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Audit Rule Disclosure and Tax Compliance

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Abstract
We show that tax authorities can stimulate tax compliance by strategically releasing audit-relevant information. We focus on audit policies that disclose to taxpayers that audit risk discretely drops above a threshold determined by their predicted revenues. In a theoretical framework, we derive conditions for the existence of improvements over flat undisclosed audit rules, and we build a test for such improvements that relies on a change in the probability jump at the threshold. Our empirical analysis relies on the Sector Studies, an Italian policy with a disclosed threshold-based design. We leverage more than 26 million Sector Study files submitted between 2007 and 2016. First, we show that taxpayers bunch at the threshold to a great extent, and that this behavior is related to evasion proxies, availability of evasion technologies, and tax incentives. Then, we exploit a staggered Sector Studies reform that widens the initial audit risk discontinuity. In line with our theory, taxpayers who benefit from audit exemptions above the threshold reduce their relative compliance, while those below the threshold improve it. However, mean reported profits increase by 16.2% in treated sectors over six years, suggesting – in light of our test – that a disclosed rule performs better than an undisclosed one.

JEL Classification: D04, D22, H24, H25, H26, H32.

Keywords: tax compliance, enforcement, evasion, audit, disclosure, firm, bunching.

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1 Introduction

Ensuring tax compliance among small businesses and the self-employed is historically a central challenge for tax agencies in developed and developing countries (Alm, Martinez-Vazquez, and Wallace, 2004). In Italy as in Denmark, the undeclared share of individual income not subject to third-party reporting may well exceed 40% (Kleven et al., 2011; Galbiati and Zanella, 2012), while 43% of the UK tax gap accrues to small firms (HRMC, 2021). In the U.S., imperfect compliance among small businesses results in at least 6.3-8.3% of the total tax liability not being collected without costly enforcement.[1] Yet, tax authorities tend to skew their audit resources toward large firms (Almunia and Lopez-Rodriguez, 2018; Bachas, Fattal Jaef, and Jensen, 2019; Basri et al., 2019).[2] This might reflect a cost-effectiveness principle of tax administration, as enforcers expect a relatively higher yield from auditing a large business rather than several small ones for any given budget. To the extent that tax agencies are unwilling or unable to distribute enforcement efforts equally across firm types, the identification of low cost strategies to promote small firms' voluntary tax compliance becomes essential to tax collection.

This paper provides the first evaluation of audit rule disclosure as a viable strategy to improve the incentives for tax base reporting by small businesses. We refer to audit rules as the criteria that tax agencies routinely adopt to guide audit case selection. These criteria help to split taxpayers into high and low audit risk pools. Tax authorities seem to value the secrecy of these rules, which they generally keep from the public. Indeed, the choice of disclosure comes with a trade-off. On one hand, revealing what behaviors trigger a tax audit might nudge some taxpayers away from evasion. On the other, those who learn to be at lower risk of an audit might end up reporting a lower tax base. On the net, the effect of disclosure is ambiguous ex ante. We set out to characterize and quantify the involved trade-off in a real-world setting.

We study a specific case of audit rule disclosure: ahead of firm reporting, a tax authority reveals the exact location of a threshold above which audit risks drop discretely. Importantly, the threshold depends on a prediction of the firm's revenues so that each firm has a "target" declaration level to comply with. We focus on revealed threshold rules of this type for three main reasons. The first is their real-world diffusion. Contemporary examples include selective

[1] We sum the estimated yearly underreporting and non-filing among individual business income earners, self-employed, and small corporations, and divide by the total true tax liability, separately for 2008-2010 and 2011-2013 (IRS, 2016, 2019). Our inability to break down other tax gap items implies our estimates are lower bounds.

[2] In a 2019 survey from Italy, our study setting, the share of firms reporting any tax inspections over the previous 12 months was 9.9% among firms with less than 20 employees, and 18% among those with more than 100 (The World Bank, 2019).

audit rule disclosure in Australia, Greece, Mexico, France and Israel.[3] Second, since they are based on the result of predictive models, these rules allow to exploit the prediction power of Tax Authorities. Third, early results in optimal audit theory suggest threshold rules maximize tax collection if authorities can commit to an audit strategy ahead of reporting by risk neutral taxpayers (Reinganum and Wilde, 1985; Sánchez and Sobel, 1993).[4] In the data, little attention has been devoted to the voluntary compliance effects of disclosed threshold rules. To our knowledge, we offer the first evidence on the effects of disclosing firm-specific thresholds above which firms secure a partial audit exemption.[5]

We rely on the Sector Studies (*Studi di Settore*, henceforth SeS), an Italian audit system dedicated to small firms and the self-employed.[6] SeS estimate a sector-specific presumed revenue function drawing from the detailed information that businesses submit each year. Just ahead of the tax season, the Italian Revenue Agency provides firms with a software to file the required information and compute the presumed revenues associated with their declaration. The law exempts taxpayers declaring at least the presumed revenue amount from audits stemming from the SeS system. To study the ensuing compliance dynamics, we access a novel confidential database of more than 26.6 million SeS files from the 2007-2016 tax period, including the previously unexploited universe of 2007-2010 files. This rich source of data covers small businesses earning less than 5.2€ million in revenues in any given year regardless of incorporation status, location, and sector.

We leverage the disclosure design in the SeS and a theoretical framework to assess whether disclosed audit rules based on statistical predictions can be used to improve tax compliance. First, we develop a theory of audit rule disclosure and we derive sufficient conditions for the existence of strict improvements over continuous secret rules. We build a test that relates the tax base response to marginal changes in the probability jump to the desirability of disclosed threshold-based rules. Then, we exploit a natural experiment to implement this test, and we show that changes in the probability jump caused increases in the tax base. We conclude that in our context a disclosed threshold-based rule based on predicted revenues performs

[3] More in detail, we refer to the periodic release of industry benchmarks by the Australian Tax Office (OECD, 2006), the publication of profit margin targets as part of Greece's self-assessment program (Al-Karablieh, Koumanakos, and Stantcheva, 2021), Mexico's introduction of effective tax rates by sector in June 2021, and France's *forfait* and Israel's *tachshiv* as early presumptive taxation schemes (Thuronyi, 1996).

[4] Lazear (2006) discusses how disclosure might improve aggregate outcomes in policy realms other than tax compliance.

[5] In this sense, we differ from the recent literature on Large Taxpayer Units, which induce taxpayers to *reduce* their tax base to escape additional monitoring, and from work on policies that promise audit risk reductions if firms comply with a common economy-wide threshold (Dwenger et al., 2016; Al-Karablieh, Koumanakos, and Stantcheva, 2021).

[6] The Italian government estimates that these taxpayer categories are responsible for as much as 30.4% of all unpaid tax liabilities in the 2014-2016 period (Ministry of Economy and Finance, 2019).

better than a continuous "secret" rule.

We begin by constructing a theoretical framework to evaluate the tradeoffs entailed by the disclosure of threshold-based audit rules. In our model, the economy is a firm class (e.g. same-sector, same-location or same-size firms) where firms are risk-neutral and can be heterogeneous in income and in their propensity to evade. Firms face a disclosed threshold-based rule such that those who declare below the threshold face a flat probability p_H larger than the probability p_L faced by those declaring above the threshold. Fixing a propensity to evade, firms partition into four groups depending on their true level of revenues. In ascending order starting from the lowest revenue earners the groups are: zero-declarers who declare zero revenues; interior H declarers whose declaration solves the problem with a perceived probability p_H; bunchers who declare at the threshold; and interior L declarers who declare their optimal level of revenues with a perceived probability p_L. The mass of zero declararers and bunchers increase in the firm's propensity to evade and in the tax rate.

Based on these partitions, we derive the marginal effect of a change in the perceived probability jump at the threshold that involves both an increase in p_H and a decrease in p_L, and we show that it depends on three types of responses. There are intensive margin responses above and below the threshold triggered by changes in the perceived probablity, and an extensive margin response of some taxpayers with true revenues above the threshold who jump from declaring in the H area to declaring at the threshold to decrease their probability of being audited.

Using the formula for marginal revenues, we develop a sufficient condition for the existence of improvements over a continuous undisclosed audit rule. This condition relies on evaluating the slope of the revenue function in response to a thought experiment that, starting from a flat rule, lowers p_L keeping p_H unchanged. A positive slope locally at $p_H = p_L$ is suffcient to conclude that there exists a threshold disclosure that improves compliance. The condition requires that bunching incentives are strong enough to compensate the losses of revenues from the L declarers caused by a lower p_L.

Since the thought experiment that keeps p_H unchanged is unfeasible, we operationalize the test for improvements over continuous rules in a more general case where the marginal change in the probability of audits affects both p_L and p_H. This case resembles the natural experiment that we study in our empirical analysis. We show that if the amount of audits allocated to a class is small, as long as the increase in targeting below the threshold is not large compared to the audit shield provided by the policy, the revenue function is globally concave. It follows that if the introduction of the regime caused an increase in total revenues and in the tax base, we can conclude that the threshold-based rule in place before the reward regime was performing better than a flat rule that used weakly more audits. We therefore turn to the empirical section of the paper with a twofold goal of validating some predictions of the model, and implement our test exploiting the introduction of the reward regime as a natural experiment.

We begin our empirical analysis with some descriptive evidence about the declaration behavior of businesses in our data. We document a significant spike in the distribution of declared revenues right above the presumed revenues threshold. Building on the methods in Kleven and Waseem (2013), we quantify the extent of bunching. Then, we test if the latter correlates with various evasion margins and with the incentives to manipulate. We find that bunching is strongly correlated with evasion on VAT, property, income taxes and with anonymous evasion reports. In addition, bunching is larger for upstream sectors where evasion technologies are more costly given the presence of third-party reporting, and it is larger in areas with higher personal income tax rates. In line with the predictions of the model, bunching also positively correlate with the share of zero revenue declarers.

To bring the model insights to the data, we rely on a natural experiment that closely mimics the marginal change in the probability jump that we studied in our theory. Starting in 2011, a staggered reform to the SeS known as "reward regime" extended the protections provided to those in line with SeS prescriptions, and promised to devote more attention to those who did not comply. This should widen the audit risk gap perceived around presumed revenues for firms exposed to the new rules. Using a balanced panel for the 2007-2016 decade, our event-study design shows that taxpayers in treated sectors report revenues closer to the SeS threshold. Both firms below and above the threshold ahead of the reform display this adjustment, confirming our intuition that disclosure-based policies might offer opposite incentives to different taxpayers. However, reported revenues rise on average by around 12% and gross profits by 16.2% over six years in treated sectors. This quasi-experimental evidence interpreted through the lens of the model suggests that the tax authority in our context was able to expand the tax base of small businesses by disclosing an audit risk discontinuity.

Related literature: This paper provides several contributions to the study of tax compliance and enforcement. Our work is most closely related to a growing tax enforcement literature evaluating the relative merits of different collection strategies. We believe this to be the first paper to study the use of selective audit rule disclosure based on statistical predictions as a revenue-enhancing strategy. Almunia and Lopez-Rodriguez (2018) analyze the case of a Large Taxpayer Unit in Spain, whereby corporations expect stricter enforcement when reporting above 6€ million.[7] Instead, the disclosure process in our setting encourages seemingly low-productivity businesses to report more – rather than less – revenues, in line with

[7] Basri et al. (2019) review a similar scheme with regional Medium Taxpayer Offices in Indonesia, but the exact formula behind firm assignment to these offices is not known.

the prescription of optimal audit design. In addition, the bulk of our data comes from micro firms and the self-employed, which are typically hard to monitor and for whom voluntary compliance schemes may compensate for the tax agency's inability to ramp up audits. More closely related to our work, is the analysis of audit exemptions for taxpayers that declare above a common (*i.e.* firm-independent) threshold on various declaration margins (Dwenger et al., 2016; Al-Karablieh, Koumanakos, and Stantcheva, 2021). Relative to these works, we focus on rules that not only disclose audit criteria, but also rely on statistical model's predictions. Paradisi and Sartori (2023) show that reliance on predictions can significantly enhance tax compliance relative to common thresholds. The focus on rules that exploit the Tax Authority's prediction power also places our paper close to the recent literature on the use of statistical learning tools in audit targeting (Battaglini et al., 2023).

A few recent papers highlight the role of incentives for taxpayers (Dunning et al., 2017; Carrillo, Castro, and Scartascini, 2017; Al-Karablieh, Koumanakos, and Stantcheva, 2021) and third parties (Naritomi, 2019; Choudhary and Gupta, 2019; Kumler, Verhoogen, and Frías, 2020) in stimulating quasi-voluntary tax compliance. Differently from common tax lotteries, tax amnesties, and temporary audit exemptions, we examine the permanent introduction of compliance incentives which taxpayers can access autonomously by following predetermined prescriptions.

SeS disclosure is also distinct from the one implied by audit threat letters, the hallmark of tax enforcement randomized control trials (Kleven et al., 2011; Pomeranz, 2015; Bérgolo et al., 2017). Unlike in SeS, the goal of these interventions is not to reveal the structure of the audit system to all taxpayers. Therefore, their general equilibrium effects and whether their threat credibility can scale up remain uncertain (Slemrod, 2019).

In addition, Italy provides a suitable setting to the study of small firm tax compliance. The Italian economy is abundant in small businesses and self-employed individuals, so its enforcement experience might yield useful insights on the design of effective audit strategies to stimulate the compliance of this type of businesses, which display large tax gaps across many countries (Arachi and Santoro, 2007).

Finally, SeS taxpayers have been the object of theoretical and empirical work by both academics and practitioners (Santoro, 2008; Santoro and Fiorio, 2011; Santoro, 2017; D'Agosto et al., 2017; Battaglini et al., 2020). This paper is the first to ask whether disclosure can prove tax base-enhancing and to asses the impact of the reward regime.

2 A model of misreporting with disclosed audit rules

2.1 Firm's Problem and Audit Rules

We analyze a model of tax evasion where the economy is a firms "class", which can be interpreted as a sector, location, or any combination of observable characteristics. A continuum of firms draw income y from a compact support $[0, \bar{y}]$ according to CDF $F(\cdot)$ that admits a continuous single-peaked density function $f(\cdot)$ that is bounded away from zero. Declared income d is taxed at linear rate τ, and discovered evasion is sanctioned at rate $\gamma > 1$.[8] Firms face an audit schedule $p : D \to [0, 1]$ that maps a level of declared income into a probability of being audited. Given y, firms choose their reported income d to maximize

$$V(y) = \max_{d} y - \tau d - \tau\gamma \cdot p(d) \cdot (y - d) - c(y - d) \tag{1}$$

for a manipulation cost function $c : \mathbb{R}^{+} \to \mathbb{R}^{+}$, which we assume to satisfy $c(0) = 0, c'(\cdot) \geq 0, c'(0) = 0, c''(\cdot) > 0$. Firms can be heterogenous in their manipulation cost function according to a cost type κ, whose joint distribution with income is $\tilde{F}(\cdot, \cdot)$. In this case, we denote costs with $c_{\kappa}(\cdot)$ to stress the dependence on the cost type. For expositional simplicity, we present the results in our baseline specification assuming that firms inside a class share the same cost function,[9] but we comment at every step how the introduction of cost heterogeneity would change our conclusions.

Since we focus on disclosed threshold-based audit rules, we consider an audit schedule that takes the following form

$$p(d, \hat{y}) = \begin{cases} p_H & d < \hat{y} \\ p_L & d \geq \hat{y} \end{cases} \tag{2}$$

for some $p_H \geq p_L$. The case $p_L = p_H$ corresponds to a flat audit rule where all firms in the "class" are audited with equal probability, while the case $p_L < p_H$ promises an "audit discount" to all firms that declare (at or) above the threshold level $\hat{y}$. This threshold can be interpreted as a signal that the Tax Authority receives on the firm's true income, and it could be the outcome of a prediction model. We can interpret the case of a flat perceived probability as the one in which audit rules and predicted income are not disclosed to taxpayers and kept "secret". For the moment, we think of $\hat{y}$, p_H, and p_L as exogenous parameters.

In this economy there is a perfect correspondence between the margin over which the threshold $\hat{y}$ is determined, and the tax base. In our data, the two do not necessarily coincide

[8] We assume that conditional on receiving an audit, the real income is discovered and the penalty γ is imposed without frictions.

[9] In the baseline model earned income y is the only dimension of private information of the firm, so $F(y) = \tilde{F}(y, \tilde{\kappa})$ where $\tilde{\kappa}$ is the only cost type.

since $\hat{y}$ is a threshold on revenues, while profits are the tax base for most of the existing taxes. However, the arguments we will make are directly applicable to taxes on revenues only. Specifically, they extend to cases where firms can manipulate both revenues and input costs as long as the costs of manipulation of revenues and production inputs are additively separable.[10]

We gather all proofs of the results presented in this Section in Appendix A.

2.2 Optimal declarations and comparative statics

If the audit rule were flat (*i.e.* $p(d) = p$), then the maximization problem (1) would be equivalent to choosing the amount of tax evasion that solves

$$\min_{e} e\tau (1 - p\gamma) - c(e),$$

irrespectively of the level of income y. The interior solution of this problem is

$$e^I(p) = (c')^{-1}(\tau(1 - p\gamma)), \tag{3}$$

which is the level of evasion chosen by all firms for which $y - e^I(p) \geq 0$.[11] Because audit rules in the family (2) are non-constant, (3) is not directly applicable to our setting. Nonetheless, we can use this condition to characterize the declaration behavior. Indeed, given an audit rule, a firm's behavior is characterized by three target evasion levels, e_H, e_L and $\tilde{e}$, where $e_i = e^I(p_i)$ in function (3) for $i = H, L$, and $\tilde{e}$ solves

$$e_H\tau(1 - p_H\gamma) - c(e_H) = \tilde{e}\tau(1 - p_L\gamma) - c(\tilde{e}). \tag{4}$$

In words, e_i is the optimal evasion if the audit rule were flat at p_i, and $\tilde{e}$ is the level of evasion such that a firm is indifferent between concealing $\tilde{e}$ income when the audit probability is p_L and choosing the optimal evasion e_H under the (higher) audit probability p_H. We can now describe the declaration behavior of firms that solve problem (1) under the class of audit rules (2).

Proposition 1. *It holds $e_L \geq e_H \geq \tilde{e}$, with strict inequalities whenever $p_H > p_L$. If $e_H >$*

[10]This extension is immediate because the optimal behavior for a given audit probability is unchanged (by additive separability), while declaring above $\hat{y}$ to decrease the audit probability to p_L becomes more attractive due to the additional manipulation margin. This further increases the incentives to bunch, but, as we discuss later, leaves the properties of the authority's revenues function – characterized in the rest of our theory – unchanged.

[11]Notice that, by the properties of c alone, we know e^I is defined over positive domain, has positive image and is increasing.

$\hat{y} + \tilde{e}$, *optimal declaration induces the following partition of income*

$$d(y) = \begin{cases} 0 & y < y^{0H} \\ y - e_H & y^{0H} \leq y < y^{HB} \\ \hat{y} & y^{HB} \leq y < y^{BL} \\ y - e_L & y \geq y^{BL} \end{cases}, \qquad e(y) = \begin{cases} y & y < y^{0H} \\ e_H & y^{0H} \leq y < y^{HB} \\ y - \hat{y} & y^{HB} \leq y < y^{BL} \\ e_L & y \geq y^{BL} \end{cases}$$

where $y^{0H} = e_H$, $y^{HB} = \hat{y} + \tilde{e}$, *and* $y^{BL} = \hat{y} + e_L$.

Notice that e_i and $\tilde{e}$ depend on the probability levels (and the cost function) only; these values — obtained from (3) and (4) — induce the declaration partition presented in Proposition 1 and graphically represented in Figure 1. Low incomes, *i.e.* those below the optimal evasion level in the p_H regime, declare no income and bunch at 0 as their optimal declaration $y - e_H$ is below the lower bound 0. They form what we define as the $\mathcal{O}$ area. Firms in the income region $\mathcal{H} = [e_H, \hat{y} + \tilde{e})$ declare as if the audit probability was flat at p_H. For some of them (those below $\hat{y}$) this is natural as all feasible declarations are associated with probability p_H; those above $\hat{y}$, instead, have a choice between behaving optimally in the p_H regime and declaring at $\hat{y}$ with a lower evasion rate but lower probability of being audited. The level of evasion $\tilde{e}$ gives the indifference between these two options and incomes in $\mathcal{B} = [\hat{y} + \tilde{e}, \hat{y} + e_L)$ bunch at declaration $\hat{y}$. Firms in $\mathcal{L} = (\hat{y} + e_L, \bar{y}]$ can behave optimally under a flat p_L audit rule and hence they do so: declarations above the threshold are disciplined exclusively by the material cost of mirseporting.[12] The Proposition assumes that $e_H > \hat{y} + \tilde{e}$, which guarantees that the region $\mathcal{H}$ is well-defined. If this was not case, then taxpayers would switch from declaring zero to bunching at $\hat{y}$. This is inconsistent with the data, where we observe firms declaring in the $\mathcal{H}$ region.

Proposition 1 allows us to study how the optimal declaration behavior of firms responds to the parameters of the model. Specifically, we consider responses to changes in the tax rate and in the propensity to evade. To compare economies with different propensities to evade, we parametrize costs as $c_\kappa(\cdot) = \kappa \cdot c(\cdot)$ so that κ shifts the cost of evading at any evasion level, and lower κ implies a higher propensity to evade. Since we do not observe the evasion levels e_H, e_L and $\tilde{e}$ for each taxpayer in the data, we derive comparative statics on the masses of the declaration areas, which we can use to empirically validate the model's predictions. We denote $M(i)$ the mass of area $i = \mathcal{O}, \mathcal{H}, \mathcal{B}, \mathcal{L}$. The following Proposition clarifies the main comparative statics.

[12] If firms with income above $\hat{y}$ declared as if the rule was flat at p_L their declaration would indeed be audited with probability p_L; this is not possible for incomes between $\hat{y}$ and $\hat{y} + e_L$ whose optimal p_L evasion would push them to declare in a region (below $\hat{y}$) where the perceived probability is different from p_L.

