Tax Noncompliance Penalties: Evidence and Optimality*

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Abstract

We study the administration of income tax noncompliance penalties in Norway. Penalties potentially offer a low-cost tool for tax administrations to use in reducing tax noncompliance. We exploit a legislative reform that decreased the statutory income tax noncompliance penalty rate from 30% to 20% to evaluate the impact of the penalty rate on the ex-post behavior of penalized taxpayers. We find that compared to non-compliant taxpayers penalized under the prior higher-rate regime, taxpayers penalized under the lower rate regime declare 10% less income and pay 10% less in taxes. This response is not explained by differences in pre-event income or social demographic characteristics. We also find that following the decrease in the penalty rate, administrative appeals also drop by 3%, suggesting that higher penalties induce a higher administrative cost. We contextualize our findings within two models that conceptually illustrate the tradeoffs of penalties, demonstrating theoretically that higher penalties may induce increased litigation/appeals, which may be costly from the tax administration's perspective. We conclude with a model of optimal penalty rates, finding that to a first-order approximation, the statutory penalty rate should be set so that the actuarial penalty rate–the in-expectation net payment rate per unit of underreported income–equals the optimal linear income tax rate.

JEL codes: H26, H83, H21, H22, H23, H24
Key words: Tax penalties, tax administration, tax evasion and avoidance

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1 Introduction

Little is known about the behavioral impacts of penalty rates on tax and regulatory noncompliance. A substantial literature has studied tax noncompliance, from modeling its behavioral foundations (Allingham and Sandmo (1972); Yitzhaki (1974); Becker (1968)) to providing empirical estimates of its size, composition, and distribution (Guyton et al. (2023); Kleven et al. (2011)). Recent work has allocated attention to optimal tax administration (Keen and Slemrod (2017)) and quantifying the benefits and costs of different measures to reduce tax noncompliance–namely audits (Boning, Hendren, et al. (2024)). The noncompliance penalty rate has many interesting properties from a tax administrative perspective. Theoretically, higher penalties generate more revenue both through decreasing income underreporting and through increasing collections on detected underreporting income. At the same time, unlike audits, there is no nominal cost associated with changing the penalty rate. Yet, empirically, little is actually known about the costs and benefits of tax noncompliance penalties.

We address this gap by studying tax noncompliance penalty administration in Norway and contextualizing our results within an optimal tax administration conceptual model environment. We provide novel evidence on the causal impacts of tax noncompliance penalties on individual taxpayer's income/wealth reporting and tax compliance behavior.[1] At this stage, we focus primarily on the ex-post impacts of the penalty rate in response to successful detection and sanction via personal income tax audits. Later stages of this work will study the ex-ante deterrence effects of the penalty rate as well as the real costs of the penalty rate in the form of administrative appeals and complaints. The second part of the work develops two conceptual models to contextualize our results. The first develops the agent-perspective response to variation in the penalty rate; the second model develops results on optimal penalty administration.

Our central empirical exercise studies a quasiexperiment in the form of a decrease in the Norwegian standard income tax noncompliance penalty rate from 30% of underreported base to 20% of underreported base that occurred in 2016 (a 33% relative decrease in the

[1] We focus primarily on individual income taxpayers, but future avenues of research will study tax noncompliance penalty assignment to businesses.

statutory penalty rate). These audits occur in a nonrandom manner, so we estimate the ex-post impact of the penalty rate by implementing a differences-in-differences event study design that relies on a parallel trends assumption for taxpayers sanctioned under the new ordinary penalty rate regime as for the pre-reform ordinary regime. Importantly, the validity of this design also relies on a like-comparability assumption—the composition of taxpayers sanctioned remains similar around the penalty-rate decrease. We validate this assumption by implementing a matching design that controls for pre-audit levels and changes in income.

We estimate a positive short-run impact of the penalty rate on ex-post declared income and taxes paid. Specifically, we find that the group sanctioned under the 20% penalty rate regime report between 5-10% income less per year than do taxpayers sanctioned under the prior 30% rate regime, corresponding with a commensurate difference in income taxes paid. This response implies a short-run elasticity of taxable income to the ex-post penalty rate of between 0.15 and 0.3. We complement our identification strategy with an instrumental variables approach that yields comparable findings. We document limited evidence that taxpayers under the less-harsh post-reform 20% rate regime experience fewer "quality-of-life" disruptions such as change of primary residence. However, we file that these taxpayers are about 2% less likely to lose stakes in a business than do those under the higher-rate sanction regime. Moreover, we find some evidence of spillover effects onto household peers and business partners of penalized taxpayers. Importantly, we also find that a higher penalty burden translates into a higher likelihood of appeal.

We rationalize our findings with two complementary conceptual models. The first develops the taxpayer's perspective to variation in the penalty rate. We show in a simplified setting that although higher penalties induce lower ex-ante evasion, they also induce two potentially adverse effects. Higher penalties induce substitution to underreporting vehicles with lower probability of detection, and higher penalties also increase the incentive for sanctioned individuals to appeal their penalties and expend greater effort pursuing those appeals. We understand these effects to increase administrative costs in the form of audit intensity and litigation costs respectively.

The second conceptual model section develops an optimal tax administration perspective (based on Keen and Slemrod (2017)) of the optimal penalty rate in the presence of a linear in-

come tax rate and a compliance-enhancing tax administrative instrument. From this model, we develop novel intuition for optimal penalty rate administration. We model penalties within a broader class of instruments we conceptualize as "dual-revenue-generating" tools—instruments that theoretically increase tax collections both through behavioral effects that reduce underreporting and mechanically through increased collections on inframarginally detected underreporting. We find that accounting for dual revenue instruments such as penalties increases the optimal linear income tax rate relative to a baseline with underreporting in absence of these instruments, as these instruments—such as penalties—also generate revenue off of underreported income. We also find that to a first-order approximation, the statutory penalty rate should be set so that the actuarial penalty rate—the in-expectation net payment rate per unit of underreported income—equals the optimal linear income tax rate. The penalty rate falls short of this level insofar as the penalties induce real administrative costs and welfare costs to those audited.

We view this paper as contributing to the literatures on tax administration, tax noncompliance, and inequality. Conceptually, Allingham and Sandmo (1972) and Keen and Slemrod (2017) are the most closely related. The former paper establishes the behavioral foundations of taxpayer's tax evasion decisions; giving the clear prescription that policymakers can affect tax evasion by altering the perceived detection probability or the fine associated with detection and punishment. Many works have focused on the role of audits and tax amnesties in determining income underreporting behavior which deal primarily with detection (although no works have empirically established a link between individual perception of detection probability and evasion (Bergolo et al. (2023), Advani, Elming, and Shaw (2023), Alstadsæter, Johannesen, Le Guern Herry, et al. (2022), Slemrod (2019))), but little empirical attention has been allocated to the role of penalties. Brounstein (2023) finds Ecuadorian taxpayers respond strongly to changes in the pecuniary cost of sending money to tax havens. Based on this finding, it is conceivable that taxpayer income underreporting may respond more strongly to pecuniary measures.

Some works have studied the role of penalties from a conceptual perspective, of course beginning with the literature establishing agent's underreporting decisions. However, there is little intuition that exists to ground our understanding of the optimal administration of

penalties. For instance, how high should the optimal penalty rate be set? Dhami and al-Nowaihi (2006) explores this question from a behavioral perspective, asking why the penalty should not be infinite (per the paper, assignment to the death penalty with positive probability of measure zero). The authors adopt a theoretical behavioral perspective based on individual internalization of probability; that according to prospect theory, individuals cannot properly internalize corner-solution expected utility values. We argue that an interior solution for the optimal penalty rate exists based on more practical revenue-raising and welfarist grounds. Keen and Slemrod (2017) develops a foundational model of optimal tax administration, characterizing the complementarity and substitutibility between enforcement expenses (most practically taken as auditing) and the income tax rate. The authors provide the framework for a general extension to other instruments, but we consider as our central object of interest precise parameterizations of penalties the interactions of penalties with other instruments—namely enforcement expense and the tax rate.

We also view our work as speaking closely to the literature on post-tax income (and wealth-) inequality. In the US, existing work has demonstrated the difference between pre- and post-tax inequality ((Auten and Splinter (Forthcoming); Piketty, Saez, and Zucman (2017); Piketty and Saez (2003))) as well as wealth inequality Smith, Zidar, and Zwick (2022); Saez and Zucman (2016)). Penalty assignment has first-order implications for affecting the distribution of post-tax income and for affecting income underreporting activities that may bias our estimates of pre-tax inequality. In particular, larger penalties may induce decreases in income underreporting that are observed disproportionately at the top of the income distribution (Guyton et al. (2023); Alstadsæter, Johannesen, and Zucman (2019); Alstadsæter, Johannesen, and Zucman (2018)). Penalties also have mechanical impacts on the distribution of post-tax income. Alternatively, we demonstrate that higher penalties may also induce taxpayer substitution from high-detection-risk underreporting vehicles to lower-detection-risk vehicles, which has ambiguous effects on the overall amount of income underreporting.

We proceed as follows. Section 2 develops a conceptual model that illustrates the microeconomic foundations of how taxpayers respond to penalties. Section 3 presents the institutional background, the data environment, and descriptive statistics. Section 4 and

Section 5 provide quasiexperimental evidence on penalty assignment and its impacts on income reporting and appeal behavior, respectively. We discuss the implications for optimal penalty administration in Section 6. Section 7 concludes.

2 Conceptual model of income underreporting with penalties

We develop the taxpayer behavioral foundations in four steps. First, we establish the environment. We then explore the relationship between noncompliance penalties and underreporting. In the third step, the tax authority detects underpayment, and the taxpayer decides whether and how much to expend on litigation. Finally, we explore the taxpayer's joint optimization procedure of simultaneously deciding underreporting and ex-ante litigation decision and effort/expense.

2.1 Model setup

A taxpayer i with true income y is deciding how to underreport her income. She has two vehicles to use, one of which is less susceptible to discovery via audit. She allocates z_1 and z_2 to each vehicle at costs $\xi_1(z_1)$ and $\xi_2(z_2)$, so that she ultimately underreports her income by $z_1 + z_2$, reporting $y - z_1 - z_2 := x$ in income to the tax authorities for personal income tax purposes.

The first underreporting vehicle is riskier than the second underreporting vehicle in terms of discovery in case of an audit, but is less expensive to use. Namely, $\xi_2'(e) > \xi_1'(e)$ and $\xi_2''(e) > \xi_1''(e)\ \forall\ e > 0$ and $\xi_2(0) = \xi_1(0) \equiv 0$. Also consider that the use of the vehicles has no effect on the cost of the other (i.e. $\frac{\partial^2 \xi_i}{\partial z_1 \partial z_2} = 0\ \forall\ i = 1, 2$). She will be audited with fixed probability ρ_1. Upon audit, all of her underreporting in the first vehicle will be discovered, whereas the underreporting in the second vehicle will be discovered with probability $0 < \rho_2 < 1$ conditional upon audit.

After underreporting and before audit realization, she pays $T(x)$ in taxes, and has disposable income amount $y - T(x) - \xi_1(z_1) - \xi_2(z_2)$. The tax authorities observe a taxpayer i

reporting income x and paying taxes $T(x)$. However, the authorities conduct an audit and detect an amount of unreported income z.[2] The penalty and appeal environment can be described as follows:

- Taxpayer i initially reported x in income and paid $T(x)$ in income taxes.
- The tax administration alleges that by underreporting her income by z, they suffered tax loss of $T(x+z) - T(x)$.
- The tax authorities require that i pays back the sum of the tax loss discovered in the audit $T(x+z) - T(x) = l(z;x)$ plus an additional fine $\phi(l(z;x); z+x) := \phi(z,x)$ where $\phi(0;x) = 0$ and $\frac{\partial \phi}{\partial z} > 0 \ \forall \ x, z$. Note that ϕ does not depend on the manner of underreporting, but rather the overall amount of detected underreporting.
- The taxpayer has the opportunity to pay resources α plus a fixed cost F to reduce the probability that the tax court is successful in its proceedings (fighting the case).
- Similarly, the tax authorities can pay resources β to increase its probability of success in court.
- Ultimately, the probability the tax administration is successful in litigation comes with probability $r(\alpha, \beta; \theta, z, x)$ for center parameters θ, z, and x.
- Upon the tax authority's successful defense, the taxpayer pays their discovered unpaid taxes and the fine. The tax authority's and the taxpayer's legal expenses are borne by each respective party.[3]
- Upon the taxpayer's successful appeal, the taxpayer makes no additional payments beyond their initial tax payment of $T(x)$. The tax authority's and the taxpayer's legal expenses are borne by each respective party.

[2]The audit (taken as fixed) may not have uncovered the entirety of taxpayer i's true underreporting, where taxpayer i's true income was $x + z + q$ (where q may equal 0 or z_2). In particular, z takes value z_1 if the audit is unsuccessful in discovering the second vehicle; z takes value $z_1 + z_2 = \mathcal{Z}$ if the audit is wholly successful.

[3]One can also study a legal environment where the losing party pays the litigation fees of the successful party. However, while this practice often occurs in civil court settings, legal fees are not typically reimbursed in the context of tax court.

2.2 Individual optimal underreporting responses

A taxpayer has utility linear in pre-audit disposable income and optimizes her expected utility. Absent audits, she allocates her underreporting portfolio such that $T'(x) = \xi_1'(z_1) = \xi_2'(z_2)$.

In the presence of audits, ignoring endogenous litigation effort, the taxpayer optimizes[4]

$$\begin{aligned} \underset{z_1,z_2}{argmax}(1-\rho_1)\Big(y - T(x) - \xi_1(z_1) - \xi_2(z_2)\Big) + \\ \rho_1(1-\rho_2)\Big(y - T(x+z_1) - \phi(z_1;x) - \xi_1(z_1) - \xi_2(z_2)\Big) + \\ \rho_2\rho_2\Big(y - T(y) - \phi(z_1+z_2;x) - \xi_1(z_1) - \xi_2(z_2)\Big) \end{aligned}$$

$$\begin{aligned} = \underset{z_1,z_2}{argmax}\Bigg(& y - \xi_1(z_1) - \xi_2(z_2) - (1-\rho_1)T(y - z_1 - z_2) \\ & - \rho_1(1-\rho_2)(T(y-z_2) + \phi(z_1;x)) - \rho_1\rho_2(T(y) + \phi(\mathcal{Z};x))\Bigg). \end{aligned}$$

Such that $y - T(y) - \xi_1(z_1) - \xi_2(z_2) - \phi(z_1+z_2) \geq 0$. We view this budget constraint as the most empirically relevant for the taxpayer's sheltering decision. As opposed to alternate formulations of the budget constraint, this constraint expresses that the taxpayer's income sheltering is limited by consideration of the "worst-case scenario" in which full discovery of sheltered assets requires her to pay full taxes as well as the resulting fine after already having paid for sheltering costs. It also represents a more conservative budget scenario, as it is very clearly true that $T(y) + \phi(z_1+z_2) > T(y - z_1 - z_2)$.[5] An alternate formulation, say that $y - T(y - z_1 - z_2) - \xi_1(z_1) - \xi_2(z_2) \geq 0$, could carry the interpretation that the cost

[4]For simplicity, we presently assume that the taxpayer does not base consider the possibility of appeal in her optimal underreporting decision. We explicitly study joint optimization after establishing underreporting and litigation results separately.

[5]This constraint also comes with the possibly undesirable interpretation that an individual never underreports income to the point that, in case of a successful audit, she would have to engage in borrowing or consumption out of savings to pay back the remainder of taxes and penalties.

of sheltering is the binding constraint.

However, it may also be the case that interior solutions for income underreporting are generated by convexly increasing sheltering costs (either pecuniary or nonpecuniary) even in the absence of a budget constraint. The distinction between incorporating no budget constraint or either of the first two budget constraint scenarios features little falsifiability, so in studying comparative statics for the optimal allocation decision, we choose to omit these constraints entirely.

Optimizing z_1 and z_2 here yields first-order conditions:

$$(1-\rho_1)T'(y-z_1-z_2) = \xi_1'(z_1) + \rho_1(1-\rho_2)\frac{\partial\phi(z_1)}{\partial z_1} + \rho_1\rho_2\frac{\partial\phi(\mathcal{Z})}{\partial z_1} \quad (1)$$

$$(1-\rho_1)T'(y-z_1-z_2) + \rho_1(1-\rho_2)T'(x+z_1) = \xi_2'(z_2) + \rho_1\rho_2\frac{\partial\phi(\mathcal{Z})}{\partial z_2}. \quad (2)$$

This system implicitly defines a solution to the optimal underreporting vehicle allocation decision (z_1^*, z_2^*).

A corner solution with zero underreporting corresponds with cost and penalty schedules with steepness far in excess of the tax schedule (or with detection of sufficiently high probability), but can also be rationalized with high fixed costs associated with sheltering. A corner solution of maximal sheltering corresponds with cases with a very steep tax schedule relative to steepness of the penalty and sheltering cost schedules (or with detection of sufficiently low probability) (where $z_1 + z_2 = y - \xi_1(z_1^*) - \xi_2(z_2^*)$) with exactly one of either z_1^* or $z_2^* = 0$ except in the knife-edge case where $U'(z_1^*) = U'(z_2^*) > 0$.[6]

[6] z_1^* and z_2^* represent a utility maximizing allocation if they satisfy the second-order conditions:

$$\begin{aligned}\xi_1''(z_1)\xi_2''(z_2) + (1-\rho_1)\xi_1''(z_1)T''(y-z_1-z_2) + \rho_1(1-\rho_2)\xi_1''(z_1)T''(y-z_2) + \rho_1\rho_2\xi_2''(z_2)\phi''(\mathcal{Z}) \\ + (1-\rho_1)\xi_2''(z_2)T''(y-z_1-z_2) + \rho_1(1-\rho_2)^2T''(y-z_1-z_2)T''(y-z_2) \\ + \rho_1(1-\rho_2)\phi_{z_1}''(z_1) + \rho_1(1-\rho_1)(1-\rho_2)T''(y-z_1-z_2)\phi_{z_1}''(z_1) \\ + \rho_1^2(1-\rho_2)^2T''(y-z_1-z_2)\phi_{z_1}''(z_1) + \rho_1(1-\rho_2)\rho_2\phi_{z_1}''(z_1)\phi''(\mathcal{Z}) \\ + \rho_1\rho_2\xi_2''(z_2)\phi''(\mathcal{Z}) + \rho_1^2(1-\rho_2)\rho_2T''(y-z_1)T''(y-z_2)\phi_{z_1}''(z_1) \geq 0\end{aligned}$$

and

$$-\xi_1''(z_1) + (1-\rho_1)T''(y-z_1-z_2) - \rho_1(1-\rho_2)\phi_{z_1}''(z_1) - \rho_1\rho_2\phi''(\mathcal{Z}) < 0.$$

This result follows from the simplifying assumption that $\frac{\partial\phi(\mathcal{Z})}{\partial z_1} = \frac{\partial\phi(\mathcal{Z})}{\partial z_2}$ and $\frac{\partial^2\phi(\mathcal{Z})}{\partial z_1\partial z_2} = \frac{\partial^2\phi(\mathcal{Z})}{\partial z_1^2} = \frac{\partial^2\phi(\mathcal{Z})}{\partial z_2^2}$, i.e. that upon fill discovery, the fine is only a function of overall underreporting and does not consider the allocation of unsheltered funds between vehicles. If the tax and penalty schedules are linear or globally convex

We turn to studying the comparative statics of this system at an initially optimum underreporting allocation (z_1^*, z_2^*). For simplicity, consider a linear income tax rate τ and penalty rate ϕ. The first-order conditions for an interior underreporting allocation define the following system:

$$f(z_1^*, z_2^*, \tau, \phi, \rho_1, \rho_2) = \begin{bmatrix} (1-\rho_1)\tau - \xi_1'(z_1) - \rho_1\phi \\ (1-\rho_1)\tau + \rho_1(1-\rho_2)\tau - \xi_2'(z_2) - \rho_1\rho_2\phi \end{bmatrix} = \vec{0} \in \mathbb{R}^2.$$

We can express partial derivatives of (z_1^*, z_2^*) with respect to ϕ.[7]

$$\begin{bmatrix} \frac{\partial z_1^*}{\partial \phi} \\ \frac{\partial z_2^*}{\partial \phi} \end{bmatrix} = - \begin{bmatrix} \frac{\rho_1}{\xi_1''} \\ \frac{\rho_1\rho_2}{\xi_2''} \end{bmatrix}, \tag{3}$$

with their sum reflecting the change in total underreporting in this framework. This simple setup reveals an important asymmetry in the response of each sheltering type to the penalty. Namely, for $\rho_2 < 1$ the penalty induces an attenuated decrease in the usage of a safer vehicle relative to the decrease in usage of the less-save sheltering vehicle. At the extreme where the second vehicle is never discovered following an audit, intuitively, the penalty rate has no effect on the optimal sheltering amount with the safer vehicle. Additionally, because the sheltering cost schedules are additively separable between vehicles and here the penalty schedule sees zero curvature, there is no cross-substitution effect where a decrease usage of the first vehicle usage increases usage of the second safer vehicle.

Alternatively, one can conceptualize perturbing the penalty rate ϕ at all points of underreporting given a nonlinear penalty schedule without affecting the curvature or other higher orders of the penalty schedule (e.g. by adding an additional linear piece $\phi_\delta z$ to the Taylor expansion of the penalty schedule).

Generally, high curvature of the penalty schedule attenuates the responsiveness of underreporting, simply because a high curvature allows a small decrease in underreporting to affect

the second-order conditions are trivially met. Basic shape regularity conditions in this setting otherwise include requirements that the tax and penalty schedules not be *too* concave, potentially implicating a lower bound of the second derivative.

[7] In the more generic case with cross-cost effects between underreporting vehicles, this derivative generalizes to $\frac{\rho_1}{\xi_{11}\xi_{22} - \xi_{12}^2} \cdot \begin{bmatrix} -\xi_{22} + \rho_2\xi_{12} \\ \xi_{12} - \rho_2\xi_{11} \end{bmatrix}$.

a large decrease in penalty. However, this relationship ultimately depends in a nontrivial manner on the relative magnitudes of the curvatures of the sheltering cost schedules, the curvature of the penalty schedule, and the discovery probabilities. The opposite intuition holds if the penalty schedule is concave.

