la rendre conforme aux éléments de fiscalité sus visés. Notez que toute déclaration indiquant un identifiant (NINEA/CNI) faux ou mal attribué sera systématiquement détectée et une nouvelle déclaration rectificative vous sera exigée.

Direction Générale des Impôts et des Domaines – Rue de Thiong x Vincens
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www.impotsetdomaines.gouv.sn

Enfin, nous attirons votre attention sur le fait que, dans le cadre du **programme Yataal** pour une répartition plus large et juste de l'effort fiscal, il est crucial que les sociétés comme vos prestataires contribuent à hauteur de leurs revenus. En tant que débiteurs de ces prestataires, votre société a un rôle à jouer, non seulement en prélevant et en déclarant la retenue à la source lorsqu'elle est due et en remplissant correctement ses états récapitulatifs, mais aussi en rappelant à ses prestataires qu'un assujettissement au réel les exonère de la retenue à la source de 5%.

Le chef de centre



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H Complementary Tables and Figures

Table H.13: Baseline Summary Statistics and Balance Tests - Conditional on Declaring 2022 Suppliers List (N = 2,633)

Source	Covariates/Outcomes	Summary Statistics			Balance Test	
		Mean	Std. dev.	Median	β	Std. err.
(A) Suppliers lists	Number of suppliers	46.211	171.930	12	-7.786	6.030
	Share suppliers without any ID	0.867	0.215	1	-0.008	0.006
	... with a positive WTS	0.123	0.238	0	-0.000	0.008
	... in the Hospitality sector	0.001	0.012	0	-0.000	0.000
	... Senegalese	0.987	0.050	1	0.000	0.001
	... with transaction bellow taxable threshold	0.018	0.068	0	-0.000	0.002
	N. of y. for which we observe a suppliers list	1.838	0.798	2	-0.010	0.023
	Declares suppliers list online	0.384	0.486	0	0.001	0.013
(B) Other Declarations	Av. Sum of WTS remitted - 2018-2020 (USD'000)	4.263	16.494	0.782	-0.748	0.610
	Av. turnover - 2018-2020 (USD'000)	6800.234	34836.098	547.211	-1674.191	1275.619
	Av. number of employees - 2018-2020	66.930	358.904	8.222	-29.915**	14.335
(C) Tax Registry	Large Taxpayers Unit (binary)	0.269	0.443	0	-2.242	2.504
	Upper-Middle Taxpayers Unit (binary)	0.132	0.339	0	4.111	2.780
	Upper-Middle Taxpayers Unit (binary)	0.255	0.436	0	-2.087	1.799
	Regulated Sector Unit (binary)	0.342	0.474	0	1.988	1.488
	Legal person (binary)	0.733	0.442	1	0.002	0.013
	Number of years since first digital admin. record	11.600	3.189	13	-0.091	0.122
	Firm created before 1990 (binary)	0.315	0.464	0	-0.005	0.017
	... btw 1990 and 2000 (binary)	0.083	0.277	0	0.001	0.010
	... btw 2000 and 2010 (binary)	0.281	0.449	0	-0.000	0.017
	... after 2010 (binary)	0.318	0.466	0	0.004	0.018

*Notes.*The first three columns provide summary statistics about covariates and outcomes we use throughout the study for the entire sample. The last two columns summarize results from OLS estimation of equation (1) (see Section 4.2) without covariates, with each variable as the outcome. Variables of panel (A) are measured using suppliers lists collected at baseline (average over the period 2018-2020. Panel (B) exploits information reported in other declarations such as monthly Withholding Tax on Services (line 1), or Personal Income Tax, Corporate Income Tax, Value Added Tax, Business Property Tax, and the Synthetic Tax for small Businesses (line 2), or Withholding on employees (line 3). Panel (C) exploits all relevant information we could retrieve from the tax registry.