Proposition 2. *Let $\tilde{\tau} = \frac{\tau}{k}$. Then, $\frac{dM(\mathcal{O})}{d\tilde{\tau}} \geq 0$, $\frac{dM(\mathcal{L})}{d\tilde{\tau}} \leq 0$ (strictly if $e_H < \bar{y}$ and $\hat{y} + e_L < \bar{y}$, respectively). Moreover, there is always a threshold $\bar{m}$ such that $M(\mathcal{L}) \geq \bar{m}$ implies that $\frac{dM(\mathcal{B})}{d\tilde{\tau}} > 0$.*

Given the definition of $\tilde{\tau}$, we can read the comparative statics both as the effect of increasing the tax rate and of decreasing the propensity to evade (increasing κ). The results on the 0 and $\mathcal{L}$ areas are straighforward from the analysis of the behavior of the evasion levels. An increase in $\tilde{\tau}$ increases the incentives to misreport income so that $\frac{\mathrm{d}e_H}{\mathrm{d}\tilde{\tau}}, \frac{\mathrm{d}e_L}{\mathrm{d}\tilde{\tau}}, \frac{\mathrm{d}\tilde{e}}{\mathrm{d}\tilde{\tau}} > 0$. Since the $\mathcal{O}$ area includes all firms with $y < e_H$, $M(\mathcal{O})$ increases in response to an increase in $\tilde{\tau}$. Conversely, since the $\mathcal{L}$ area is composed of the $y > e_L$, $M(\mathcal{L})$ shrinks when $\tilde{\tau}$ increases.

The behavior of the bunching area is less obvious. On the one hand, the increase in e_L expands the upper-bound income of the bunching area. On the other hand, the increase in $\tilde{e}$ increases the lower-bound shrinking the bunching area. As a result, to determine the effect on $M(\mathcal{B})$ we must weight the positive effect of increasing the upper bound e_L and the negative effect of increasing the lower bound $\tilde{e}$ by their densities. $M(\mathcal{L})$ is large if and only if $\tilde{\tau}$ is small, which implies that the two bounds are close and, a fortiori, have similar densities. Hence, it is enough to establish that e_L increases faster than $\tilde{e}$ for small $\tilde{\tau}$. Intuitively, this happens because changing $\tilde{\tau}$ has a stronger effect on the optimal declaration in $\mathcal{L}$ (see (3)) than on the indifference condition (4) where both sides of the equality are shifted in the same direction.[13]

2.3 Government revenues and their response to audit reforms

The objective of the Tax Authority is to maximize declared income, or equivalently to minimize tax evasion. We disregard for the moment the revenues from audit and we also assume that the Authority allocates a limited amount of resources (*i.e.* runs a small number of audits) in the sector. Both the assumptions are motivated by our interest in small businesses, for which the contribution of audit collection to government revenues is negligible due to the scarce resources, and where audit is ineffective due to the limited potential gains.[14] Essentially, our authority takes as given an audit threshold $\hat{y}$, and chooses the size of the audit probability gap around it, starting from a low baseline μ. To operationalize our assumptions, we parametrize the audit rule (2) assuming the authority chooses $\Delta \in [0, \min\{\mu, 1 - \alpha\mu\}]$ and sets $p_L = \mu - \Delta$ and $p_H = \mu + \alpha\Delta$. If μ is small, then it represents the binding upper-bound on Δ. The parameter α scales the increase in p_H associated to a unitary decrease in

[13] A more direct argument that loses some of the economic intuition is that e_L needs to be uniformly above $\tilde{e}$ and since they are both equal to 0 at $\tilde{\tau} = 0$, e_L must increase faster local to $\tilde{\tau} = 0$.

[14] Loosely speaking, we have in mind a situation where the authority allocates her budget to different sectors, focusing on those with higher income potential. The remaining sectors are those of interest for this study, as they are allocated a limited amount of resources and have negligible audit collection.

the audit probability above the threshold. The authority takes μ and α, as well as γ, τ, the cost and income distribution as primitives and sets Δ to maximize revenues[15]

$$R(\Delta) = \mathbb{E}\left[d(y, \Delta)\right] = \mathbb{E}\left[y\right] - \mathbb{E}\left[e(y, \Delta)\right].$$

We derive the following representation of how widening the audit probability gap (increasing Δ) affects the authority's objective

Proposition 3. *The marginal revenue caused by a change in Δ is*

$$\frac{\mathrm{d}R(\Delta)}{\mathrm{d}\Delta} = \frac{\mathrm{d}\tilde{e}}{\mathrm{d}\Delta}\left(e_H - \tilde{e}\right) f\left(\hat{y} + \tilde{e}\right) - M(\mathcal{H}) \frac{\mathrm{d}e_H}{\mathrm{d}\Delta} - M(\mathcal{L}) \frac{\mathrm{d}e_L}{\mathrm{d}\Delta}. \tag{5}$$

Figure 1 Panel C provides a graphical representation of equation (5). Computing marginal revenues is conceptually simple. There are two intensive margins, corresponding to the response of firms that declared in the $\mathcal{H}$ and $\mathcal{L}$ regions to the change in the probability of audit in their respective regions. These are the red area $\Delta e_H \cdot M(\mathcal{H})$ and the orange area $\Delta e_L \cdot M(\mathcal{L})$ in Figure 1, where Δe_H and Δe_L are the changes in evasion in the $\mathcal{H}$ and $\mathcal{L}$ regions, respectively. Importantly, higher Δ lowers the probability of audit and increases evasion only in the $\mathcal{L}$ region, constituting the only negative contribution to (5). Moreover, notice that declared income and evasion jump discontinuously only for the lowest income buncher, *i.e.* the firm that is indifferent between optimal evasion under probability p_H and declaring $\hat{y}$ to obtain an audit discount. Hence, the only extensive margin that affects total revenues is the one involving a change of threshold y^{HB}. Since the latter moves one for one with $\tilde{e}$, we multiply the change $\Delta\tilde{e}$ in $\tilde{e}$ by the declaration gap and obtain the purple area $\Delta\tilde{e} \cdot (e_H - \tilde{e})$ in Figure 1.

In the presence of heterogeneous costs of evasion, the expression (5) is easily modified to

$$\frac{\mathrm{d}R(\Delta)}{\mathrm{d}\Delta} = \mathbb{E}\left[\frac{\mathrm{d}\tilde{e}}{\mathrm{d}\Delta}\left(e_H - \tilde{e}\right) f\left(\hat{y} + \tilde{e}\right) - M(\mathcal{H}) \frac{\mathrm{d}e_H}{\mathrm{d}\Delta} - M(\mathcal{L}) \frac{\mathrm{d}e_L}{\mathrm{d}\Delta}\right]$$

where the expected value operator integrates over the marginal distribution of cost types.

2.4 Testing improvements over a flat audit schedule

Our goal is to assess the performance of disclosed audit rules that promise a reward to taxpayers who declare more than a certain threshold. Towards this end, we fix a benchmark audit rule with $\Delta = 0$. Under this rule, all declarations are audited with probability μ and, by Proposition 1, all incomes below $e^I(\mu)$ declare 0 and all incomes above $e^I(\mu)$ declare

[15] The expectation operator integrates over the distribution of income F. If evasion costs were also heterogeneous, then $\mathbb{E}$ would integrate under the joint distribution $\tilde{F}$.

$y - e^I(\mu)$. We ask under what conditions can the authority improve over such rule by granting an audit discount above a certain threshold. First, we consider a test based on a local perturbation of the policy that delivers the following result.

Theorem 4. *If*

$$e^I(\mu) > \frac{1 - F\left(\hat{y} + e^I(\mu)\right)}{f\left(\hat{y} + e^I(\mu)\right)} \tag{6}$$

then there exists a threshold-based audit rule that improves upon a flat one by achieving higher revenues using less budget.

To get the desired conclusion we test whether marginal revenues (5) are positive local to $\Delta = 0$ in an environment with $\alpha = 0$. This corresponds to a situation where the authority marginally lowers the audit probability above the threshold $\hat{y}$, leaving the probability below the threshold constant at μ. Clearly, this policy saves budget because any firm receives a weakly lower number of audits. To see the impact on revenues, notice that $\alpha = 0$ shuts down the second addendum in the decomposition (5) (as $\frac{\mathrm{d}e_H}{\mathrm{d}\Delta} = 0$), implying that the impact on revenues depends on the relative sizes of the losses in the $\mathcal{L}$ region and the gains from the bunching margin. Local to $\Delta = 0$, $\tilde{e}$ decreases with infinite slope from its original level $e^I(\mu)$. As a consequence, the bunching region expands fast for the first modicum of audit premium, which counteracts the fact that $\tilde{e} \to e^I(\mu)$ and gives a finite (positive) limit to the marginal revenues from the extensive margin.[16] Condition (6) ensures that this finite limit more than offsets the revenue loss from the marginal increase of evasion above the threshold.

The interpretation of condition (6) is intuitive. The hazard rate captures the ratio between losses and gains in the limit $\Delta \to 0$. The mass $1 - F\left(\hat{y} + e^I(\mu)\right)$ corresponds to the share of firms that lower their declaration in response to an increase in Δ, while $f\left(\hat{y} + e^I(\mu)\right)$ is the mass of marginal bunchers who respond over the extensive margin increasing their declaration. The level of evasion instead measures the extent to which bunching can improve compliance: if evasion is low, there is little room to adjust reported revenues. Because $e^I(\mu)$ is decreasing in μ, it follows that for μ small enough and a given $\hat{y}$ the condition is satisfied. This result suggests that threshold-based audit discounts can be particularly effective when the number of audits allocated to a firm class is small.

The test is designed holding $\hat{y}$ fixed, but if the authority had the option to also choose $\hat{y}$, then such improvement would exist for sure. As condition (6) only requires that evasion under the flat rule exceeds the hazard rate at the "degenerate bunching point" $\hat{y} + e^I(\mu)$, pushing such point to the upper bound of the support (where the hazard rate vanishes) makes sure that this condition is met.[17] This argument provides the following corollary.

[16] See Lemma 8 for a formal proof.

[17] The hazard rate vanishes as the CDF converges to 1 while the PDF remains bounded away from zero by

Corollary 5. *If the authority can set $\hat{y}$ arbitrarily large, then they can always improve over any flat rule using less budget.*

Although interesting from a conceptual point of view, the results of Theorem 4 and Corollary 5 are of limited practical interest. Condition (6) is hard to quantify on the data because it requires to know the true distribution of income and $e^I(\mu)$, which is most likely not observed. Its distribution-free implication (Corollary 5) has two drawbacks. First, we see $\hat{y}$ as a primitive rather than a policy instrument: in our empirical setting, the authority considers threshold rules around the predicted income $\hat{y}$ resulting from an independent statistical analysis.[18] Moreover, Corollary 5 looks at improvements that alter a small portion of the audit schedule and affect the behavior of top-income earners only. Although it ensures higher revenues and lower budget, such improvement is likely to be quantitatively small. Finally, the assumption that $\alpha = 0$ might not be accurate since any reduction in p_L is likely complemented with a concentration of audits in the $\mathcal{H}$ area.

For these reasons, we construct a different test that, to reject a similar null hypothesis, uses the change in average declarations associated to a perturbation of Δ when $\alpha > 0$. This policy perturbation resembles the natural experiment of the reward regime. Intuitively, our test identifies conditions under which the average declaration is a concave function in Δ. If this is the case, then observing an increase in average declariations when moving from a positive Δ_1 to a larger Δ_2 implies that the original disclosed rule performed better than a flat rule with $\Delta = 0$. Because the reward regime is a shift in Δ starting from $\Delta > 0$, its causal effect on average declarations is sufficient to evaluate whether it is desirable to disclose how audit rules depend on predicted income $\hat{y}$.

Theorem 6. ***[Concavity test]*** *Assume that μ is relatively small, that $\alpha < \frac{1}{F(\hat{y}+e^I(\mu))} - 1$ and that*

$$f\left(\hat{y} + e^I(\mu)\right) + e^I(\mu) \cdot f'\left(\hat{y} + e^I(\mu)\right) > 0 \tag{7}$$

If the reward regime increases revenue, then the pre-reward disclosed rule performed better than a flat rule that required more audit budget.

There are two main requirements that are necessary to ensure concavity in Δ. The first is that α is not too large, which implies that the drop in p_L caused by the reward scheme is large enough compared to the increase in p_H. Since the bound on α can be close to or even above 1, it is plausible that this condition is satisfied in the policy, whose main goal was to provide a shield from audit to those complying with their presumed level of revenues $\hat{y}$. The second

our initial assumption.

[18] Therefore, if the procedure consistently estimates the mean income in the class, we have $\hat{y} = \mathbb{E}[y]$.

condition is about the distribution of true income. Notice that we can find weaker sufficient conditions for (7). For example, it is sufficient to require that $f'\left(\hat{y}+e^{I}\left(\mu\right)\right)>0$, *i.e.* the "first" marginal buncher is in the increasing part of the income distribution. Otherwise, it is enough to require a bound on the absolute value of $\left|f'\left(\hat{y}+e^{I}\left(\mu\right)\right)\right|$.[19] If income is normally distributed $y\sim\mathcal{N}\left(\nu_{y},\sigma_{y}\right)$, as it is the case if $\hat{y}$ is the fitted value of a statistcial model, then the condition is equivalent to

$$\left(e^{I}\left(\mu\right)+\hat{y}-\nu_{y}\right)e^{I}\left(\mu\right)-\sigma_{y}^{2}\leq 0.$$

If the threshold is set at the income mean ν_{y}, the condition further simplifies to $e^{I}\left(\mu\right)<\sigma_{y}$. So the assumption requires that firms evade less than a standard deviation of true income, which in practice is a very weak requirement.

The intuition for the concavity of the objective function comes from main tradeoff faced by the authority when increasing Δ and clarified by condition (5). On the one hand, such change increases the intensive margin declaration of those in the $\mathcal{H}$ area, and induces more firms to bunch to $\hat{y}$. Both these forces contribute to increase the level of declared revenues. On the other hand, the drop in p_{L} reduces declared income of those in the $\mathcal{L}$ area. The marginal change in $\tilde{e}$ is infinite when Δ is close to zero, which suggests that even a small discontinuity in incentives can induce many people to bunch even with low elasticity of evasion (Kleven and Waseem, 2013). As the discontinuity in probability increases, the marginal effect decreases and so do the marginal gains from increasing Δ. This decreasing marginal effects determine the concavity to the revenue function.

Evaluating concavity in the heterogeneous costs case requires a similar exercise. Under mild assumptions on the support of evasion costs across incomes, we can express the test in expected values (across cost types) and require that $\mathbb{E}\left[f\left(\hat{y}+e^{I}\left(\mu\right)\right)+e^{I}\left(\mu\right)\cdot f'\left(\hat{y}+e^{I}\left(\mu\right)\right)\right]>0$, where the expectation integrates over the marginal distribution of cost types and $e^{I}\left(\mu\right)$ is heterogeneous across cost types.[20] This trivially holds if the condition (7) is satisfied for any cost type, which can be turned into an assumption about the support of cost types if they can be ordered in the sense that $c_{\kappa''}\left(e\right)\geq c_{\kappa'}\left(e\right)$ for any e if $\kappa''>\kappa'$.[21]

Our concavity test in Theorem 6 guarantees that it is sufficient to look at the direction over which revenues improve for a marginal change in Δ to establish whether any discontinuity with the same α and a smaller Δ was doing better than a flat rule at μ.[22] We test this

[19] For example, in the extreme case of a uniform distribution $f'=0$ and (7) holds.

[20] In particular, we need that the support of cost types does not change across incomes so that we can exchange the derivative of $R\left(\Delta\right)$ and the expected value operator.

[21] In this case, one can simply require that the condition (7) holds for the lowest cost type (the one with largest evasion).

[22] Notice that this does not imply that revenues need to be monotone in Δ: if the declaration loss in the

claim in the rest of the paper using data from the Italian SeS policy, which we describe in the next Section.

3 Disclosing audit rules: the Italian Sector Studies

In 1998 the Italian government implemented a novel auditing tool known as *Studi di Settore* or Sector Studies (henceforth, SeS), targeting non-employee taxpayers generating no more than 5.2€ million in revenues.[23] Since then, individuals, partnerships (pass-through businesses), and small corporations file every year towards their Sector Study, and are subject to tax audits ensuing from the analysis of the supplied information.

SeS provide taxpayers with a file-specific discontinuity in the probability of experiencing an audit on reported revenues. *Agenzia delle Entrate* (the Italian Revenue Agency), in collaboration with *SOSE*, a publicly-owned analysis company, estimates sector-specific linear models of presumed revenues using past declarations on business turnover, operating costs, workforce details, physical capital, input quantities, the size and location of their premises. Every year, businesses are required to report on these dimensions of their activity, allowing the model to determine a level of presumed revenues idiosyncratic to their annual file. As specified in the instituting Law 146/1998, declaring less than the presumed revenue amount provides the Revenue Agency with a motive to initiate a tax assessment.[24]

Both the timing and transparency built into the policy provide taxpayers with incentives to adjust their reporting behavior to the presumed revenue threshold. Figure 2 helps clarify this point. For any given tax year, production ends months before tax season, when taxpayers fulfill both their tax and SeS obligations. Filing deadlines are generally set in June or by the end of September, at least half a year after production decisions have been made for the relevant tax year.[25]

Taxpayers can learn about their SeS threshold at no cost. Just ahead of the tax season, between February and May, the Revenue Agency releases a freely downloadable software that assists taxpayers in preparing their SeS file.[26] The software, known as *Gerico*, stores the

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$\mathcal{L}$ area and the share of firms evading e_L remain relatively stable over larger values of Δ, then revenues might decrease for large enough Δs.

[23] In our main sample period, 2007-2010, taxpayers could seek exemption from SeS by opting into a minimum taxpayer regime, with eligibility conditional on reporting up to 30,000€ in the previous tax year.

[24] The opening statement of Law 146/1998 makes it explicit: *"Tax assessments based on Sector Studies [...] shall apply to taxpayers [...] when declared revenues or remunerations are less than the revenues or remunerations which may be determined on the basis of such Studies"*.

[25] Although the exact tax days often change across years, deadlines are generally set in the early summer and in the fall for taxpayers filing on paper or required to do so online, respectively.

[26] A yearly press release announces the availability of the software's free download on the Revenue Agency website. Figure D1 in the Appendix shows that Google searches for the word "gerico" in Italy peak around the two tax seasons.

coefficients associated to any sector-specific presumed revenue function estimated by *SOSE*. Upon imputation of the relevant accounting and structural information, *Gerico* informs the taxpayer of their threshold value before they submit their file, allowing for adjustments. Working through the software provides the fastest way to learn one's threshold, although most details regarding the estimation procedure are published by the Revenue Agency in dedicated yearly technical reports. *Gerico* also allows the dissemination of the estimation models' updates, which the law requires at least once every three years according to a sector-specific calendar.[27]

However sophisticated, SeS represent just one of many tax compliance instruments in the hands of the administration. As a result, taxpayers can trigger an audit for reasons unrelated to SeS behavior irrespective of where they locate relative to the SeS threshold. Crucial to our analysis, this residual audit risk independent of SeS filing stays constant around the presumed revenues threshold. Moreover, crossing this threshold provides no substantial fiscal benefit other than a reduction in audit risks. This allows us to attribute the observed revenue responses solely to the audit incentives provided by SeS.[28]

Reward regime as a test for improved compliance: In Section 2 we have developed a test to assess whether the introduction of a disclosed threshold rule can improve compliance. The test relies on a perturbation of the probability jump at the threshold. We exploit a reform of the SeS system to operationalize the test. Starting in 2011, the Italian government reinforced the discontinuity in incentives associated to SeS reporting. Law Decree 201/2011 instituted what is commonly referred to as *regime premiale* or reward regime, which sought to extend a set of ancillary audit protections for taxpayers complying with SeS prescriptions. We compare the pre- and post-reform regimes in Table G1. Introduced in a staggered manner across SeS business sectors, the new regime promised audit exemptions from additional investigation sources other than SeS and shortened the statute of limitations of audits by one year.[29] To access these benefits, businesses would not only report revenues at or above the presumed level (a condition known as congruence in the SeS framework), but also fall within

[27] Model revisions involve re-estimating the sector-specific presumed revenue functions with relatively more recent data. The process may thus affect both the selection of relevant input variables as well as the size of the associated coefficients.

[28] The Italian tax enforcement system further includes *Guardia di Finanza*, a police force tasked with fighting tax crimes. Although they can rely on information from a taxpayer's SeS file to initiate an audit, their investigative activity focuses on tax-related crimes. The Revenue Agency runs most of the ordinary file auditing, and is the only agency with the power to request additional tax payments.

[29] Inclusion would happen at the beginning of each tax season for the previous calendar year, with the Revenue Agency releasing the updated list of sectors to benefit from the new incentives. A majority of businesses in manufacturing, commerce, and services were included by the 2016 tax year, when our data period ends. Professionals were mostly excluded until a more organic transformation of the SeS system starting with the 2018 tax year.

acceptable ranges of several sector-specific accounting indicators (two conditions known as normality and coherence). The reform otherwise encouraged the tax authorities to boost their enforcement efforts among non-compliant businesses.

4 Data and Descriptive Facts

4.1 Administrative Data on Sector Studies

To examine taxpayer behavior in light of the selective audit rule disclosure implied by SeS, we access the confidential administrative universe of SeS files over the period 2007-2010. We complement our main dataset with an unbalanced panel stretching to 2016 of all taxpayers filing continuously between 2008 and 2010. To our knowledge, this is the first paper to exploit all SeS files available in any given year. Put together, the raw data covers almost 26.7 million SeS declarations filed by over 4.7 million Italian micro businesses and self-employed. Each of the tax years between 2007 and 2010 alone generates more than 3.4 million files. Appendix B offers an overview.

The data provide detailed information about the taxpayer's economic activity for the relevant tax year, including their reported revenues, gross profit or income, the size of the workforce, the wage bill, a number of cost items, and the surface area of their premises. Crucially, each file comes with the exact location of the associated SeS threshold. This allows us to assess the relative distance between the revenues declared by the taxpayer and those presumed and disclosed by *Gerico* before filing.

A snapshot of the context in which each taxpayer operates comes from their files' information on their business sector and location. Sectors are identified both by the standard 6-digit industry code (2007 ATECO), as well as by the administrative SeS code of reference. Reported locations have special relevance since the vast majority of SeS filers are single-establishment businesses with low spatial mobility in a very heterogeneous country.[30] Over the 2007-2010 period, about 95% of all files are associated to at least one of the 110 provinces existing at that time and we are also able to assign 77% of the subset of personal income taxpayers to one of more than 8,000 municipalities.[31] We further associate municipalities to one of the 686 local labor markets as defined by the Italian Institute of Statistics (*ISTAT*) ahead of our sample period, and exploit this link to perform subprovincial analysis.

SeS cover a broad spectrum of firm types with diverse legal status. Almost two thirds of

[30] More than 98% of 2007-2010 files are submitted by taxpayers who never move out of their original province over the observed period.