2.3 Litigation (appeal) decision

Well after paying taxes on the honestly-reported portion of the income, an audit is realized and the tax authorities discover underreported income amount $z \in \{z_1, z_1 + z_2\}$, and are requiring the individual to pay the difference in taxes plus a fine on the underreported amount $T(x+z) - T(x) + \phi(z;x)$.

The taxpayer can either concede this amount or engage in litigation at cost $\alpha + F$ with probability of failure $r(\alpha, \beta; \theta, z)$.[8] The taxpayer ultimately bases her litigation decision and effort (extensive and intensive margins) to maximize payoff:

$$\begin{cases} \textbf{No litigation: } -\Big(T(x+z) - T(x) + \phi(z;x)\Big) \ w.p.\ 1 \\ \\ \textbf{Litigation win: } -(F+\alpha), \ w.p.\ 1 - r(\alpha^*, \beta; \theta, z) \\ \\ \textbf{Litigation loss: } -\Big(T(x+z) - T(x) + \phi(z;x) + F + \alpha\Big), \ w.p.\ r(\alpha^*, \beta; \theta, z) \end{cases}$$

2.3.1 Intensive margin litigation decision

Conditional on litigation, the taxpayer chooses litigation effort to maximize

$$-F - \alpha - r(\alpha)\Lambda$$

i.e. minimize

$$\alpha + r(\alpha)\Lambda,$$

[8] This central specification features legal expenses as not reimbursed by the losing party. Section C considers the alternative where the winning party's legal expenses are covered by the losing party.

for the stakes of the negative outcomes (from the taxpayer's perspective) $\Lambda := T(x^* + z^*) - T(x^*) + \phi(z^*; x^*)$ and shorthand $r(\alpha) := r(\alpha, \beta; \theta, z)$ for the probability that the taxpayer loses (i.e. that the tax authority wins). Importantly, the taxpayer takes all other arguments in her litigation failure probability, including tax authorities' litigation efforts, as exogenous to her litigation effort. This setup yields a first-order condition and simple elasticity rule for optimal litigation effort:

$$\underbrace{1 + \frac{\partial r(\alpha^*)}{\partial \alpha}\Lambda}_{-f} = 0.$$

$$\varepsilon_{r,\alpha^*} = -\frac{\alpha^*}{r(\alpha^*)\Lambda}.$$

$$\varepsilon_{\tilde{r},\alpha^*} = -\frac{\alpha^*}{\Lambda}$$

At the optimal level of intensive-margin litigation effort, the elasticity of taxpayer win probability equals the ratio of optimal taxpayer litigation expense and the expected payment on the stakes. Alternatively, the semi-elasticity of taxpayer win probability in optimality is simply the ratio of intensive-margin expense and the stakes. As a more direct expression of optimal litigation expense,

$$\alpha^* = -\varepsilon_{\tilde{r},\alpha^*}\Lambda^* = -r(\alpha^*)\varepsilon_{r,\alpha^*}\Lambda^*, \tag{4}$$

with taxpayer optimal litigation expense increasing in the elasticity of taxpayer loss probability with respect to taxpayer litigation expenses (where $\frac{\partial r(\alpha)}{\partial \alpha} < 0$ for an interior solution) as well as in alleged tax deficiency, penalty, and tax authority litigation expense. This result here implies that the taxpayer's optimal litigation expense is a linear transformation of the penalty schedule. [9]

Applying the implicit function theorem to the first-order condition allows us to gauge

[9]The second-order condition for this interior solution to produce an optimum is:

$$\Lambda \cdot \frac{\partial^2 r(\alpha)}{\partial \alpha^2}|_{\alpha^*} > 0,$$

i.e. the taxpayer sees diminishing returns to her legal expenses in terms of the probability of litigation success.

the response of optimal litigation effort as the penalty varies in a linear fashion:

$$\frac{\partial \alpha^*}{\partial \phi} = \frac{-\frac{\partial r(\alpha)}{\partial \alpha} z}{\Lambda \frac{\partial^2 r(\alpha)}{\partial \alpha^2}} > 0,$$

given the the condition $\frac{\partial^2 r(\alpha)}{\partial \alpha^2} > 0$ (i.e the taxpayer appeal success probability is concavely increasing in appeal effort/expense).This comparative static generates an important piece of intuition: that optimal litigation effort/expenses conditional on litigation is increasing in the penalty rate.

2.3.2 Extensive margin litigation decision

As an expected utility maximizer, the taxpayer decides to litigate if

$$T(x^* + z^*) - T(x^*) + \phi(z^*; x^*) > F + \alpha + r(\alpha^*, \beta; \theta, z^*, x^*)\Big(T(x^* + z^*) - T(x^*) + \phi(z^*; x^*)\Big).$$

$$\implies \big(1 - r(\alpha^*, \beta; \theta, z^*, x^*)\big)\Lambda^* > F + \alpha^*.$$

The intuition underlying the taxypayer's extensive margin decision of whether to litigate is straightforward. All else equal, a greater amount of tax loss and underreporting penalty increase the incentive to litigate. Litigation is disincentivized by 1) greater fixed costs of litigation, 2) greater expected total litigation expenses, and 3) lower probability of litigation success.

2.4 Joint optimization

Now, consider the joint optimization problem. The taxpayer makes a decision allocation (z, L, α) underreporting $z \in \mathbb{R}_+$, extensive margin litigation decision $L \in \{0, 1\}$, and intensive margin litigation effort/expense $\alpha \in \mathbb{R}_+$. To simplify the analysis, consider the agent's joint optimization problem in the presence of only a single underreporting vehicle. An agent optimizes jointly the amount of underreporting, whether to litigate upon detection, and the amount of litigation effort/expense.

Let $L := 1\{F + \alpha^* + r(\alpha^*_{L=1})\Lambda < \Lambda\}$, i.e. whether the taxpayer decides to litigate

upon alleged underpayment. Intuitively, the taxpayer decides to litigate if the expected cost of litigation is less than the repayment and fines required in acquiescing to the terms of underpayment ("the stakes"). The taxpayer performs

$$\max_{z,\alpha\in\mathbb{R}_+,L\in\{0,1\}} y-\xi(z)-T(y-z)-\rho\Big((1-L)\Lambda+L((1-r(\alpha))F+r(\alpha)\Lambda)\Big).$$

As before, conditional on litigating, the taxpayer expends $\alpha^*=\varepsilon_{\tilde{r},\alpha^*}\Lambda$ in litigation effort/expense (recall that $r(\alpha)$ and $\varepsilon_{\tilde{r},\alpha}$ read in the direction of a ruling in favor of the tax authorities).

The central insight that comes with specifying a joint optimization deals with optimal underreporting. Consider the underreporting occurring under two different optima $L=0$ and $L=1$. As before, when the taxpayer does not litigate from an ex ante perspective, optimal underreporting is characterized by the first-order condition:

$$z^*_{L=0}: T'(y-z^*_{L=0})=\xi'(z^*_{L=0})+\rho\big(T'(y-z^*_{L=0})+\phi'(z^*_{L=0})\big).$$

However, in the case where ex-ante, the taxpayer intends on litigating, optimal underreporting is characterized by the alternate first-order condition:

$$z^*_{L=1}: T'(y-z^*_{L=1})=\xi'(z^*_{L=1})+\rho r(\alpha)\big(T'(y-z^*_{L=1})+\phi'(z^*_{L=1})\big). \tag{5}$$

It is clear that $z^*_{L=1}\geq z^*_{L=0}$, with strict inequality for interior solutions. The intuition is straightforward. Litigating serves to lower the probability that the taxpayer will have to pay back any underpayment or penalty, so that the taxpayer compensates by engaging in greater underreporting relative to the no-litigation baseline.[10]

An analogous set of results arises from the government's perspective (aside from the litigation decision, as we do not consider that the government selectively engages in auditing in anticipation of these costs). The benefits of higher penalties in decreasing underreporting and increasing revenue on inframarginal detected underreporters are weighed down by increased probability of litigation (lower probability of collection) and increased administrative

[10]The following section will consider penalties in studying optimal tax administration.

costs from the perspective of the tax authorities.

3 Institutional background and data description

3.1 Tax reporting and penalty administration in Norway

The empirical testing ground for this paper is Norway, which has operated under a dual income tax system since 1992. This system combines a proportional tax rate on capital income with progressive taxation of labor income. The taxation of personal income involves a flat rate on ordinary income (net income after deductions) of 22% and a bracket (step) tax on gross income (primarily labor and pension income) before deductions. Since ordinary income and personal income tax apply together, in addition to social security contributions, the effective marginal tax rate can be substantially higher than 22%. As of 2025, the top marginal tax rate on labor income can reach around 47.4%. Moreover, all taxpayers with a net wealth exceeding NOK 1,760,000 are liable to pay wealth tax to the municipality and state with a combined maximum rate of up to 1.1%.

Every year in March/April, individuals who receive a salary, pension or disability benefit are issued a pre-filled tax return with a summary of their income, deductions, wealth and debt for the previous fiscal year. Individuals are responsible to check the accuracy of the provided information and make amendments to this preliminary statement. The deadline for changing and submitting the tax return is April 30. Following the submission, the Norwegian tax authorities process the returns and send out a final tax assessment notice before December 1. While in the presence of third-party reporting tax noncompliance is expected to be more concentrated along margins where information is harder to verify, such as self-employment or foreign-reported income, Bjørneby, Alstadsæter, and Telle (2021) demonstrate the limits of Norway's third-party reporting system and find evidence of collusive tax evasion involving employers and employees. Underreporting or misreporting may trigger penalties and interest on unpaid taxes. To enforce compliance, the Norwegian tax authorities regularly conduct random audits and risk-based audits.

The administration of income tax penalties in Norway is regulated in Section 14 of the

Tax Administration Act. Under this provision, taxpayers may be charged with penalties ("tilleggsskatt") in cases where they did not provide correct or complete information in their tax returns. Such penalties are only imposed if inaccurate information results in a tax advantage for the taxpayer. A tax advantage typically arises if the taxpayer has paid too little tax, for example if she did not report all of her income or wealth, or entered a deduction or debt to which she is not entitled. Notification of penalties is provided in writing. The ordinary penalty rate amounts to 20% of underreported base. In more serious cases, the Norwegian tax authorities may levy an increased penalty of up to 40%. Hence, the highest applicable penalty can be as high as 60% of underpaid tax (to be paid back in full along with interest). The elevated penalty rate is applied in cases where the taxpayer provides intentionally or with gross negligence incorrect or incomplete information to the tax authorities. Tax penalties will not be levied if the incorrect information is due to excusable conditions, such as illness, old age, inexperience or other related reasons. However, there are strict requirements to familiarize yourself with the relevant regulations.

Prior to 2016, the ordinary tax penalty rate was levied at 30% of tax that has been or could have been evaded. In 2016, Norway implemented a major reform of its tax penalty system by reducing the standard rate from 30% to 20%. This change occurred in the course of the passage of the Tax Administration Act and was introduced through proposition 38 L (2015-2016) to the Norwegian Parliament (Finansdepartementet (2015)). The Ministry of Finance submitted this proposal on December 11, 2015[11]. The reform aimed to enhance legal certainty, proportionality, and fairness in tax enforcement. Specifically, it sought to simplify the penalty system, increase its predictability, and encourage voluntary compliance. According to the Ministry, the introduction of a more moderate and standardized penalty rate was expected to improve perceptions of legitimacy and fairness in the tax system, thereby promoting long-term compliance behavior. With the introduction of the Tax Administration Act the Norwegian government also introduced a compulsory fine for taxpayers who do not submit their tax returns within the deadline. This compulsory fine is deducted from the tax penalty. In our data environment, we are able to disentangle late filing fees from tax

[11] https://www.regjeringen.no/no/dokumentarkiv/regjeringen-solberg/aktuelt-regjeringen-solberg/fin/pressemeldinger/2015/forenkler-reglene-for-skatteforvaltning-og-styrker-rettssikkerheten/id2466803/

noncompliance penalties. The Tax Administration Act was passed in 2016 and the new penalty rate came into effect on January 1, 2017. Moreover, the new regulations contain a transitional rule, which states that when a first-instance on penalty assignment is applied after January 1, 2017, the legal framework that results in the lowest penalty rate shall be applied. In our data, we observe exactly the income year the issued penalty relates to.

Taxpayers have the right to appeal the tax authorities' decision within six weeks of receiving the notification of penalty assignment. Appeals must be submitted in written format, either electronically or on paper to the tax office, and contain a justification. The appeal is first processed by the tax office, and if the tax office upholds its decision, the case will be forwarded to the Directorate of Taxes or the Tax Appeals Board. If taxpayers disagree with the decision of the tax office or Tax Appeals Board, they can take legal action within six months of the decision being made. As long as a case concerning penalty assignment has not been legally decided, taxpayers are entitled to deferral of claims for payment of the penalty.

3.2 Data

To study the impact of tax noncompliance penalties on individual behavior, we combine data from Statistics Norway and the Norwegian tax authorities on the universe of income and wealth taxpayers in Norway from 2007 to 2021, including novel data on penalty amount recipiency. Our data environment combines commonly employed administrative tax data (with the benefit of also including data on wealth underlying the administration of the Norwegian wealth tax) with additional data indicating whether a taxpayer was assigned a penalty in a given year, whether the penalty was assigned in an ordinary or elevated penalty rate regime, and the penalty amounts assigned under each regime. From the shareholder registry, we are able to infer business ownership in addition to other demographic characteristics. We winsorize all monetary variables on the 0.5% and 99.5% levels within year and express all values in terms of NOK 2015 (the exchange rate to USD is approximately NOK 11 per USD as of August 2024).

We construct an individual-year panel of taxpayers and impose perfect balance from 2007 to 2021. We observe 3 million individuals of working age each year, or around 60% of the

2015 national population.

Individuals in our environment receive penalties for a variety of tax noncompliance infractions. While we do not observe the reason for penalty assignment aside from late payment status, we understand these penalties to reflect instances of underreporting and misreporting. Importantly, these penalties are assigned contemporaneously in response to operational audits: e.g. for a penalty observed in 2015, the penalty was implemented in response to an operational audit of a 2015-2016 tax declaration prior to the 2016 tax year. While we do not yet observe either statutory penalty rate assigned nor amount underreported, we do observe whether an individual faced an ordinary or an elevated penalty. Prior to 2016, the ordinary penalty rate was levied at 30% of underreported base; the elevated penalty was levied at a discretionary amount between 45% and 60%. Tax non-compliant individuals are assigned to the high-rate penalty regime if they deliberately engage in tax fraud or act with gross negligence.

3.3 Descriptive evidence on income tax penalties and appeals

We now turn to producing descriptive statistics on penalties and the statutory distributional incidence of penalties. Little is known—even descriptively—about who receives penalties and how penalties impact overall tax liability and net collections. A distinctive feature of our analysis is the ability to incorporate information on appeals of penalties. This allows us to examine not only the initial imposition of penalties across taxpayers but also to shed light on the characteristics of those who appeal, appeal outcomes, and the interconnection between penalty severity and the appeals process.

The incidence of income tax penalties. Table 1 establishes descriptive statistics on penalty assignment. Panel (a) provides an overview of penalty characteristics. Between 2011 and 2021, we observe 88,562 penalty assignments in our data, of which 11,251 correspond to elevated penalties. The average (median) penalty amounts to NOK 21,075 (NOK 7,000). Panel (b) focuses on the attributes of taxpayers, stratifying by whether they received any tax noncompliance penalty. The table suggests notable differences between penalty recipients in terms of gender, age, education, and immigrant status. Implicated taxpayers are on average

more likely to be male, younger, less educated, and more likely to have an immigration background. Moreover, significant differences emerge for economic status. Specifically, penalty recipients have higher total incomes, income tax liabilities, exhibit a significantly higher probability of claiming self-employment income (26pp relative to a non-penalized baseline of 7%) or capital income (2pp relative to a non-penalized baseline of 87%), and are more likely to transfer money abroad and to tax haven jurisdictions in a given year. Table 2 explores heterogeneity in penalty size among penalized taxpayers. The penalties assigned increase significantly in income, tax liabilities, self-employment status, and the likelihood of undertaking international bank transfers. Older and male taxpayers face somewhat higher penalties, while immigrants receive lower amounts. Marital status and education appear to be negatively correlated with the severity of penalties.

Figure 1 elaborates on these descriptive results, showing the frequency of penalty assignment along income and wealth.[12] We observe a level of progressivity for the assignment of tax penalties. In a given year, nearly 1.5% of the top 1% by wealth receive a penalty. Around 3% of earners in the top 0.01% receive a penalty. These insights are not driven by the fact that high-income earners are audited more frequently and hold up when restricting the sample to audited taxpayers only (Panels (b) and (d)).[13] Figure A.7 shows the conditional distribution of penalty size by income rank and Figure A.8 shows penalty collections on a per capita and aggregate basis by income rank. The figures illustrate that while penalty sizes rise at the top of the income distribution both in terms of mean amount and per capita assignment, the aggregate amount of penalties raised is somewhat flat across the income distribution.

Figure A.6 shows the distribution of effective penalty rates assigned (as distinct from statutory penalty rates), measured as penalty assigned divided by gross taxable income. Panel (a) truncates the distribution above an effective rate of 100%, whereas Panel (b) stratifies the distribution by ordinary-/elevated rate status and implements a log specification to capture the whole distribution of effective penalty rates. The figures illustrate that penalties are typically quite small. The ordinary rate regime sees two modal rates at around

[12] Our measures of income and wealth are corrected for detected underreporting.

[13] Figure A.5 plots the number of times individuals are penalized annually in our eleven-year observation period. Figure 13 shows a decrease in penalties administered over time. Overall, penalties comprise a very small portion of Norwegian tax collections (less than 1%).

1% ($\sim e^{-4.5}$) and 10% ($\sim e^{-2.3}$). The high-rate penalty regime sees a modal effective rate of around 5% ($\sim e^{-3.5}$) although right tail dominates that of the ordinary penalty rate regime, with substantial observed mass implying effective penalty rates above 100%.

Figure 2 plots effective income tax rates and effective penalty rates across the income distribution. Among both penalized and non-penalized taxpayers, effective income tax rates rise with income, reflecting the de facto progressivity of the Norwegian tax system. Penalized taxpayers face slightly higher effective income tax rates than their non-penalized counterparts, particularly in the lower part of the distribution. By contrast, effective penalty rates exhibit strong regressivity conditional on receipt of a penalty. At the very bottom of the distribution, penalties exceed 60% of income, but they fall rapidly with income rank and flatten below 1% for top earners. This descriptive evidence illustrates that, although the statutory penalty rate is uniform, its effective incidence places a disproportionate burden on low-income taxpayers.

Appeals. Our unique data environment also allows us to provide a detailed picture of the characteristics of appeals and their interconnection with the degree of severity of tax penalties. Table 3 compares the demographic attributes of the 1,484 taxpayers who appealed their assigned penalty during 2011-2021 to penalty recipients who did not. Appellants have significantly higher income and wealth, are more likely to claim capital income and transfer money to tax haven jurisdictions, are older, and are more likely to have completed university. Figure 8 illustrates the distributional pattern of appeals across the income spectrum, conditional on having received a penalty. The incidence of appeals follows a U-shaped pattern: compared to middle-income earners, individuals situated at the lower end of the income distribution exhibit a higher likelihood of appealing. We further observe a pronounced right-tail of the distribution, showcasing that the likelihood to appeal rises sharply at the top of the income distribution. This pattern suggests that both resource availability and perceived returns to contesting may shape the decision to appeal, with affluent taxpayers potentially leveraging greater financial and informational resources, while lower-income individuals may appeal as a defensive strategy when faced with additional burden.

Figure 9 elaborates on the relationship between different measures of penalty severity and

the probability that taxpayers file an appeal. As suggested by our behavioral framework, the binscatter reveals a clear upward relationship: as the size of the penalty increases, so does the likelihood of appeal. Complementing these insights, Table 8 reports the corresponding descriptive regression results, controlling for individual total income and wealth status. Both the amount of penalties and the effective penalty rates stand out as strong predictors of the appeals decision. Building on these insights, Table 9 provides summary statistics on appeal *outcomes*.[14] In 73.5% of cases we observe the closing date, 63.6% of appeals have been collected during our sample period. Conditional on observing the closing date, in 14% of cases the penalty has been at least partially removed. Table 10 shows that the penalty amount and -rate strongly decrease the likelihood of observing an appeals' closing date. Similarly, Table 11, Table 12 and Table 14 provide descriptive evidence that higher penalties significantly shape processing times, pointing to the notable administrative burden and complexity behind the litigation process. Table 13 demonstrates that, controlling for taxpayer income and wealth, higher penalty sizes decrease the removal share of penalties post-appeal. Figure 10 and Figure 11 visualize the relationship between penalty sizes and appeal outcomes in binscatter plots. Figure 12 illustrates appeal outcomes across the taxpayer income distribution, indicating that income is only weakly correlated with systematic patterns in these outcomes.[15]

4 The impact of the penalty rate on ex-post income reporting behavior

4.1 Quasiexperiment: The 2016 reform to the statutory penalty rate

To estimate the causal impacts of changing the penalty rate, we exploit a legislative reform to the statutory penalty rate. Prior to 2016, individuals penalized under the standard

[14] Table A.2 and Table A.3 do so separately for appeals related to ordinary- and elevated-rate penalties, respectively.

[15] We obtain similar results on the penalty severity/income rank–appeals outcomes nexus when controlling for taxpayer characteristics; see Figure A.2, Figure A.3, and Figure A.4.

ordinary penalty rate regime faced a statutory 30% fee on the underreported base, to be paid back alongside the underpaid tax obligation in full and interest. On December 11, 2015, the Norwegian government announced to lower the statutory penalty under this regime to 20%, constituting a 33.3% relative decrease in the statutory penalty rate.

We leverage the timing of penalty recipiency before and after this reform to estimate the differential evolution in reporting behavior for around penalty recipiency for ordinary penalty rate recipients. We define taxpayers' penalty events as the year of their earliest observed penalty between 2011 and 2021. We implement this definition in order to avoid mechanically biasing our estimates by conditioning on ex-post compliance or noncompliance behavior, although Figure A.5 shows that the overwhelming majority of penalized taxpayers are observed only ever receiving a single penalty.[16] Importantly, because we study the differential response of penalized individuals, this design can only estimate agents' ex-post responses to penalties, as opposed to the deterrence response induced by the penalty rate.