Table H.14: Baseline Summary Statistics and Balance Tests - Conditional on Declaring 2021 Suppliers List (N = 2,608)

Source	Covariates/Outcomes	Summary Statistics			Balance Test	
		Mean	Std. dev.	Median	β	Std. err.
(A) Suppliers lists	Number of suppliers	45.997	172.999	11.166	-7.709	6.116
	Share suppliers without any ID	0.867	0.215	1	-0.008	0.006
	... with a positive WTS	0.128	0.241	0	-0.004	0.008
	... in the Hospitality sector	0.002	0.014	0	-0.000	0.000
	... Senegalese	0.987	0.051	1	0.000	0.001
	... with transaction bellow taxable threshold	0.018	0.065	0	-0.000	0.002
	N. of y. for which we observe a suppliers list	1.878	0.793	2	-0.017	0.024
	Declares suppliers list online	0.406	0.491	0	0.000	0.013
(B) Other Declarations	Av. Sum of WTS remitted - 2018-2020 (USD'000)	4.796	25.873	0.751	-1.197	1.014
	Av. turnover - 2018-2020 (USD'000)	6978.232	35199.960	543.427	-1439.344	1293.853
	Av. number of employees - 2018-2020	68.479	363.883	8.116	-28.367*	14.694
(C) Tax Registry	Large Taxpayers Unit (binary)	0.274	0.446	0	1.006	1.778
	Upper-Middle Taxpayers Unit (binary)	0.141	0.348	0	3.641	9.668
	Upper-Middle Taxpayers Unit (binary)	0.205	0.404	0	-1.195*	6.478
	Regulated Sector Unit (binary)	0.378	0.485	0	1.404	9.982
	Legal person (binary)	0.712	0.452	1	-0.001	0.013
	Number of years since first digital admin. record	11.547	3.253	13	-0.086	0.126
	Firm created before 1990 (binary)	0.316	0.465	0	0.002	0.017
	... btw 1990 and 2000 (binary)	0.083	0.277	0	-0.002	0.010
	... btw 2000 and 2010 (binary)	0.277	0.447	0	-0.009	0.017
	... after 2010 (binary)	0.322	0.467	0	0.010	0.018

Notes. The first three columns provide summary statistics about covariates and outcomes we use throughout the study for the entire sample. The last two columns summarize results from OLS estimation of equation (1) (see Section 4.2) without covariates, with each variable as the outcome. Variables of panel (A) are measured using suppliers lists collected at baseline (average over the period 2018-2020. Panel (B) exploits information reported in other declarations such as monthly Withholding Tax on Services (line 1), or Personal Income Tax, Corporate Income Tax, Value Added Tax, Business Property Tax, and the Synthetic Tax for small Businesses (line 2), or Withholding on employees (line 3). Panel (C) exploits all relevant information we could retrieve from the tax registry.

Table H.15: Conditional Impact on Misreporting, Information, Fraud Detection - comparing 2021 and 2022 suppliers lists