[31] The Revenue Agency forbids the disclosure of a taxpayer's location when there are no more than three establishments in their same sector in a given municipality. Given the extremely low mobility of our taxpayers, we impute a taxpayer's municipality for a given SeS file using their location reported in any of their other SeS files in our data.

2007-2010 files come from individual businesses and self-employed professionals (64.8%). The rest pertain to partnerships (19.5%) and corporations (15.7%). Along with the geographic location, the legal status of a firm determines its profit tax regime. Personal income taxes (PIT) are paid by individuals and partnerships, with the latter akin to U.S. S-corps for tax purposes. Corporate income taxes affect corporations only. In our structural analysis, we rely on the tax heterogeneity generated by municipal and regional surcharges applied on top of national personal income tax rates, and thus exclude corporations who face the flat corporate income tax rate set by the central government.

Additional sources: A wide range of additional sources outlined in Appendix C complements our administrative data. We construct a comprehensive database of evasion levels across geographies and tax bases with information from the existing literature and administrative reports. More than 620,000 anonymous evasion reports submitted to *www.evasori.info* help us develop our own misreporting proxies for the period 2008-2011. We collect details about local tax rates and tax litigation from the Ministry of Finance and the Economy. *ISTAT* disseminates input-output tables with information on sectoral exposure to final consumers, which can be used to classify industries as upstream or downstream along the supply chain. We also draw from *ISTAT*'s Census sources and national accounts to characterize the context of operations of our taxpayers.

4.2 Bunching at the SeS threshold and tax manipulation

We begin our empirical analysis presenting some descriptive facts about reporting within the SeS system. This section has three goals: *i)* documenting the exent of bunching at the disclosed threshold, *ii)* uncover correlational patterns of this measure with other evasion proxies and with incentives to manipulate the tax base, *iii)* investigate if bunching could reflect production responses rather than misreporting. We document that taxpayers bunch to a great extent at their presumed level of revenues, and that this reponse is highly correlated with the ease of misreporting and the incentives to misreport, while it seems to be unrelated to true production adjustments.

Measuring bunching: Figure 3 Panel A shows the distribution of reported revenues around $\hat{y}$, leveraging the universe of SeS files submitted by single-sector businesses for the 2007-2010 tax years. The horizontal axis represents the distance of reported revenues from the file's associated $\hat{y}$ in percentage terms of $\hat{y}$ itself.[32] There is a significant spike in the distribution within 1 percentage point of $\hat{y}$, consistent with a large share of taxpayers declaring

[32] We rely on the relative distance from the threshold for illustrative purposes only. In our structural analysis, we will model taxpayers responses based on their absolute distance from the threshold, that is in Euro terms.

at or slightly above the threshold to avoid audits.

To quantify the extent to which taxpayers bunch at the presumed revenue level, we build an empirical counterfactual bunching distribution to capture the declaration patterns in a scenario with a constant p_L probability. Our strategy relies on the observation that businesses declaring above $\hat{y}$ face probability p_L. We therefore infer from their behavior the counterfactual bunching distribution following the approximation method in Kleven and Waseem (2013) that requires choosing a polynomial order to fit the distribution and a threshold y^u that delimits the bunching region on the right of $\hat{y}$. Bunching is then defined as the ratio between the oserved distribution and the counterfactual one in the bunching region. We derive standard errors to the estimates using a boostrap procedure with 1,000 iterations. Appendix E provides the details of the estimation.

Figure 3 Panel B exemplifies our bunching estimate in the universe of filers for the 2007-2010 tax period. The counterfactual closely follows the empirical distribution on the right of $\hat{y}$ up until y^u. On the left of $\hat{y}$ the empirical distribution lies below the counterfactual and the difference between the two is the missing mass generated by bunchers. We find substantial bunching equal to 9.56 (bootstrap sd = 0.61) in our baseline. Bunching induces higher revenue reports relative to the counterfactual. The extra revenues reported by bunchers only are equivalent to a uniform right-shift of the counterfactual distribution for an amount equal to 1.13% and 3.05% of the observed mean and median revenues, respectively. Table G2 reports the sensitivity of our bunching estimates to the choice of polynomial order and y^u. Our baseline estimate lies on the lower end of the estimates distribution. This follows from our conservative definition of excess bunching, since we attribute any excess mass to SeS incentives only if within 1 percentage point of presumed revenues.

Bunching and evasion behavior: Next, we ask if bunching correlates with attitudes towards evasion and incentives to evade, as predicted by Proposition 2. We thus study the correlation between bunching of SeS files for each of the 110 Italian provinces or 686 local labor markets (LLMs) in 2007-2010 and available local proxies of evasion across several tax bases, controlling for regional fixed-effects and value added per capita.[33] Figure 4 documents a positive and, in most cases, significant correlation between the local bunching estimate and twelve different measures of evasion, including one that we build scraping 620,000 anonymous evasion reports from the web. To summarize the magnitude of the correlation, we construct an index of evasion in administrative sources using a first principal component of the administrative-data-based proxies. A one standard deviation increase in this index is associated with a 0.5 standard deviation increase in bunching, suggesting a strong relation

[33] Appendix F provides the details of this exercise.

between bunching and evasion behavior. This positive association documented across several measures could be the result of both a relative ease of misreporting (lower κ) or of higher payoffs to evasion (higher τ). We further investigate both explanations providing two separate sets of evidence. Consistently with bunching being the result of an ease of misreport we show that bunching is larger in downstream sectors that are less subject to third party reporting, and in smaller and less complex legal forms of businesses (Figure 5). Moving from a sector with zero share of sales to final consumers (upstream) to one that only sells to final consumers (downstream) is associated with a 5 points statistically significant increase in bunching out of an average slightly above 9. Moreover, the distribution of bunching among self-employed that are subject to less strict accounting standards lies almost entirely to the right of the distribution for corporations.[34] A sector Bunching also correlates to the incentives to misreport as it is positively associated to the PIT tax surcharge rate.[35] Additionally, we investigate the correlation between bunching and the share of zero revenue declarers. An immediate corollary of Proposition 2 is that if a common driver such as the cost of evading or the tax rate affects $M(\mathcal{O})$ and $M(\mathcal{B})$, then the masses of the two areas should positively correlate. Figure 6 shows that this prediction finds strong support in the data: a 1 percentage point increase in the share of zero declarers is associated with a bunching increase of 0.5 over an average of 9.2 across LLMs.

Reporting VS production responses: Our model assumes that production and evasion margins are separable. However, in principle firms could adapt to the disclosed threshold by adjusting their true production. We provide two pieces of evidence to argue that production responses are second order in determining bunching. As showed in Figure 3, bunching is very sharp at the threshold. If what we observe was the result of production, firms should be able to perfectly anticipate where $\hat{y}$ is located in advance, which seems unlikely given the several months time lag between production and the model disclosure. Then, we observe that if production responded to the incentives of the SeS system we should find evidence of "learning" over time after a new SeS has been introduced. We exploit the fact that the statistical models of each sector are updated every three years to test if there is some adaptation that could be consistent with production responses. We show that individuals do not increasingly locate at the threshold over time in the years following a new SeS model introduction (Appendix F). This evidence against production responses being the main driver of bunching supports our modelling assumption of separability between the reporting and production margins, and

[34] SeS taxpayers face increasing reporting and book-keeping requirements, with accounting complexity rising from a relatively low level in individually-owned activities to a progressively higher level among partnerships and corporations.

[35] See Figure F3.

our focus on a manipulation margin only.

5 Reward System: testing the effectiveness of disclosed audit rules

In this Section, we rely on a natural experiment to test the impact of disclosure-based policies based on the theory we developed in Section 2, and to study the effects of audit rule disclosure on a broader set of compliance margins. Conveniently, the staggered introduction of the 2011 reward regime (*"regime premiale"*) closely resembles the logic of our original policy exercise, where disclosure affects reporting incentives in opposite directions depending on the relative position of each taxpayer. In line with our conceptual framework, we show that taxpayers approach their presumed revenues from both sides of the threshold. Still, mean gross profits increase in response to the reform, showing that tax authorities can expand the tax base by strengthening the incentives associated to a disclosed audit rule. Through the lens of the test that we developed in our theory, this evidence suggests that threshold-based disclosed audit rules can improve upon secret flat rules.

Starting in 2011, the Italian government has promised stronger audit exemptions for taxpayers complying with SeS prescriptions, while threatening the others with higher chances of enforcement. The new regime influenced audit risk perceptions in opposite ways depending on the relative location of the taxpayer with respect to the presumed revenues threshold. Those planning on reporting more revenues than presumed while complying with several accounting indicators put forth by the tax authority would experience comparatively greater protection from enforcement for that year's report $p_{L,\text{Reward}} \leq p_{L,\text{Pre-Reward}}$. On the other hand, the reform encouraged greater scrutiny over those failing to comply. The combination of these measures implies that $\Delta\,(\text{Reward}) \geq \Delta\,(\text{Pre-Reward})$, that is, taxpayers should perceive a larger audit risk discontinuity at the presumed revenue threshold after the reform.

We exploit the staggered inclusion of SeS sectors into the reward regime over the 2011-2016 (Figure G1) period to evaluate the reform's effects. We focus on businesses in 155 treated sectors across manufacturing, commerce, services, and the skilled professions, and create a balanced panel of those continuously filing for SeS over the 2007-2016 decade.[36] Since we observe each SeS sector s entering the regime in a specific tax year t, we set up an event-study design to estimate equations with the following structure:

[36] Differently from the other SeS macro-industries, the Revenue Agency has included only three out of twenty-four SeS sectors in the skilled professions by 2016, only to overhaul the SeS system for all sectors in 2018. Our results may thus not be fully representative for all professional groups. In addition, panel balancing tends to overrepresent businesses with larger size and better SeS compliance, as shown in Table \ref{tab:balancedpanel_descriptives}.

$$y_{s,t} = \lambda_s + \gamma_t + \sum_{q=-k}^{+k'} \beta_q \cdot I\left(Q_{s,t} = q\right) + \sum_{r=2007}^{2016} \delta_r \cdot X_s \cdot I\left(t = r\right) + \varepsilon_{s,t}. \tag{8}$$

For any given sector-by-tax year outcome $y_{s,t}$ covered below, coefficients β_q capture the effect of including a sector into the reward regime in each period q relative to sector entry. Identification of these effects relies on a parallel path assumption. Specifically, we assume that outcomes in a sector currently under treatment would evolve in a similar fashion to those in yet-to-be-treated sectors absent the reform. We further control for sector and tax year fixed effects λ and γ, respectively, and a vector of pre-treatment features summarized by X, interacted with tax year dummy variables.[37] Lastly, we weight each sector by the number of SeS files submitted at the outset of our sample period, and cluster standard errors at the sector level, following the recommendation in Bertrand, Duflo, and Mullainathan (2004) for treatment-level clustering.[38] We also provide robustness tests that employ the corrections in de Chaisemartin and D'Haultfœuille (2020) to avoid the issues that might arise in two-way fixed-effects specifications in presence of heterogeneous treatment effects.

5.1 Distribution shifts caused by the introduction of the Reward System

Disclosure-based policies such as the reward regime might reduce perceived risks above the revealed threshold and raise them below. As a result, bunching may come from taxpayer adjustments of opposite signs, with different implications for relative compliance.

The introduction of the reward regime provides a chance to assess whether bunchers originate both from below and above the SeS threshold. In the data, we group taxpayers by their relative distance from the presumed revenues in the year before their sector's reform. We set up six symmetric categories of filers around $\hat{y}$, based on whether they reported revenues within 5, 5 to 10, or more than 10 percentage points from what presumed just before the reform. For each of these six groups, we measure the share of files located in each one percentage point bin in every year. We then estimate (8) using these shares as outcomes of separate event-studies around a sector's regime entry.

Figure 7 shows the results. In each panel, we plot for each one percentage point bin the average of the six treatment coefficients β_q and the 95% confidence interval of this linear combination. In the background, a green band marks the range where each group was located the year before the introduction of the reward system.

[37] Controls include dummies for the categories of manufactures, commerce, services, and the professions as defined by the Revenue Agency; and 2007-2010 averages for a set of variables including revenues, gross profits, the incidence of employment costs on turnover, and yearly growths of employment cost rates and revenues.

[38] Weighting by the number of files submitted allows us to capture the behavior of the average taxpayer in our data.

A stark pattern emerges: whether taxpayers start out below $\hat{y}$ or not, the reform's larger risk gap at $\hat{y}$ draws a larger number of them to their threshold or just above it. In addition, the stronger drop in bin shares for bins below but closer to the threshold is, all else equal, consistent with a lower cost of achieving congruence for those having to move a relatively shorter distance. These patterns are consistent with our theory: taxpayers facing an increase in risks below the threshold tend to raise their relative compliance, while those awarded stronger protections tend to reduce it.

5.2 Improvements over flat rules: the effects of the Reward System

We then exploit the adoption of the reward regime to study the period-by-period mean effect of disclosure along a number of reported margins, and we interpret the implications of these results in light of our theoretical model. Figure 8 Panels A and B first show the full set of β_q coefficients from (8) when the outcome is mean reported revenues by sector and tax year (in logarithms and Euros, respectively). Ahead of the reform, treated sectors report slightly less revenues on average, but the path is fairly stable as we approach the reform period. After a sector's reform, reported revenues are on average 2.4% higher than in control sectors in the first year, and up by about 20.4% by year six.

Next, Panels C and D study net reporting behavior in terms of gross profits. Just as for revenues, the stronger audit incentives introduced by the reward regime appear to have stimulated the emergence of a larger tax base. On average each year, firms in a treated sector report 16.2% higher gross profits than those in sectors still to treat. The pattern of coefficients is once again increasing, suggesting that familiarity with the new system improves compliance over time. Overall, our estimates imply that the reform encouraged a cumulative gain of €33,671.77 in taxable profits from the average treated business.

The profit increase we document is however smaller in magnitude than that in revenues. Figure 9, Panels A and B summarize the effect of the reward system on the difference between revenues and profits, which provides an aggregate measure of the costs reported in each SeS file. The resulting patterns are similar to those in the previous figure, with treated sectors reporting average costs from 2% to 20.7% higher than in control sectors in the first and in the last available year, respectively.

Our results show that both revenues and profits (the tax base) increased per effect of the introduction of the reward regime. There are two implications of this result. First, the evidence suggests that disclosed rules could be locally improved by increasing the probability jump at the threshold. In addition, invoking Theorem 6, these results suggest that the pre-reward regime rule was doing better than a flat rule that conducts a strictly larger number of audits. We therefore provide evidence that SeS are desirable over flat undisclosed rules in the context that we study.

Robustness: Recent contributions on two-way fixed effects estimation have elucidated a number of potential issues in interpreting the dynamic treatment coefficients of standard event-study designs. To address these concerns, Appendix G replicates the estimation with the robust estimator in de Chaisemartin and D'Haultfœuille (2020), obtaining a similar pattern of results to those in our baseline.

6 Conclusions

Tax audits and their threat are a primary enforcement tool across developed and developing countries. The dissuasive power of audits, however, has hardly solved the long-standing problem of low compliance among micro to small businesses and the self-employed. We ask whether the strategic disclosure of audit selection criteria can improve the effectiveness of enforcement among these taxpayers. We answer our question by developing a theoretical model of audit disclosure, and implementing a test derived by the model using a quasi-experiment in the context of Sector Studies (SeS), an Italian policy informing small firms of their relative audit risk around a revenue threshold.

We develop a theory of optimal tax declarations of firms that face a discontinuous threshold-based audit probability, and we derive a test for the existence of improvements over flat audit rules. The test is based on studying the behavior of the revenue function in response to a marginal change in the audit probability jump at the threshold. Consistently with the model, the distribution of SeS files reveals that taxpayers are especially aware of and willing to adjust to clear audit risk signals. The extent of bunching is strongly related to several evasion proxies on other declaration margins, and seems to respond to the incentives to evade and the availability of evasion technologies. To implement the test for improvements over flat rules, we exploit a 2011 staggered reform that strengthened the original risk discontinuity at the disclosed SeS threshold. While taxpayers respond by bunching at the cutoff regardless of their relative position ahead of the reform, mean gross profits rise by 16.2% in treated sectors over the course of six years, suggesting that the pre-reform discontinuity performed strictly better than a counterfactual flat rule that used more audits.

Our work is encouraging as international attention grows on the importance of voluntary tax compliance and reliable tax collection for fiscal sustainability (OECD, 2017; IMF, 2021). Differently from tax lotteries and traditional tax amnesties, the disclosure framework we study grants broadly accessible and stable incentives to stimulate compliance. As tax agencies routinely define thresholds to target their audits, they might develop cost-effective communication strategies to nudge taxpayers around these cutoffs. At the same time, we are aware that net collection effects also depend on the quality of the ensuing audits once the pool of exempted taxpayers is defined. Although such effects are bounded to be of second-order importance in contexts where limited audit resources are allocated, we leave the study of realized audit collection in the presence of threshold-based rules to future research.

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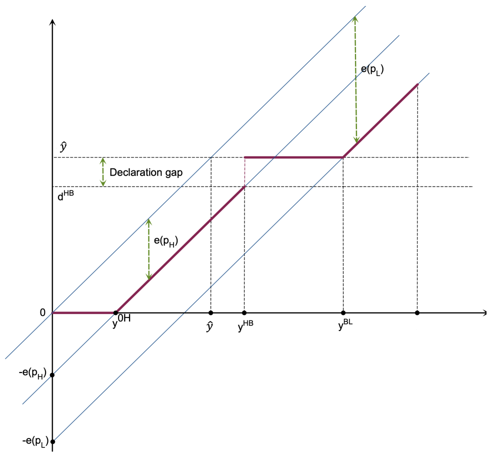
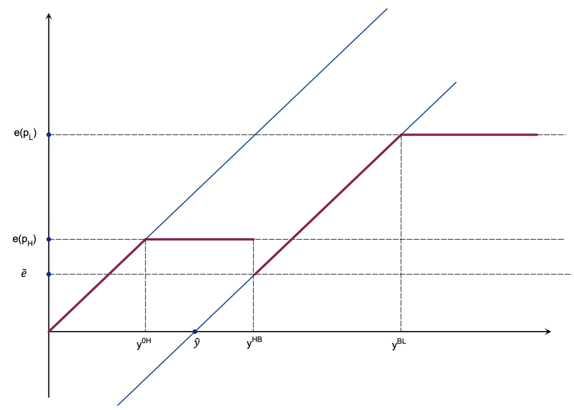
Figures and Tables

Figure 1: Optimal Declaration and Evasion

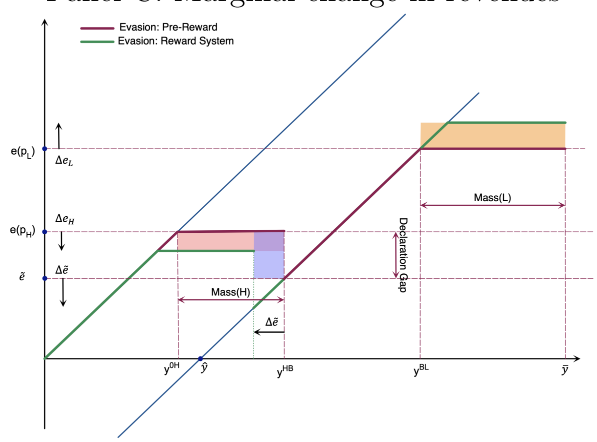
Panel A: Declaration Partition



Panel B: Evasion Partition

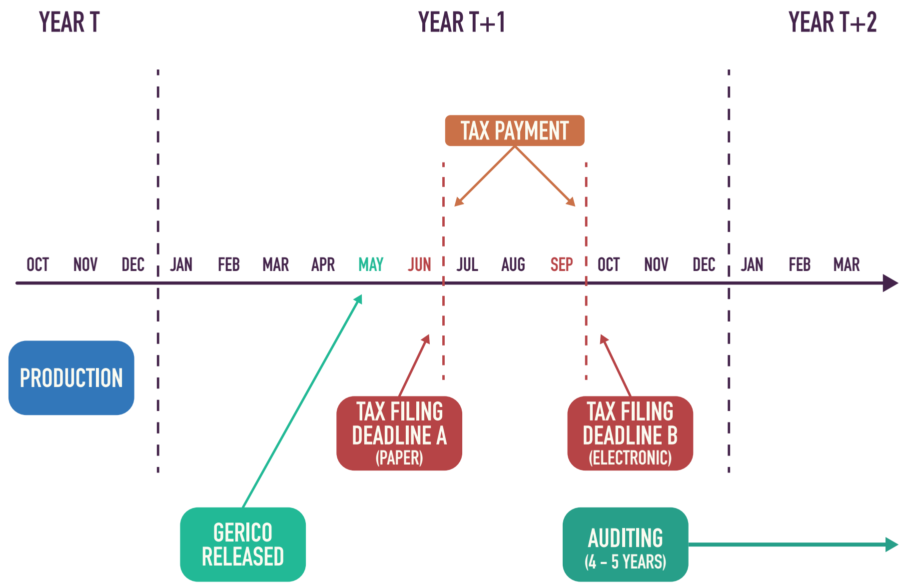


Panel C: Marginal change in revenues



Notes: this Figure outlines the optimal declaration (Panel A) and evasion (Panel B) for all levels of income (on the x-axis) and for a fixed cost function such that, given a perceived probability of audit, all incomes evade the same amount. Panel C shows graphically the marginal change in revenues caused by an increase in Δ, as described by Proposition 3. In Panel A, the blue diagonal lines represent (from top to bottom) the honest declaration pattern (45-degree line); the declaration pattern with a constant p_L; the declaration pattern with a constant p_H. The purple line shows the equilibrium pattern of declarations. In Panel B, the diagonal blue lines represent (from top to bottom) the full evasion pattern (45-degree line); and the evasion patter if firms declared $\hat{y}$ (parallel to 45-degree intersecting x-axis at $\hat{y}$). The purple line shows the equilibrium pattern of evasion. In Panel C, the blue lines are identical to the ones in Panel B, the purple line represents the evasion pattern before the change in Δ, while the green line is the evasion pattern after the increase in Δ.