Equation (6) shows the reduced form of our main estimating equation. The first sum itself only measures the effect associated with event time (i.e. detection), which we typically view as invalid for inference purposes. The second summed term isolates the differential effect of the post-reform penalty recipients that face the 10pp lower statutory penalty rate. Importantly, we only use observations within five years of penalty recipiency. This estimating equation omits year fixed effects, as in the absence of an appropriate never-treated group, year-fixed effects may demonstrate collinearity with post-reform cohort status interacted with event time; we also implement our design without any fixed effects. Our main outcomes of interest are declared gross income and income tax payments (in logarithms). We additionally estimate this equation for a broader set of variables, including income-type disaggregations of wealth and its components and "quality-of-life" events, such as change of residence and divestment of business ownership.[17]

[16] We also do not duplicate individuals receiving multiple penalties to study their subsequent penalty events.

[17] We further consider other parameterizations, i.e. level specifications and binary indicators for non-zero values. The results are available upon request.

$$y_{it} = \alpha_i + \underbrace{\sum_{k=-5}^{5} \gamma_k EventTime_{k(it)}}_{\text{Detection}} + \underbrace{\sum_{k=-5}^{5} \beta_k Event\ Time_{k(it)} \cdot 1\{Penalty\ Year_i \geq 2016\}}_{\text{Intensity effect}} + \varepsilon_{it}. \tag{6}$$

This "difference-in-differences event study" approach overcomes the fundamentally non-random nature of audits and penalty occurrence in our setting. Individuals here are audited and penalized contemporaneously by the tax authorities in a manner so that their earnings and declarations trajectories are unlikely to exhibit "parallel" trends pre-detection to as to compellingly estimate a treatment effect of audits or penalties on the treated. However, this design relies on a parallel trends assumption that cohorts of penalty recipients evolve in a parallel manner prior to their detection and penalty assignment, which we validate empirically.

In a homogeneous treatment effects setting and under a parallel trends assumption, estimators $\{\hat{\beta}_k\}_{k\geq 0}$ identify the average treatment effect (ex-post detection and penalty assignment) of the lower penalty rate on dependent variable y.

However, in a heterogeneous treatment effects environment, the main threat to identifying the average causal effect of the penalty rate lies in the possibility of differential composition of pre- and post-reform cohorts. Figure 13 shows that the frequency of penalties significantly drops off starting 2016. Indeed, we observe around one-third the number of penalty recipients per year post-reform as we do pre-reform. Table 16 elaborates on the differences in observable characteristics between cohorts, finding significant differences in observable characteristics between ordinary rate penalty recipients before and after the statutory rate decrease. In particular, during the four years prior to receiving their penalties, the post-reform individuals report 40% more income and around twice the taxable wealth as do the pre-reform penalty recipients. They are also four years older on average, 10% (3.3pp) more likely to have completed university, and slightly more likely to be married (+1.3pp relative to 49% baseline) but do not differ largely in terms of gender or immigrant status. The table indicates no substantial difference in whether the individuals claim self-employment income, but individuals penalized post-reform around 1.3pp more likely to claim capital income (relative to a baseline of 96.1%).

It is possible that the reform also induced differential sample composition. We are un-

aware of any explicit change in the leniency audit targeting policy of the Norwegian tax authorities. This said, differential sample composition can enter our setting either on part of a change in audit policy or penalty selection by the tax authorities or by change in the composition of taxpayers engaged in underreporting (and successfully detected) following the reform. Absent a change in audit or penalty assignment policy, this latter possibility would require a negative relationship between risk aversion and income/wealth, as the sample becomes more positively selected on income and wealth following the decrease in the statutory penalty rate. If potential outcomes vary in a heterogeneous treatment effects setting, our design risks misattributing the differential effect of audits between the two samples to the decrease in the penalty rate. To address this concern, Section 4.4 implements a matching design that attempts to alleviate the differential sample composition, and in particular, align potential outcomes that may manifest through differences in these pre-event observable characteristics.

4.2 Results

Figure 14 and Figure 15 show the estimates for this design, displaying the net differential response in the first panel and the stratified event studies in the second panel. The figures demonstrate the design's success in netting out the non-random pre-event evolution in economic outcomes. Panel (b) presents the results from a stratified event study, applying the estimation technique by Callaway and Sant'Anna (2021). Accounting for the staggered nature of penalty assignment eliminates differences in pre-event trends in income- and tax reporting between pre-reform and post-reform cohorts. Following the implementation of the penalty however, the two groups diverge in their reported income trajectories. Both groups decrease their reported income relative to their pre-reform trends, but the post-reform penalty recipients exhibit a close to 10% decrease in their reported income relative to the pre-reform group, attenuating three years out from the reform. Figure 15 shows that this differential income reporting responses corresponds with a commensurate difference in collected taxes, demonstrating less attenuation post-reform.

The results suggest an 8-12% decrease in reported income and taxes paid among the group subject to the lower 20% statutory penalty rate. Contextualizing this response within

the relative change in the statutory rate of $-1/3$, we estimate an behavioral elasticity of reported income and taxes paid to the ex-post penalty rate of between 0.15 and 0.3.[18]

Figure 16 breaks down the overall response by income type, distinguishing between salary income, self-employment income, and capital income. Panel (a) shows a clear heterogeneity in the response of wage earners: individuals penalized under the post-2016 regime increase their reported wage and salary income relative to their pre-reform counterparts. By contrast, self-employed individuals that got penalized after 2016 substantially decrease their income reporting following the receipt of a penalty (see panel (b)). Moreover, as shown in panel (c), we find no differential response for capital income across cohorts. Both pre-reform and post-reform taxpayers decrease their reported capital income after penalty recipiency.

4.3 Instrumental variables design

In addition to exploiting the 2016 reform to the ordinary statutory penalty rate as a quasiexperiment, we provide an alternative approach to identify the causal effect of a change in the penalty rate on taxpayer behavior. This design further harnesses the richness of our penalty data and utilizes information on assigned penalty *amounts* as direct measures of a taxpayer's effective penalty burden. Specifically, we parameterize the penalty size as three continuous variables: (i) the logarithm of the penalty amount, (ii) effective penalty rate as measured by the assigned penalty amount per total gross income, and (iii) the logarithm of the effective penalty rate. We estimate the following equation:

$$y_{it} = \alpha_i + \underbrace{\sum_{k=-5}^{5} \gamma_k EventTime_{k(it)}}_{\text{Detection}} + \underbrace{\sum_{k=-5}^{5} \beta_k \theta_i EventTime_{k(it)}}_{\text{Intensity effect}} + \varepsilon_{it}. \tag{7}$$

Here, θ_i captures the "intensity" of the assigned penalty as measured by the three parameterizations above. While the first term of Equation (7) gauges the extensive margin effect of penalty recipiency, estimates of β_k yield the average treatment effect on the treated (ATT)

[18] It is not immediately obvious whether this elasticity should be with respect to the net-of-penalty income keep-rate or with respect to the statutory penalty rate (or with respect to a net-of-tax-and-penalty income keep rate $1-\tau-\theta$). If one uses the change in the net-of-penalty income keep-rate to normalize the response (i.e. a 1/7 proportional change), we estimate an elasticity of reported income and taxes paid to the ex-post net-of-penalty keep of between 1 and 2.

of a change in the size of a penalty under a parallel trends assumption. Again, α_i represents a set of individual fixed effects, and we cluster standard errors at the taxpayer level. To achieve a causal interpretation of our results, we draw on an instrumental design using two sources of exogenous variation for penalty stringency. First, we exploit the reform to the statutory penalty rate in 2016 described above as an instrument. Specifically, we generate a binary indicator equal to one if the taxpayer was assigned a penalty in the years 2016 or after, and zero otherwise. Our second instrument is constructed by the leave-one-out mean of the effective penalty rate, i.e. the average penalty rate faced by other individuals that got penalized in the same year, excluding the taxpayer in question.

Table 4 reports the first-stage estimates in which the penalty rate reform serves as instrument for taxpayers' effective penalty rates. Consistent with the institutional design of the reform, we document a significant decrease in the effective penalty burden of affected individuals. The strong predictive power is supported by F statistics that by far exceed conventional thresholds for instrument relevance across all specifications for penalty size. The magnitude of the relationship is particularly pronounced during the 2016-2018 period, when the reform was most salient. Table 5 presents complementary first-stage results using the leave-one-out average penalty rate as an instrument. We document a large and robust positive association between a taxpayer's effective penalty burden and those of her peers. The relevance of this instrument is again supported by sizable F statistics.

Figure 3 displays the event study graph applying the reform as instrument for the logarithm of penalty size. We find that a 10% increase in the penalty amount raises reported income by 5-7% on average. This positive effect corroborates the findings from our quasi-experimental design. The absence of significant pre-event coefficients lend support for the validity of the parallel trends assumption. Figure 4 presents the event study results for the reform-induced effects of changing the effective penalty rate, while Figure 5 does using the logarithm of the effective penalty rate as treatment variable. Again, we find no indication for violations of diverging pre-trends in both cases. Consistent with our previous findings, we document a persistent positive effect on income reporting. Specifically, an increase in the penalty rate leads to an increase in reported income by 2-3%. As shown in Figure 6, this is mirrored by a sustained increase in income tax payments following a change in the effective

penalty rate. Hence, our instrumentation strategy largely corroborates our quasiexperimental results.

4.4 Further robustness tests and extensions

Matching and Correlated Random Effects. A central concern regarding the robustness of our results from the quasiexperimental design pertains to heterogeneous treatment effects and differential sample composition between those penalized before and after the statutory penalty rate decrease from 30% to 20% in 2016. Indeed, we observe that those penalized following the change report significantly more earnings and wealth than those penalized before the reform. Heterogeneous treatment effects may correlate systematically with these observable characteristics. For instance, higher earners may demonstrate greater sensitivity to the ex-post penalty rate, thus biasing estimates greater in magnitude.

To address this concern, we attempt to control for these differences by implementing a matching procedure so as to align the pre-event characteristics of penalty recipients before and starting 2016. We implement a Mahalanobis matching that maps each individual penalized starting 2016 with five individuals penalized between 2011 and 2015; individuals are matched based on the reported income for four years prior to penalty and the matches are constructed with replacement among the pre-reform sample. Of course, this design does not address the threat of heterogeneous potential outcomes correlated with unobservable characteristics in a manner not captured by conditioning on observables.

Table 18 displays the balance of the matching procedure. Compared to Table 16, Table 18 aligns observable characteristics of the two groups moderately well. Importantly, the two groups do not show substantial differences in total income. Although this balance comes somewhat expected because the match is performed on pre-event income, this observation alleviates some concern over the differential selection between the samples. In addition, the matched samples do not see significant differences in age, gender, or marital status. However, even after performing the matching procedure, individuals penalized under the 20% statutory rate regime claim 20% more taxable wealth.

Figure 17 displays the results of estimating our central specification on the matched sample. We document largely similar results, albeit somewhat attenuated. For this matched

sample, income declared decreases by around 5% among the post-reform group; this difference completely attenuates four years after the event. We document a similar response for income taxes paid. Figure 18 disaggregates this response by income types. Similar to before, we find a relative drop in wage/salary income. Self-employment income shows a starker response in the first year after penalty assignmnet, showing a relative decrease of up to 10% that dissipates. Capital income does not demonstrate a compelling response in either direction.

Figure 19 expands further on the validity of our results using a correlated random effects model, controlling for pre-event log income. We observe similar results as in our main specification and find a relative decrease in both declared income and total taxes paid by about 8% to 10%. Controlling for pre-event income in both of these specifications ensures that the response we estimate is not attributable to differences in potential outcomes as predicted systematically based on differences in income, suggesting that our results are not driven by differences in observable characteristics. Table 19 summarizes the findings for both designs.

Spillover effects. A nascent literature has evolved that studies spillover effects of tax enforcement that can arise from information sharing and joint tax preparer networks (Battaglini et al. (2019), Boning, Guyton, et al. (2020)). The richness of the Norwegian data allow us to analyze peer effects in the context of tax noncompliance penalties along two dimensions. First, we examine the effects on non-implicated individuals that share the same household identifier as the penalty recipients. Second, we leverage information from the shareholder registry to analyze spillovers to business partners that hold at least 10% ownership shares in the same company. An advantage of analyzing spillover effects lies in the potential that peers may not suffer from non-comparability that we observed for post- vs. pre-reform penalized taxpayers. Figure 20 displays the results from the quasiexperimental design for household peers (panels (a) and (b)) and business partners (panels (c) and (d)) of post-reform penalty recipients relative to those of pre-reform recipients. We document a relative decline in declared income and income tax payments among both household- and business peers of taxpayers that got penalized under new 20% penalty regime. The effects are slightly smaller than for directly impacted taxpayers and turn statistically insignificant

for business partners two years after the penalty event.

Welfare outcomes. Lastly, we turn to studying a set of "quality-of-life"-related outcomes. A welfarist position against higher penalties could argue that penalties induce negative effects on well-being or utility, such as disruptions to financial stability, solvency-related change in residence, or the loss of business assets. If larger penalties induce negative effects on individuals' quality-of-life outcomes not directly related to payment of the penalty, we should observe a relative improvement in these measures for the group of taxpayers penalized under the 20% statutory penalty rate regime over those facing the 30% penalty rate. Figure 21 plots the differential evolution of these outcomes for the two groups. We find no compelling differential effect of the decrease in the penalty rate on the occurrence of change of residence (Panel (a)). By contrast, we observe a meaningful effect on business outcomes: taxpayers facing the lower penalty regime are about 2% less likely to lose stakes in a business, as captured by the probability of remaining a direct owner of a business (Panel (b)). This showcases that targeted enforcement strategies, while designed to improve compliance, have the potential to generate unintended welfare costs that extend beyond tax collection matters.

5 The impact of the penalty rate on appeal behavior

5.1 Identification strategy

In this section, we estimate the causal impact of changes in the tax noncompliance penalty rate on a taxpayer's likelihood of appealing an assigned penalty. As elucidated above, we have access to unique information on appeal characteristics from the Norwegian Tax Authorities that reveal a clear systematic relationship with penalty amounts and appeal decisions (see Figure 9, Figure 10, Figure 11 and Table 8). While our event study design exploiting the 2016 decrease in the statutory penalty rate as a quasiexperiment is well suited for analyzing ex-post income reporting, this framework faces limitations in the appeals setting. The central challenge lies in a possible exclusion violation, in which taxpayer responses may be affected through channels other than the reform itself. Specifically, the 2016 change in

the penalty regime may have influenced appeals not only by lowering the penalty rate, but also by changing taxpayer perceptions of fairness or the composition of taxpayers subject to penalties. In such cases, comparing appeals rates across regimes risks conflating the effect of the penalty rate with broader reform-induced changes. In Figure 7 we plot the time series of appeal rates by penalty rate regime. This illustrates a divergence in the likelihood of appeals from 2016 between the lowered ordinary penalty rate regime and the unchanged penalty rate regime, the former seeing declines after the reform. This pattern highlights the reform as a pivotal source of variation in appeals behavior and suggests a positive relationship between penalty amounts and the propensity to appeal.

To address concerns about exclusion violations and credibly identify the causal effect of the penalty rate on appeals behavior, we adopt an instrumental variables strategy. As before, we instrument for the size of a penalty faced by a taxpayer using two sources of exogenous variation: (i) the statutory reduction in the penalty rate from 30% to 20% implemented in 2016, and (ii) a leave-one-out average penalty rate constructed from other taxpayer's penalty assignments within the same year. The reform generates sharp variation in penalty rates across cohorts, while the leave-one-out mean captures plausibly exogenous cross-sectional variation, mitigating concerns about endogenous penalty assignment. Formally, we estimate the following equation to isolate the causal impact of changes in assigned penalties on appeals behavior:

$$Appeal_{it} = \alpha_t + \beta \times PenaltySize_{it} + \varepsilon_{it}. \tag{8}$$

$Appeal_{it}$ is a binary indicator equal to one if taxpayer i appeals a penalty in year t and zero otherwise. $PenaltySize_{it}$ is a continuous measure of penalty exposure that allows us to directly leverage changes in penalty severity and is measured in three ways: (i) the natural logarithm of the total penalty amount assigned to a taxpayer, (ii) the effective penalty rate (total penalty amount divided by total income), and (iii) the logarithm of the effective penalty rate. Equation (8) further features year fixed effects, indicated by α_t. ε_{it} is the error term. We cluster standard errors at the year level.

5.2 Results

As shown in Table 4 and Table 5, our instruments are highly predictive of individuals' respective penalty burdens and show strong first stages across all specifications, i.e. a consistently negative relationship between the 2016 reform and effective penalty rates and penalty amounts, as well as positive effects of the leave-out mean penalty rate. Table 6 and Table 7 report the main results from our instrumentation approach. We document positive impacts of the penalty size and -rate on the probability of appealing. Specifically, we find that a 10% increase in the penalty amount raises the probability of appeal by 0.25 percentage points. Similarly, a 10 percentage point increase in the effective penalty rate leads to an increase in the probability of appealing by 0.036 percentage points on average.

These results are in line with the predictions from our taxpayer behavioral model: while stricter enforcement through higher penalties exert a positive effect on tax compliance, they also heighten taxpayers' incentives to challenge their imposed penalties and engage in a potentially lengthy appeals process. Given that appeals require substantial resources - including staff time and legal assessments - the additional amount generated by higher penalties may considerably strain tax authorities' capacities. This then does not only result in increased administrative expenditures but may also delay the resolution of other cases, thereby decreasing overall system efficiency. Our analysis is the first to shed light on both the deterrence benefits and the costs associated with administering tax noncompliance penalties, and provides a basis for the design of an efficient penalty schedule. In the next section, we study theoretically how the optimal penalty rate should be set so as to balance the tradeoff between compliance enhancement and administrative feasibility.

6 Optimal tax administration with dual-revenue instruments

To study the government's optimal penalty policy, suppose the following. Consider a representative individual with quasi-linear preferences expressed implicitly in expectation.

$$W = x - \psi(l) + v(g), \tag{9}$$

for expected consumption x, labor supply l, and common good g. $\psi(\cdot)$ and $v(\cdot)$ are both increasing and strictly convex and concave respectively. Public spending g is financed by a linear tax on income and is taken as exogenous by the taxpayer. The taxpayer is capable of sheltering and underreporting an amount e off of her true tax base wl at some cost $c(e, \alpha)$ based on amount underreported and sheltering costs. We impose c_e, c_{ee}, and $c_{e\alpha} > 0$ and that the taxpayer chooses strictly positive concealment. Additionally, with some probability, the taxpayer will be caught by the tax authorities and required to pay back the taxes due on the discovered underreporting; this expected repayment depends on policy parameters that affect probability of discovery, expected amount of discovery, the tax rate, and penalty schedule $r := r(e, t, \Xi)$ for a vector of enforcement instruments Ξ.

$$x = wl - t(wl - e) - c(e, \alpha) - r(e, t, \Xi) \tag{10}$$

This setup expands on the model environment in Keen and Slemrod (2017); the instruments contained in vector Ξ enact a dual revenue effect: through affecting underreporting behavior and from the collections on successful detection of inframarginal underreporting.

In Keen and Slemrod (2017), the function $c(e, \alpha)$ refers to the costs of compliance or concealment. Part of the strength of their model environment lies in the quite general interpretation of how these costs are internalized; in their setting, the reader interprets this as some average internalized cost of associated of underreporting that presumably internalizes detection risk. However, consider in our setting that $c(e, \alpha)$ explicitly captures the pecuniary costs of underreporting, which the social planner can influence (e.g. increasing information reporting

increases the costs that individuals need to pay to misreport in more sophisticated manners). Furthermore, individuals consume out of post-detection income in expectation. Also assume that detection is associated with perfect specificity (no false positives).

This setup yields first-order conditions for interior optima for labor supply and underreporting: $(1-t)w = \psi'(l)$ and $t = c_e + r_e$, with $e_\alpha = -c_{e\alpha}/(c_{ee}+r_{ee}) < 0$ and $e_t = (1-r_{et})/(c_{ee}+r_{ee})$. For a simple parameterization of collections on underreporting $r = \rho\eta(t+\theta)e$ (for penalty rate θ, audit rate ρ and expected discovery share η), $r_{et} = \rho\eta$, i.e. the share of underreporting that will be detected in expectation, which we can understand as less than one so that $e_t > 0$. Lastly, we have $e_\xi = -\frac{r_{e\xi}}{c_{ee}+r_{ee}} < 0$ for an arbitrary dual-revenue instrument $\xi \in \Xi$.

The government collects revenues via the linear tax and on penalties levied and expends funds on public goods and the enforcement costs:

$$g + a(\alpha, \Xi) = t(wl - e) + r(e, t, \Xi). \tag{11}$$

Combining this equation with Equation (9) and Equation (10) yields an alternative expression for social welfare:

$$W(t, \Xi) = wl - tz - c(e, \alpha) - r(e, t, \Xi) - \psi(l) + v\Big(tz + r(e, t, \Xi) - a(\alpha, \Xi)\Big), \tag{12}$$

for taxable income $z(t, \alpha, \Xi) := wl(t, w) - e(t, \alpha, \Xi)$. The government's cost $a(\alpha, \Xi)$ is assumed to be weakly monotonically increasing and nonnegative in its arguments. Additionally, note that in this specification, enforcement efforts do not have first-order effects on earnings. We omit potential real impacts of underreporting behavior on labor income for simplicity; in general, allowing for endogenous response of labor supply to underreporting activity generates real earnings responses to enforcement measures, which change the perceived tax rate and mediate a negative relationship between the perceived tax rate and labor supply.

6.1 Optimal tax administration

Differentiating Equation (12) with respect to the linear tax rate and applying the envelope theorem gives the necessary condition for an interior optimum:

$$W_t = -(z + r_t) + v' \cdot \Big(z + tz_t + r_e e_t + r_t\Big) = 0. \tag{13}$$

We can modify this expression to give a generalization of the standard inverse elasticity rule:

$$\frac{t}{1-t} = \frac{1}{\varepsilon_{z,1-t}} \cdot \Big(\frac{v'-1}{v'} \cdot (1 + \epsilon_{r,t}\frac{r}{tz}) + \epsilon_{r,e}\varepsilon_{e,t}\frac{r}{tz}\Big). \tag{14}$$

In this expression, $\frac{r}{tz}$ represents the ratio of collections on underreporting to initial pre-audit income tax collections. In the case that the tax administration makes no use of post-audit revenue collection instruments, this expression collapses to the well-known condition: $\frac{1}{1-t} = \frac{1}{\varepsilon_{z,1-t}} \cdot \frac{v'-1}{v'}$. We use $\epsilon_{a,b}$ as opposed to $\varepsilon_{a,b}$ to describe a mechanical elasticity of objects a with respect to b that holds agent behavior constant.