		2021						2022					
		β	Std. err.	Lee Bounds lower	Lee Bounds upper	μ_c	N	β	Std. err.	Lee Bounds lower	Lee Bounds upper	μ_c	N
(A) Misreporting	Misreports no supplier (binary)	0.059***	0.014	0.012	0.074	0.158	2608	0.101***	0.015	0.089	0.109	0.182	2633
	Misreports all suppliers (binary)	-0.143***	0.015	-0.197	-0.135	0.304	2608	-0.195***	0.014	-0.214	-0.194	0.289	2633
	Misreports some suppliers (binary)	0.084***	0.018	0.060	0.122	0.536	2608	0.093***	0.018	0.085	0.105	0.527	2633
	Share of suppliers misreported suppliers	-0.163***	0.015	-0.201	-0.138	0.587	2608	-0.233***	0.014	-0.248	-0.228	0.543	2633
(B) Information prevalence	Share of suppliers ...												
	... with a formally valid ID	0.186***	0.015	0.163	0.226	0.415	2608	0.247***	0.014	0.243	0.263	0.469	2633
	... with intentionally wrong ID	-0.002	0.005	-0.031	-0.001	0.031	2608	-0.003	0.005	-0.019	-0.003	0.026	2633
	... with positive WTS	0.018	0.014	-0.013	0.049	0.485	2608	0.036***	0.014	0.026	0.046	0.508	2633
	... satisfying cond. to be exempt of WTS	-0.000	0.003	-0.019	0.001	0.033	2608	0.001	0.003	-0.007	0.002	0.033	2633
	... with a telephone number	0.068***	0.016	0.035	0.098	0.383	2608	0.092***	0.016	0.084	0.104	0.410	2633
(C) Fraud Detection	Share of suppliers identified as ...												
	... informal	0.117***	0.012	0.075	0.137	0.194	2608	0.175***	0.012	0.163	0.182	0.229	2633
	... formal	0.068***	0.011	0.025	0.087	0.214	2608	0.069***	0.012	0.057	0.077	0.232	2633
	... formal and compliant	0.042***	0.010	-0.003	0.056	0.170	2608	0.043***	0.010	0.029	0.049	0.175	2633
	... formal and under-reporting	0.026***	0.005	-0.004	0.030	0.044	2608	0.025***	0.005	0.008	0.027	0.056	2633
(C) Structure of service supply	Number of suppliers	-0.662	5.615	-26.567	0.402	47.944	2608	4.590	7.203	-19.075	4.853	49.903	2633
	Total (ihs)	0.043	0.055	-0.303	0.230	17.841	2608	0.036	0.056	-0.095	0.111	17.934	2633
	Average (ihs)	0.029	0.043	-0.165	0.153	15.409	2608	-0.021	0.043	-0.098	0.033	15.472	2633
	Median (ihs)	0.011	0.043	-0.142	0.151	14.672	2608	-0.079*	0.043	-0.133	-0.018	14.765	2633
	Standard Deviation (ihs)	0.052	0.174	-0.284	0.936	13.783	2608	0.105	0.171	0.014	0.425	13.928	2633
	Declares suppliers list	0.049***	0.013			0.750	3487	0.017	0.013			0.772	3487

Notes. This table displays results on outcome measured in 2021 and 2022 suppliers lists, submitted in January 2022 and January 2023, respectively. We use OLS method to estimate the model specified in 4.2, with variables displayed in Table 6 as controls. Besides of the last line, which estimates treatment impact on the probability to declare a suppliers list, all results are conditional on declaring a suppliers list, for each year separately. Outcome variable of panel (A) capture impact on misreporting of suppliers list. Outcome variables for panel (B) and (C) measure the share, at the client level, of some specific type of line/suppliers. For each client, i, outcome variables of panel (D) measure properties of the distribution of payments made by client i. We provide conservative lower and upper bounds for our estimates to account potential biases due to selection.

Table H.16: Comparing WTS Declared in Yearly Suppliers List with monthly WTS Remittances - 2022

		β	Std. err.	Lee Bounds lower	Lee Bounds upper	μ_c	N
(A)	Share of suppliers with WTS > 0	0.036***	0.014	0.026	0.046	0.508	2633
	Share of suppliers exempt of WTS	0.001	0.003	-0.007	0.002	0.033	2633
(B)	Total WTS declared (ihs)	0.870***	0.221	0.711	1.079	10.422	2633
	Total WTS remitted (ihs)	0.116	0.209	-0.041	0.320	11.288	2633
(C)	Declares some WTS	0.061***	0.015	0.057	0.077	0.729	2633
	Remits some WTS	0.009	0.014	0.005	0.025	0.791	2633
	Remits some but declares none	-0.044***	0.011	-0.062	-0.042	0.111	2633
	Declares some but remits none	0.007	0.008	-0.010	0.009	0.049	2633
	Declares *and* remits some	0.054***	0.016	0.048	0.067	0.680	2633