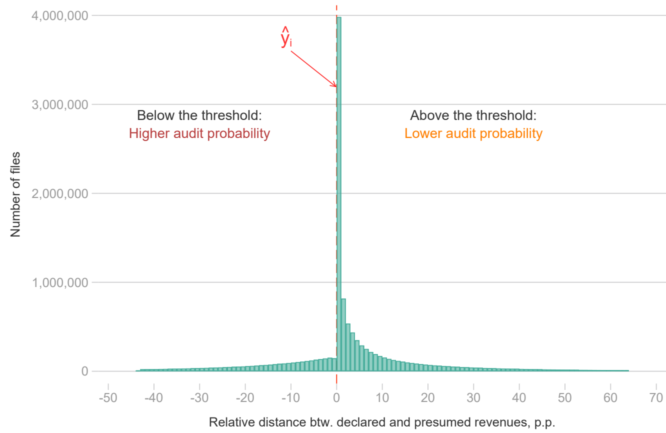
Figure 2: Timeline of Sector Studies Reporting



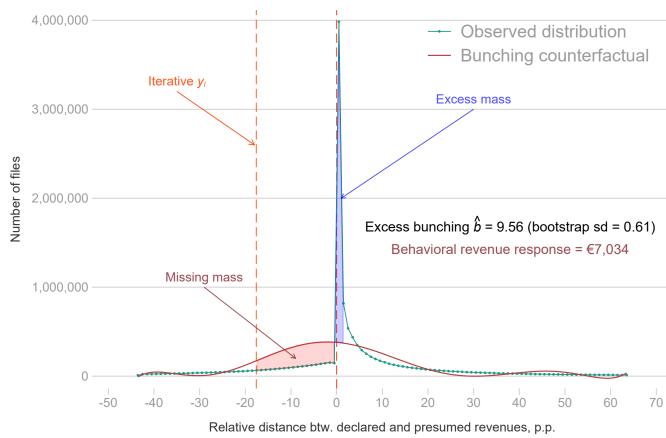
Notes: this Figure outlines the timeline of production and tax enforcement events from the perspective of taxpayers. Businesses generating revenues during year T are required to file their tax returns as well as their separate SeS file during the following year $T+1$. SeS filing follows the tax filing cycle. During our sample period, the taxpayers in our data file and pay their taxes either in June or in September, depending on whether they file on paper or electronically, respectively. At the beginning of every filing season, the Italian Revenue Agency releases *Gerico* to help with SeS filing and allowing taxpayers to compute their presumed revenues and a broader set of accounting indicators. After submission, auditing of SeS files and tax returns can take place over the following 4 to 5 years.

Figure 3: Bunching in the universe of single-sector SeS filers, 2007-2010

Panel A: Reported revenues relative to SeS threshold

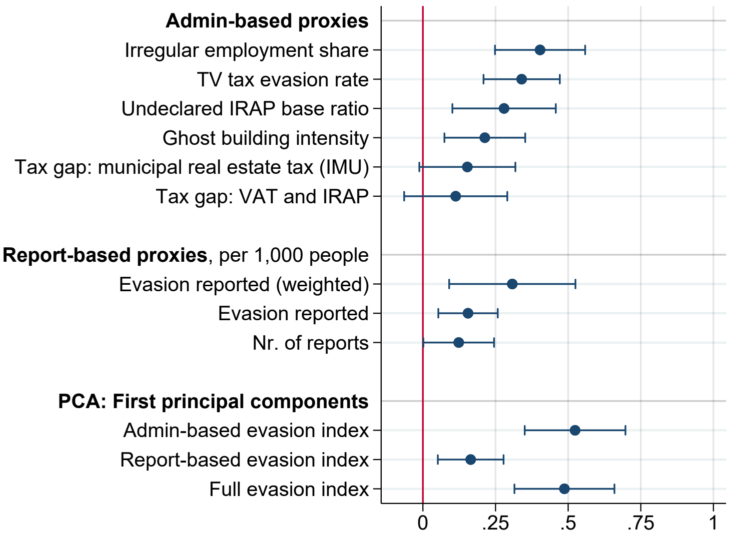


Panel B: Bunching estimates



Notes: the Figure presents the distribution of $(d_i - \hat{y}_i)/\hat{y}_i$, the relative distance between reported revenues d_i and presumed revenues $\hat{y}_i$, from each SeS file in the universe of single-sector businesses in the 2007-2010 tax years. Units on the horizontal axis are percentage points of each file's presumed revenues. We trim files reporting revenues below the 5^{th} percentile or above the 95^{th} percentile of relative distance from $\hat{y}$. This excludes taxpayers declaring zero revenues. Panel A displays the observed histogram of relative reported revenues. Panel B adds the smooth bunching counterfactual and presents the relevant estimates. The counterfactual density is estimated with an iterative procedure seeking to equate the excess mass above the threshold with the missing mass below it. The procedure stops with the definition of a lower bound y^l marked in Panel B with a dashed dark orange line. The smooth fit is obtained by estimating a regression with a 7^{th}-order polynomial in the bin order, and an upper bound set at the threshold bin (files with revenues falling within 1 percentage point above their presumed revenues). Excess bunching is the ratio of the excess mass and the height of the counterfactual at the threshold bin. Standard errors are computed with 1,000 bootstrap replications. The behavioral revenue response estimate comes from a corresponding bunching estimation where threshold distance is defined in Euro terms and bin width is equal to 500€.

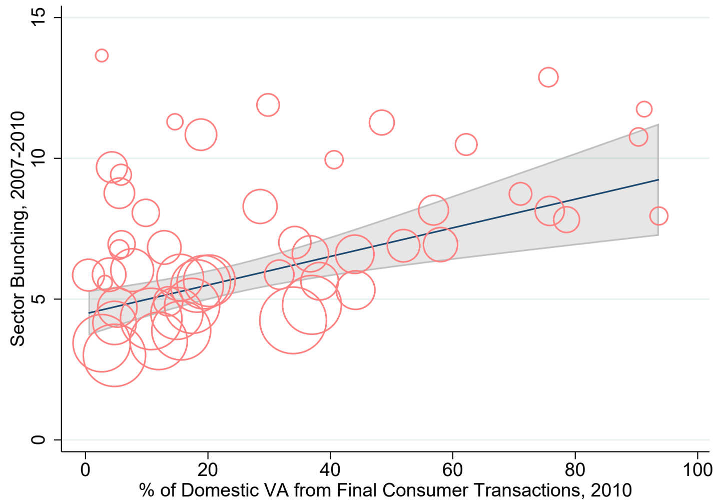
Figure 4: Provincial bunching correlates positively with local evasion



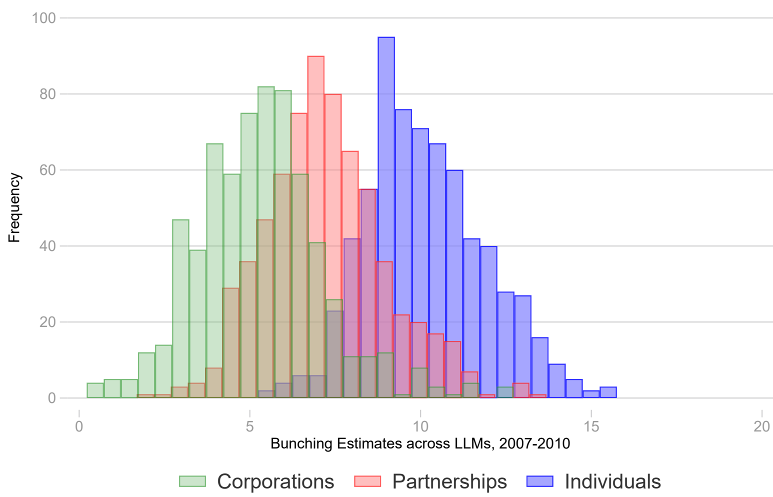
Notes: the Figure plots the standardized coefficients β and their 95% CIs from several regressions of SeS bunching on evasion proxies Evasion_i^j across 110 provinces i according to the model: $\text{Bunching}_i = \alpha + \beta \text{Evasion}_i^j + \gamma \log \text{VA pc}_i + \text{macroregion}_i + \varepsilon_i$. Standard errors are robust to heteroskedasticity. The sample includes each SeS file in the universe of single-sector businesses in the 2007-2010 tax years, except the top and bottom 5% in each province-level distribution that we trim to avoid irregularities in the estimation of the counterfactual. Bunching is computed at the province level following the procedure outlined in Section 4.2. Evasion proxies and their sources are described in Appendix C. The last three evasion proxies are the first principal components of the administrative-based, report-based, and all listed proxies, respectively. The first regression with our report-based proxies is weighted by the number of evasion reports from each province in 2008-2011.

Figure 5: Bunching tracks evasion potential: downstream sectors

Panel A: Correlation with share of sales to final consumers

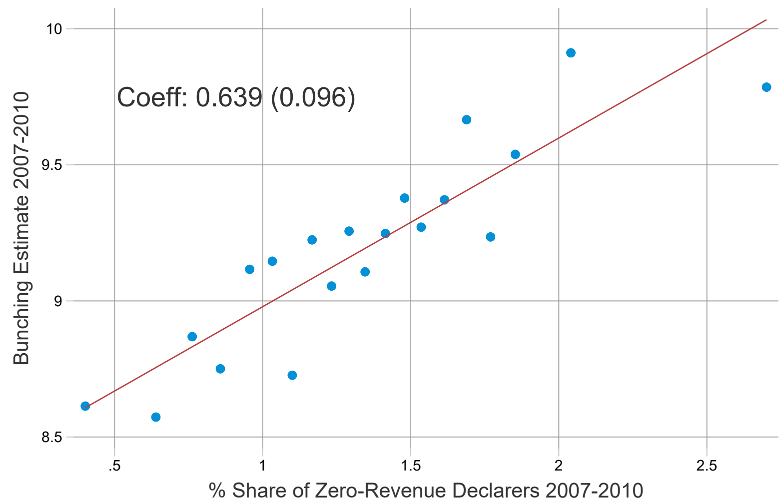


Panel B: Bunching across taxpayers with different legal complexity



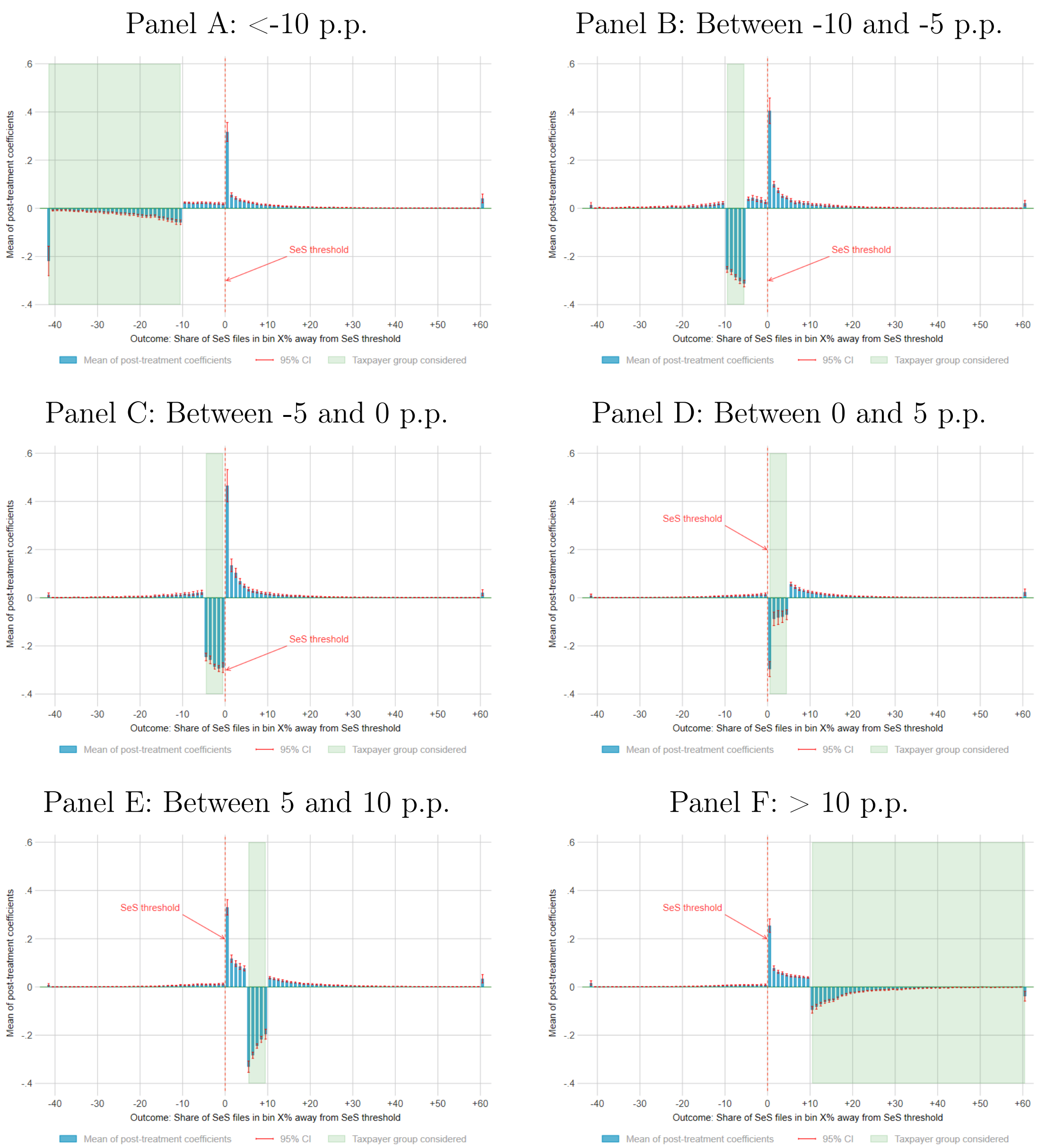
Notes: this Figure' Panel A shows the sector-level scatterplot and linear fit of the relation between 2007-2010 bunching and the degree of relative exposure to the final consumer in 2010. Exposure is defined as a business sector's share of domestic value added (in 2010 current prices) that is determined by final consumption (see details in Appendix B). The sample consists of 51 1-digit and 2-digit ATECO sectors that we find both in the SeS database and *ISTAT*'s 2010-2013 input-output tables. Some sectors in this sample consist of one or more 2-digit sectors in the SeS data, in which case bunching is a weighted average of the 2-digit sector's bunching estimate, with weights equal to the sectors' number of 2007-2010 SeS files. We weight sectors by the mean presumed revenues associated to their 2007-2010 SeS files. The shaded area corresponds to a 95% confidence interval. The slope coefficient (robust standard error) from the corresponding weighted regression is 5.085 (1.106). Panel B plots the distribution of 2007-2010 bunching estimates computed at the LLM-level, separately for individuals (individual businesses and self-employed individuals), partnerships, and corporations. SeS taxpayers face increasing reporting and book-keeping requirements, with accounting complexity rising from a relatively low level in individually-owned activities to a progressively higher level among partnerships and corporations. We exclude 4% of estimates that are negative or in the 99$^{\text{th}}$ percentile of the distribution.

Figure 6: Provincial bunching correlates positively with share of zero declarers



Notes: the Figure correlates LLM-level shares of zero-revenue declarers with local SeS bunching. A binned scatterplot reports the slope coefficient and robust standard error from a regression of the form $\text{Bunching}_i = \alpha + \beta\text{Share zero declarers}_i^j + \gamma \log(\text{PIT base per taxpayer}_i) + \text{region}_i + \varepsilon_i$, including regional fixed effects and the logarithm of the average local PIT-base per individual taxpayer. The share of zero declarers is computed as the 2007-2010 local labor market share of SeS filers reporting exactly zero revenues. It ranges from 0 to 4.7%. The sample includes each SeS file in the universe of single-sector businesses in the 2007-2010 tax years, except the top and bottom 5% in each LLM-level distribution that we trim to avoid irregularities in the estimation of the counterfactual. Bunching is computed at the LLM level following the procedure outlines in Section 4.2.

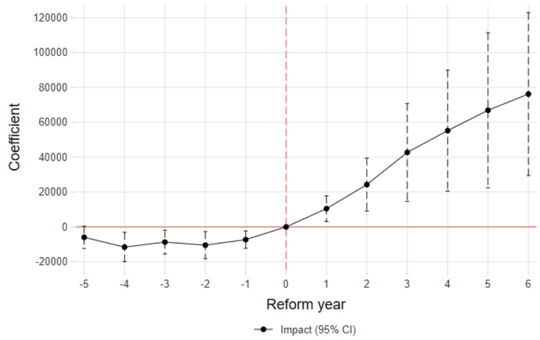
Figure 7: Reward regime-induced distribution shifts, by presumed revenues distance before the reform



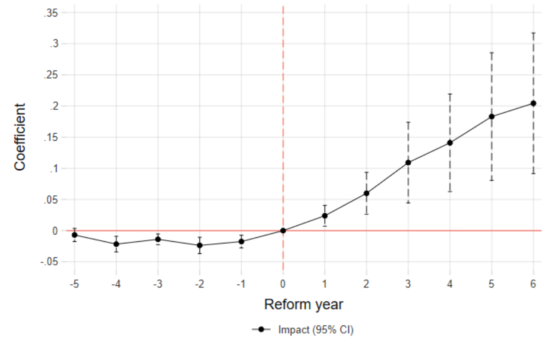
Notes: this Figure shows the effect of the reward regime on the average share of SeS files in bins of size one percentage point in presumed revenue terms. Each panel refers to one of six taxpayers' groups defined by their distance from the presumed revenue amount in the year before their sector's reform. The original location of each group is highlighted by the green band in each panel. Each bar represents the average of six group-specific post-treatment coefficients from an event-study based on the specification in (\ref{eq:eventstudy}). Whiskers represent 95% CIs of these linear combinations of coefficients. Standard errors are clustered at the sector level. The regressions are estimated on the sample of all SeS files from single-sector taxpayers continuously filing over the 2007-2016 period, aggregated by sector-year. Only sectors accessing the reward regime by 2016 are considered. Number of sector-years: 1550. Declared revenues are winsorized at the 99th percentile. Each panel represents a group of taxpayers defined as follows: taxpayers who reported revenues 10 p.p. or more below (Panel A), between 10 and 5 p.p. below (Panel B), between 5 and 0 excluded below (Panel C), between 0 and 5 p.p. above (Panel D), between 5 and 10 above (Panel E), and 10 p.p. or more above the presumed revenue amount the year before the reform (Panel F).

Figure 8: Reward regime effects on mean revenues and profits

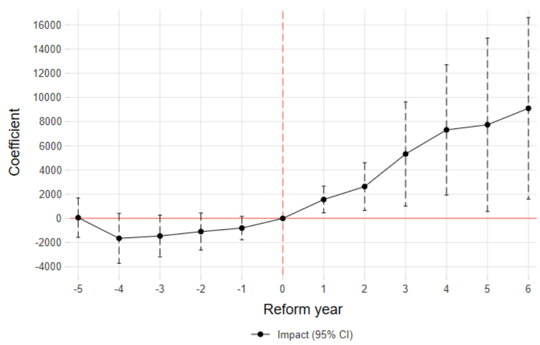
Panel A: Mean reported revenues



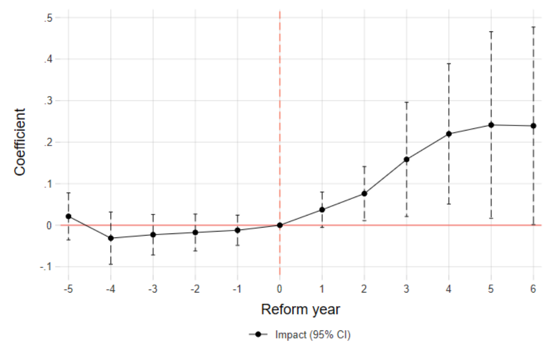
Panel B: Log-Mean reported revenues



Panel C: Mean reported income



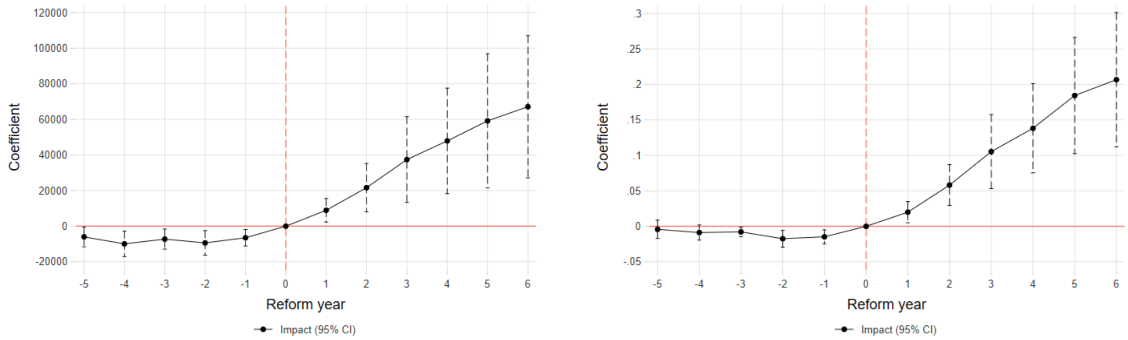
Panel D: Log-Mean reported income



Notes: this Figure shows the effects of the reward regime's introduction in a sector on mean reported revenues (Panels A and B) and mean gross profits (Panels C and D). Dependent variables are expressed in logarithms (left panels) or in Euro terms (right panels). Whiskers represent 95% CIs. Effects are relative to the year before the advent of the reform in each sector, marked at year 0 by the red dashed vertical line. Estimates are based on our event-study specification in (8). Standard errors are clustered at the sector level. The regressions are estimated on the sample of all Sector Study files from single-sector taxpayers continuously filing over the 2007-2016 period, aggregated by sector-year. Only sectors accessing the reward regime by 2016 are considered. Number of sector-years: 1550. Reported revenues are winsorized at the 99th percentile.

Figure 9: Reward regime effects on costs

Panel A: Mean reported costs   Panel B: Log-Mean reported log-costs



Notes: this Figure shows the effects of the reward regime's introduction in a sector on aggregate costs. Mean total costs are defined as the difference between reported revenues and gross profits, in logarithms and Euros, respectively. Whiskers represent 95% CIs. Effects are relative to the year before the advent of the reform in each sector, marked at year 0 by the red dashed vertical line. Estimates are based on our event-study specification in (8). Standard errors are clustered at the sector level. The regressions are estimated on the sample of all Sector Study files from single-sector taxpayers continuously filing over the 2007-2016 period, aggregated by sector-year. Only sectors accessing the reward regime by 2016 are considered. Number of sector-years: 1550. Reported revenues are winsorized at the 99th percentile.