This expression shows the standard inverse elasticity result that greater the base elasticity, the lower the optimal tax rate. However, the coefficient on the marginal utility of public goods consumption relative to private consumption is augmented by the fiscal externality of the income tax on collections on discovered underreporting: $\epsilon_{r,t}$, reflecting the fact that mechanically, a higher income tax results in greater collections on inframarginal successfully detected underreporting. The optimal income tax sees additional upward pressure through the addition of collections on marginal underreporting that is successfully detected $\epsilon_{r,e}\varepsilon_{e,t}$. Note also that by the envelope condition, the increased revenues raised on induced underreporting do not weigh against private welfare changes.

Lastly, take note that the condition to generate a positive optimal income tax rate is slightly relaxed here relative to the standard benchmark $v' > 1$. Here, we have the requirement that $v' > \frac{1}{b+1}$ for $b = \frac{\epsilon_{r,e}\varepsilon_{e,t}}{\frac{tz}{r}+\epsilon_{rt}} = \frac{r_e e_t}{z+r_t} \geq 0$, which weighs the revenue response on marginally-induced detected underreporting against the mechanical increase in collections from an increase in

the tax rate. The difference here is that the expression takes into account the fiscal spillovers of successfully captured underreporting. We nonetheless maintain for simplicity the stronger assumption that $v' > 1$, i.e. that government spending is socially desired relative to private consumption.

Note also that for tax instruments $i \in \{\alpha, \xi\}$ where $\xi \in \Xi$, $z_i = -e_i$, because they have no direct effect on earnings and we assume real earnings is exogenous to underreporting activity. Now we derive the social planner's first-order conditions for instruments α and $\xi \in \Xi$.

Taking first-order conditions with respect to α, we can derive an analogue for the adjusted marginal cost-revenue ratio:

$$W_\alpha = -c_\alpha + v'(tz_\alpha + r_e e_\alpha - a_\alpha) = 0 \tag{15}$$

$$\frac{\alpha \cdot (c_\alpha / v') + \alpha a_\alpha}{(t - r_e)z} = \varepsilon_{z,\alpha} := \phi. \tag{16}$$

In Keen and Slemrod (2017), ϕ refers to the *adjusted marginal cost-revenue ratio*, where the numerator approximates the sum of compliance and administrative costs and the denominator measures the collections on reported income. This expression differs from that in Keen and Slemrod (2017) in that the denominator accounts for the actuarial penalty rate on underreported income (a decrease in revenues relative to the no penalty instruments case). More directly, the optimal level of enforcement should be set at

$$\alpha^* = \frac{(t - r_e)z}{(c_\alpha / v') - a_\alpha} \cdot \varepsilon_{z,\alpha}. \tag{17}$$

This expression differs from the benchmark case without revenue-collection spillovers based on the denominator $t - r_e$. Here, the collections on detected underreported undermine the benefit of discouraging underreporting. Indeed, in the hypothetical scenario that $r_e > t$ (perhaps where underreporting agents are risk loving or exhibit behavioral internalities that them from internalizing that underreporting delivers losses on average), the optimal α is ac-

tually negative in order to encourage underreporting (delivering more revenue to the social planner in expectation than via the income tax).

Let us finally characterize the first-order condition for an arbitrary instrument $\xi \in \Xi$ with dual revenue externalties:

$$W_\xi = -r_\xi + v' \cdot (r_\xi + z_\xi(t - r_e) - a_\xi) = 0. \tag{18}$$

The left-hand side here gives the welfare loss from the loss in private consumption due to the change in the penalty instrument ξ. The right-hand side reflects the net revenue change multiplied by the value of the public good. The revenue change is composed of three parts: 1) the increase in revenues on inframarginal collections; 2) the change in collections due to the behavioral responses of agents that substitute away from underreporting (thereby paying income tax as opposed to the actuarial marginal rate on underreported income); and 3) administrative/other costs of increasing the level of the instrument.

Rearranging this condition gives:

$$\varepsilon_{e,\xi} = \frac{r}{e(t - r_e)} \cdot \frac{\epsilon_{r\xi}(v'(1 - \frac{a_\xi}{r_\xi}) - 1)}{v'}. \tag{19}$$

Note that $\frac{r}{e(t-r_e)}$ measures the ratio of collections on underreporting to the overall tax gap after accounting for collections on successfully detected underreporting. This expression prescribes that the penalty instrument ξ should be calibrated such that the elasticity of underreporting with respect to ξ should equal the ratio of the welfare effect impact of the mechanical change in collections to the tax gap.

Closer inspection of this result reveals a perhaps counter-intuitive finding: Presuming $\varepsilon_{e,\xi} \leq 0$, the welfare-weighted mechanical net change in collections and the tax gap should be opposite sign. Given that $v' > 1$, we can rationalize opposite signs of these objects in two manners. In the more likely case, we have $t > r_e$. Given that $\epsilon_{r\xi} > 0$, it must be the case that $v'(1 - \frac{a_\xi}{r_\xi}) - 1) < 0$, i.e. that $\frac{a_\xi}{r_\xi} > \frac{v'-1}{v'}$: the mechanical marginal-cost-revenue ratio

must exceed the relative valuation of the public good and private consumption.

A second possibility is that $r_e > t$: that the actuarial penalty rate (not only the penalty rate) collected on underreported income *exceed* the linear income tax rate. This case would come with the surprising implication that the social *budgeter* would prefer individuals underreport their income rather than honestly pay income tax. In this case, a risk-neutral agent would of course not choose to underreport; i.e. $e = 0$. This situation would arise if the tax administration's marginal cost of increasing the penalty instrument ξ are very low, which may indeed be the case for zero-nominal cost instruments with low behavioral salience.

We cannot simply calibrate ξ^* in closed form as, ξ^* likely appears in the partial derivatives of r, but one expression of $\xi^* > 0$ (for $\varepsilon_{e,\xi} \neq 0$, $r_e \neq t$ and $\frac{a_\xi}{r_\xi} \neq \frac{v'-1}{v'}$) gives

$$\xi^* = \varepsilon_{z,\xi} \cdot \frac{z(t - r_e)}{r} \cdot \left(\frac{\epsilon_{r\xi}(1 - v'(1 - \frac{a_\xi}{r_\xi}))}{v'} \right)^{-1} \tag{20}$$

Dual-revenue generating instruments see an opposite elasticity rule to the that of the optimal income tax; increasing in proportion with the sensitivity of agents; a greater (positive) elasticity of reported income to the instrument $\varepsilon_{z,\xi}$ implies a greater effectiveness in inducing agent substitution from underreporting to honest declaration (and paying income tax). Intuitively, greater costs a_ξ imply a lower ξ^* such that similarly to as with the above intuition, we can rationalize a very large ξ so that that $r_e > t$ if marginal costs are very low. However, with risk-neutral agents with full knowledge of the penalty environment and a monotonically increasing costs in ξ, the maximum optimal ξ^* would be set such that $r_e(\xi^*) = t$.

Before proceeding, to illustrate additional properties of the optimal level of ξ, we highlight two special cases:

Case 1. $\varepsilon_{z,\xi} = 0$, i.e. taxpayers are unresponsive to the penalty rate, the first-order condition reduces to a perhaps more simple optimality condition that the marginal-cost-revenue ratio

equal the relative valuation of the public good and private consumption:

$$\frac{a_\xi}{r_\xi} = \frac{v' - 1}{v'}. \tag{21}$$

Case 2: $a_\xi = 0$: we highlight this benchmark as of interest because changing the penalty rate, as opposed to audit rate or intensity indeed incurs zero *nominal cost* (Becker (1968)). Of course, we detail the potential behavioral responses to increased penalty rates that may induce increased administrative expenses, but these have not been empirically verified. In this case, the first-order condition is:

$$\frac{v' - 1}{v'} \cdot r_\xi = e_\xi(t - r_e) \tag{22}$$

Because $\varepsilon_{e,\xi} < 0$, this condition implies that the actuarial collection rate on underreported income *exceeds* the linear income tax rate so that $r_e > t$. In this case, agents would only continue to engage in underreporting if they exhibit behavioral internalities or behave as risk-loving.

Noting that for an agent at her envelope, $e_\alpha = e_\xi \cdot c_{e\alpha}/r_{e\xi}$,[19] so that substituting this equivalence into Equation (15) and simplifying yields the relationship at the optimal levels of α and ξ:

$$\frac{r_\xi/v' + a_\xi - r_\xi}{c_\alpha/v' + a_\alpha} = \frac{r_{e\xi}}{c_{e\alpha}}. \tag{23}$$

The numerator of the left-hand side is a first-order approximation of the marginal welfare cost of increasing ξ, and the denominator represents the marginal welfare cost of increasing α. The optimum, this marginal welfare cost ratio is equal to the ratio of the curvatures of each respective instrument's cost function from the taxpayer's perspective.

[19] In terms of elasticities, $\varepsilon_{e,\alpha} = \frac{c_{e\alpha}\alpha}{r_{e\xi}\xi} \cdot \varepsilon_{e,\xi}$

At an optimal level of ξ, from Equation 18 results that

$$\frac{r_e(\xi^*)}{t} = 1 + \left(\frac{v'-1}{v'} - \frac{a_\xi}{r_\xi}\right) \cdot \frac{1}{\varepsilon_{et}} \cdot \frac{r_\xi}{e} \cdot m, \tag{24}$$

for $m = \frac{1-r_{et}}{r_{e\xi}}$.

This expression very clearly indicates the optimal relationship between r_e and t. Because $\varepsilon_{et}, r_\xi, e, m > 0$, it is necessarily the case that $r_e(\xi^*) > t$ if $\frac{a_{\xi^*}}{r_{\xi^*}} < \frac{v'-1}{v'}$, which is the case when v' is very large or the marginal cost of increasing instrument ξ is very low (relative to marginal collections).

6.2 Optimal compliance gap and recoup gap

We turn to characterizing the optimal compliance gap; this procedure is nearly identical to that in Keen and Slemrod (2017). Take a reporting gap $G = te/twl = e/wl$. Noting that $\varepsilon_{z,\alpha} = -\frac{e}{z}\varepsilon_{e,\alpha}$ and that $e/z = \frac{G}{1-G}$, it follows that

$$\frac{G}{1-G} = \frac{-\varepsilon_{z,\alpha}}{\varepsilon_{e,\alpha}} = \frac{-\phi}{\varepsilon_{e,\alpha}}, \tag{25}$$

where this relationship implies higher optimal underreporting (from an tax administrative perspective) when administrative costs are higher, when underreporting exhibits lower elasticity to enforcement measures, and when collections on declared earnings (relative to the hypothetical collections if those declared earnings in fact went unreported) are lower. One important implication of incorporating collections on underreporting is that the optimal tax gap increases as the actuarial penalty rate on underreported income approaches the linear income tax rate: the tax administration tolerates more underreporting if in expectation more underreported revenues are re-captured.[20]

[20] An identical relationship between z and e holds for instrument ξ, such that an analogous condition arises with nearly identical interpretation:

$$\frac{G}{1-G} = \frac{\epsilon_{r\xi}((1-\frac{a_\xi}{r_\xi}) - \frac{1}{v'})}{-\varepsilon_{e,\xi}} \cdot \frac{r}{z(t-r_e)}.$$

Consider the recouped collections gap, say $\mathcal{T} := r/e$ To a first-order approximation, if $r = 0$ for $e = 0$, we simply can think of this object as $r_e \cdot e/e = r_e$. From Equation 18 we have that

$$\frac{r(t, e, \xi^*)}{e} = \frac{r(t, e, \xi^*) - r(t, 0, \xi^*)}{e - 0} \approx r_e(\xi^*) = t + \left(1 - \frac{a_\xi}{r_\xi} - \frac{1}{v'}\right) \cdot \frac{r_\xi}{z_\xi} \tag{26}$$

This relationship gives intuition for the optimal gap on recouped collections. As a baseline when $\frac{a_\xi}{r_\xi} = \frac{v'-1}{v'}$, the optimal collections recoup as share of overall underreporting is precisely equal to the tax rate. However, the optimal recoup share departs from the tax rate based on the marginal social value of the public good and on the marginal cost of increasing instrument ξ relative to marginal collections. When the marginal cost of shifting the instrument at ξ^* is very low or the marignal welfare impact of further spending on the public good is very high, a social optimum features a recoup rate greater than the tax rate (and vice versa).

6.3 Complementarity and substitutibility among instruments

To what extent do these different instruments operate as strategic complements or substitutes? This question is relevant if one or multiple instruments cannot be feasibly adjusted (perhaps due to political economy constraints). Keen and Slemrod (2017) pose the illustrative question: if α is constrained below its optimum, is it better to increase the statutory tax rate t to offset the weak administration or is it better to set a lower tax rate to expand the base in light of suboptimally high underreporting?

First, note that following an identical proof to Keen and Slemrod (2017) Equation (14) (as demonstrated in their Footnote 23, replacing α with ξ), there is a symmetry in the taxable income elasticities with respect to the penalty instrument and with the tax rate, that $\frac{\partial \varepsilon_{z,1-t}}{\partial \ln \alpha} = \frac{\partial \varepsilon_{z,\xi}}{\partial \ln(1-t)}$. This relation comes with the convenient implication: "Suppose, for instance, it is known that an increase in the [penalty instrument] reduces the elasticity of taxable income; then it must be the case that an increase in the tax rate increases the [elasticity of reported income with respect to the penalty instrument]."

We ask five questions here pertaining to the strategic interactions of the tax rate, administrative enforcement effort, and penalizing instruments:

1. Is it better to raise funds with ξ, α, or t?
2. If ξ is constrained, (when) should the tax administration raise t? I.e. what is the slope of the best response function $t(\xi)$?
3. If ξ is constrained, (when) should the tax administration raise α? I.e. what is the slope of the best response function $\alpha(\xi)$?
4. If t is constrained, (when) should the tax administration raise ξ?
5. If α is constrained, (when) should the tax administration raise ξ?

In answering these questions, we assume constant v' for simplicity. Questions (4) and (5) are of course symmetric with questions (2) and (3) respectively.

6.3.1 If ξ is constrained, (when) should the tax administration raise t?

We apply the implicit function theorem to Equation 13, the first-order condition for the choice of t, resulting in the derivative of the marginal welfare impact of t with respect to the penalty instrument ξ. If this object is positive, then the penalty instrument and the tax rate are strategic complements. If the object is negative, then the instruments are strategic substitutes.

The sign of the slope of the best response function $t(\xi)$ is given by the sign of:

$$W_{t\xi} = \underbrace{(v' - 1) \cdot (r_{t\xi} + z_{\xi})}_{>0} + \underbrace{v' \cdot r_{e\xi} \cdot e_t}_{>0} + v' \cdot (t - r_e) \cdot z_{t\xi}. \tag{27}$$

Therefore, it is a sufficient, but not necessary condition for the statutory tax rate and the penalty instrument to be strategic complements (i.e. that $dt/d\xi > 0$) that $(t - r_e)$ and $z_{t\xi}$ be of the same sign.

The first two terms of Equation 27 are positive and support the idea that t and ξ are strategic complements. An increase in the penalty instrument increases revenue both by discouraging underreporting and by increasing collections on inframarginal underreporting. However, if $t < r_e$, then the tax administration expects greater collections on marginal underreporting than on marginal honest reporting. This force undermines the complementarity of the instrument if the case holds and $z_{t\xi} > 0$. We typically think that $z_{t\xi} \geq 0$, i.e. the taxable income response to the tax rate attenuates for greater levels of penalty. Empirically, we cannot find any cases where $t > z_e$ so that heuristically, we think of t and ξ unambiguously as strategic complements.

6.3.2 If ξ is constrained, (when) should the tax administration raise α?

We apply the implicit function theorem to Equation 15, the first-order condition for the choice of α. The slope of the best response function is given by the sign of

$$W_{\alpha\xi} = -(a_{\alpha\xi} - r_{e\xi}e_\alpha) + z_{\alpha\xi}(t - r_e) \tag{28}$$

Unlike the relationship between ξ and t, the first two terms here unambiguously suggest the strategic substitutibility of ξ and α. First, the tax administrative cost function α likely is weakly convexly increasing so that $a_{\alpha\xi} \geq 0$, if administrative costs are additively separable between ξ and α, then this term is equal to zero. The second term reflects a decrease in collections on underreporting through the negative effect of the enforcement instrument on underreporting. The last term is ambiguous, based on whether the signs of $(t - r_e)$ and $z_{\alpha\xi}$ agree.

It is a sufficient, but not necessary, condition for the enforcement instrument and the penalty instrument to be strategic substitutes (i.e. that $d\alpha/d\xi < 0$) that $t < r_e$. Because $z_{\alpha\xi} \geq 0$, an increase in the penalty instrument reinforces the enforcement instrument such that if $t < r_e$, the substitution response from underreporting to honest declaration results in a decrease in collections. This said, given that typically $t > r_e$ it is possible that the instruments indeed

serve as complements.

6.3.3 Is it better to raise funds with t, ξ, or α?

Lastly, we turn to the very practical question: should policymakers finance additional public spending by raising the statutory tax rate, by increasing enforcement, or by increasing the penalty instrument ξ?

First, we replicate the result in Keen and Slemrod (2017) for our penalty instrument. This question is equivalent to determining whether there is a welfare gain from increasing ξ while reducing t so as to leave government spending unchanged. Evaluating $dW = W_t \frac{\mathrm{d}t}{\mathrm{d}\xi}|_g + W_\xi$ yields a rule for when it is better for the social planner to raise funds by increasing ξ rather than increasing t:

$$\frac{z_\xi(t - r_e) + (r_\xi - a_\xi)}{z + r_t + (tz_t + r_e e_t)} > \frac{r_\xi}{z + r_t} \tag{29}$$

Alternatively, as a sufficient but not necessary condition, (using the fact that $e_t < -z_t$) it is better to raise funds using the statutory tax rate t rather than raising ξ if

$$\frac{z_\xi(t - r_e) + (r_\xi - a_\xi)}{z_t(t - r_e) + z + r_t} < \frac{r_\xi}{z + r_t}. \tag{30}$$

Lastly, we turn to the relationship between α and ξ. Analogously, we ask whether there is a welfare gain from increasing ξ while reducing α so as to leave public spending g constant. We evaluate the sign of $dW = W_\alpha \frac{\mathrm{d}\alpha}{\mathrm{d}\xi}|_g + W_\xi$ to yield a simple rule:

$$\frac{(r_\xi - a_\xi) + z_\xi(t - r_e)}{-a_\alpha + z_\alpha(t - r_e)} > \frac{r_\xi}{c_\alpha} \tag{31}$$

This rule states that the social planner should prefer to raise the penalty instrument ξ over the enforcement instrument α when the net marginal revenue ratio of penalties to enforcement exceeds the ratio of privately-borne costs for penalties to enforcement.

6.4 Parametric application

To more concretely illustrate our results, we give an explicit parametric form to the penalty instruments. Namely, we specify an audit rate of ρ, an expected discovery share η, and a linear penalty schedule that requires the taxpayer pay a penalty rate θ plus the underpaid taxes t on successfully detected underreported income. That is, $r(e, t, \Xi) := r(e, t, \rho, \eta, \theta) = \rho\eta(t + \theta)e$.

6.4.1 Optimal penalty rate θ

We can re-express the first-order optimality condition for the penalty rate as:

$$\theta^* = \Delta \cdot \frac{z}{D} \cdot \varepsilon_{z,\theta} \cdot \frac{v'}{1 - v'(1 - \frac{a_\theta}{D})}. \tag{32}$$

This expression is not purely closed-form, as the penalty rate θ appears in the term Δ. Further rearranging this expression yields:

$$\theta^* = \frac{t(\frac{1}{d} - 1)}{1 + \frac{1}{\varepsilon_{e,\theta}} \cdot \frac{v' \cdot (1 - \frac{a_\theta}{D}) - 1}{v'}}. \tag{33}$$

We highlight a few special cases:

Case 1. $a_\theta = 0$: we highlight this benchmark as of interest because changing the penalty rate indeed incurs zero nominal cost. Of course, we detail the potential behavioral responses to increased penalty rates that may induce increased administrative expenses, but these have not been empirically verified. In this case, the first-order condition is:

$$\frac{1}{\varepsilon_{e,\theta}} \frac{v' - 1}{v'} = \frac{\Delta}{\rho\eta\theta}. \tag{34}$$

Note that $\varepsilon_{e,\theta} < 0$, and $v' > 1$ necessarily implies a negative actuarial penalty gap when $\alpha_\theta = 0$. More explicitly, we have

$$\theta^* = \frac{t(\frac{1}{d} - 1)}{1 + \frac{1}{\varepsilon_{e,\theta}} \cdot \frac{v' - 1}{v'}}. \tag{35}$$

Case 2. $\varepsilon_{z,\theta} = 0$, i.e. taxpayers are unresponsive to the penalty rate, the first-order

condition reduces to a perhaps more simple optimality condition:

$$a_\theta = D \cdot \frac{v' - 1}{v'}, \tag{36}$$

for $D := \rho\eta e$.

Case 3. $\rho\eta = 1$; *i.e.* $D = e$, all underreported income is perfectly discovered by the tax authority. Clearly the utility of this case is conceptual, as agents have no reason to underreport income in this case. i.e. taxpayers are unresponsive to the penalty rate, the first-order condition reduces to a perhaps more simple optimality condition:

$$\varepsilon_{e,\theta} = \frac{v' \cdot (1 - \frac{a_\theta}{e}) - 1}{v'} \tag{37}$$

Case 4. $\rho\eta = 0$; *i.e.* $D = 0$, no underreported income is discovered by the tax authority. The utility of this case is again clearly conceptual, as agents have no reason to underreport income in this case other than based on the costs they perceive. The first-order condition reduces to another more simple optimality condition:

$$tz_\theta = a_\theta \tag{38}$$

6.5 Numerical simulation

What is the marginal cost per unit underreported income detected that we can rationalize with the formula for optimal θ? Assume the following values of environmental model parameters to solve for $\frac{\alpha_\theta}{D}$:

- $\theta = .25$
- $t = .35$
- $d = .07$
- $\varepsilon_{e,\theta} = -1$
- $v' = 1.2$

These values would imply a perceived marginal cost of the penalty rate per unit of undetected income of around 17. Figure 22 plots the relationship between α_θ/D and $\varepsilon_{e,\theta}$—the two main environmental parameters with substantial uncertainty—for calibrations of optimal levels of θ^* that we empirically observe. The figure illustrates that currently-existing penalty regimes are characterized by low penalty rates which can be rationalized by very high perceived marginal costs of penalties per unit of detected underreported income.