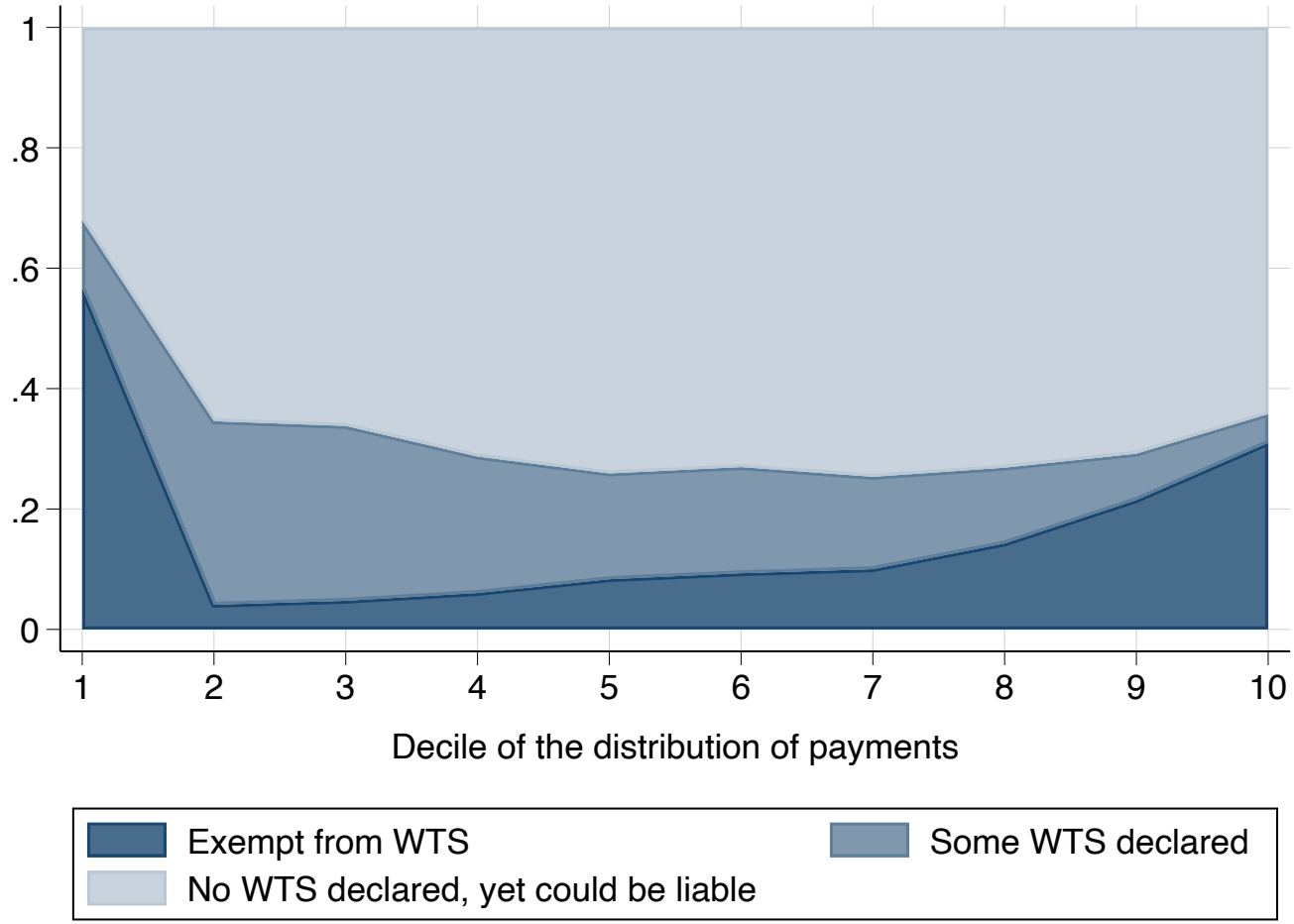
Notes. This table displays results on outcome measured in 2022 suppliers lists, and aggregated data from monthly WTS remittances. We use OLS method to estimate the model specified in 4.2, with variables displayed in Table 6 as controls. Outcome variable of panel (A) measure the share, at the client level, of some specific type of line/suppliers. Panel (B) allows to compare the total of WTS declared to have been withheld according to yearly suppliers list with the total of WTS effectively remitted on a monthly basis throughout 2022. Outcome variables for panel (C) are all binary. We provide conservative lower and upper bounds for our estimates to account potential biases due to selection.