Online Appendix

A Proofs of Propositions

Proof of Proposition 1

Declarations partition: A firm with income y solves

$$\max_d \left[\max\left\{u_H(y,d), u_L(y,d)\cdot \mathbb{I}(d>\hat{y})\right\}\right]$$

where

$$u_H(y,d) = y - \tau d - \tau\gamma p_H (y-d)^+ - \kappa c(y-d)$$
$$u_L(y,d) = y - \tau d - \tau\gamma p_L (y-d)^+ - \kappa c(y-d)$$

First notice that for all y, $u_i(y,d)$ is decreasing in d for $d \geq y$, so no firm over-reports. Maximizing $u_i(y,d)$ is the same as maximizing $\tilde{u}_i(e) = \tau(1-\gamma p_i)e - \kappa c(e)$. By concavity of the objective, an interior maximum is characterized by the FOC

$$c'(e) = \frac{\tau(1-\gamma p_i)}{\kappa}.$$

We denote e_i the solutions to these equations and use convexity of c to conclude that $e_L > e_H > 0$. We need to deal with corner cases. First, notice that $\tilde{u}_L(e)$ is valid only for declarations $d = y - e$ that lie above $\hat{y}$. Since for all e, $\tilde{u}_H(e) < \tilde{u}_L(e)$ then whenever e_L is feasible, i.e. $y - e_L > \hat{y}$ (and therefore $y > \hat{y} + e_L$) then it solves the firm's problem.

For firms with $y < \hat{y}$ all candidate declarations (recall that over-reporting is suboptimal) are in the H region. As $\tilde{u}_H(e)$ is increasing below e_H, whenever e_H is not feasible (*i.e.* when $y - e_H < 0$, with 0 being the lower bound on feasible declarations), then $e = y$ (*i.e.* $d = 0$) is optimal. When instead $y > e_H$, then $d = y - e_H$ is optimal.

We are only left with solving the problem for firms with income $y \in [\hat{y}, \hat{y} + e_L]$. For y in that range, $\hat{y} = \arg\max_d u_L(y,d)\cdot\mathbb{I}(d \geq \hat{y})$ since the unconstrained maximum $y - e_L$ occurs at a point where the function already dropped to 0 and the objective is decreasing in the feasible domain. The maximum of $\tilde{u}_H(e)$ is instead e_H as this is feasible (recall we assumed $e_H < \hat{y}$). To find the global optimum we therefore need to compare the utility of evading $y - \hat{y}$ and facing p_L and of evading e_H and facing p_H. The former dominates iff

$$\tilde{u}_L(y-\hat{y}) > \tilde{u}_H(e_H) \equiv V_H$$

Notice that the RHS is flat in y, while the LHS is contiunous and increasing from $\tilde{u}_L(0) < V_H$ to $V_L \equiv \tilde{u}_L(e_L) > V_H$ (the latter inequality following by a simple envelope argument). Therefore there is a unique crossing, which is characterized by

$$V_H = \tilde{u}_L(\tilde{e}),$$

which yields to the condition

$$\frac{\tau}{\kappa}\left[e_H(1-p_H\gamma) - \tilde{e}(1-p_L\gamma)\right] = c(e_H) - c(\tilde{e}).$$

Summarizing, firms declare 0 if $y < e_H$, declare $y - e_H$ if $y \in [e_H, \hat{y}+\tilde{e}]$, bunch at $\hat{y}$ if $y \in [\hat{y}+\tilde{e}, \hat{y}+e_L]$, and declare $y - e_L$ above $\hat{y}+e_L$. This solution is valid if the $e_H < \hat{y}+\tilde{e}$. Otherwise, the relevant deviation in the H region is to declare 0, there is no interior declarers in the H region and $\tilde{e}$ is defined by

$$(\hat{y}+\tilde{e}_0)\,\tau\,(1-p_H\gamma)-\kappa c\,(\hat{y}+\tilde{e}_0)=\tilde{e}_0\tau\,(1-p_L\gamma)-\kappa c\,(\tilde{e}_0)\,.$$

Comparative statics: We derive first the comparative statics for the three evasion levels $e_H, e_L, \tilde{e}$. The FOC for interior evasions is $c'(e_i)=\tilde{\tau}(1-\gamma p_i)$ for $i=H,L$, from which we have

$$\frac{\mathrm{d}e_i}{\mathrm{d}\tilde{\tau}}=\frac{1-\gamma p_i}{c''(e_i)}=\frac{c'(e_i)}{\tilde{\tau}c''(e_i)}>0.$$

Manipulating the equation that determines $\tilde{e}$ we obtain

$$\tilde{\tau}\left[e_H(1-p_H\gamma)-\tilde{e}(1-p_L\gamma)\right]=c(e_H)-c(\tilde{e})\,,$$

which using an envelope argument implies the following

$$e_H(1-p_H\gamma)-\tilde{e}(1-p_L\gamma)-\tilde{\tau}(1-p_L\gamma)\frac{\mathrm{d}\tilde{e}}{\mathrm{d}\tilde{\tau}}=-c'(\tilde{e})\frac{\mathrm{d}\tilde{e}}{\mathrm{d}\tilde{\tau}},$$

and rearranging delivers

$$\frac{\mathrm{d}\tilde{e}}{\mathrm{d}\tilde{\tau}}=\frac{e_H(1-p_H\gamma)-\tilde{e}(1-p_L\gamma)}{\tilde{\tau}(1-p_L\gamma)-c'(\tilde{e})}.$$

Using the FOC for e_L and the definition of $\tilde{e}$ yields

$$\frac{\mathrm{d}\tilde{e}}{\mathrm{d}\tilde{\tau}}=\frac{c(e_H)-c(\tilde{e})}{\tilde{\tau}(c'(e_L)-c'(\tilde{e}))}>0,$$

where the inequality follows from the fact that $e_L>e_H>\tilde{e}$ and from the fact that $c(\cdot)$ and $c'(\cdot)$ are increasing.

Notice that $M(0)=F(e_H)$, $M(\mathcal{L})=1-F(\hat{y}+e_L)$, $M(\mathcal{B})=F(\hat{y}+e_L)-F(\hat{y}+\tilde{e})$. The comparative statics of e_H, e_L then imply that $M(0)$ is decreasing and $M(\mathcal{L})$ is increasing in $\tilde{\tau}$, strictly if the areas are non-degenerate which requires, respectively, that e_H and $\hat{y}+e_L$ are below $\bar{y}$. This proves the first two statements in the comparative statics part of the Proposition.

For $M(\mathcal{B})$, a quantitative assessment is needed since both the upper bound and the lower bound of the region decrease in $\tilde{\tau}$. The change in the size of the bunching region caused by a change in $\tilde{\tau}$ is

$$\frac{\mathrm{d}M(\mathcal{B})}{\mathrm{d}\tilde{\tau}}=f(\hat{y}+e_L)\frac{\mathrm{d}e_L}{\mathrm{d}\tilde{\tau}}-f(\hat{y}+\tilde{e})\frac{\mathrm{d}\tilde{e}}{\mathrm{d}\tilde{\tau}}.$$

If $\hat{y}+e_L>\bar{y}$ (*i.e.* $M(\mathcal{L})=0$) then $f(\hat{y}+e_L)=0$ and $\frac{\mathrm{d}M(\mathcal{B})}{\mathrm{d}\tilde{\tau}}<0$ as only the lower-bound of the bunching area increases. Otherwise, the condition $\frac{\mathrm{d}M(\mathcal{B})}{\mathrm{d}\tilde{\tau}}>0$ is equivalent to

$$\frac{f(\hat{y}+e_L)}{f(\hat{y}+\tilde{e})}>\frac{\frac{\mathrm{d}\tilde{e}}{\mathrm{d}\tilde{\tau}}}{\frac{\mathrm{d}e_L}{\mathrm{d}\tilde{\tau}}}.$$

Since $M(\mathcal{L})$ is monotonically decreasing in $\tilde{\tau}$ the condition $M(\mathcal{L})>\bar{m}$ (stated in the Proposition) is equivalent to $\tilde{\tau}\leq\bar{\tau}$ for $\bar{\tau}$ such that $M(\mathcal{L})(\bar{\tau})=\bar{m}$. Hence, we equivalently prove that the inequality is satisfied as $\tilde{\tau}$ vanishes, which is

$$\lim_{\tilde{\tau}\to 0}\frac{f(\hat{y}+e_L)}{f(\hat{y}+\tilde{e})}>\lim_{\tilde{\tau}\to 0}\frac{\frac{\mathrm{d}\tilde{e}}{\mathrm{d}\tilde{\tau}}}{\frac{\mathrm{d}e_L}{\mathrm{d}\tilde{\tau}}}.$$

Using the FOC we get that $\lim_{\tilde{\tau}\to 0} c'(e_i) = 0$, implying that e_L, e_H (and a fortiori $\tilde{e}$ which is bounded above by both) converge to zero. This implies that $\lim_{\tilde{\tau}\to 0} \frac{f(\hat{y}+e_L)}{f(\hat{y}+\tilde{e})} = 1$. Regarding the right hand side, we show that its limit converges to a number below 1 by contradiction. We know that for all $\tilde{\tau} > 0$, $0 < \tilde{e}(\tilde{\tau}) < e_L(\tilde{\tau})$. Given its definition, $\frac{\mathrm{d}e_L}{\mathrm{d}\tilde{\tau}}$ is bounded as long as $c''(0) > 0$. Since $e_L > \tilde{e}$, by the fundamental theorem of calculus, $\frac{\mathrm{d}\tilde{e}}{\mathrm{d}\tilde{\tau}}$ is also bounded. Because both $\frac{\mathrm{d}e_L}{\mathrm{d}\tilde{\tau}}$ and $\frac{\mathrm{d}\tilde{e}}{\mathrm{d}\tilde{\tau}}$ are bounded and well-behaved, $\frac{\frac{\mathrm{d}}{\mathrm{d}\tilde{\tau}}\tilde{e}}{\frac{\mathrm{d}}{\mathrm{d}\tilde{\tau}}e_L}$ has a limit a. Suppose $a > 1$, then there would exist $\underline{\tau} > 0$ such that $\forall \tilde{\tau} \in [0, \underline{\tau}]$, $\frac{\frac{\mathrm{d}}{\mathrm{d}\tilde{\tau}}\tilde{e}}{\frac{\mathrm{d}}{\mathrm{d}\tilde{\tau}}e_L} > 1$, which in turns implies that

$$\tilde{e}(\underline{\tau}) = \tilde{e}(0) + \int_0^{\underline{\tau}} \frac{\mathrm{d}}{\mathrm{d}\tilde{\tau}}\tilde{e}(\tilde{\tau})\,\mathrm{d}\tilde{\tau} > e_L(0) + \int_0^{\underline{\tau}} \frac{\mathrm{d}}{\mathrm{d}\tilde{\tau}}e_L(\tilde{\tau})\,\mathrm{d}\tilde{\tau} = e_L(\underline{\tau}).$$

This is however a contradiction. Hence, it must be that $a < 1$ and that $\lim_{\tilde{\tau}\to 0} \frac{\frac{\mathrm{d}\tilde{e}}{\mathrm{d}\tilde{\tau}}}{\frac{\mathrm{d}e_L}{\mathrm{d}\tilde{\tau}}} < 1$.

Proof of Proposition 3

Using the thesholds on income defined in Proposition 1, we define total revenues as follows

$$R(\Delta) = \int_{y^{0H}}^{y^{HB}} d^H(y) f(y)\,\mathrm{d}y + \int_{y^{HB}}^{y^{BL}} \hat{y} f(y)\,\mathrm{d}y + \int_{y^{BL}}^{\bar{y}} d^L(y) f(y)\,\mathrm{d}y$$

so marginal revenues are

$$\begin{aligned}
\frac{\mathrm{d}R(\Delta)}{\mathrm{d}\Delta} &= -\frac{\mathrm{d}y^{0H}}{\mathrm{d}\Delta}\left[d^H\left(y^{0H}\right)\right] f\left(y^{0H}\right) + \frac{\mathrm{d}y^{HB}}{\mathrm{d}\Delta}\left[d^H\left(y^{HB}\right) - \hat{y}\right] f\left(y^{HB}\right) = \\
&+ \frac{\mathrm{d}y^{BL}}{\mathrm{d}\Delta}\left[\hat{y} - d^L\left(y^{BL}\right)\right] f\left(y^{BL}\right) + \int_{y^{0H}}^{y^{HB}} \frac{\mathrm{d}}{\mathrm{d}\Delta} d^H(y) f(y)\,\mathrm{d}y + \\
&+ \int_{y^{BL}}^{\bar{y}} \frac{\mathrm{d}}{\mathrm{d}\Delta} d^L(y) f(y)\,\mathrm{d}y \\
&= \overbrace{\underbrace{\frac{\mathrm{d}y^{HB}}{\mathrm{d}\Delta}}_{<0}\left[\underbrace{d^H\left(y^{HB}\right) - \hat{y}}_{<0}\right]}^{>0} f\left(y^{HB}\right) + M(\mathcal{H})\underbrace{\frac{\mathrm{d}}{\mathrm{d}\Delta}d^H(y)}_{>0} + M(\mathcal{L})\underbrace{\frac{\mathrm{d}}{\mathrm{d}\Delta}d^L(y)}_{<0}
\end{aligned}$$

where the last equality exploits the fact that $d^H\left(y^{0H}\right) = 0$ and $d^L\left(y^{BL}\right) = \hat{y} + e_L$ by definition, that for a given cost function $\frac{\mathrm{d}}{\mathrm{d}\Delta}d^H(y)$ and $\frac{\mathrm{d}}{\mathrm{d}\Delta}d^L(y)$ are constant across ys, and defines $M(\mathcal{H}) = F\left(y^{HB}\right) - F\left(y^{0H}\right)$ and $M(\mathcal{L}) = 1 - F\left(y^{BL}\right)$. To obtain the expression in the statement, notice furher that

$$d^H\left(y^{HB}\right) - \hat{y} = y^{HB} - e_H - \hat{y} = \hat{y} + \tilde{e} - e_H - \hat{y} = \tilde{e} - e_H$$

and

$$\frac{\mathrm{d}y^{HB}}{\mathrm{d}\Delta} = \frac{\mathrm{d}\tilde{e}}{\mathrm{d}\Delta}$$

Proof of Theorem 4

We prove the Theorem by proving the following two Lemmas.

Lemma 7. *The change in the threshold y^{HB} induced by a marginal increase in Δ is*

$$\frac{dy^{HB}}{d\Delta} = -\frac{\tau\gamma\left[\tilde{e}\left(\Delta\right)+\alpha e_H\right]}{\tau\gamma\left(p_H-p_L\right)+c'\left(e_H\right)-c'\left(\tilde{e}\left(\Delta\right)\right)}, \tag{A.1}$$

and

$$\lim_{\Delta\to 0}\frac{dy^{HB}}{d\Delta} = -\infty$$

Proof. From the indifference condition we have $V^H\left(y^{HB}, d^H\left(y^{HB}\right)\right) = V^L\left(y^{HB}, \hat{y}\right)$ that solves

$$V^H\left(y\right) \equiv \max_d \left(y-d\right)\tau\left(1-\gamma p_H\left(\Delta\right)\right) - c\left(y-d\right) = \left(y-\hat{y}\right)\tau\left(1-\gamma p_L\left(\Delta\right)\right) - c\left(y-\hat{y}\right) \equiv V^B\left(y\right).$$

So, we want $\frac{\mathrm{d}y^{HB}}{\mathrm{d}\Delta}$ where y^{HB} solves $V^H\left(y\right)-V^B\left(y\right) = g\left(y,\Delta\right) = 0$. Hence,

$$\frac{\mathrm{d}}{\mathrm{d}\Delta}y^{HB} = -\frac{\frac{\partial}{\partial\Delta}g\left(y,\Delta\right)}{\frac{\partial}{\partial y}g\left(y,\Delta\right)},$$

and

$$\begin{aligned}\frac{\partial}{\partial\Delta}g\left(y,\Delta\right) &= \frac{\partial}{\partial\Delta}\left[V^H\left(y\right)-V^B\left(y\right)\right] = -\tau\gamma\frac{\partial p_H}{\partial\Delta}\left(y-d\right)+\tau\gamma\frac{\partial p_L}{\partial\Delta}\left(y-\hat{y}\right)\\ &= \tau\gamma\left[\frac{\partial p_L}{\partial\Delta}\left(y-\hat{y}\right)-\frac{\partial p_H}{\partial\Delta}\left(y-d\right)\right] < 0.\end{aligned}$$

It follows that $\frac{\mathrm{d}}{\mathrm{d}\Delta}y^{HB} \propto \frac{\partial}{\partial y}g\left(y,\Delta\right)$, which is

$$\begin{aligned}\frac{\partial}{\partial y}g\left(y,\Delta\right) &= \frac{\partial}{\partial y}\left[V^H\left(y\right)-V^B\left(y\right)\right] = \tau\left(1-\gamma p_H\right)-c'\left(y-d\right)-\left[\tau\left(1-\gamma p_L\right)-c'\left(y-\hat{y}\right)\right]\\ &= \tau\left(1-\gamma p_H-1+\gamma p_L\right)+c'\left(y-\hat{y}\right)-c'\left(y-d\right)\\ &= -\tau\gamma\left(p_H-p_L\right)+c'\left(y-\hat{y}\right)-c'\left(y-d\right)\end{aligned}$$

Evaluating at $y = y^{HB}$, $d = d^{HB}$ we get

$$\left.\frac{\partial}{\partial y}g\left(y,\Delta\right)\right|_{y=y^{HB}} = -\tau\gamma\left(p_H-p_L\right)+c'\left(y^{HB}-\hat{y}\right)-c'\left(y^{HB}-d^{HB}\right)$$

we know that $\tilde{e} = y^{HB}-\hat{y}$ and $e_H = y^{HB}-d^{HB}$, and that $c'\left(\tilde{e}\right)-c'\left(e_H\right) < 0$ since $e_H > \tilde{e}$ and costs are convex. The expression for the comparative statics is

$$\begin{aligned}\frac{\mathrm{d}}{\mathrm{d}\Delta}y^{HB} &= -\frac{\tau\gamma\left[\frac{\partial p_L}{\partial\Delta}\left(y-\hat{y}\right)-\frac{\partial p_H}{\partial\Delta}\left(y-d\right)\right]}{-\tau\gamma\left(p_H-p_L\right)+c'\left(y^{HB}-\hat{y}\right)-c'\left(y^{HB}-d^{HB}\right)}\\ &= -\frac{\tau\gamma\left[\tilde{e}\left(\Delta\right)+\alpha e_H\right]}{\tau\gamma\left(p_H-p_L\right)+c'\left(e_H\right)-c'\left(\tilde{e}\left(\Delta\right)\right)},\end{aligned}$$

where the second equality uses the definitions of $\tilde{e}$ and e_H, and the fact that $\frac{\partial p_H}{\partial\Delta} = \alpha$ and $\frac{\partial p_L}{\partial\Delta} = -1$. Because both the numerator and denominator are positive, we obtain $\frac{\mathrm{d}}{\mathrm{d}\Delta}y^{HB} < 0$. In addition, we have

$$\lim_{\Delta\to 0}\frac{\mathrm{d}}{\mathrm{d}\Delta}y^{HB} = -\infty$$

because of the following: 1) $\lim_{\Delta\to 0}\frac{\partial}{\partial\Delta}g(y,\Delta)\neq 0$ because $\frac{\partial p_L}{\partial\Delta},\frac{\partial p_H}{\partial\Delta}\neq 0$ and $y^{HB}\neq\hat{y}$ because $y^{HB}\to y^{BL}$ and y^{BL} solves $d^L\left(y^{BL}\right)=\hat{y}$ and therefore $y^{BL}>\hat{y}$; and 2) $\lim_{\Delta\to 0}\frac{\partial}{\partial y}g(y,\Delta)=0$ because $\lim_{\Delta\to 0}p_H-p_L=0$, $d^{HB}\to\hat{y}$ as we prove below, and costs (and marginal costs) are continuous functions, which implies that $\lim_{\Delta\to 0}c'(e_H)-c'(\tilde{e}(\Delta))=0$.