7 Conclusion

We study the impact of income tax noncompliance penalties on taxpayer behavior. The magnitudes and directions of taxpayer responses to the penalty rate have central implications for optimal tax administration.

Our work focuses on a specific component of this response: the ex-post reporting response to the penalty rate following the receipt of a tax noncompliance penalty. Our main design leverages quasiexperimental variation in the penalty rate in the form of a Norwegian legislative reform that lowered the standard statutory penalty rate from 30% of underreported base to 20%. To isolate the effect of this response, we implement a differences-in-differences event study design that compares the evolution in outcomes of cohorts penalized before and after this reform. We find that the 10pp penalty rate decrease induced a 10% relative decline in gross income declared and overall tax payments in the years following receipt of penalty. Given the relative penalty rate decrease, this response corresponds with an elasticity of tax collections and taxable income with respect to the ex-post penalty rate of upwards of 0.3.

We also document no evidence that the decrease in the penalty rate led to an improvement in quality-of-life outcomes among penalized individuals, undermining welfarist arguments in favor of lower penalty rates.

We further develop the conceptual foundations of the tradeoffs and optimality considerations inherent to setting the penalty rate. Using a model based on Allingham and Sandmo (1972), we establish the conceptual grounds for adverse responses to higher penalty rates, demonstrating that higher penalty rates, while likely decreasing overall underreporting, also potentially induce increased appeals or litigation on part of the taxpayer, which may be costly from an administrative perspective. Additionally, higher penalties may also induce substitution to underreporting vehicles with lower probability of detection (although under only a change in penalty rate (i.e. ceterus paribus), this cross-vehicle substitution does not outweigh the own-vehicle decrease in underreporting).

We conclude by considering the optimal tax noncompliance penalty rate in a optimal tax administrative framework (Keen and Slemrod (2017)). We model penalties with a broader class of tax administrative instruments that generate fiscal revenues both through improve-

ments in compliance as well as through increased collections on inframarginally underreported income that is successfully detected by the tax authorities. We find that accounting for dual revenue instruments such as penalties increases the optimal linear income tax rate relative to a baseline with underreporting in absence of these instruments, because these instruments—such as penalties—also generate revenue off of income underreporting cases that are successfully detected and penalized. We also find that to a first-order approximation, the statutory penalty rate should be set so that the actuarial penalty rate—the in-expectation net payment rate per unit of underreported income—equals the optimal linear income tax rate. The penalty rate falls short of this level insofar as the penalties induce real administrative costs and welfare costs to those audited.

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Table 1: Descriptive statistics of tax noncompliance penalties
Panel (a): Penalty characteristics

	Mean	SD	p10	p50	p90	N
Penalty amount	21,075	117,163	0	7,000	45,075	88,562
Penalty amount (log)	9.19	1.26	7.62	9.13	10.8	77,475
Positive penalty amount (binary)	.87	.33	0	1	1	88,562
Any penalty count	88,562					
Elevated penalty count	11,251					
Penalized population share	.0002					
Penalized share of income tax receipts	.003					
Penalty share of income tax receipts	.0004					

Panel (b): Penalty recipient characteristics

	Non-penalized	Penalized	Difference
Total income	444,445	622,356	183,846
	[833,008]	[1,609,389]	(7,442)
Log total income	12.6	12.6	-.0224
	[1.23]	[1.9]	(.01)
Any self-employment income	.07	.33	.26
	[.26]	[.47]	(.0021)
Any capital income	.87	.9	.02
	[.33]	[.3]	(.0013)
Income tax	97,091	165,398	69,927
	[224,505]	[460,228]	(2,001)
Log income tax	11.2	11.5	.35
	[1.16]	[1.18]	(.01)
Log gross wealth	13.1	12.6	-.4
	[2.6]	[3.28]	(.02)
Log net taxable wealth	12.3	12.8	.56
	[2.46]	[2.77]	(.02)
Any transfer abroad	.17	.35	.18
	[.38]	[.48]	(.002)
Any transfer with havens	.02	.04	.03
	[.13]	[.2]	(.0008)
Age	47.9	44	-3.63
	[18.8]	[12.3]	(.06)
Immigrant	.16	.33	.18
	[.37]	[.47]	(.0023)
Female	.49	.18	-.305
	[.5]	[.39]	(.0018)
Married	.4	.4	-.0001
	[.49]	[.49]	(.0023)
University	.32	.26	-.0614
	[.47]	[.44]	(.0022)
Count individual-years	50,140,952	88,264	
Unique individuals	5,769,673	61,769	

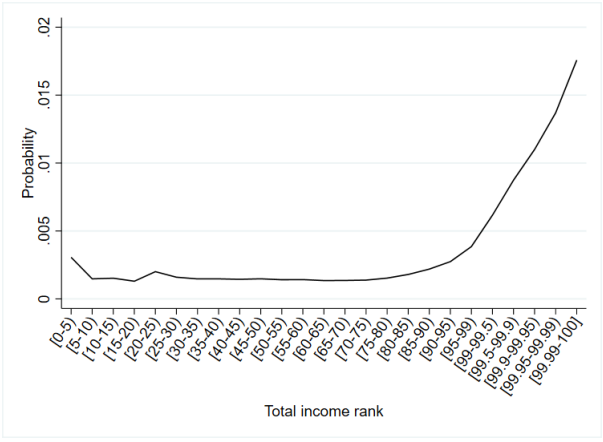
Note: This table displays descriptive statistics of tax noncompliance penalties in Panel (a) and the attributes of penalty (non-)recipients in Panel (b). The "Non-penalized" and "Penalized" columns in Panel (b) present means and standard deviations (in hard parentheses) of taxpayer characteristics stratified by penalty recipiency status. The "Difference" column presents the coefficients of a series of regressions of each row variable on an indicator of penalty assignment and year fixed effects, with standard clustered at the taxpayer level in soft parentheses. All monetary values are expressed in real NOK 2015.

Table 2: Balance by penalty amount characteristics (among penalized individuals)

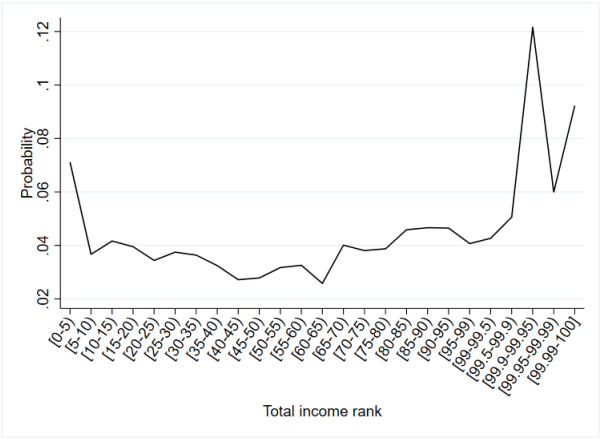
	Independent variable			
	Log penalty amount		Non-zero penalty amount	
	Unsaturated	Controls	Unsaturated	Controls
Total income	80,796	114,385	-216,283	-230,729
	(9,735)	(9,859)	(53,631)	(54,868)
Log total income	-.0964	-	.41	-
	(.01)	-	(.04)	-
Any self employment income	.11	.12	.26	.23
	(.0016)	(.0016)	(.01)	(.01)
Any capital income	.01	-.0023	.02	-.002
	(.001)	(.0004)	(.0049)	(.0015)
Income tax	39,172	49,057	-29,383	-43,643
	(2,780)	(3,120)	(12,395)	(14,103)
Log income tax	.19	.08	.1	.25
	(.0048)	(.0024)	(.02)	(.01)
Log gross wealth	-.0166	-	-1.2	-
	(.01)	-	(.05)	-
Log net taxable wealth	.36	.02	-1.09	-.111
	(.01)	(.01)	(.06)	(.02)
Any transfer abroad	.01	.01	-.0688	-.0782
	(.0016)	(.0017)	(.01)	(.01)
Any transfer havens	.01	.01	-.0299	-.0261
	(.0007)	(.0007)	(.0034)	(.0036)
Age	.51	.52	-1.46	-.486
	(.04)	(.04)	(.18)	(.19)
Immigrant	-.0229	-.0278	-.006	-.0563
	(.0018)	(.0018)	(.01)	(.01)
Female	-.048	-.0521	.02	.02
	(.0014)	(.0015)	(.01)	(.01)
Married	-.0018	-.003	-.0633	-.0571
	(.0018)	(.0019)	(.01)	(.01)
Uni	-.0096	-.008	-.0771	-.0515
	(.0017)	(.0017)	(.01)	(.01)

Note: This table displays results from a series of regressions of each respective row variable on the (logarithm of) penalty amount or an indicator of observing a non-zero penalty amount, respectively. All regressions contain year fixed effects and feature both an unsaturated version and a variant with (the logarithms) of total income and gross wealth as control variables. Standard errors clustered at the taxpayer level are in parentheses. All monetary values are expressed in real NOK 2015.

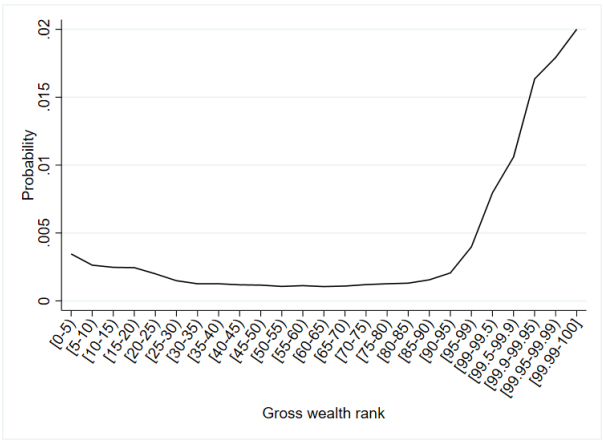
Figure 1: Conditional distribution of penalty assignment by income and wealth rank



Panel (a): By income



Panel (b): By income, conditional on audit



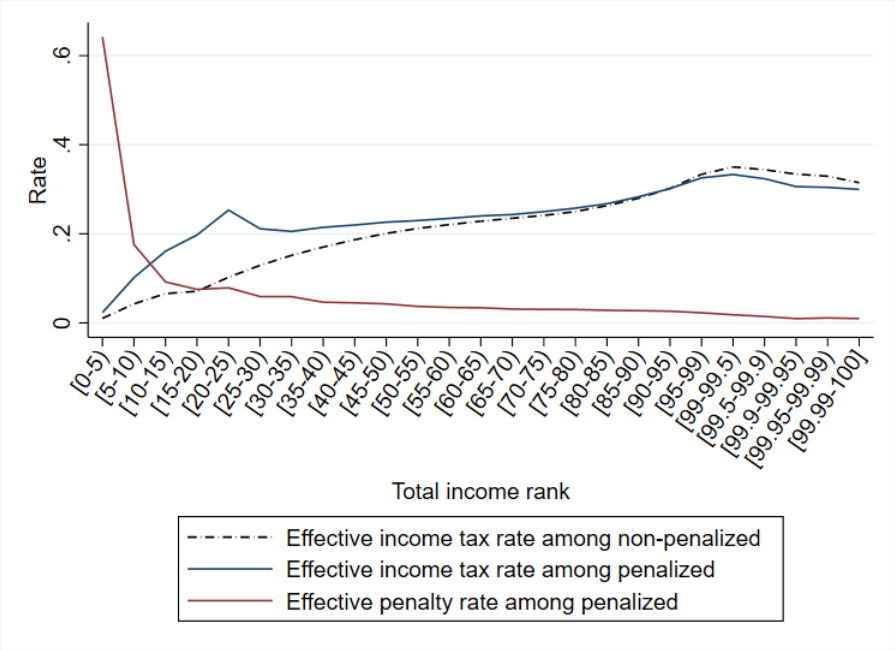
Panel (c): By wealth



Panel (d): By wealth, conditional on audit

Note: These figures plot the conditional distribution of penalty recipiency along income and wealth rank for individual-years between 2011 and 2015. Income and wealth ranks are calculated following correction for detected underreporting and are based on pooled observations deflated to NOK 2015.

Figure 2: Effective income tax rates and penalty rates by income rank



Note: This figure plots the conditional distribution of effective income tax rates and penalty rates along the income rank for individual-years between 2011 and 2021. Income ranks are calculated within year following correction for detected underreporting and are based on pooled observations deflated to NOK 2015. Effective rates refer to amounts divided by total income.

Table 3: Appeals balance on observable characteristics

	All	Non-appealed	Appealed	Difference
Log total income	12.6	12.6	12.9	.16
	[1.91]	[1.91]	[1.99]	(.07)
Log penalty size	9.18	9.17	9.69	.56
	[1.26]	[1.25]	[1.44]	(.05)
Non-zero penalty	.13	.12	.3	.18
	[.33]	[.33]	[.46]	(.01)
Elevated penalty	.13	.12	.28	.14
	[.33]	[.33]	[.45]	(.02)
Effective penalty rate (winsorized)	.09	.09	.1	.02
	[.21]	[.21]	[.23]	(.01)
Any self employment income	.32	.32	.31	-.0055
	[.47]	[.47]	[.46]	(.01)
Any capital income	.9	.9	.94	.04
	[.3]	[.3]	[.24]	(.01)
Income tax	164,585	162,997	226,962	46,201
	[461,505]	[459,235]	[539,632]	(15,950)
Log income tax	11.5	11.5	11.7	.14
	[1.19]	[1.18]	[1.32]	(.04)
Log gross wealth	12.6	12.6	14.1	1.34
	[3.28]	[3.28]	[2.75]	(.09)
Log net taxable wealth	12.8	12.7	14	.99
	[2.78]	[2.78]	[2.43]	(.1)
Any transfer abroad	.35	.35	.44	.07
	[.48]	[.48]	[.5]	(.01)
Any transfer with havens	.04	.04	.08	.03
	[.2]	[.2]	[.27]	(.01)
Age	44	43.9	46.9	2.29
	[12.3]	[12.3]	[12.3]	(.4)
Immigrant	.33	.33	.32	-.0058
	[.47]	[.47]	[.47]	(.02)
Female	.18	.18	.19	.01
	[.39]	[.39]	[.39]	(.01)
Married	.4	.4	.48	.08
	[.49]	[.49]	[.5]	(.02)
University	.26	.26	.37	.09
	[.44]	[.44]	[.48]	(.02)
Count individual-years	87,468	85,301	2,167	
Unique individuals	61,307	60,287	1,484	

Note: This table displays descriptive statistics on appeal behavior for the sample of penalty recipients. The table presents means and standard deviations (in hard parentheses) of taxpayer characteristics stratified by appeal decision. The "Difference" column presents the coefficients of a series of regressions of each row variable on an indicator of appeal status and year fixed effects, with standard clustered at the taxpayer level in soft parentheses. All monetary values are expressed in real NOK 2015.

Table 4: First-stage effect of the penalty rate reform on penalty size

	(1)	(2)	(3)	(4)	(5)	(6)
	Log penalty	Log penalty	Penalty rate	Penalty rate	Log penalty rate	Log penalty rate
Year $\in [2016, 2018]$	-0.21	-0.21	-1.41	-1.41	-0.50	-0.50
	(0.012)	(0.012)	(0.16)	(0.16)	(0.019)	(0.019)
Year $\in [2019, 2021]$	0.64		0.15		0.20	
	(0.020)		(0.27)		(0.029)	
Constant	8.87	8.87	5.62	5.62	-3.86	-3.86
	(0.0060)	(0.0060)	(0.080)	(0.080)	(0.0098)	(0.0098)
Years	All Years	2011-2018	All Years	2011-2018	All Years	2011-2018
Observations	51,904	48,705	52,340	49,345	47,853	44,858
F-statistic	749	306	40.3	77.1	400	672
Adjusted R-squared	.0257	.00573	.00127	.00131	.0145	.0134

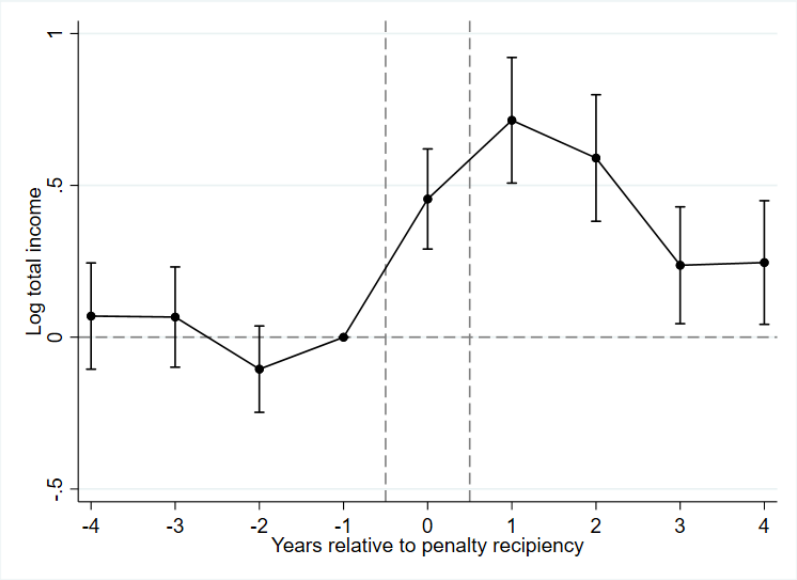
Note: This table displays results from a series of regressions with different parameterizations of penalty size as dependent variables on binary indicators of whether the penalty assignment occurred within the time span 2016-2018 and 2019-2021, respectively. Odd-numbered columns rely on penalty assignments over the whole period 2011-2021, while odd-numbered columns are restricted to penalty assignments during 2011-2018. Standard errors clustered at the taxpayer level are in parentheses.

Table 5: First-stage effect of the penalty leave-out instrument on penalty size

	(1)	(2)	(3)	(4)	(5)	(6)
	Log penalty	Log penalty	Penalty rate	Penalty rate	Log penalty rate	Log penalty rate
Leave-out mean log penalty	1.01					
	(0.015)					
Log of leave out mean penalty		0.69				
		(0.15)				
Leave-out mean penalty rate			1.00			
			(0.0039)			
Rate of leave-out mean penalty				0.75		
				(0.092)		
Leave-out mean log penalty rate					0.98	
					(0.0074)	
Log rate of leave-out mean penalty						0.10
						(0.048)
Constant	-0.073	2.26	0.072	0.089	-0.041	-4.25
	(0.14)	(1.43)	(0.026)	(0.39)	(0.029)	(0.088)
Years						
Observations	51,839	51,839	52,340	52,340	47,853	47,853
F-statistic	4,377	22.1	66,287	65.6	17,706	4.75
Adjusted R-squared	.0463	.0358	.0159	.641	.0336	.00546

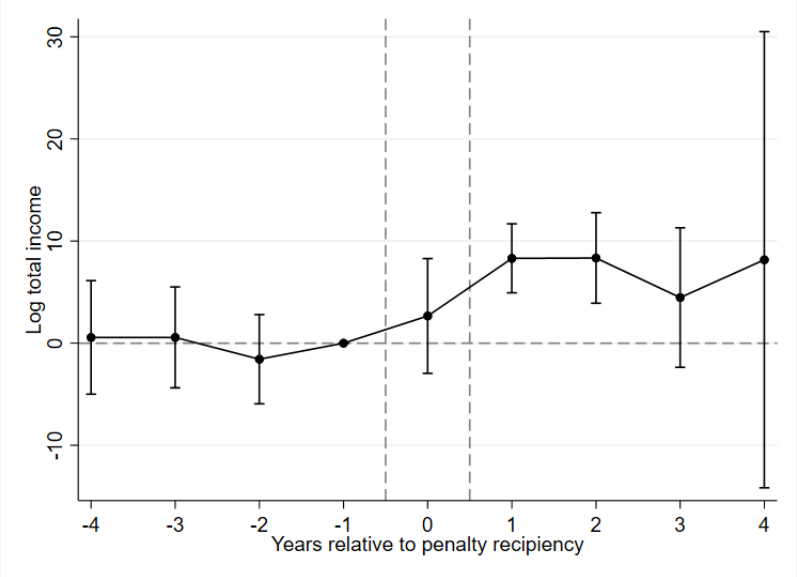
Note: This table displays results from a series of regressions with different parameterizations of penalty size as dependent variables on different measures of the leave-out penalty rate, i.e. the average effective penalty rate faced by *other* implicated taxpayers in the same year. Standard errors clustered at the taxpayer level are in parentheses.

Figure 3: Log income versus log penalty size



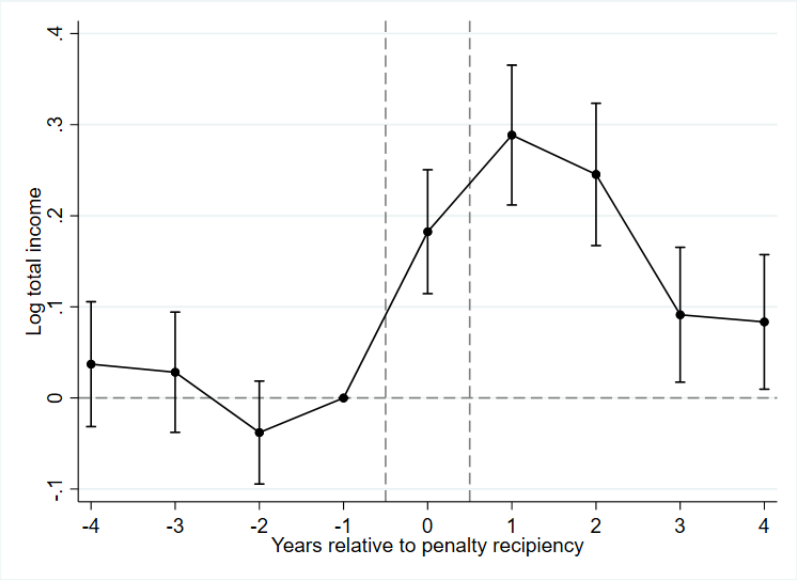
Note: This figure plots the treatment effect coefficients $\{\hat{\beta}_k\}_{k\geq 0}$ and 95% confidence bands associated with the difference-in-differences event study $y_{it} = \alpha_i + \sum_{k=-5}^{5} \gamma_k EventTime_{k(it)} + \sum_{k=-5}^{5} \beta_k \theta_i EventTime_{k(it)} + \varepsilon_{it}$. The underlying approach leverages an instrumental variable design, using a binary indicator for the post-2016 reform years as an instrument for the logarithm of the penalty amount (as represented by θ_i). Standard errors are clustered at the taxpayer level.