Table H.17: Treatment Heterogeneity on Monthly Declaration and Remittance of the WTS

	Quartile of WTS share in revenue (av. 2018-2020)	Has submitted at least once a monthly WTS (binary) (1)	Yearly Total paid to informal service suppliers (ihs) (2)	Has remitted at least once some WTS (binary) (3)	Yearly Total remitted (ihs) (4)
2022	1	0.060*	1.104***	0.046	0.694*
		(0.031)	(0.463)	(0.028)	(0.388)
		[0.527]	[5.876]	[0.327]	[4.472]
		{872}	{872}	{872}	{872}
	2	-0.003	-0.326	-0.002	-0.225
		(0.017)	(0.379)	(0.024)	(0.339)
		[0.933]	[14.870]	[0.834]	[11.812]
		{872}	{872}	{872}	{872}
	3	0.010	-0.138	0.000	0.091
		(0.015)	(0.366)	(0.022)	(0.325)
		[0.939]	[15.299]	[0.868]	[12.212]
		{872}	{872}	{872}	{872}
	4	-0.006	0.296	0.009	0.206
		(0.026)	(0.519)	(0.030)	(0.440)
		[0.790]	[11.968]	[0.666]	[9.738]
		{871}	{871}	{871}	{871}
2023	1	0.079***	1.508***	0.075***	0.984***
		(0.031)	(0.447)	(0.028)	(0.366)
		[0.472]	[4.900]	[0.281]	[3.731]
		{872}	{872}	{872}	{872}
	2	-0.027	-0.510	-0.011	-0.399
		(0.022)	(0.436)	(0.028)	(0.380)