We are left to prove that $\lim_{\Delta\to 0}d^H\left(y^{HB}\right)-\hat{y}=0$. To do that, recall that $V^H\left(y^{HB},d^H\left(y^{HB}\right)\right)=V^L\left(y^{HB},\hat{y}\right)$ since $V^H\to V^L$ as a function (because $p_L\to p_H\to\mu$), then the equality can be satisfied only if $d^H\left(y^{HB}\right)=\hat{y}$. ☐

Lemma 8. *The limit of the bunching component of marginal revenues for $\Delta\to 0$ is finite and reads*

$$\lim_{\Delta\to 0}\frac{\partial y^{HB}}{\partial\Delta}\left[d^H\left(y^{HB}\right)-\hat{y}\right]f\left(y^{HB}\right)=\frac{\tau\gamma(1+\alpha)e^I(\mu)}{c''\left(e^I(\mu)\right)}f\left(\hat{y}+e^I(\mu)\right)$$

Proof. Using (A.1), we have

$$\frac{\partial y^{HB}}{\partial\Delta}\left[d^H\left(y^{HB}\right)-\hat{y}\right]=-\frac{\tau\gamma\left[\frac{\partial p_L}{\partial\Delta}(y-\hat{y})-\frac{\partial p_H}{\partial\Delta}\left(y-d^H\left(y^{HB}\right)\right)\right]\left(\hat{y}-d^H\left(y^{HB}\right)\right)}{-\tau\gamma(p_H-p_L)+c'(\tilde{e})-c'(e_H)}$$

as $\Delta\to 0$ both the numerator and the denominator go to 0. Since

$$\tau\gamma\left[\frac{\partial p_L}{\partial\Delta}\left(y^{HB}-\hat{y}\right)-\frac{\partial p_H}{\partial\Delta}\left(y^{HB}-d^{HB}\right)\right]=-\tau\gamma(e_H+\alpha\tilde{e})$$

converges to a (negative) number $-\tau\gamma e^I(\mu)(1+\alpha)$, we use the L'Hospital rule to conclude

$$\begin{aligned}\lim_{\Delta\to 0}\frac{\partial y^{HB}}{\partial\Delta}\left[d^H\left(y^{HB}\right)-\hat{y}\right]f\left(y^{HB}\right)&=\tau\gamma e^I(\mu)(1+\alpha)\lim_{\Delta\to 0}\frac{\frac{\mathrm{d}}{\mathrm{d}\Delta}e_H-\frac{\mathrm{d}}{\mathrm{d}\Delta}\tilde{e}}{\frac{\mathrm{d}}{\mathrm{d}\Delta}\tau\gamma(p_H-p_L)+\frac{\mathrm{d}}{\mathrm{d}\Delta}\left\{c'(e_H)-c'(\tilde{e})\right\}}\\&=\tau\gamma e^I(\mu)(1+\alpha)\lim_{\Delta\to 0}\frac{\frac{\mathrm{d}}{\mathrm{d}\Delta}e_H-\frac{\mathrm{d}}{\mathrm{d}\Delta}\tilde{e}}{\frac{\mathrm{d}}{\mathrm{d}\Delta}\tau\gamma(p_H-p_L)+\frac{\mathrm{d}}{\mathrm{d}\Delta}e_Hc''(e_H)-\frac{\mathrm{d}}{\mathrm{d}\Delta}\tilde{e}c''(\tilde{e})}\\&=\tau\gamma e^I(\mu)(1+\alpha)\lim_{\Delta\to 0}\frac{-\frac{\mathrm{d}}{\mathrm{d}\Delta}\tilde{e}}{-\frac{\mathrm{d}}{\mathrm{d}\Delta}\tilde{e}c''(\tilde{e})}=\tau\gamma e^I(\mu)(1+\alpha)\frac{1}{c''(\tilde{e})}\end{aligned}$$

where we used that

$$\frac{\mathrm{d}}{\mathrm{d}\Delta}\tau\gamma(p_H-p_L)=\tau\gamma(\alpha+1)$$

and the fact that, local to 0, $\frac{\mathrm{d}}{\mathrm{d}\Delta}\tilde{e}$ diverges (Lemma 7) while

$$\frac{\mathrm{d}e_H}{\mathrm{d}\Delta}=-\frac{\gamma\tau\frac{\mathrm{d}p_H}{\mathrm{d}\Delta}}{c''\left(e^I(p_H)\right)}=-\frac{\gamma\tau\alpha}{c''(e_H)}\to-\frac{\gamma\tau\alpha}{c''\left(e^I(\mu)\right)}$$

remains bounded. ☐

Putting the results of Lemmata 7 and 8 together, we obtain

$$
\begin{aligned}
\lim_{\Delta\to 0} R'(\Delta) &= \frac{\tau\gamma(1+\alpha)\, e^I(\mu)}{c''(e^I(\mu))} f\left(y^{HB}\right) - \left(1 - F\left(\hat{y} + e^I(\mu)\right)\right) \frac{\tau\gamma}{c''(e^I(\mu))} \\
&\quad + \left[F\left(\hat{y} + e^I(\mu)\right) - F\left(e^I(\mu)\right)\right] \frac{\tau\gamma\alpha}{c''(e^I(\mu))} \\
&= \frac{\tau\gamma}{c''(e^I(\mu))} \left[(1+\alpha)\left[e^I(\mu) f\left(\hat{y} + e^I(\mu)\right) - \left(1 - F\left(\hat{y} + e^I(\mu)\right)\right)\right] + \alpha\left[1 - F\left(e^I(\mu)\right)\right]\right]
\end{aligned}
$$

which, in the case $\alpha = 0$ simplifies to

$$
e^I(\mu) f\left(\hat{y} + e^I(\mu)\right) - \left(1 - F\left(\hat{y} + e^I(\mu)\right)\right).
$$

Therefore, if

$$
e^I(\mu) > \frac{1 - F\left(\hat{y} + e^I(\mu)\right)}{f\left(\hat{y} + e^I(\mu)\right)} \tag{A.2}
$$

then marginally decreasing the audit probability for declarations above $\hat{y}$ improves revenues. Since the number of audits run also decreases (by quantity $1 - F\left(\hat{y} + e^I(\mu)\right)$), we have our desideratum.

Corollary 5 follows from the fact that $h(y) = \frac{1-F(y)}{f(y)}$ decreases to zero as y approaches $\bar{y}$. This implies that, if the authority is given a flat rule μ, they can always set a threshold such that a marginal increase in the probability of audit above the threshold raises revenues.

Proof of Theorem 6

The proof relies on the following fact

Lemma 9. *If $f\left(\hat{y} + e^I(\mu)\right) + e^I(\mu) \cdot f'\left(\hat{y} + e^I(\mu)\right) > 0$, then $\lim_{\Delta\to 0} R''(\Delta) = -\infty$.*

Proof. The proof is conceptually simple (we directly differentiate the marginal revenue function), but involves many algebraic steps. We express

$$
MR(\Delta) = B(\Delta) + L(\Delta) + H(\Delta)
$$

where

$$
\begin{aligned}
B(\Delta) &= -\frac{\mathrm{d}\tilde{e}(\Delta)}{\mathrm{d}\Delta} \cdot \left(e^I(\mu) - \tilde{e}(\Delta)\right) \cdot f\left(\hat{y} + \tilde{e}(\Delta)\right) \\
L(\Delta) &= -\frac{\mathrm{d}e_L(\Delta)}{\mathrm{d}\Delta} \cdot \left(1 - F\left(\hat{y} + e_L(\Delta)\right)\right) \\
H(\Delta) &= -\frac{\mathrm{d}e_H(\Delta)}{\mathrm{d}\Delta} \cdot \left(F\left(\hat{y} + \tilde{e}(\Delta)\right) - F\left(e_H(\Delta)\right)\right).
\end{aligned}
$$

By direct differentiation,

$$
H'(\Delta) = -\left(\frac{\mathrm{d}^2 e_H(\Delta)}{\mathrm{d}\Delta^2} \cdot \left(F\left(\hat{y} + \tilde{e}(\Delta)\right) - F\left(e_H(\Delta)\right)\right) - \left(\frac{\mathrm{d}e_H(\Delta)}{\mathrm{d}\Delta}\right)^2 f\left(e_H(\Delta)\right) + \frac{\mathrm{d}e_H(\Delta)}{\mathrm{d}\Delta}\frac{\mathrm{d}\tilde{e}(\Delta)}{\mathrm{d}\Delta} f\left(\hat{y} + \tilde{e}(\Delta)\right)\right)
$$

from which we obtain

$$\frac{\mathrm{d}^2 R}{\mathrm{d}\Delta^2} = -\left(\frac{\mathrm{d}^2\tilde{e}(\Delta)}{\mathrm{d}\Delta^2}\cdot\left(e^I(\mu)-\tilde{e}(\Delta)\right)\cdot f(\hat{y}+\tilde{e}(\Delta)) - \left(\frac{\mathrm{d}\tilde{e}(\Delta)}{\mathrm{d}\Delta}\right)^2 f(\hat{y}+\tilde{e}(\Delta))\right.$$
$$\left. + \left(\frac{\mathrm{d}\tilde{e}(\Delta)}{\mathrm{d}\Delta}\right)^2\left(e^I(\mu)-\tilde{e}(\Delta)\right)\cdot f'(\hat{y}+\tilde{e}(\Delta))\right)$$
$$-\left(\frac{\mathrm{d}^2 e_L(\Delta)}{\mathrm{d}\Delta^2}\cdot\left(1-F(\hat{y}+e_L(\Delta))\right) - \left(\frac{\mathrm{d}e_L(\Delta)}{\mathrm{d}\Delta}\right)^2 f(\hat{y}+e_L(\Delta))\right)$$
$$-\left(\frac{\mathrm{d}^2 e_H(\Delta)}{\mathrm{d}\Delta^2}\cdot\left(F(\hat{y}+\tilde{e}(\Delta))-F(e_H(\Delta))\right) - \left(\frac{\mathrm{d}e_H(\Delta)}{\mathrm{d}\Delta}\right)^2 f(e_H(\Delta)) + \frac{\mathrm{d}e_H(\Delta)}{\mathrm{d}\Delta}\frac{\mathrm{d}\tilde{e}(\Delta)}{\mathrm{d}\Delta} f(\hat{y}+\tilde{e}(\Delta))\right). \tag{A.3}$$

Then, differentiating (A.1) we obtain

$$\lim_{\Delta\to 0}\frac{\mathrm{d}^2\tilde{e}(\Delta)}{\mathrm{d}\Delta^2} = \lim_{\Delta\to 0} -\frac{\frac{\mathrm{d}\tilde{e}}{\mathrm{d}\Delta}\tau\gamma\left[\tau\gamma\Delta(\alpha+1)+c'(e_H)-c'(\tilde{e}(\Delta))+c''(\tilde{e})\left[\tilde{e}(\Delta)+\alpha e_H\right]\right]}{\left[\tau\gamma\Delta(\alpha+1)+c'(e_H)-c'(\tilde{e}(\Delta))\right]^2}$$

using that $\frac{\mathrm{d}^2 e_i(\Delta)}{\mathrm{d}\Delta^2}$, $\frac{\mathrm{d}e_i(\Delta)}{\mathrm{d}\Delta}$ are bounded (by c''', c'', respectively) in the limit as $\Delta\to 0$ the second derivative (A.3) evaluates to

$$\frac{\mathrm{d}^2 R}{\mathrm{d}\Delta^2} = -\left(\frac{\mathrm{d}^2\tilde{e}(\Delta)}{\mathrm{d}\Delta^2}\cdot\left(e_H-\tilde{e}(\Delta)\right)\cdot f(\hat{y}+\tilde{e}(\Delta)) - \left(\frac{\mathrm{d}\tilde{e}(\Delta)}{\mathrm{d}\Delta}\right)^2 f(\hat{y}+\tilde{e}(\Delta))\right.$$
$$\left. + \left(\frac{\mathrm{d}\tilde{e}(\Delta)}{\mathrm{d}\Delta}\right)^2\left(e_H-\tilde{e}(\Delta)\right)\cdot f'(\hat{y}+\tilde{e}(\Delta))\right)$$
$$-\left(\frac{\mathrm{d}e_H(\Delta)}{\mathrm{d}\Delta}\frac{\mathrm{d}\tilde{e}(\Delta)}{\mathrm{d}\Delta} f(\hat{y}+\tilde{e}(\Delta))\right)$$

By substituting, we obtain that

$$\frac{\mathrm{d}^2 R}{\mathrm{d}\Delta^2} = A^2\left(B_1+B_2+B_3+B_4+B_5\right)$$

where

$$A = \frac{\tau\gamma}{\tau\gamma\Delta(\alpha+1)+c'(e_H)-c'(\tilde{e}(\Delta))},$$
$$B_1 = -\left[\tilde{e}(\Delta)+\alpha e_H\right](1+\alpha)\,\tilde{e}(\Delta)\cdot f(\hat{y}+\tilde{e}(\Delta))$$

$$B_2 = \left(\tilde{e}(\Delta)+\alpha e_H\right)^2 f(\hat{y}+\tilde{e}(\Delta))$$
$$B_3 = -(\alpha+1)\left[\tilde{e}(\Delta)+\alpha e_H\right]\left(e_H-\tilde{e}(\Delta)\right)\cdot f(\hat{y}+\tilde{e}(\Delta))$$
$$B_4 = -\left(\tau\gamma\Delta(\alpha+1)+c'(e_H)-c'(\tilde{e}(\Delta))\right)\left(\tilde{e}(\Delta)+\alpha e_H\right)\left(\frac{(1+\alpha)\,\tilde{e}(\Delta)}{c''(\tilde{e}(\Delta))}\right)\cdot f'(\hat{y}+\tilde{e}(\Delta))$$
$$B_5 = -\left(\tau\gamma\Delta(\alpha+1)+c'(e_H)-c'(\tilde{e}(\Delta))\right)\frac{\alpha}{c''(e_H(\Delta))}\left[\tilde{e}(\Delta)+\alpha e_H\right] f(\hat{y}+\tilde{e}(\Delta))$$

where clearly $\lim_{\Delta\to 0} A = \infty$ and

$$\begin{aligned}
\lim_{\Delta\to 0} A\left(B_1+B_2\right) &= \lim_{\Delta\to 0}\left(\frac{\tau\gamma}{\tau\gamma\Delta\left(\alpha+1\right)+c'\left(e_H\right)-c'\left(\tilde{e}\left(\Delta\right)\right)}\right)\left(\alpha\left[\tilde{e}\left(\Delta\right)+\alpha e_H\right]\left(e_H-\tilde{e}\left(\Delta\right)\right)\right)f\left(\hat{y}+\tilde{e}\left(\Delta\right)\right)\\
&= \frac{\tau\gamma\alpha\left(1+\alpha\right)}{c''\left(e^I\left(\mu\right)\right)}e^I\left(\mu\right)f\left(\hat{y}+e^I\left(\mu\right)\right)\\
\lim_{\Delta\to 0} A\left(B_3\right) &= -\lim_{\Delta\to 0}\left(\frac{\tau\gamma}{\tau\gamma\Delta\left(\alpha+1\right)+c'\left(e_H\right)-c'\left(\tilde{e}\left(\Delta\right)\right)}\right)\left(\alpha+1\right)\left[\tilde{e}\left(\Delta\right)+\alpha e_H\right]\left(e_H-\tilde{e}\left(\Delta\right)\right)\cdot f\left(\hat{y}+\tilde{e}\left(\Delta\right)\right)\\
&= -\frac{\tau\gamma\left(\alpha+1\right)^2}{c''\left(e^I\left(\mu\right)\right)}e^I\left(\mu\right)\cdot f\left(\hat{y}+e^I\left(\mu\right)\right)\\
\lim_{\Delta\to 0} A\left(B_4\right) &= -\tau\gamma\frac{\left(1+\alpha\right)^2e^2\left(\mu\right)}{c''\left(e^I\left(\mu\right)\right)}\cdot f'\left(\hat{y}+e^I\left(\mu\right)\right)\\
\lim_{\Delta\to 0} A\left(B_5\right) &= -\tau\gamma\frac{\alpha\left(1+\alpha\right)}{c''\left(e^I\left(\mu\right)\right)}e^I\left(\mu\right)f\left(\hat{y}+e^I\left(\mu\right)\right).
\end{aligned}$$

As $\lim\sqrt{A}\left(B_1+B_2\right)+\lim\sqrt{A}\left(B_5\right)=0$ we have

$$\begin{aligned}
\lim\sqrt{A}B = \lim\sqrt{A}\left(B_3\right)+\lim\sqrt{A}\left(B_4\right) &= -\frac{\tau\gamma\left(\alpha+1\right)^2}{c''\left(e^I\left(\mu\right)\right)}e^I\left(\mu\right)\cdot f\left(\hat{y}+e^I\left(\mu\right)\right)-\tau\gamma\frac{\left(1+\alpha\right)^2e^2\left(\mu\right)}{c''\left(e^I\left(\mu\right)\right)}\cdot f'\left(\hat{y}+e^I\left(\mu\right)\right)\\
&= -\frac{\tau\gamma\left(\alpha+1\right)^2e^I\left(\mu\right)}{c''\left(e^I\left(\mu\right)\right)}\left(f\left(\hat{y}+e^I\left(\mu\right)\right)+e^I\left(\mu\right)\cdot f'\left(\hat{y}+e^I\left(\mu\right)\right)\right).
\end{aligned}$$

which gives the desideratum. □

Lemma 9 identifies a sufficient condition to have concavity at (and, by continuity, in a neighborhood of) 0. If μ is small, this means the function is concave in the relevant domain $[0,\mu]$. As marginal revenues are decreasing, observing a positive increment in the reward system means the pre-reward system performs better than the flat rule μ. Define the budget function Q as the mapping from an audit rule to the share of audited taxpayers, given by

$$\begin{aligned}
Q &= \left(\mu+\alpha\Delta\right)F\left(y^{HB}\right)+\left(\mu-\Delta\right)\left[1-F\left(y^{HB}\right)\right] \qquad \text{(A.4)}\\
&= \left(\mu+\alpha\Delta\right)F\left(\hat{y}+\tilde{e}\left(\Delta\right)\right)+\left(\mu-\Delta\right)\left[1-F\left(\hat{y}+\tilde{e}\left(\Delta\right)\right)\right].
\end{aligned}$$

We have

Lemma 10. *If $\alpha < \frac{1}{F(\hat{y}+e(\mu))}-1$ then $\lim_{\Delta\to 0}\frac{dQ}{d\Delta}<0$, that is a local perturbation of the flat audit rule saves budget.*

Proof. Differentiating (A.4),

$$\begin{aligned}
\frac{\mathrm{d}Q}{\mathrm{d}\Delta} &= \alpha F\left(\hat{y}+\tilde{e}\left(\Delta\right)\right)+\left(\mu+\alpha\Delta\right)\frac{\mathrm{d}\tilde{e}}{\mathrm{d}\Delta}f\left(\hat{y}+\tilde{e}\left(\Delta\right)\right)-\left[1-F\left(\hat{y}+\tilde{e}\left(\Delta\right)\right)\right]-\left(\mu-\Delta\right)\frac{\mathrm{d}\tilde{e}}{\mathrm{d}\Delta}f\left(\hat{y}+\tilde{e}\left(\Delta\right)\right)\\
&= \alpha F\left(\hat{y}+\tilde{e}\left(\Delta\right)\right)-\left[1-F\left(\hat{y}+\tilde{e}\left(\Delta\right)\right)\right]+\left(\alpha+1\right)\Delta\frac{\mathrm{d}\tilde{e}}{\mathrm{d}\Delta}f\left(\hat{y}+\tilde{e}\left(\Delta\right)\right)
\end{aligned}$$

so

$$\lim_{\Delta\to 0}\frac{\mathrm{d}Q}{\mathrm{d}\Delta} = \alpha F\left(\hat{y}+e\left(\mu\right)\right)-\left[1-F\left(\hat{y}+e\left(\mu\right)\right)\right]+\left(\alpha+1\right)f\left(\hat{y}+e\left(\mu\right)\right)\lim_{\Delta\to 0}\Delta\frac{\mathrm{d}\tilde{e}}{\mathrm{d}\Delta} \qquad \text{(A.5)}$$

finally,

$$\begin{aligned}
\lim_{\Delta \to 0} \Delta \frac{\mathrm{d}\tilde{e}}{\mathrm{d}\Delta} &= \lim_{\Delta \to 0} -\frac{\Delta \tau\gamma \left[\tilde{e}\left(\Delta\right) + \alpha e\left(p_H\right)\right]}{\tau\gamma\Delta\left(\alpha+1\right) + c'\left(e\left(p_H\right)\right) - c'\left(\tilde{e}\left(\Delta\right)\right)} \\
&= \lim_{\Delta \to 0} -\frac{\tau\gamma\left[\tilde{e}\left(\Delta\right) + \alpha e\left(p_H\right)\right] + \Delta\tau\gamma\left(\frac{\mathrm{d}\tilde{e}}{\mathrm{d}\Delta} + \alpha\frac{\mathrm{d}e(p_H)}{\mathrm{d}\Delta}\right)}{\tau\gamma\left(\alpha+1\right) + \frac{\mathrm{d}e(p_H)}{\mathrm{d}\Delta}c''\left(e\left(p_H\right)\right) - \frac{\mathrm{d}\tilde{e}}{\mathrm{d}\Delta}c''\left(\tilde{e}\left(\Delta\right)\right)} \\
&= \lim_{\Delta \to 0} \frac{\Delta\tau\gamma\frac{\mathrm{d}\tilde{e}}{\mathrm{d}\Delta}}{\frac{\mathrm{d}\tilde{e}}{\mathrm{d}\Delta}c''\left(\tilde{e}\left(\Delta\right)\right)} = \frac{\Delta\tau\gamma}{c''\left(\tilde{e}\left(\Delta\right)\right)} = 0
\end{aligned}$$

which, plugged back in (A.5) yields the statement of the lemma. □

Lemmata 9 and 10, combined, imply the Theorem.

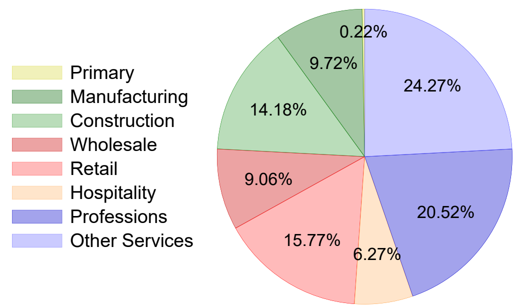
B Details on SeS Data

Figure B1: SeS dataset overview

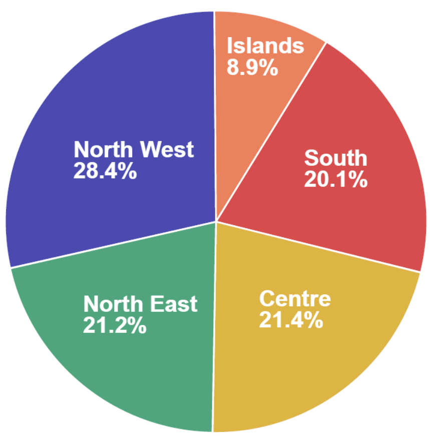
Panel A: Dataset Structure

Tax Year	Observations
2007	3, 753, 997
2008	3, 475, 482
2009	3, 470, 191
2010	3, 482, 862
2011	2, 472, 183
2012	2, 318, 416
2013	2, 142, 884
2014	2, 016, 286
2015	1, 849, 767
2016	1, 700, 551

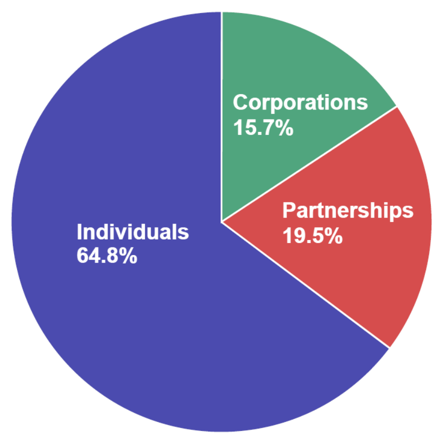
Panel B: 2007-2010 macro-sectors



Panel C: 2007-2010 geographic composition

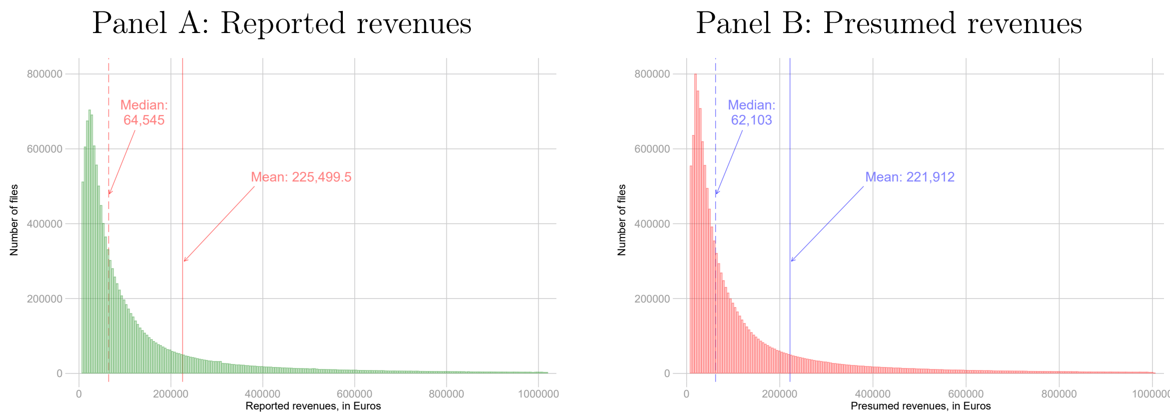


Panel D: 2007-2010 legal status



Notes: this Figure provides an overview of our Sector Studies (SeS) database. Italian businesses and the self-employed file for SeS if they generate no more than 5.2€ million in a given year. Panel A shows the total number of files we access for each of the 2007-2016 tax years. The first four years (in blue) consists of the universe of files submitted by SeS taxpayers in that period. The following years (in green) consist of the files submitted by taxpayers who continuously filed for SeS over 2008-2010. Hence, the sample size decreases as we move to the end of our sample period. The following panels break down the 2007-2010 universe along three dimensions. Panel B shows the relative distribution of SeS files across eight macro-sectors defined by the authors. Panel C shows the breakdown across the five NUTS-1 macro-regions of Italy. Panel D shows the three-way split between individuals, partnerships (akin to U.S. S-corps for tax purposes), and corporations. Italian individual taxpayers and partnerships are subject to the personal income tax, while corporations are subject to the corporate income tax.