Figure 4: Log income versus penalty rate



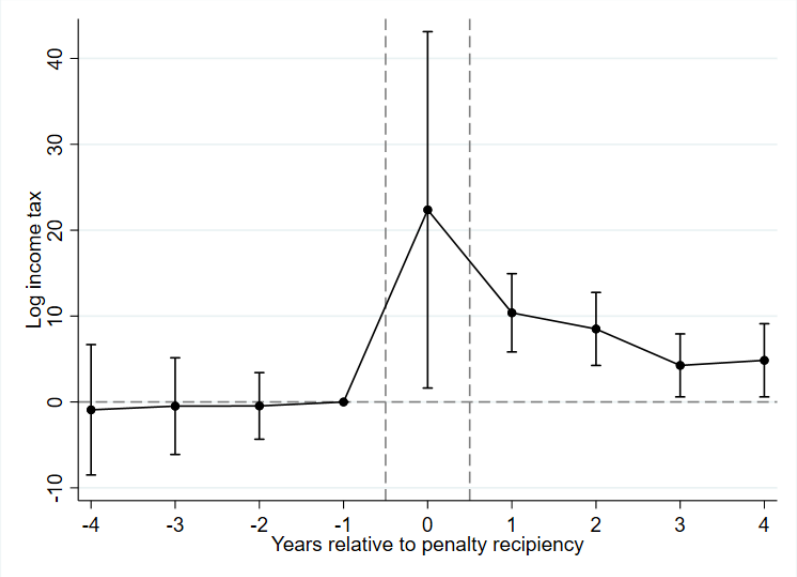
Note: This figure plots the treatment effect coefficients $\{\hat{\beta}_k\}_{k\geq 0}$ and 95% confidence bands associated with the difference-in-differences event study $y_{it} = \alpha_i + \sum_{k=-5}^{5} \gamma_k EventTime_{k(it)} + \sum_{k=-5}^{5} \beta_k \theta_i EventTime_{k(it)} + \varepsilon_{it}$. The underlying approach leverages an instrumental variable design, using a binary indicator for the post-2016 reform years as an instrument for the level of the penalty rate (as represented by θ_i). Standard errors are clustered at the taxpayer level.

Figure 5: Log income versus log penalty rate



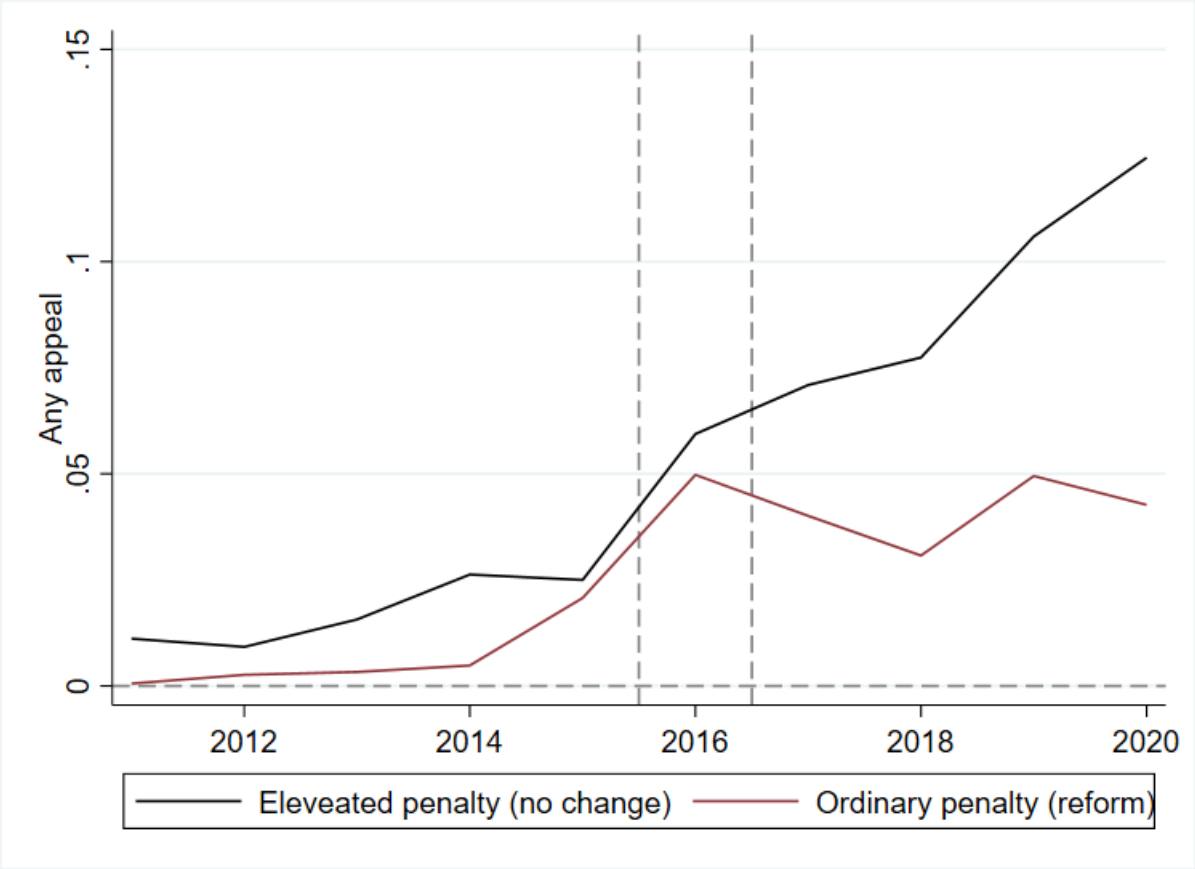
Note: This figure plots the treatment effect coefficients $\{\hat{\beta}_k\}_{k\geq 0}$ and 95% confidence bands associated with the difference-in-differences event study $y_{it} = \alpha_i + \sum_{k=-5}^{5} \gamma_k EventTime_{k(it)} + \sum_{k=-5}^{5} \beta_k \theta_i EventTime_{k(it)} + \varepsilon_{it}$. The underlying approach leverages an instrumental variable design, using a binary indicator for the post-2016 reform years as an instrument for the logarithm of the penalty rate (as represented by θ_i). Standard errors are clustered at the taxpayer level.

Figure 6: Log income tax versus penalty rate



Note: This figure plots the treatment effect coefficients $\{\hat{\beta}_k\}_{k\geq 0}$ and 95% confidence bands associated with the difference-in-differences event study $y_{it} = \alpha_i + \sum_{k=-5}^{5} \gamma_k EventTime_{k(it)} + \sum_{k=-5}^{5} \beta_k \theta_i EventTime_{k(it)} + \varepsilon_{it}$. The underlying approach leverages an instrumental variable design, using a binary indicator for the post-2016 reform years as an instrument for the level of the penalty rate (as represented by θ_i). Standard errors are clustered at the taxpayer level.

Figure 7: Appeals by type over time



This figure plots the evolution of appeals linked to elevated- and ordinary rate penalties over the 2011-2020 period.

Table 6: IV results: appeals

	(1) any_appeal	(2) any_appeal	(3) any_appeal	(4) any_appeal	(5) any_appeal	(6) any_appeal	(7) any_appeal	(8) any_appeal	(9) any_appeal
Log penalty	-0.21	0.0072	0.012						
	(0.074)	(0.0019)	(0.0045)						
Penalty rate				0.37	0.00012	0.000039			
				(4.16)	(0.000079)	(0.000065)			
Log penalty rate							-0.11	0.0018	0.00086
							(0.018)	(0.00077)	(0.0023)
Constant	1.92			-2.17			-0.41		
	(0.66)			(25.1)			(0.075)		
Instrument	Penalty rate reform	Leave-out mean	Leave-out mean (alt.)	Penalty rate reform	Leave-out mean	Leave-out mean (alt.)	Penalty rate reform	Leave-out mean	Leave-out mean (alt.)
Observations	64,114	68,278	68,278	66,217	70,104	70,104	59,272	63,159	63,159
F-statistic	7.26	13.7	7.24	.00682	2.31	.351	31.9	5.3	.141

Note: This table displays results from a series of instrumental variable regressions with a binary indicator of appealing a penalty as dependent variable on different parameterizations of penalty severity, using the penalty-rate reform and the leave-out mean penalty rate as instrumental variables. Standard errors clustered at the taxpayer level are in parentheses.

Table 7: IV results: appeals (including elevated penalties)

	(1) any_appeal	(2) any_appeal	(3) any_appeal	(4) any_appeal	(5) any_appeal	(6) any_appeal	(7) any_appeal	(8) any_appeal	(9) any_appeal
Log penalty	-0.21	-0.091	-0.079						
	(0.074)	(0.024)	(0.024)						
Penalty rate				0.37	0.0065	0.000036			
				(4.16)	(0.012)	(0.000065)			
Log penalty rate							-0.11	-0.082	-0.00096
							(0.018)	(0.044)	(0.00073)
Elevated penalty × Log penalty	0.037	-0.018	-0.0082						
	(0.065)	(0.028)	(0.031)						
Elevated penalty × Penalty rate				-0.36	-0.0057	-0.00046			
				(4.15)	(0.0095)	(0.00011)			
Elevated penalty × Log penalty rate							0.052	0.032	-0.00096
							(0.021)	(0.026)	(0.00098)
Elevated penalty	-0.043	0.34	0.22	2.09	0.051	0.041	0.38	0.27	0.023
	(0.58)	(0.29)	(0.33)	(24.9)	(0.023)	(0.0049)	(0.077)	(0.14)	(0.0060)
Constant	1.92			-2.17			-0.41		
	(0.66)			(25.1)			(0.075)		
Instrument	Penalty rate reform	Leave-out mean	Leave-out mean (alt.)	Penalty rate reform	Leave-out mean	Leave-out mean (alt.)	Penalty rate reform	Leave-out mean	Leave-out mean (alt.)
Observations	71,419	76,381	76,381	75,785	80,396	80,396	66,029	70,640	70,640
F-statistic	10.4	14.8	13.2	3.95	19.9	33	26.5	13.1	6.94

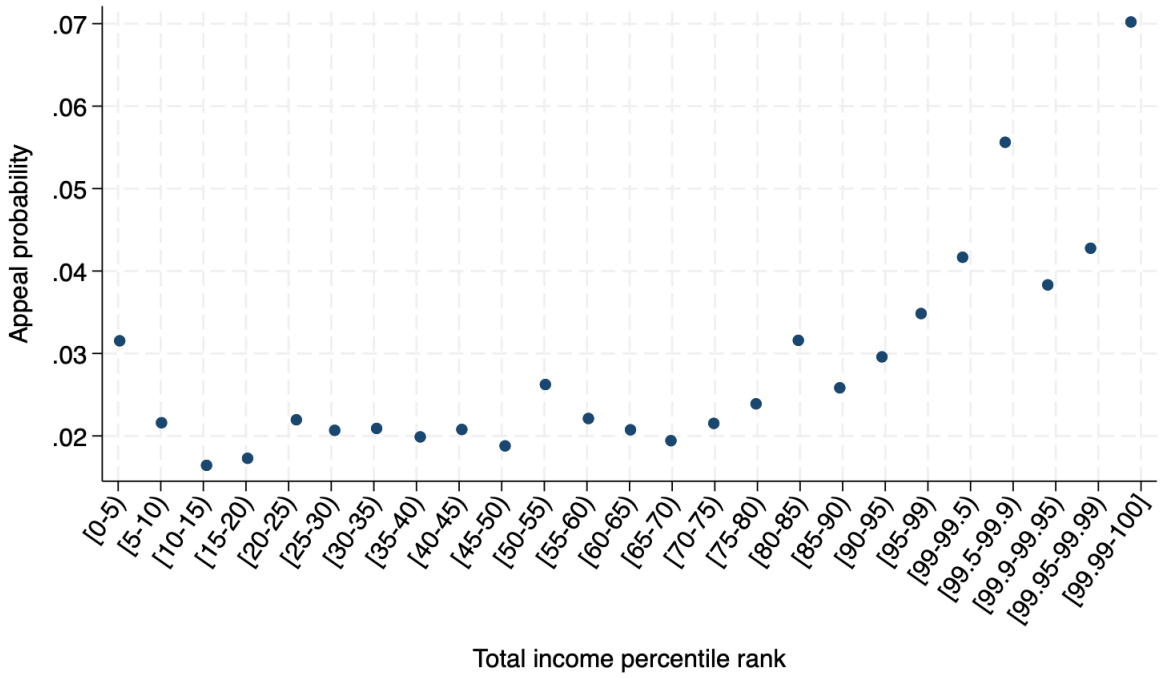
Note: This table displays results from a series of instrumental variable regressions with a binary indicator of appealing a penalty (both ordinary-rate and elevated) as dependent variable on different parameterizations of penalty severity, using the penalty-rate reform and the leave-out penalty mean penalty rate as instrumental variables. Standard errors clustered at the taxpayer level are in parentheses.

Table 8: Descriptive relationship between penalty and appeal decision

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log penalty amount	.007	.007		.0059			.0058
	(.0022)	(.0022)		(.0018)			(.002)
Effective penalty rate			.0092	.018			
			(.0081)	(.0078)			
Log effective penalty rate					.0017		
					(.00072)		
Elevated penalty						.031	.015
						(.0042)	(.0041)
Log gross wealth		.0022		.002			.0021
		(.00082)		(.00078)			(.00084)
Log income		-.00039		.0014			.000079
		(.0005)		(.0007)			(.00041)
Constant	-.044	-.065	.025	-.077	.027	.021	-.061
	(.02)	(.027)	(.00067)	(.032)	(.0025)	(.00053)	(.026)
Year fixed effects	Y	Y	Y	Y	Y	Y	Y
Controls	N	Y	N	Y	N	N	Y
N	77,475	70,372	81,440	70,372	71,684	88,562	70,372
Adjusted R2	.025	.028	.013	.028	.023	.017	.029

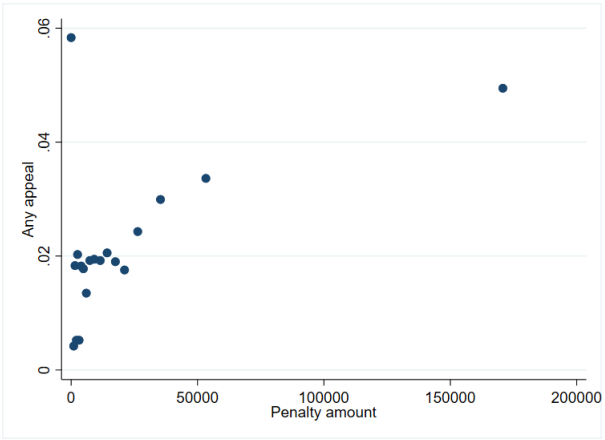
Note: This table displays results from a series of regressions with a binary indicator of appealing a penalty as dependent variable on different parameterizations of penalty severity. Standard errors clustered at the taxpayer level are in parentheses.

Figure 8: Appeal probability by income rank, conditional on penalty

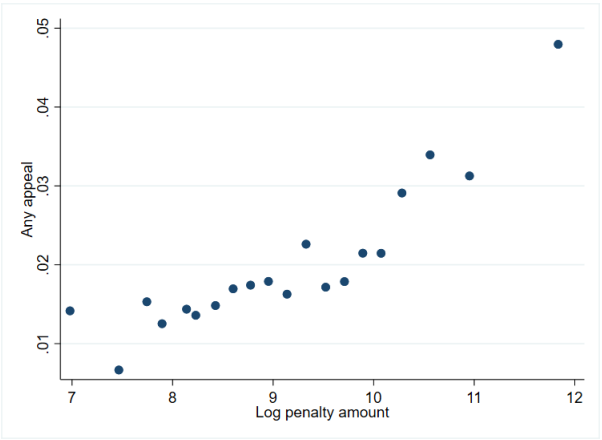


Note: This figure plots the conditional distribution of the probability to appeal an assigned penalty along the income rank for individual-years between 2011 and 2021. Income ranks are based on pooled pooled observations deflated to NOK 2015.

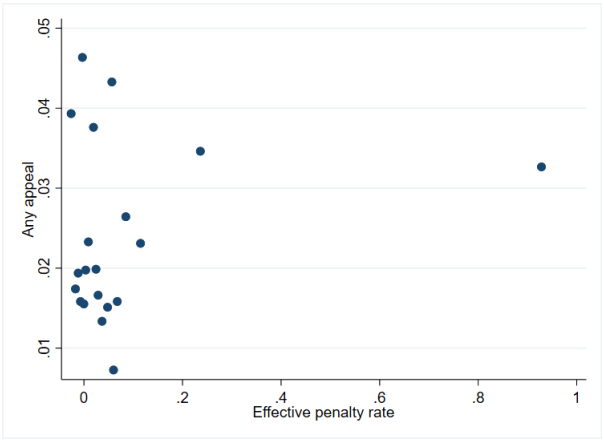
Figure 9: Appeal probability by penalty size, conditional on penalty



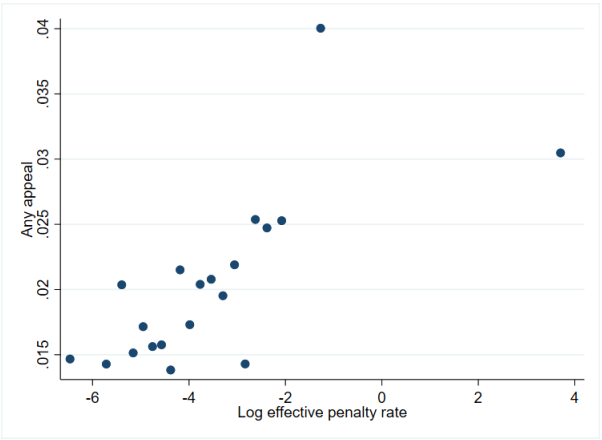
Panel (a): Levels penalty amount



Panel (b): Log penalty amount



Panel (c): Levels effective penalty rate



Panel (d): Log effective penalty rate

Note: These figures show binned scatter plots of the probability to appeal a penalty along penalty size, conditional on receiving a penalty. Panels (a) and (b) use the level and logarithm of assigned penalty amount on the horizontal axis, respectively, while Panels (c) and (d) use the levels and logarithms of the effective penalty rate as measures of penalty severity.

Table 9: Summary statistics on appeals outcomes

Variable	Mean	SD	N
All appeals			
Has a closing	.735	.441	3,562
Collected	.636	.481	3,562
Years to initial audit ruling	3.47	2.1	3,562
Conditional on closing			
Penalty is at least partially removed	.14	.347	2,650
Penalty is not removed	.864	.343	2,618
Process time (years)	.203	.663	2,618
Process time (log years)	-1.85	1.68	1,001
Share removed	.0867	.272	2,637
Share removed (conditional on some removal)	.618	.445	370

Note: This table displays descriptive statistics on appeals outcomes, separately for all appeals between 2011 and 2021 and for those appeals for which a closing date is observed.

Table 10: Predictors of whether an appeal has a closing

	Log penalty amount		Penalty share of income	Log penalty share of income	
	(1)	(2)	(3)	(4)	(5)
Log penalty amount	-.131	-.144			-.01
	(.007)	(.009)			(.119)
Penalty rate			-.491		
			(.058)		
Log penalty rate				-.069	-.123
				(.006)	(.12)
Log total income		.03			-.093
		(.005)			(.116)
Log gross wealth		.021			.025
		(.003)			(.005)
Constant	1.93	1.41	.767	.478	1.25
	(.072)	(.101)	(.005)	(.019)	(.085)
Controls	N	Y	N	N	Y
N	2,637	2,286	2,068	1,464	1,453
Adjusted R2	.294	.331	.147	.229	.29

Note: This table displays results from a series of regressions with a binary indicator of observing an appeals' closing date as dependent variable on different parameterizations of penalty severity. Standard errors clustered at the taxpayer level are in parentheses.

Table 11: Predictors of appeal processing time

	Log penalty amount		Penalty share of income	Log penalty share of income	
	(1)	(2)	(3)	(4)	(5)
Log penalty amount	.052	.061			-.027
	(.021)	(.024)			(.053)
Penalty rate			.113		
			(.086)		
Log penalty rate				.038	.118
				(.012)	(.053)
Log total income		-.001			.129
		(.019)			(.052)
Log gross wealth		-.037			-.059
		(.01)			(.011)
Constant	-.173	.297	.306	.436	.134
	(.199)	(.399)	(.005)	(.046)	(.156)
Controls	N	Y	N	N	Y
N	1,693	1,525	1,491	1,022	1,018
Adjusted R2	.014	.021	.007	.013	.051

Note: This table displays results from a series of regressions with appeal processing time (in years) as dependent variable on different parameterizations of penalty severity. Standard errors clustered at the taxpayer level are in parentheses.

Table 12: Predictors of log appeal processing time

	Log penalty amount		Penalty share of income	Log penalty share of income	
	(1)	(2)	(3)	(4)	(5)
Log penalty amount	.138	.174			-6.69
	(.04)	(.044)			(2.89)
Penalty rate			1.03		
			(.266)		
Log penalty rate				.115	6.9
				(.025)	(2.87)
Log total income		-.017			6.9
		(.023)			(2.84)
Log gross wealth		-.064			-.098
		(.018)			(.031)
Constant	-3.16	-2.38	-1.94	-1.33	-1.92
	(.38)	(.451)	(.013)	(.092)	(.68)
Controls	N	Y	N	N	Y
N	1,000	873	818	542	541
Adjusted R2	.015	.022	.012	.036	.061

Note: This table displays results from a series of regressions with the logarithm of appeal processing time (in years) as dependent variable on different parameterizations of penalty severity. Standard errors clustered at the taxpayer level are in parentheses.