		[0.885]	[13.124]	[0.753]	[10.336]
		{872}	{872}	{872}	{872}
	3	0.000	-0.198	-0.028	-0.334
		(0.021)	(0.429)	(0.027)	(0.378)
		[0.886]	[13.563]	[0.799]	[10.767]
		{872}	{872}	{872}	{872}
	4	-0.007	-0.027	-0.016	-0.052
		(0.029)	(0.533)	(0.032)	(0.453)
		[0.719]	[10.526]	[0.598]	[8.338]
		{871}	{871}	{871}	{871}

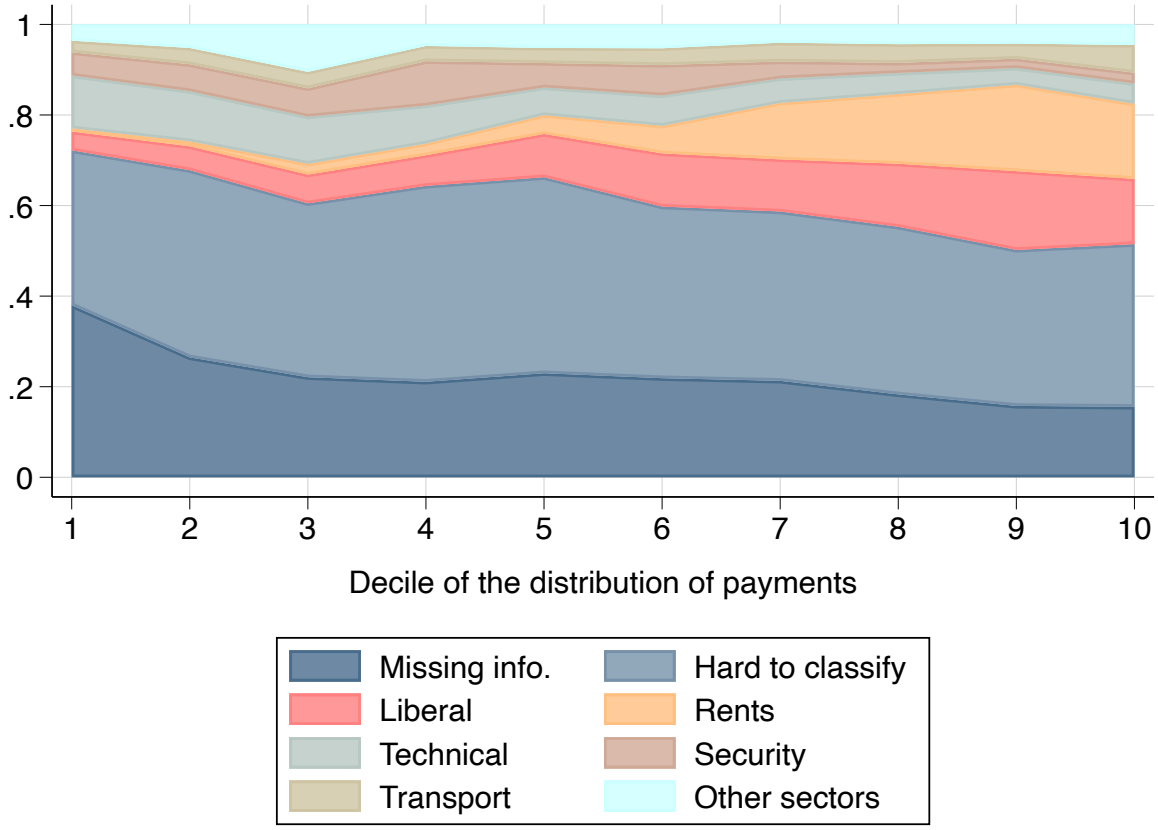
Notes. This table displays results from OLS estimation of equation (1) (see Section 4.2) with variables displayed in Table 6 as controls. on four different outcome variables, across quartiles of WTS share. The statistical unit is the taxpayer (treatment or control). We measure WTS share at baseline as the ratio between the sum of WTS effectively remitted to the tax administration throughout the year and total revenue. We average this measure over 2018-2020 and split our full sample in four accordingly. All outcome variables synthesize data at the year level. We exploit only the first 6 months of 2023. For each quadruplet we have : β-coefficient, (std. err), [control group's average], {N}