Figure B2: Distribution of reported revenues and presumed revenues, 2007-2010



Notes: this Figure shows the distribution of the revenues reported by taxpayers in their SeS files (Panel A) and the revenues presumed by *Gerico* using the relevant sector-specific prediction function and the information imputed by the taxpayer (Panel B). The data consists of the universe of SeS files submitted in the 2007-2010 period, trimmed at 5th and 95th percentile of the respective distributions. In the left panel, this excludes about 2% of files which report 0 revenues. SeS technical details: reported revenues include so-called spontaneous revenue adjustment to the SeS presumed revenues available to SeS filers upon submitting. Presumed revenues include any SeS recession corrective available to taxpayers in that tax year.

Figure B3: Reward regime: balanced vs. unbalanced samples, 2007-2010

Variable	Year	Balanced 2007-2016	*Obs.*	Unbalanced	*Obs.*	Sig.
Declared revenues (€,000)	2007	241.42	*1,412,980*	184.07	*2,181,464*	***
	2008	245.61	*1,412,980*	208.71	*1,896,637*	***
	2009	229.36	*1,412,980*	202.17	*1,890,103*	***
	2010	235.52	*1,412,980*	198.17	*1,902,521*	***
Gross profits (€,000)	2007	44.25	*1,412,973*	22.68	*2,181,435*	***
	2008	43.59	*1,412,980*	21.86	*1,896,637*	***
	2009	40.42	*1,412,980*	20.04	*1,890,103*	***
	2010	42.11	*1,412,980*	21.63	*1,902,521*	***
Congruous, normal, coherent	2007	52.0%	*1,411,105*	36.5%	*2,174,708*	***
	2008	40.4%	*1,411,316*	24.7%	*1,892,864*	***
	2009	47.1%	*1,411,926*	29.8%	*1,882,565*	***
	2010	52.4%	*1,407,532*	34.3%	*1,893,273*	***

Notes: the Table reports summary statistics for single-sector taxpayers from the 2007-2016 balanced panel used in the reward regime analysis and the remaining taxpayers in each year of our universe period (2007-2010). Congruence, normality, and coherence are the SeS conditions ultimately required to access the reward regime within those sectors progressively included starting from 2011. Columns 3 and 5 report mean values for each sample-year combination. The last column reports, for each variable-year combination, the p-value from an unequal variances test for the equality of variable means across the two samples. *** denotes 1% significance of mean differences. In line with the rest of the reward regime analysis, declared revenues are winsorized at the 99th percentile of the global distribution.

C Additional Data Sources

C.1 Local evasion proxies

We construct a broad dataset of local evasion proxies for Italian regions, provinces, and municipalities, depending on data availability. Since the definition and true extent of evasion and underreporting are elusive, we gather several sources from the administrative and economic literature, as well as a large number of citizen-supplied evasion reports submitted to the private online platform at *evasori.info* over four years. Below, we list the sources of the variables we generate, along with their original level of disaggregation. We include all relevant references in our bibliography, and refer to them for further details.

Irregular employment share: Average share of irregular employment for the years 1999 and 2000. *ISTAT* estimates for 103 provinces reported in Table 3 of Censis (2003). Provincial estimates are obtained by *ISTAT* applying at the provincial level the coefficients of a region-level, step-wise regression of irregular employment shares on contextual factors. Significant factors from the region-level regression include unemployment rates, relative relevance of foreign trade and the construction sector, the frequency of workplace injuries, per capita firm registration rates, and population aging.

TV tax evasion rate: Ratio between the number of 2014 TV subscriptions and the 2011 Census number of resident households. Municipal-level estimates are available online at *twig.carto.com* and are based on the TV subscription records with the Italian public TV service *RAI*. Provincial and LLM estimates are a weighted average of the municipal-level estimates, using the number of resident households as weights.

Undeclared IRAP base ratio: Ratio between undeclared and declared IRAP tax bases, 1998-2002. IRAP is the regional tax on productive activities. Its tax base is essentially given by business revenues minus operating costs, with the general exception of employee-related expenses. Estimates for 103 provinces from Table A1 in Pisani and Polito (2006). Estimation relies on a comparison between the local valued added at factor prices reported by *ISTAT* and the local reported tax base for IRAP. We additionally define a regional *IRAP base gap* from Table 31 in the same source as the ratio between the undeclared IRAP base and the sum of the declared and undeclared IRAP base. We compute the declared base dividing the undeclared base by the reported intensity of underreporting.

Ghost-building intensity: Ratio of the number of land registry parcels found with unregistered buildings to the total number of land registry parcels. Municipal-level estimates were produced by the Agenzia del Territorio as a result of a 2007 aerial-photograph and land-mapping exercise. More details are provided in Casaburi and Troiano (2016). Provincial and LLM estimates are a weighted average of the municipal-level estimates, using the number of land registry parcels as weights.

Tax gap: municipal real estate tax (IMU): Ratio between the tax gap and the potential tax base for the 2012 municipal property tax (*imposta municipale unica*, or IMU). We use the first year of IMU implementation, covering all residential units, land holdings, and other buildings. Estimates for 108 provinces based on underlying municipal estimates are provided to the authors by the Ministry of the Economy and Finance. Provinces in the Trentino-Alto Adige region are excluded due to the presence of a different type of real estate tax.

Tax gap: VAT and IRAP: Combined estimates for VAT and IRAP tax gaps, 2007-2010. Estimates for 106 provinces are computed by the Italian Revenue Agency and reported as Table 3 in Vallanti and Gianfreda (2020). Gaps are computed as the difference between the revenues expected by and actually reported to the tax authority, divided by the expected revenues. Estimation of the potential tax base involves both a “top-down”' approach, comparing the national accounts with tax collection data, as well as a “bottom-up” approach, relying on audit data.

Concealed income share: Ratio of the difference between the average taxable income attested by the Italian Tax Police auditors and the average taxable income reported by taxpayers as a percentage of the average attested taxable income, 1987. Regional estimates come from Table 2 in Galbiati and Zanella (2012) and rely on the universe of audits on individual businesses and the self-employed carried out by the Italian Tax Police for the 1987 tax year.

PIT evasion index: Personal income tax evasion index, computed as the ratio of taxed income and taxable income, late 1980s. Regional estimates come from Table 1 in Brosio, Cassone, and Ricciuti (2002) and draw from Ragazzi (1993).

VAT evasion index: Ratio between taxed value added and taxable value, late 1980s. Regional estimates come from Table 1 in Brosio, Cassone, and Ricciuti (2002) and draw from the analysis of the commerce sector in Cerea (1992).

VAT base gap: Ratio between the VAT base gap and the VAT base theoretical liability (including that from the General Government), averaged over 2007-2010. Regional estimates come from Table B.3 in D'Agosto, Marigliani, and Pisani (2014) (VAT base gap propensity).

Total tax gap ratio: 2001-2011 median of the ratio between the difference of the potential tax yield and the actual tax revenues, and the total voluntary returns, for several taxes under the duty of the Italian Revenue Agency. Taxes considered include the VAT, personal income taxes, corporate income taxes, and IRAP. Regional estimates come from Table 1 in Carfora, Pansini, and Pisani (2016).

Evasion reports from *evasori.info*: In 2008, a computer science professor started an online initiative to raise awareness on the diffusion of evasion behaviors, launching the website *evasori.info*. Through this platform, business customers can anonymously report the location, amount, and sector of any evasion instance they encounter in their daily life in Italy. Most commonly these are missing receipts for modest amounts, but they might reflect more sizable underreporting, as in the case of salaries paid out to irregular workers. *evasori.info* thus provides an independent repository for crowd-sourced and fine-grained repository of information on evasion in Italy.

Coherently with the civic engagement spirit of the initiative, the website provides access to the individual reports via a dedicated API available at `evasori.info/api`. We write a Python script to download all reports submitted between 2008 and 2011, and summarize the obtained information in Table \ref{table:evasori_info}.

We then develop two province-level measures of evasion intensity based on these reports. One is the raw count of reports submitted from each province throughout our sample period, divided by the 2011 Census population. The other is the 2008-2011 total volume of reported evasion divided by the 2011 Census population. We then rescale each measure in terms of 1,000 inhabitants.

C.2 Other data sources

Personal income tax data: 2007-2010 data for the national progressive PIT rate schedule and the municipal PIT surcharge rates come from the website of the Ministry of the Economy and Finance (`finanze.gov.it`). Separate files from the same source report the number of individuals filing for the PIT at the municipal level in each tax year, as well as their total reported PIT base. Regional surcharges are instead desumed from the instruction tables attached to the PIT returns for the relevant time period.

For our correlational analysis, we construct a 2007-2010 LLM-level weighted average of the municipal PIT surchage rates in two steps. In the first step, we take the LLM-year average of all municipality-years with a recorded PIT surcharge, weighting each observation by the number of individuals filing for the PIT in that municipality-year. In the second step, we take the simple within-LLM average of the yearly averages obtained in the first step.

Local value added and population data: We draw from *ISTAT*'s online database at dati.istat.it to gather information about Italy's provinces. Province-level value added per capita comes from the national accounts tables (*Principali aggregati territoriali di Contabilità Nazionale*). For our correlational analysis, we average the yearly estimates over 2007-2010 for each province. 2011 Census estimates for the provincial resident population are available at dati-censimentopopolazione.istat.it.

Input-output tables: We compute measures of sector-level exposure to the final consumer drawing from *ISTAT*'s input-output tables for the 2010-2013 period. We retrieve the relevant data at https://www.istat.it/it/archivio/195028. We rely on the symmetric table for 63 1-digit 2-digit sectors, which we are able to match with 51 corresponding sectors with data in the SeS database. The table reports the total value of final uses at 2010 current prices. We build our estimates of the share of domestic value added from final consumer transactions as the sector-specific ratio of final consumer spending and the difference between total uses and exports.

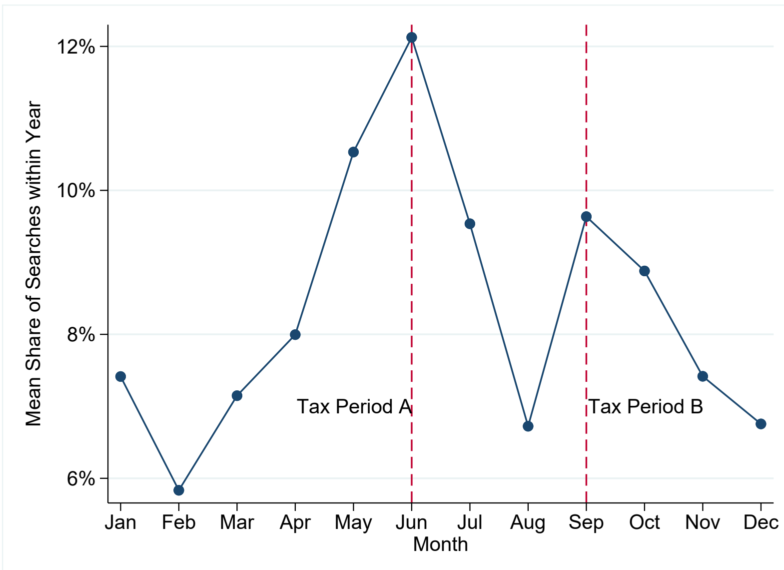
Tax litigation: We capture a component of the cost of engaging with the tax administration with the average length of litigation at the provincial tax court level. Data come from the annual reports on the state of tax litigation and the tax courts released by Ministry of the Economy and Finance and available at finanze.gov.it. We gather the province court-level estimates of the average duration of adjudicated cases. Each year, the Ministry estimates this duration as the ratio between the number of days - summed across all cases - it takes to adjudicate each case since the appeal is filed with the court, and the number of adjudicated cases during the year. For each province, we take a simple average of the mean litigation length in each year for the 2009-2012 period.

Beyond the provincial level, litigation can move to the regional level and at the level of the Supreme Court of Cassation (the highest civil court in Italy). By the Ministry's reports, provincial litigation is on average between one third and one half longer than regional litigation in the 2009-2012 period.

D Knowledge of the threshold: Gerico's software Google Searches

Audit rules are effectively disclosed if taxpayers are aware of their functioning. In the context of SeS, we claim that businesses know the threshold at which the probability of audit jumps discontinously because they can learn it at no cost. Indeed, ahead of the tax season, the Revenue Agency releases a freely downloadable software that assists taxpayers in preparing their SeS file. The software is called *Gerico*. We look for evidence of taxpayers awareness about it by looking at Google searches for the word "*gerico*" over the 2004-2017 period in Italy. Figure D1 shows that searches spike in June and September, which are the two tax periods in each tax year.

Figure D1: Google searches for "gerico" spike in tax periods, 2004-2017



Notes: this Figure shows the month-by-month average intensity of Google searches for "*gerico*" over the 2004-2017 period in Italy. This time frame fully includes our SeS sample period, which stretches over the 2007-2016 tax years and the 2008-2017 filing years. Month-level data come from `trends.google.com`. Searches in off-peak months are partly explained by the fact that the actual filing deadlines are postponed in some years due to administrative constraints.

E Bunching Estimation

We define bunching as the excess mass in the observed revenue declaration distribution relative to a counterfactual distribution that would arise with a constant p_L probability. Since businesses declaring above $\hat{y}$ face probability p_L, our strategy uses their distribution to infer this counterfactual. Empirically, we follow the approach in Kleven and Waseem (2013), which relies on a flexible polynomial and excludes an area $[y_l, y_u]$ around $\hat{y}$ from the density distribution estimation. We bin the data in segments whose length is 1 percentage point of $\hat{y}$ and run the following regression for the number of SeS files c in each bin j

$$c_j = \sum_{i=1}^{K} \beta_i (y_j)^i + \sum_{h=y_l}^{y_u} \gamma_h \mathbb{1}(y_j = h) + \varepsilon_j, \tag{E.1}$$

where i indicates the polynomial degree in the first sum. We use a 7^{th} degree polynomial in our baseline estimates and provide estimates with different degrees for robustness. To avoid irregularities coming from the far tails of the distribution, we exclude files with reported revenues below the 5^{th} percentile or above the 95^{th} percentile of relative distance from $\hat{y}$. These restrictions automatically drop files with zero reported revenues, which account for slightly less than 2% of all 2007-2010 files. The excluded segment $\left[y^l, y^u\right]$ is the area affected by bunching responses. Bin dummies for $y \in \left[y^l, y^u\right]$ ensure that the excess mass at $\hat{y}$ does not affect the counterfactual distribution fit. While our preferred choice is to set y^u visually at the first bin above $\hat{y}$, we choose y^l using an iterative procedure. The latter searches for the bin that generates an estimated counterfactual with a missing mass below $\hat{y}$ equal to the excess mass above $\hat{y}$. Using the estimated counterfactual, we can compute the excess mass as the ratio between the excess (relative to counterfactual) observed number of SeS files and the average level of the counterfactual in the segment $[\hat{y}, y^u]$. We will refer to this relative excess mass as a bunching estimate, or $\hat{B}$.

We compute standard errors to bunching estimates using a semi-parametric bootstrap procedure. Equation (E.1) provides the structure for our routine. In every bootstrap iteration we draw with replacement from the residuals $\hat{\varepsilon}_j = c_j - \hat{c}_j$, where $\hat{c}_j = \sum_{i=1}^{K} \hat{\beta}_i (y_j)^i + \sum_{i=y_l}^{y_u} \hat{\gamma}_i \mathbb{1}(y_j = i)$, and $\left(\hat{\beta}, \hat{\gamma}\right)$ are the estimated coefficients from the specification in (E.1). We use the residuals to build a new number of taxpayers in each bin j so that in iteration r the number of taxpayers in bin j is $c_j^r = \hat{c}_j + \varepsilon_j^r$ and ε_j^r is the residual drawn for bin j in iteration r. We use the new vector $\left(c_j^r\right)_{j \in J}$ as the dependent variable when re-estimating (E.1) and we employ the resulting $\left(\hat{c}_j^r\right)_{j \in J}$ as the counterfactual needed to compute a bunching quantity $\hat{B}^r$. We repeat this routine for 1,000 iterations. Confidence intervals on $\hat{B}$ can be computed by taking the 2.5^{th} and the 97.5^{th} percentiles of the bunching estimate distribution across all iterations, while the bunching standard deviation is simply the standard deviation of the same empirical distribution.

F Reporting VS Production Responses

We present evidence consistent with the idea that firms respond to SeS incentives adjusting their reports rather than their production. This motivates the assumption of separability between the reporting and production margins that we introduce in Section 2.

To the extent that bunching at the SeS threshold reflects a reporting response, we should observe higher bunching in contexts where underreporting of real economic activity is more intense, either because of higher payoffs to evasion or because of a relative ease of misreporting. We thus study the correlation between bunching of SeS files for each of the 110 Italian provinces in 2007-2010 and available local proxies of evasion across several tax bases.[39] Specifically, we regress the bunching estimates for all local areas i on one evasion proxy Evasion^j at a time according to the following model:

$$\text{Bunching}_i = \alpha + \beta \text{Evasion}_i^j + \gamma \log \text{VA pc}_i + \text{macroregion}_i + \varepsilon_i,$$

where we introduce fixed effects for the five NUTS-1 macroregions (North West, North East, Center, South, and the Islands) and the logarithm of value added per inhabitant to control for relative provincial prosperity. We use several definitions of i depending on the level of observation of the relevant evasion proxy. Figure 4 displays the standardized coefficients for all our evasion proxies. All of our estimates turn out to be positive, and most are significant and meaningful in magnitude. This result holds not just for the proxies we draw from the existing economic and administrative literature, but also for those we build from over 620,000 "whistleblower"' reports submitted by consumers to the private website *evasori.info* over 2008-2011. Relying on a first principal component of the various measures does not alter the pattern of results. Finally, Figure F2 disaggregates our analysis whenever a finer evasion measure is available. We show that the correlation between bunching and misreporting holds even at the level of the 686 local labor markets (LLMs) defined by *ISTAT* in 2001, controlling for twenty regional fixed effects and the logarithm of the local PIT base per taxpayer reported by resident individuals.

We also find a positive correlation between bunching and the incentives as well as the opportunities for underreporting. Figure F3 displays a positive and significant conditional correlation between LLM bunching and the weighted average of municipal PIT surcharge rates.[40] We also find higher bunching among firms that are more exposed to the final consumer (Figure 5), among taxpayers with relatively lower turnover (Figure **??**), and among businesses with relatively fewer reporting requirements, as in the case of individual businesses as opposed to the partnerships and corporations in our data (Figure **??**). This aligns with the literature's suggestions that these features ease the concealment of true production due to the structure of VAT incentives and hurdles in the successful monitoring of smaller enterprises.

The sharp bunching observed in Figure 3, as well as the fact that knowledge of the exact location of the threshold is acquired after the end of the production period, make it unlikely that taxpayers respond to SeS by adjusting their true production. However, while a new edition of *Gerico* is released every tax season, a sector's underlying presumed revenue function is revised only once every three years. Therefore, taxpayers might learn how to fine-tune production over the course of a three-year cycle.

We assess the learning-to-adjust hypothesis in two ways. First, we estimate bunching for every

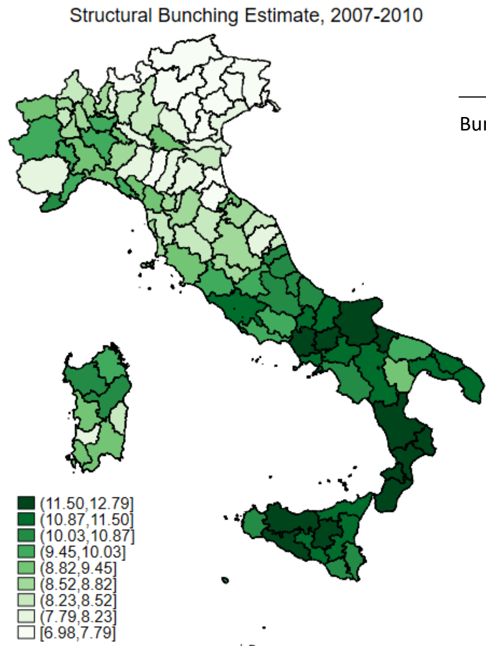
[39] Figure F1, Panel A provides summary statistics and a map of province-level bunching, while Panel B shows the local labor market (LLM) patterns. At both levels of aggregation, bunching is both sizable and heterogeneous across geographical units.

[40] Municipalities can impose a surcharge rate of less than 1% on top of the national personal income tax schedule.

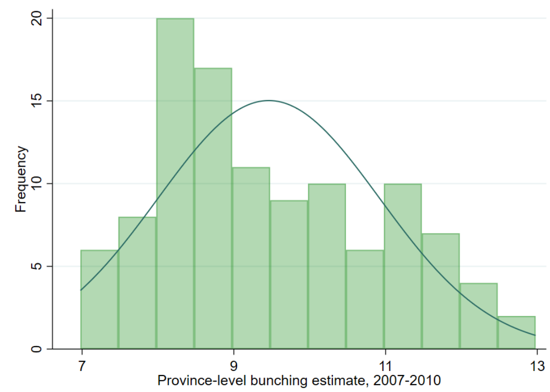
sector and year, and residualize these estimates by sector and year fixed effects. Figure F4 plots the residual bunching distributions for the first, second, and third year of application of a given revenue prediction model for any given sector. Despite the potential for learning, bunching residuals aren't significantly higher for the later years of application of the same model. Second, we split SeS files in one percentage point bins of distance from the presumed revenues for each sector-year. If production adjustment takes place over time, we expect mass gains in the bins just above the SeS threshold. For each bin, we thus regress its file share on a dummy for the last year of application of the relevant model, along with sector and calendar year fixed effects. Figure F5 plots the coefficient on the third-year dummy for each bin around the SeS threshold. We don't find any evidence that the bins just above the threshold gain mass by the end of a model's application, as most coefficients are negative but small or insignificant in size.