Table 13: Predictors of removal share, post-appeal

	Log penalty amount		Penalty share of income	Log penalty share of income	
	(1)	(2)	(3)	(4)	(5)
Log penalty amount	-.03	-.028			-.019
	(.008)	(.007)			(.022)
Penalty rate			-.06		
			(.031)		
Log penalty rate				-.015	-.014
				(.004)	(.021)
Log total income		.002			-.007
		(.003)			(.021)
Log gross wealth		-.009			-.008
		(.002)			(.003)
Constant	.378	.465	.106	.06	.451
	(.078)	(.1)	(.003)	(.012)	(.134)
Controls	N	Y	N	N	Y
N	2,637	2,286	2,045	1,464	1,453
Adjusted R2	.068	.068	.038	.091	.108

Note: This table displays results from a series of regressions with removal share (post-appeal) as dependent variable on different parameterizations of penalty severity. Standard errors clustered at the taxpayer level are in parentheses.

Table 14: Predictors of time to initial audit ruling, conditional on appeal

	Log penalty amount		Penalty share of income	Log penalty share of income	
	(1)	(2)	(3)	(4)	(5)
Log penalty amount	.363	.347			.857
	(.051)	(.049)			(.717)
Penalty rate			1.08		
			(.514)		
Log penalty rate				.181	-.545
				(.039)	(.695)
Log total income		-.125			-.69
		(.025)			(.699)
Log gross wealth		.113			.091
		(.011)			(.011)
Constant	.097	.346	3.59	3.67	.631
	(.503)	(.465)	(.048)	(.125)	(.337)
Controls	N	Y	N	N	Y
N	2,637	2,286	2,068	1,464	1,453
Adjusted R2	.371	.394	.346	.236	.28

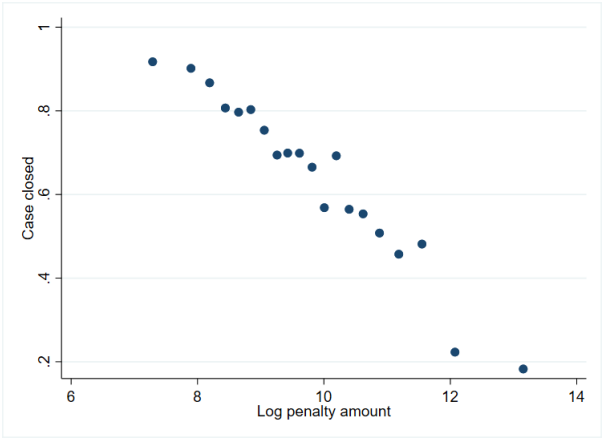
Note: This table displays results from a series of regressions with time to initial audit ruling (in years; conditional on appeal) as dependent variable on different parameterizations of penalty severity. Standard errors clustered at the taxpayer level are in parentheses.

Table 15: Descriptive statistics of Norwegian taxpayers by tax penalty status, 2015

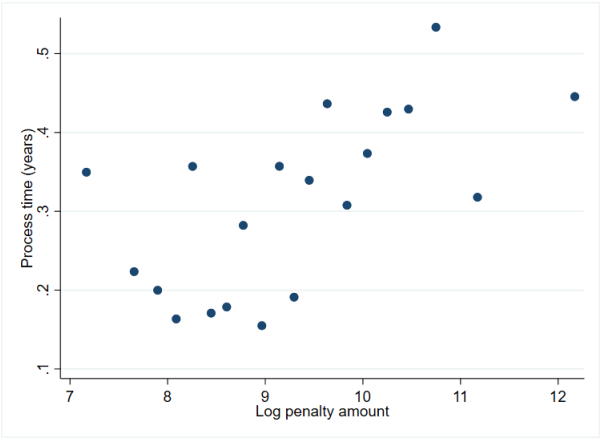
	Non-penalized	Penalized	Difference
Unique taxpayers	2952000	28230	
Age	50.92	51	0.077
	[14.79]	[14.82]	(0.0886)
Female	0.504	0.503	-0.000388
	[0.5]	[0.5]	(0.00299)
Married	0.509	0.506	-0.00298
	[0.5]	[0.5]	(0.00299)
Immigrant	0.089	0.0901	0.00112
	[0.285]	[0.286]	(0.00171)
Completed university	0.357	0.357	-0.00037
	[0.479]	[0.479]	(0.00287)
Log total income	12.49	12.81	0.321
	[1.443]	[1.564]	(0.00988)
Any self-employment income	0.0694	0.257	0.188
	[0.254]	[0.437]	(0.003)
Any capital income	0.878	0.967	0.0897
	[0.328]	[0.178]	(0.00113)
Log taxable wealth	12.67	12.68	0.00931
	[1.921]	[2.426]	(0.0157)

Note: This table displays descriptive statistics of Norwegian taxpayers in year 2015. Hard brackets indicate standard deviations; soft brackets indicate heteroskedasticity-robust standard errors. All monetary values are expressed in real NOK 2015.

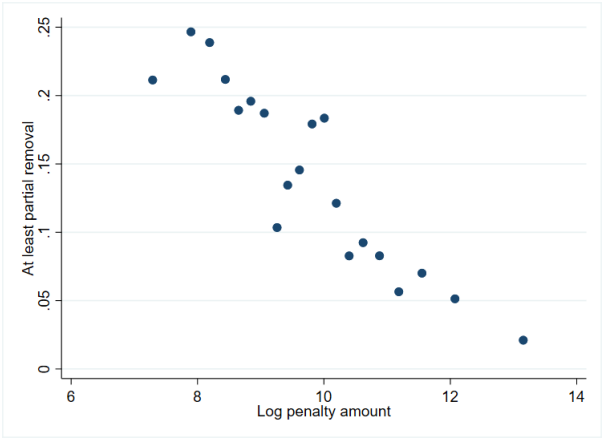
Figure 10: Appeals outcomes versus log penalty size



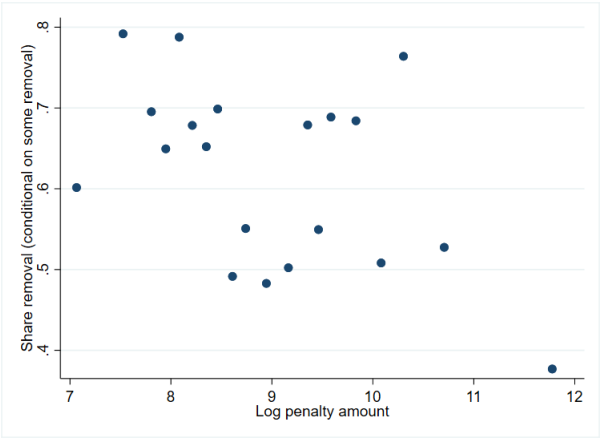
Panel (a): Case has closing



Panel (b): Final processing time (years)



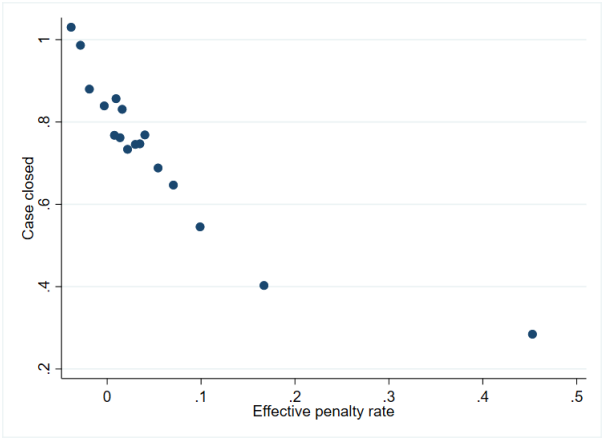
Panel (c): Has any penalty removal



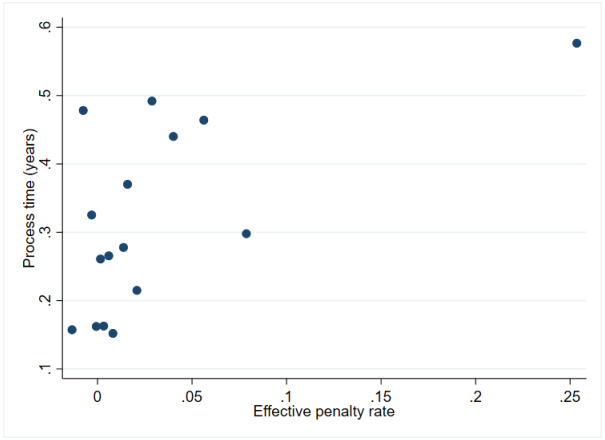
Panel (d): Share removed (conditionally positive)

Note: These figures show binned scatter plots of different indicators of appeals outcomes against the logarithm of penalty size. Panel (a) uses a binary variable equal to one if a case has an observed closing date, while Panel (b) draws on the final processing time of the appeal (measured in years). Panels (c) and (d) use a binary variable indicating whether any penalty has been removed and the removed share (conditional on being positive), respectively.

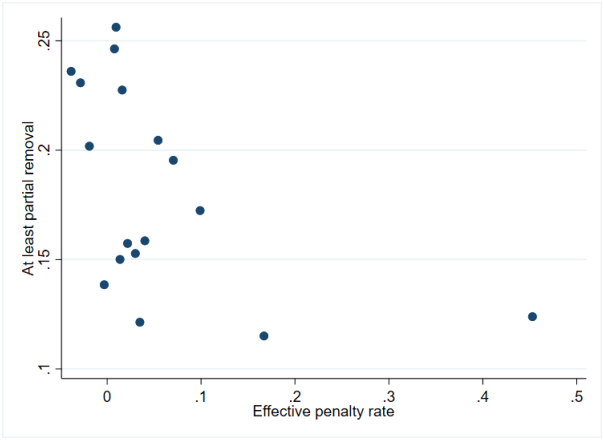
Figure 11: Appeals outcomes versus penalty rate



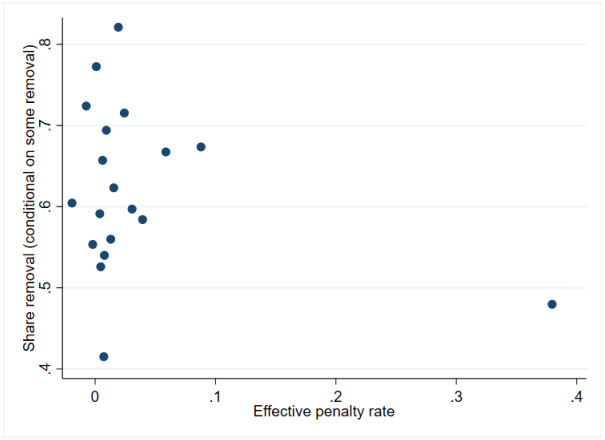
Panel (a): Case has closing



Panel (b): Final processing time (years)



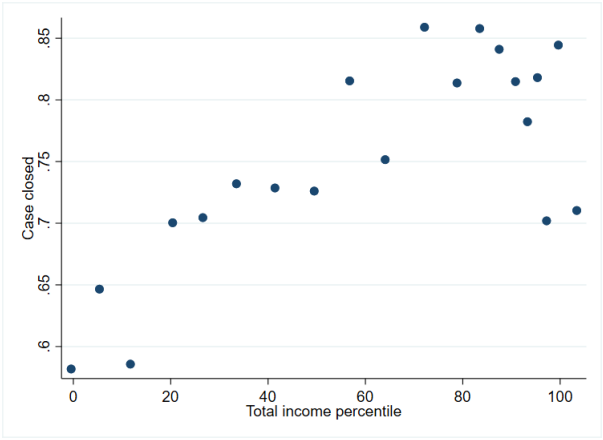
Panel (c): Has any penalty removal



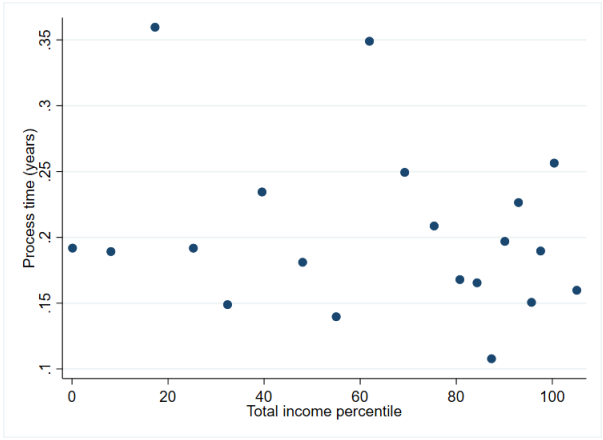
Panel (d): Share removed (conditionally positive)

Note: These figures show binned scatter plots of different indicators of appeals outcomes against the effective penalty rate. Panel (a) uses a binary variable equal to one if a case has an observed closing date, while Panel (b) draws on the final processing time of the appeal (measured in years). Panels (c) and (d) use a binary variable indicating whether any penalty has been removed and the removed share (conditional on being positive), respectively.

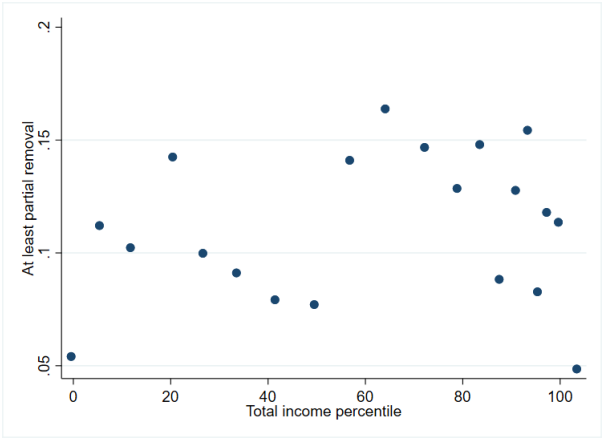
Figure 12: Appeals outcomes versus taxpayer income rank



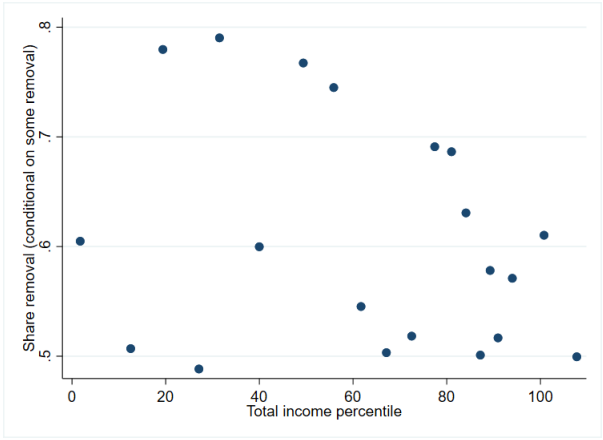
Panel (a): Case has closing



Panel (b): Final processing time (years)



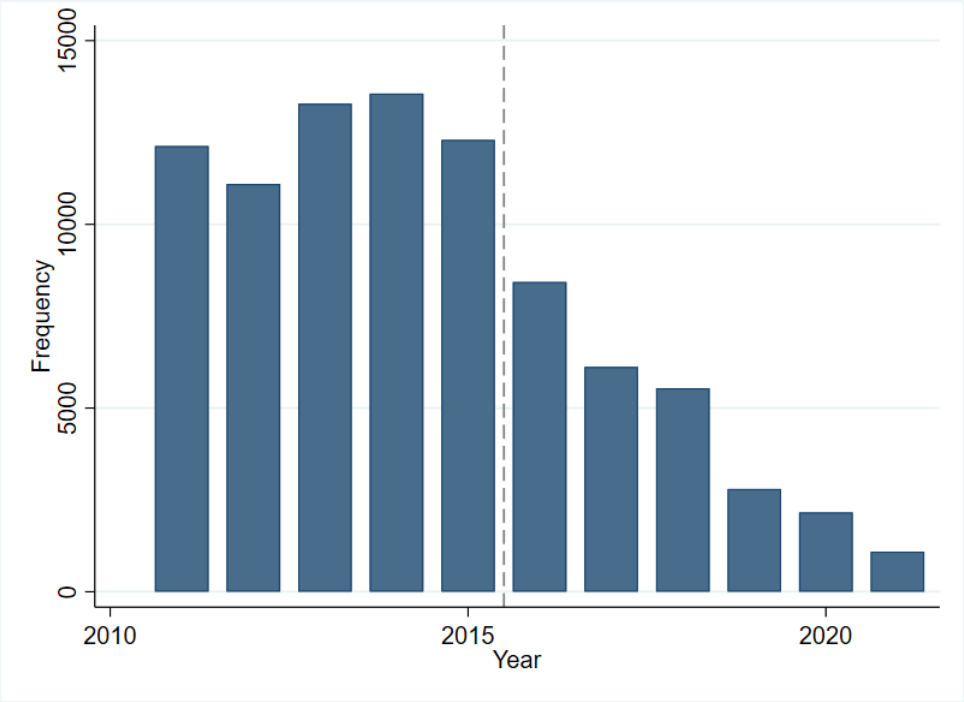
Panel (c): Has any penalty removal



Panel (d): Share removed (conditionally positive)

Note: These figures show binned scatter plots of different indicators of appeals outcomes along the income rank. Panel (a) uses a binary variable equal to one if a case has an observed closing date, while Panel (b) draws on the final processing time of the appeal (measures in years). Panels (c) and (d) use a binary variable indicating whether any penalty has been removed and the removed share (conditional on being positive), respectively.

Figure 13: Ordinary-rate penalty events by year



Note: This figure displays the occurrence of ordinary-rate penalty assignments by year over the 2011-2021 period.

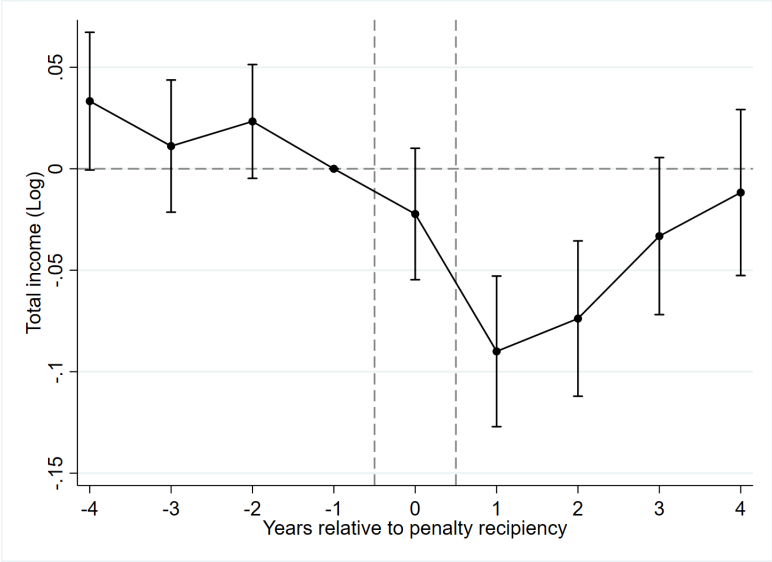
Table 16: Pre-penalty descriptive statistics of ordinary-rate penalty recipients
Before and after statutory penalty-rate decrease

	Pre-reform	Post-reform	Difference
Unique taxpayers	21375	6050	
Age	46.4	50.41	4.007
	[14.88]	[14.9]	(0.217)
Female	0.504	0.499	-0.00558
	[0.5]	[0.5]	(0.00728)
Married	0.488	0.501	0.013
	[0.486]	[0.488]	(0.0071)
Immigrant	0.0905	0.0869	-0.00354
	[0.287]	[0.282]	(0.00412)
Completed university	0.328	0.361	0.0329
	[0.464]	[0.478]	(0.00693)
Log total income	12.66	13.01	0.353
	[1.572]	[1.434]	(.02241)
Any self-employment income	0.28	0.234	-0.0463
	[0.401]	[0.378]	(0.00578)
Any capital income	0.961	0.974	0.0128
	[0.157]	[0.123]	(0.00197)
Log taxable wealth	12.15	12.89	0.745
	[2.241]	[2.312]	(0.0349)

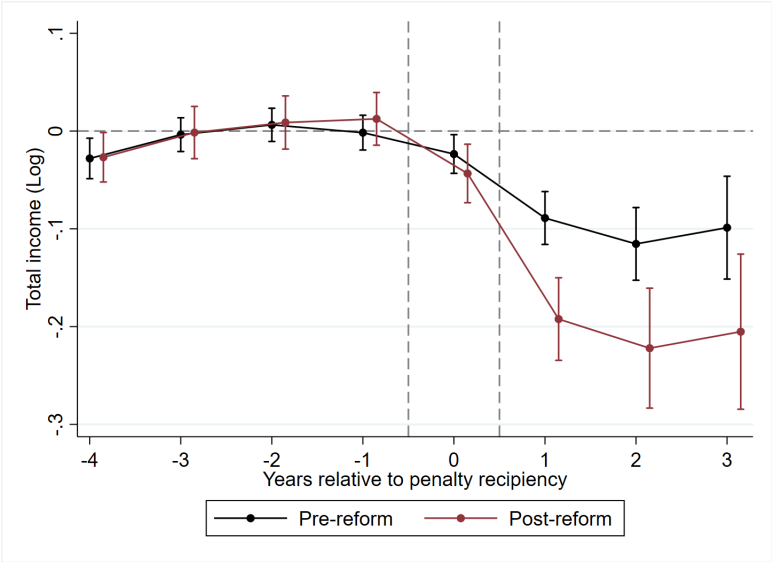
Note: This table displays four-to-one year pre-event average descriptive statistics of Norwegian ordinary-rate personal income tax noncompliance penalty recipients based on whether they received their penalty under the pre-reform 30% statutory rate or the post-reform 20% statutory rate. Hard brackets indicate standard deviations; soft brackets indicate heteroskedasticity-robust standard errors. All monetary values are expressed in real NOK 2015.