Figure H.10: Baseline Decomposition of the Distribution of Payments According to WTS Liability Status - 2018



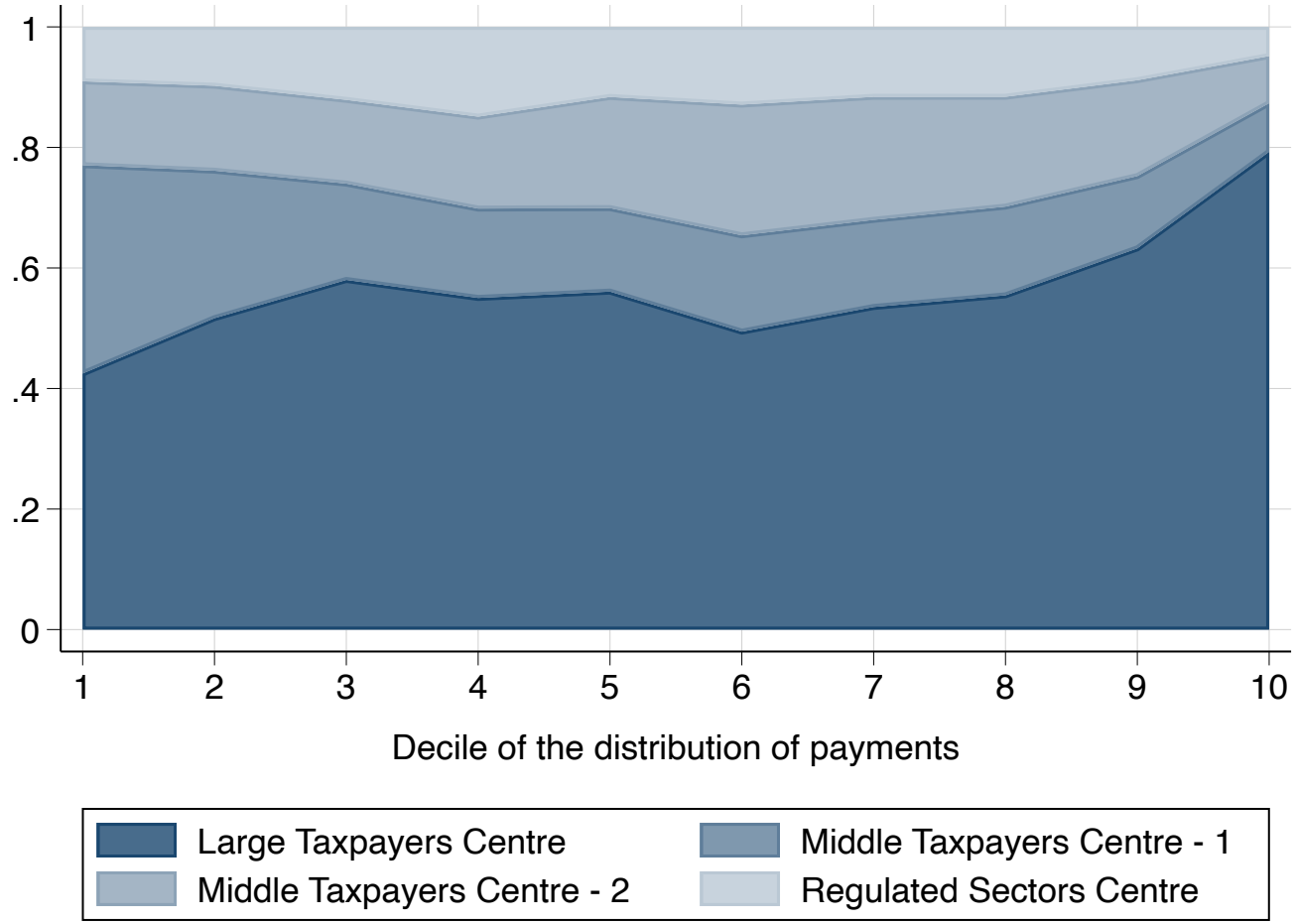
Notes: This Figure decomposes the distribution of all (pooled) payments (client-supplier pairs) declared by taxpayers of our experimental sample at baseline. We consider only the year 2018 as this is the year for which we have the best coverage ex-ante. Suppliers are considered exempt of the WTS if their client reported a correct firm-ID, if they are registered outside of Senegal, if the transaction is bellow 25,000 XOF (hence the pike for the first decile), or in case they operate in the hospitality sector. Example : among the 10% largest payments declared in 2018 supplier lists about %30 were not liable of the tax and close to 5% were subject to it. However, for the remaining 65%, we do not observe any tax withheld in supplier lists while the complementary information is insufficient to ascertain that the supplier was eligible for exemption.

Figure H.11: Baseline Decomposition of the Distribution of Payments According to Suppliers' Sector - 2018