Figure F1: Local heterogeneity in bunching estimates, 2007-2010

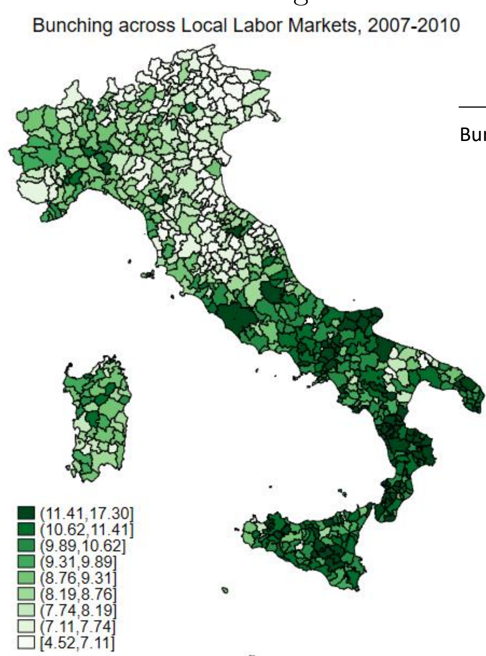
Panel A: Bunching across 110 provinces



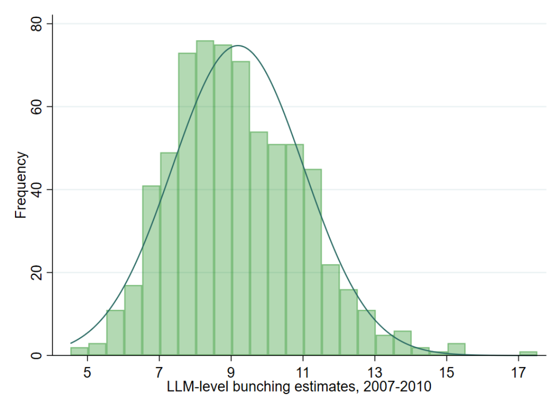
	N. Obs.	Mean	Median	SD	Min	Max
Bunching	110	9.46	9.23	1.46	6.98	12.79



Panel B: Bunching across 686 local labor markets (2010 LLMs)



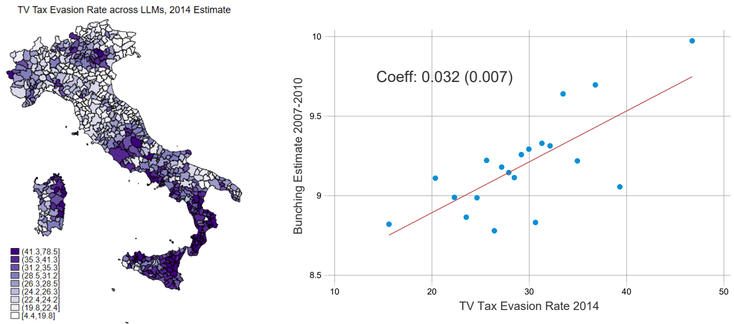
	N. Obs.	Mean	Median	SD	Min	Max
Bunching	686	9.19	8.99	1.83	4.52	17.30



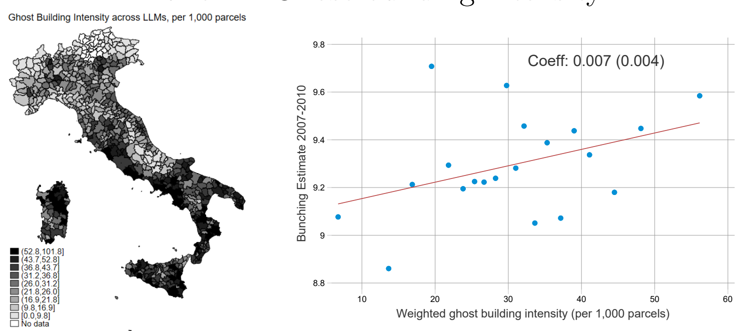
Notes: this Figure plots and summarizes our estimates of bunching at the SeS presumed revenues at the level of the Italian provinces (Panel A) and 2001 LLMs (Panel B). The sample includes each SeS file in the universe of single-sector businesses in the 2007-2010 tax years, except the top and bottom 5% in each province- or local-labor-market-level distribution that we trim to avoid irregularities in the estimation of the counterfactual. Bunching is computed at the local level following the procedure outlines in Section 4.2.

Figure F2: LLM bunching correlates positively with local evasion

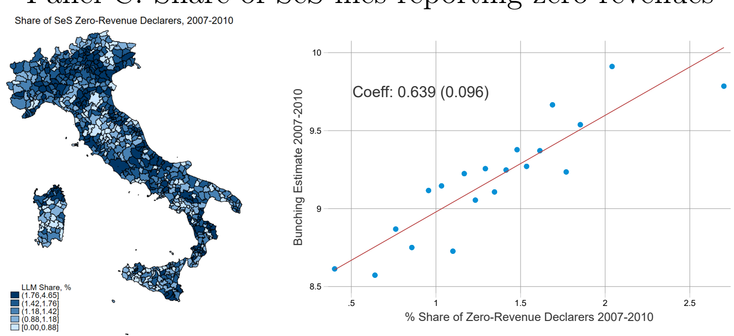
Panel A: TV tax evasion rate



Panel B: Ghost-building intensity

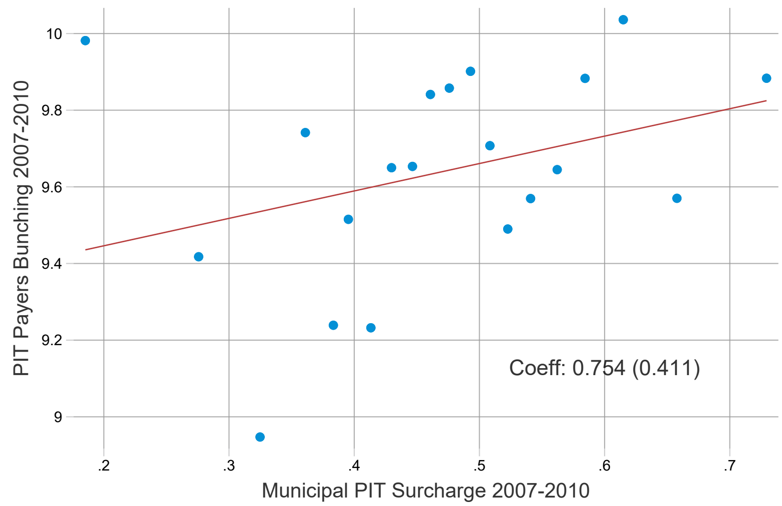


Panel C: Share of SeS files reporting zero revenues



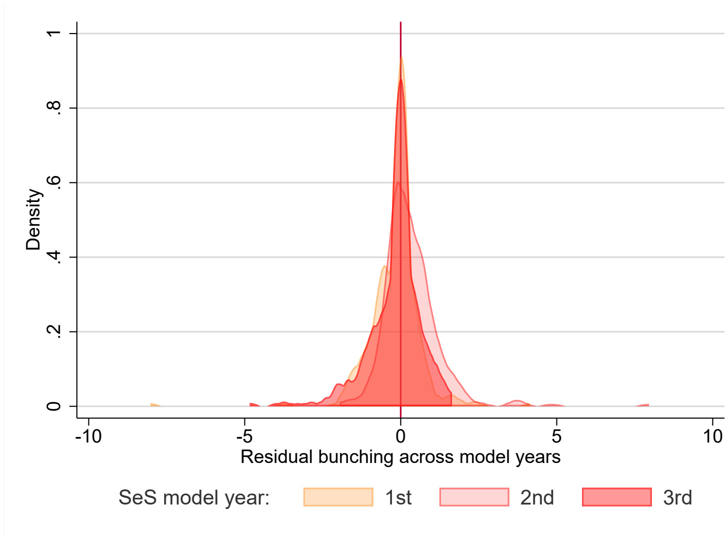
Notes: the Figure maps three LLM-level estimates of behaviors that are plausibly related to evasion or misreporting, and correlates each with local SeS bunching. The three evasion proxies are defined in Appendix C. On the right, binned scatterplots report the main slope coefficient and robust standard error from a regression of the form $\text{Bunching}_i = \alpha + \beta Evasion_i^j + \gamma \log(\text{PIT base per taxpayer}_i) + \text{region}_i + \varepsilon_i$, including regional fixed effects and the logarithm of the average local PIT-base per individual taxpayer. Panel A: 2014 TV tax evasion estimates from 8,044 municipalities, weighted by 2011 resident households. Panel B: 2007 ghost-building intensity data from 7,744 municipalities, weighted by number of land registry parcels. Panel C: the 2007-2010 local labor market share of SeS filers reporting exactly zero revenues, which ranges from 0 to 4.7%. The sample includes each SeS file in the universe of single-sector businesses in the 2007-2010 tax years, except the top and bottom 5% in each LLM-level distribution that we trim to avoid irregularities in the estimation of the counterfactual. Bunching is computed at the LLM level following the procedure outlines in Section 4.2.

Figure F3: Bunching tracks evasion incentives: municipal taxes



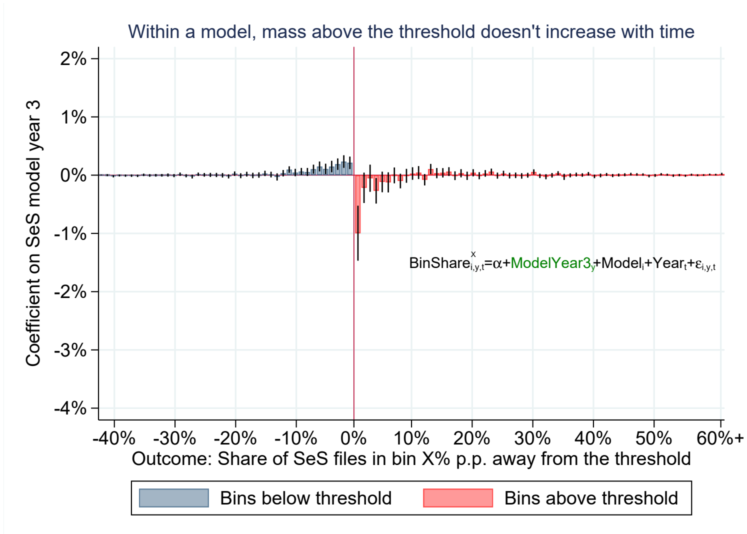
Notes: this Figure provides a binned scatterplot and the linear fit for the relation between SeS bunching among PIT-payers and the weighted average of municipal PIT surcharges for the 2007-2010 period at the LLM level. We also report the main slope coefficient and robust standard error from a regression of the form $\text{Bunching}_{i,p} = \alpha + \beta(\text{PIT surcharge}_i) + \gamma\text{Litigation}_p + \delta \log(\text{PIT base per taxpayer}_i) + \text{region}_i + \varepsilon_{i,j}$, including the 2009-2012 mean length of litigation at the tax court of province p, regional fixed effects, and the logarithm of the average local PIT-base per individual taxpayer in LLM i. Municipal PIT surcharges don't exceed the national PIT schedule rates by more than 0.8%. Regional PIT surcharge variation is captured by regional fixed effects. The sample includes each SeS file in the universe of single-sector businesses in the 2007-2010 tax years, except the top and bottom 5% in each LLM-level distribution that we trim to avoid irregularities in the estimation of the counterfactual. Bunching is computed at the LLM level following the procedure outlines in Section 4.2.

Figure F4: Bunching evolution within SeS models, 2007-2010



Notes: this Figure plots the distribution of 2007-2010 bunching residuals from a regression of the form: $\text{bunching}_{i,t} = \alpha + \beta_i + \gamma_t + \varepsilon_{i,t}$, where the unit of observation is a SeS model-year, and we include fixed effects for each SeS model i and calendar year t. By SeS model we refer to the three-year application of a given SeS estimation model, inclusive of the presumed revenues function, to a given business sector defined by the SeS. We thus plot three residual distributions, separately for the first, second, or third year of application of a given SeS model. Only positive bunching estimates are employed. Regression sample is of size 762 and excludes SeS model-years with negative bunching estimates.

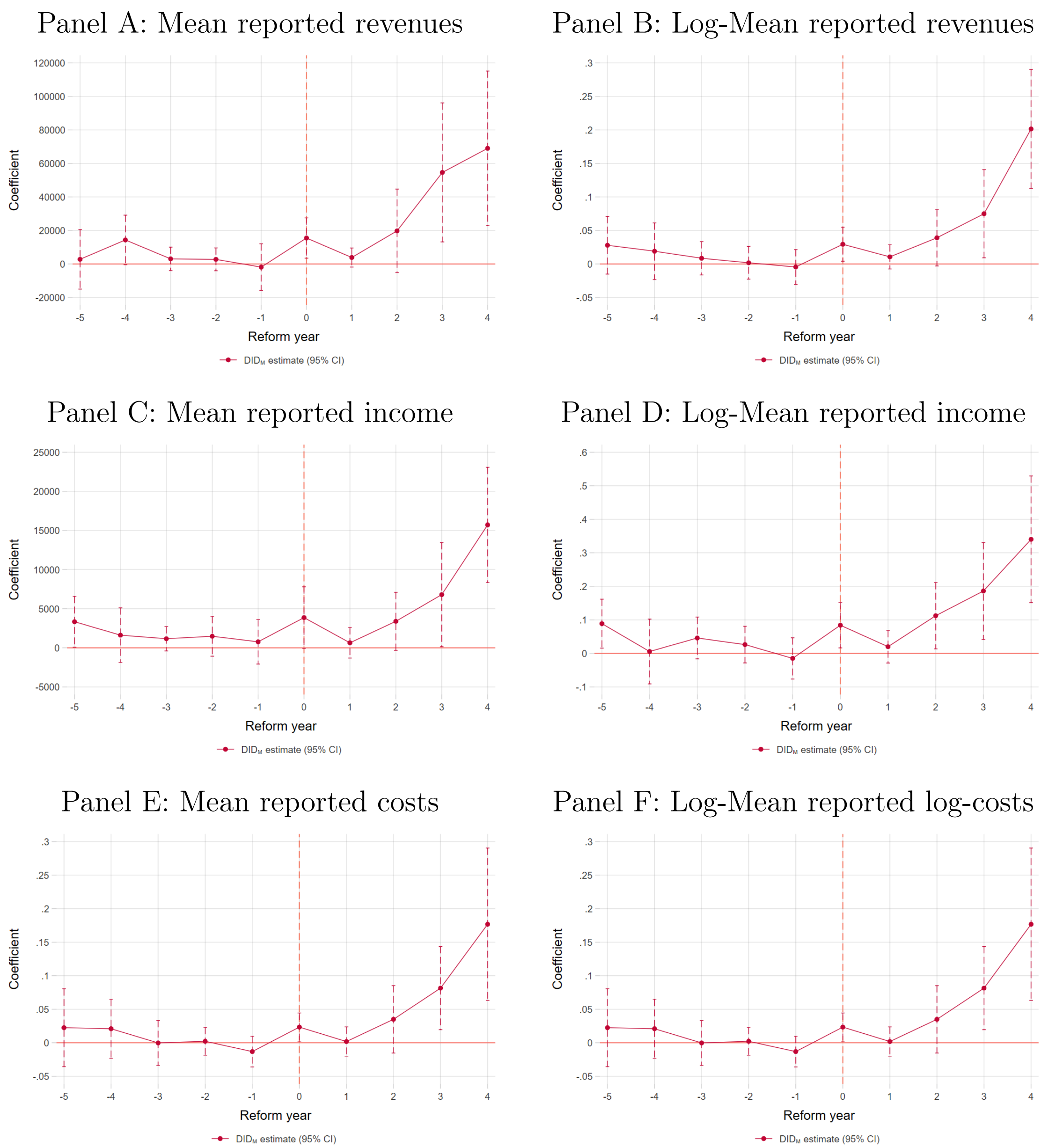
Figure F5: Bin share effect of the last year of application of a SeS model



Notes: this Figure provides the coefficient plot from several regressions as the one printed above. Specifically, we observe SeS models i and consider whether they are being applied for the s^{th} year (that is, first, second, or third year) during calendar year t. Across all SeS model-years, we regress the share of SeS files at each one percentage point of distance X from the SeS presumed revenue threshold on a dummy for the third (last) year of application of a SeS estimation model, controlling for SeS model and calendar year fixed effects, and clustering standard errors by SeS model. We then plot the coefficient associated to the third (last) year dummy at each point of distance below (in blue) and above the threshold (in red), along with its 95% CIs. To compute the bin shares, we consider the sample of SeS taxpayers continuously filing over 2007-2016.

G Robustness of Event Study Estimates

Figure F6: Robustness: de Chaisemartin and D'Haultfoeuille (2020) correction



Notes: this Figure shows the effects of the reward regime's introduction in a sector from the estimator proposed by de Chaisemartin and D'Haultfoeuille (2020) (DID$_M$). The regressions are estimated on the sample of all Sector Study files from single-sector taxpayers continuously filing over the 2007-2016 period, aggregated by sector-year. Only sectors accessing the reward regime by 2016 are considered. Number of sector-years: 1550. Reported revenues are winsorized at the 99th percentile. Controls and weighting are as defined in the discussion of Eq. (8). We mark the relative year before the reform with the red dashed vertical line at year 0. Estimation is performed using the *dynamic* and *placebo* options of the authors' supplied Stata package *did_multiplegt*. Estimation requirements allow us to compute only up to four post-treatment effects. Standard errors are computed with a bootstrap procedure with 50 replications.

H Additional Tables and Figures

H.1 Additional Tables

Table G1: Sector Studies compliance benefits, before and after 2011

SeS required condition			**Audit exemption benefits**	
Congruence	*Normality*	*Coherence*	*Before 2011*	*Since 2011*
✓			**No SeS audits** (revenues)	
	✓	✓	**No SeS audits** (costs, inputs)	
✓	✓		**No analytic-inductive audits** *up to $e \leq 40\% y$, $e \leq €50{,}000$*	
✓	✓	✓		**1. No analytic-inductive audits** *up to any amount* **2. No synthetic audits** *up to $\pi(s)$-$\pi \leq 33\% \cdot \pi(s)$* **3. Shorter statute of limitation**

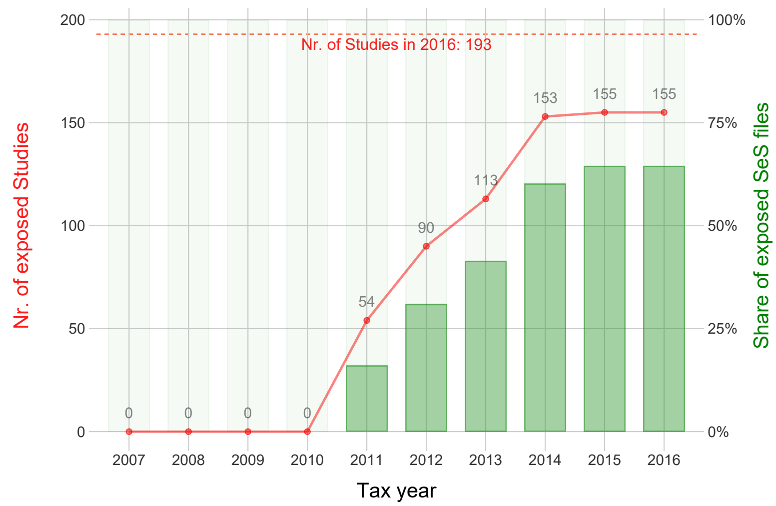
Notes: the Table reports the main tax audit and assessment benefits from being congruous, coherent, and normal by the definitions provided by Sector Studies, before and after the introduction of the 2011 reward regime. Congruence refers to the condition of reporting revenues at or above the level presumed by *Gerico*. Normality and coherence refer to the condition of reporting a number of accounting and economic indicators within sector-specific acceptable ranges as determined by *Gerico*. Notation: e refers to undeclared amounts, y to revenues, π to gross profits or income, and $\pi(s)$ to synthetically-determined income. The statute of limitation to inspect an eligibile taxpayer's file drops by one year since 2011.

Table G2: Bunching estimates by polynomial order and upper bound

	POLYNOMIAL ORDER							
UPPER BOUND	3	4	5	6	7	8	9	10
0	15.38	14.95	11.53	11.42	**9.56**	9.15	8.47	7.69
1	18.57	18.77	14.45	14.01	12.27	11.63	10.74	9.95
2	21.36	20.66	16.86	16.25	14.6	13.03	12.75	11.45
3	23.73	23.91	19.55	18.33	16.85	14.57	14.77	13.24
4	15.07	24.78	21.83	19.93	18.91	16.39	16.32	14.91
5	17.17	26.59	24.34	21.31	20.4	17.99	17.43	16.71

Notes: the Table reports various bunching estimates computed with the SeS files submitted by the universe of single-sector businesses in the 2007-2010 tax years. Estimates are reported for each combination of two parameters choices. First, the upper bound y_u of the area affected by excess bunching, identified by the floor of the relevant bin in percentage points of presumed revenues. For reference, upper bound 0 indicates we limit the bunching area to the one-percentage-point bin including the presumed revenues threshold. Second, the polynomial order, that is the degree of the polynomial in bin order used to estimate the smooth bunching counterfactual. We select 0 for the upper bound and 7 for the polynomial order in our baseline estimate, highlighted in orange. In all estimations, bin width is fixed at one percentage point of presumed revenues.

Figure G1: Reward regime: staggered introduction, 2011-2016



Notes: the Figure shows the staggered introduction of the 2011 reward regime among existing Sector Studies (for brevity, referred to as sectors). The red line displays the number of sectors with access to the regime in each year up to 2016 (scale on the left vertical axis). The dark green bars reflect the share of all files with access to the reward regime in each year (scale on the right vertical axis). The share is computed over the population of files from single-sector, continuous filers over 2007-2016. For simplicity, we code five sectors with partial access as having full regime access. The horizontal dashed line represents the total number of sectors in 2016.