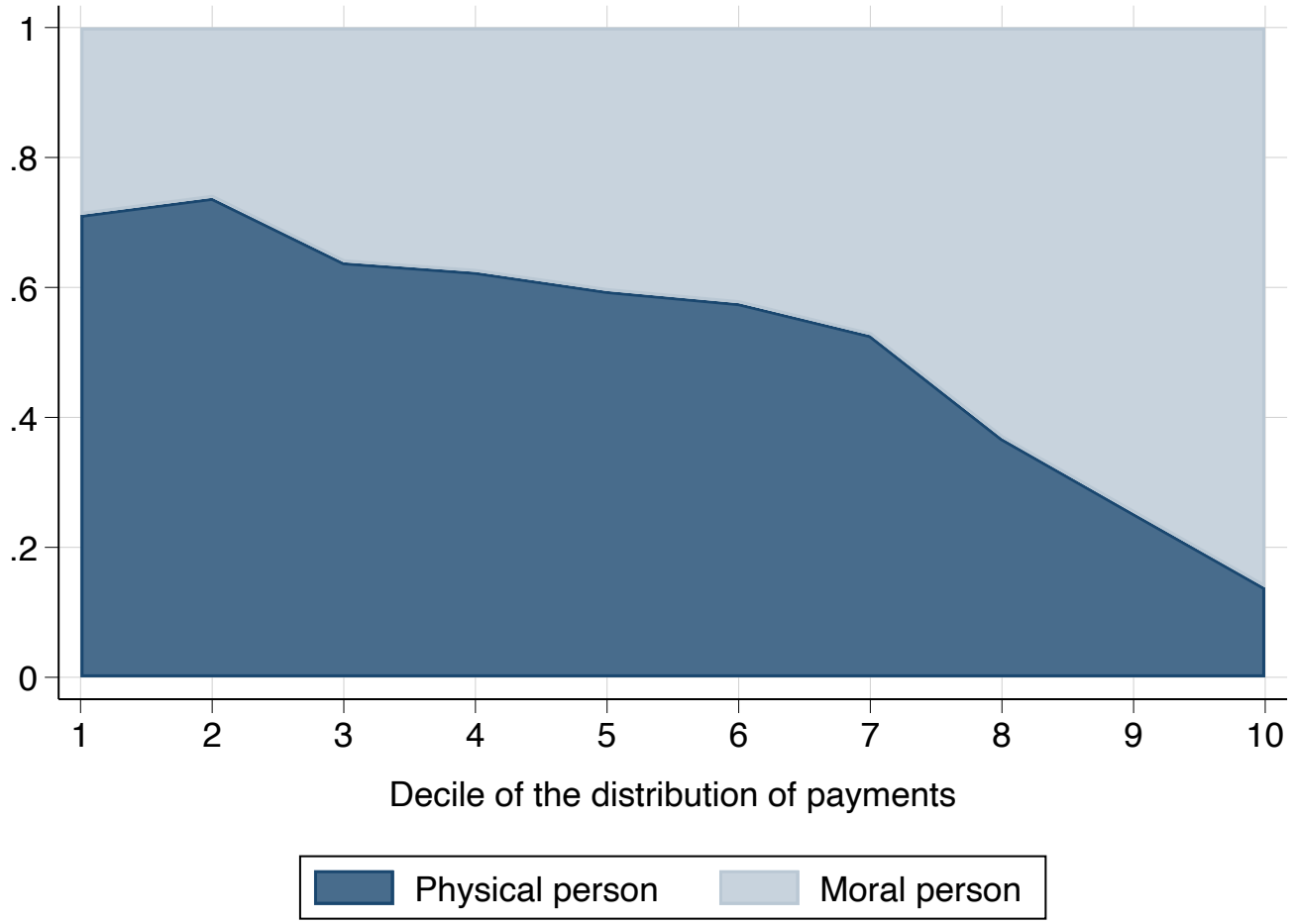
Notes: This Figure decomposes the distribution of all (pooled) payments (client-supplier pairs) declared by taxpayers of our experimental sample at baseline. We consider only the year 2018 as this is the year for which we have the best coverage ex-ante. For about 20% of all payments, the information about the sector is missing. For an additional 40% almost, the information is unfortunately hard to classify: unspecific for the vast majority (e.g. "services") or sometimes too specific (no key words, thus requiring a case by base inspection). The rest are classified based on key words, in an attempt to capture homogeneous groups. "Liberal": doctors, lawyers, consultants, architects, teachers, accountant etc. "Technical": electricians, plumbers, workers in the construction sectors, technical maintenance, etc. "Other sectors": interns, hotels, restaurants, communication, advertisement and distribution.

Figure H.12: Baseline Decomposition of the Distribution of Payments According to Clients' Tax Center



Notes: This Figure decomposes the distribution of all (pooled) payments (client-supplier pairs) declared by taxpayers of our experimental sample at baseline. We consider only the year 2018 as this is the year for which we have the best coverage ex-ante. We classify each payment based on the tax center of the client. Example: About 60% of all payments come from firms registered at the Large Taxpayers Center.

Figure H.13: Baseline Decomposition of the Distribution of Paymentx According the Suppliers' Type of Person



Notes: This Figure decomposes the distribution of all (pooled) payments (client-supplier pairs) declared by taxpayers of our experimental sample at baseline. We consider only payments made in 2020 by taxpayers of the Large Taxpayers Center. Indeed, we have information on the suppliers' type of person (either legal or natural person) mostly for that sub-sample as it is required only in the online form, which the LTC fully adopts in 2020. Note that this information, declared by the client, is a very imperfect predictor of whether the supplier is tax registered or not.