Figure 14: Total declared income response to the decrease in statutory penalty rate

(a) Net differential response



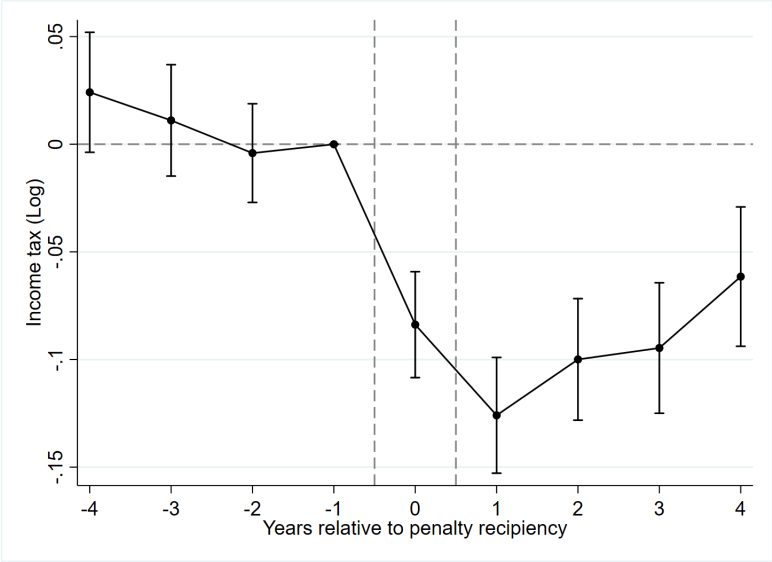
(b) Stratified event study



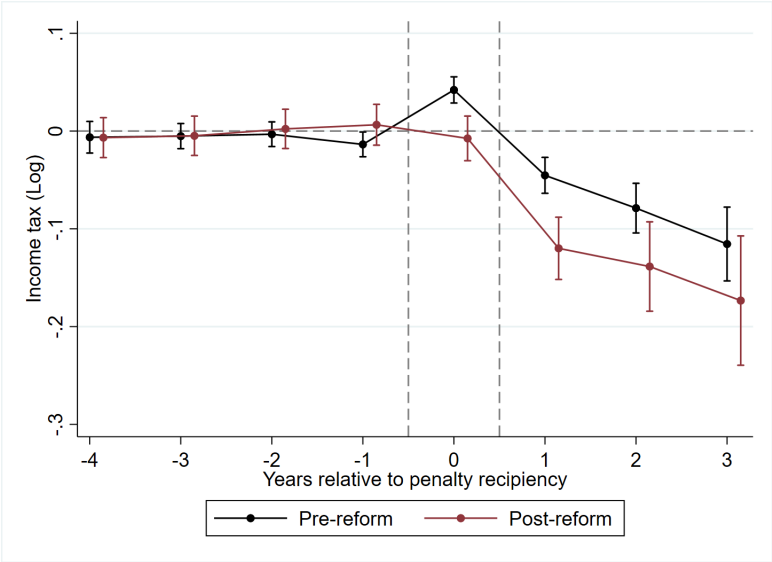
Note: These figures display the dynamic effects of the decrease in the statutory penalty rate on the logarithm of total declared income. Panel (a) plots the treatment effect coefficients $\{\hat{\beta}_k\}_{k\geq 0}$ and 95% confidence bands associated with the event study $y_{it} = \alpha_i + \sum_{k=-5}^{5} \gamma_k EventTime_{k(it)} + \sum_{k=-5}^{5} \beta_k Event\ Time_{k(it)} \cdot 1\{Penalty\ Year_i \geq 2016\} + \varepsilon_{it}$. This design yields the net differential response arising from the stratified event study $y_{it} = \alpha_i + \sum_{k=-5}^{5} \gamma_k EventTime_{k(it)} + \varepsilon_{it}$ as estimated in Panel (b) on two subsamples of individuals receiving penalties prior to and after the decrease in the ordinary penalty rate from 30% to 20% in 2016, respectively. The coefficient estimates $\{\hat{\gamma}_k\}_{k\geq 0}$ were obtained using the methodology by Callaway and Sant'Anna (2021). All specifications include taxpayer fixed effects. Standard errors are clustered at the taxpayer level.

Figure 15: Income taxes paid response to the decrease in statutory penalty rate

(a) Net differential response

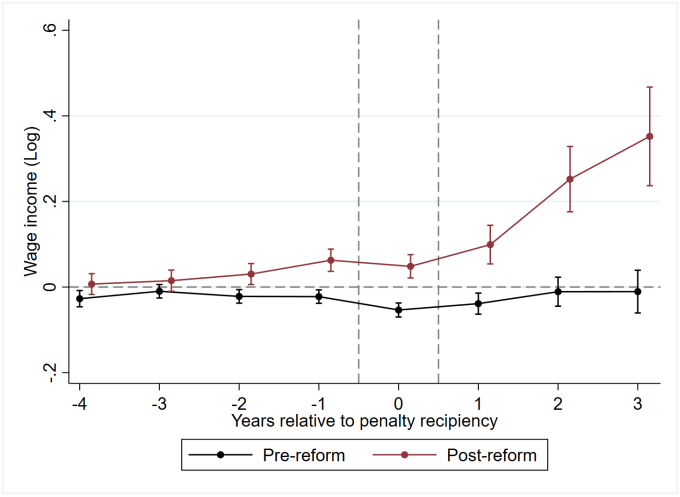


(b) Stratified event study

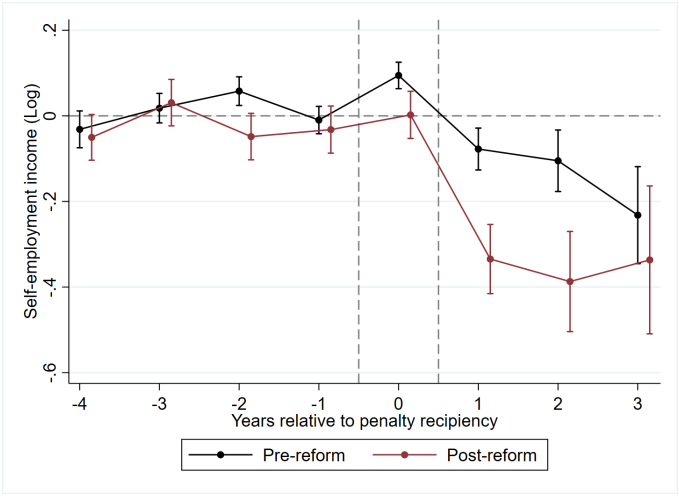


Note: These figures display the dynamic effects of the decrease in the statutory penalty rate on the logarithm of income taxes paid. Panel (a) plots the treatment effect coefficients $\{\hat{\beta}_k\}_{k\geq 0}$ and 95% confidence bands associated with the event study $y_{it} = \alpha_i + \sum_{k=-5}^{5} \gamma_k EventTime_{k(it)} + \sum_{k=-5}^{5} \beta_k Event\ Time_{k(it)} \cdot 1\{Penalty\ Year_i \geq 2016\} + \varepsilon_{it}$. This design yields the net differential response arising from the stratified event study $y_{it} = \alpha_i + \sum_{k=-5}^{5} \gamma_k EventTime_{k(it)} + \varepsilon_{it}$ as estimated in Panel (b) on two subsamples of individuals receiving penalties prior to and after the decrease in the ordinary penalty rate from 30% to 20% in 2016, respectively. The coefficient estimates $\{\hat{\gamma}_k\}_{k\geq 0}$ were obtained using the methodology by Callaway and Sant'Anna (2021). All specifications include taxpayer fixed effects. Standard errors are clustered at the taxpayer level.

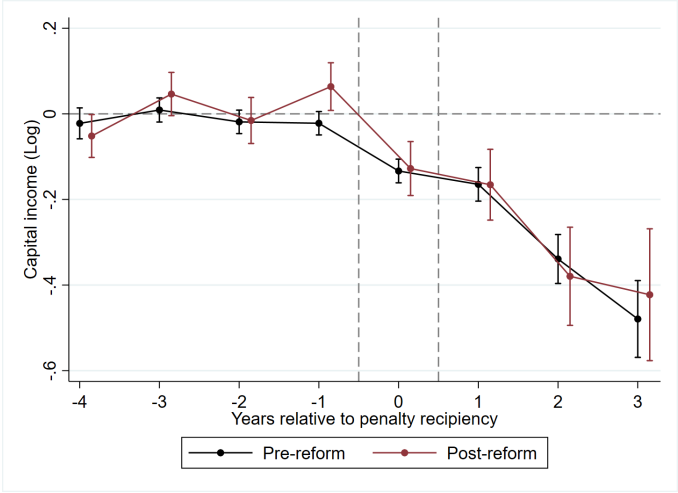
Figure 16: Response to the decrease in statutory penalty rate:
Income disaggregation



(a) Wage/salary



(b) Self-employment income



(c) Capital income

Note: These figures display the dynamic effects of receiving a tax noncompliance penalty on different types of incomes. Panel (a) - (c) plot the treatment effect coefficients and 95% confidence bands associated with the stratified event study $y_{it} = \alpha_i + \sum_{k=-5}^{5} \gamma_k EventTime_{k(it)} + \varepsilon_{it}$ on two subsamples of individuals receiving penalties prior to and after the decrease in the ordinary penalty rate from 30% to 20% in 2016, respectively. Panel (a) uses the logarithm of wage and salary income as dependent variable, while Panels (b) and (c) use the logarithms of self-employment income and capital income as dependent variables, respectively. The coefficient estimates $\{\hat{\gamma}_k\}_{k\geq 0}$ were obtained using the methodology by Callaway and Sant'Anna (2021). All specifications include taxpayer fixed effects. Standard errors are clustered at the taxpayer level.

Table 17: Income- and tax payment responses to the decrease in statutory penalty rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Total income	Total income	Log total income	Log total income	Log total tax	Log total tax	Log capital income	Log capital income	Log self-emp. income	Log self-emp. income	Log work income	Log work income
Treat x Post	-2.57e+04	-2.24e+04	-0.068	-0.073	-0.066	-0.078	0.038	-0.042	-0.026	-0.027	-0.109	-0.119
	(6401.214)	(6774.104)	(0.012)	(0.013)	(0.010)	(0.010)	(0.027)	(0.027)	(0.031)	(0.032)	(0.012)	(0.013)
Treat	2.29e+05		0.360		0.381		0.853		0.158		0.272	
	(8841.381)		(0.013)		(0.013)		(0.038)		(0.031)		(0.014)	
Post	72545.555	72545.555	0.113	0.115	0.131	0.157	-0.118	-0.118	-0.035	0.029	0.096	0.043
	(2195.042)	(2329.754)	(0.006)	(0.006)	(0.005)	(0.005)	(0.011)	(0.011)	(0.012)	(0.013)	(0.006)	(0.006)
Constant	5.58e+05	6.08e+05	12.752	12.829	11.447	11.517	6.779	6.971	12.078	12.072	12.466	12.558
	(3051.158)	(1251.990)	(0.007)	(0.003)	(0.006)	(0.002)	(0.016)	(0.006)	(0.012)	(0.006)	(0.007)	(0.003)
N	361,533	361,533	357,765	357,765	342,298	342,298	341,572	341,572	86,280	86,280	288,349	288,349
Adj. R^2	0.015	0.633	0.010	0.458	0.014	0.576	0.011	0.703	0.002	0.583	0.005	0.542
Taxpayer FE	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y

Note: This table displays the estimated coefficients associated with the difference-in-differences model $y_{it} = \beta_0 + \gamma \cdot 1\{Penalty\ Year_i \geq 2016\} + \delta \cdot 1\{Event\ Time_t \geq 0\} + \beta_k \cdot 1\{Penalty\ Year_i \geq 2016\} \cdot 1\{Event\ Time_t \geq 0\} + \varepsilon_{it}$. Standard errors are clustered at the taxpayer level.

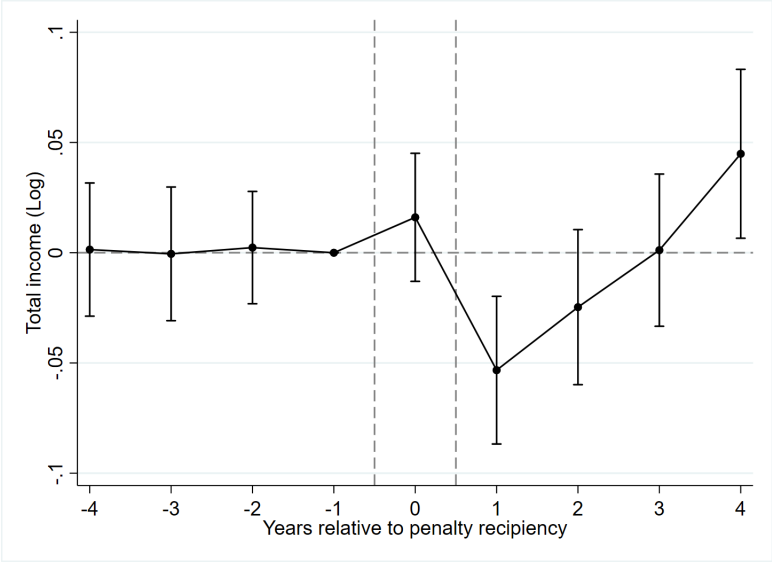
Table 18: Pre-penalty descriptive statistics of matched sample of ordinary-rate penalty recipients
Before and after statutory penalty-rate decrease

	Pre-reform	Post-reform	Difference
Unique taxpayers	20563	8711	
Age	46.62	46.58	0.0568
	[18.63]	[18.88]	(0.275)
Female	0.501	0.487	-0.0139
	[0.5]	[0.5]	(0.00727)
Married	0.433	0.42	-0.0105
	[0.48]	[0.48]	(0.00698)
Immigrant	0.144	0.167	0.0247
	[0.351]	[0.373]	(0.00535)
Completed university	0.291	0.327	0.0368
	[0.449]	[0.461]	(0.00677)
Log total income	13.18	13.18	0.00178
	[0.936]	[0.945]	(0.00128)
Any self-employment income	0.264	0.244	-0.200
	[0.395]	[0.384]	(0.004)
Any capital income	0.991	0.992	0.00138
	[0.0701]	[0.0585]	(0.000706)
Log taxable wealth	13.19	13.39	0.201
	[2.129]	[2.158]	(0.0178)

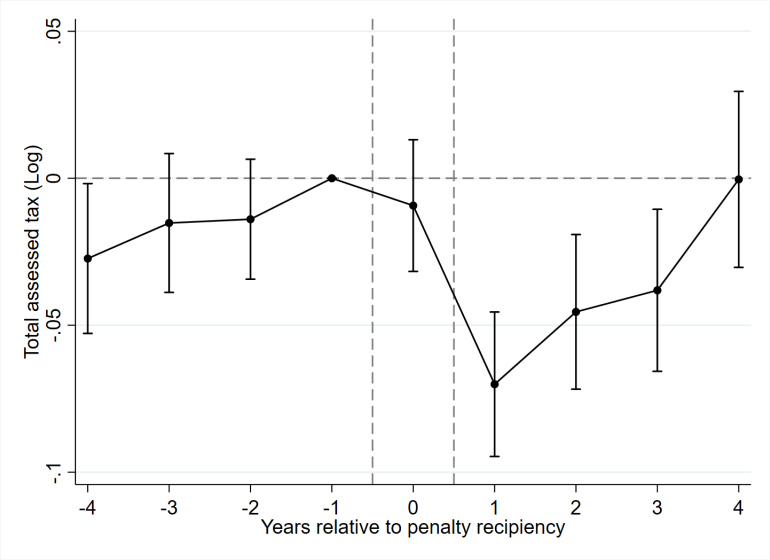
Note: This table displays four-to-one year pre-event average descriptive statistics of Norwegian ordinary-rate personal income tax noncompliance penalty recipients based on whether they received their penalty under the pre-reform 30% statutory rate or the post-reform 20% statutory rate. Here, each post-reform penalty recipient is matched using pre-event income declaration characteristics to five pre-reform ordinary-rate penalty recipients using a Mahalanobis matching procedure with replacement. Hard brackets indicate standard deviations; soft brackets indicate heteroskedasticity-robust standard errors. The difference column does not necessarily correspond with the simple difference between the post- and pre-reform columns, as the regression that computes the difference includes match-group fixed effects. All monetary values are expressed in real NOK 2015.

Figure 17: Income- and tax payment responses to the decrease in statutory penalty rate
Mahalanobis Matching

(a) Income declared

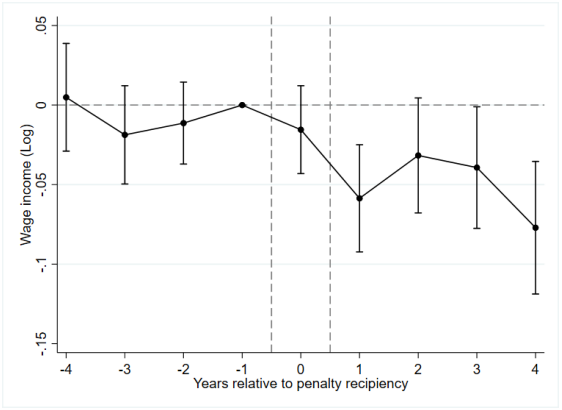


(b) Income taxes paid

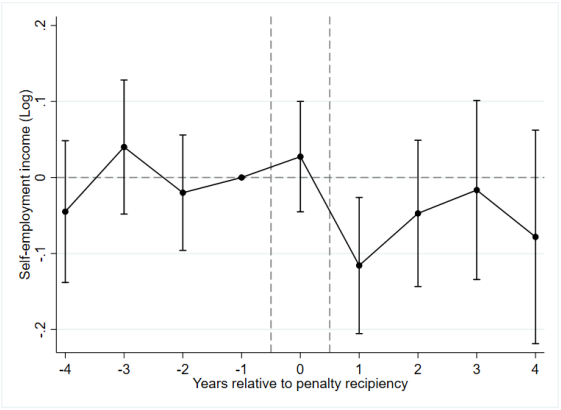


Note: These figures display the dynamic effects of the decrease in the statutory penalty rate on the logarithms of total declared income (Panel (a)) and income taxes paid (Panel (b)). Both panels plot the treatment effect coefficients $\{\hat{\beta}_k\}_{k\geq 0}$ and 95% confidence bands associated with the event study $y_{it} = \alpha_i + \theta_{g(i)} + \sum_{k=-5}^{5} \gamma_k EventTime_{k(it)} + \sum_{k=-5}^{5} \beta_k Event\ Time_{k(it)} \cdot 1\{Penalty\ Year_i \geq 2016\} + \varepsilon_{it}$. Here, $\theta_{g(i)}$ represents a group fixed effect constructed via a Mahalanobis five-nearest neighbor matching procedure based on pre-event income declaration characteristics. All specifications include taxpayer fixed effects. Standard errors are clustered at the taxpayer level.

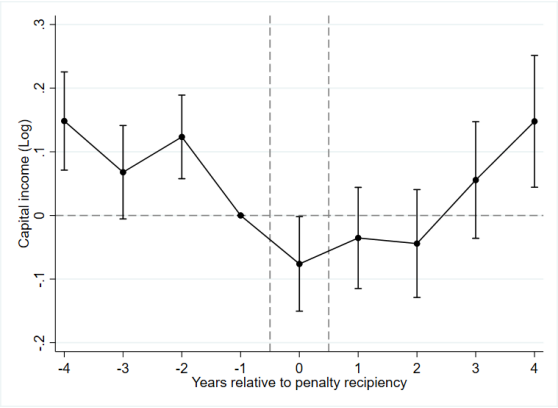
Figure 18: Response to the decrease in statutory penalty rate:
Income disaggregation
Mahalanobis Matching



(a) Wage/salary



(b) Self-employment income

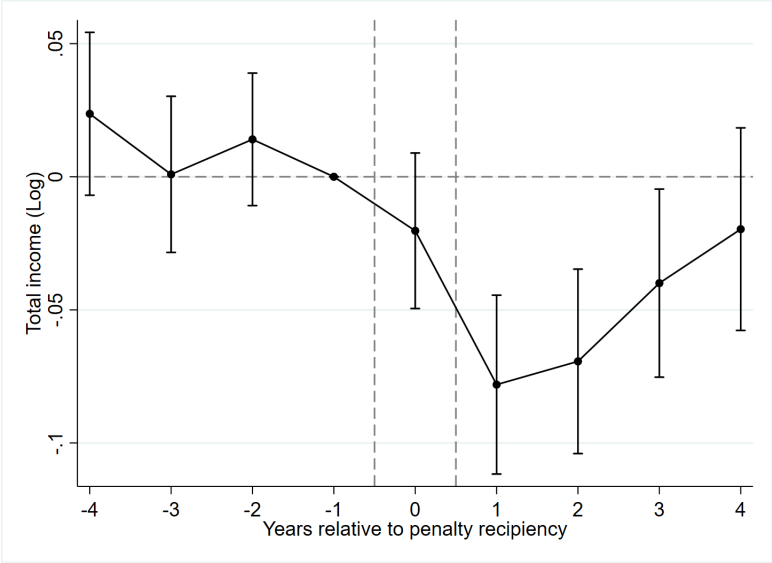


(c) Capital income

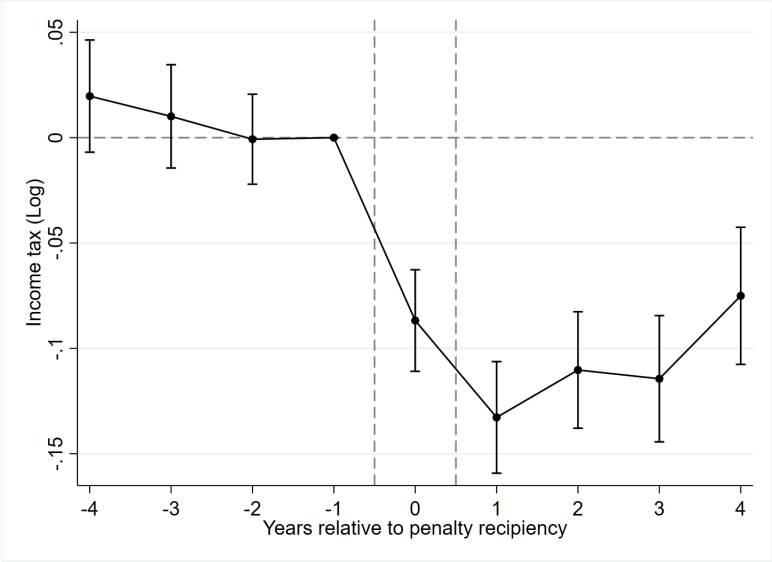
Note: These figures display the dynamic effects of the decrease in the statutory penalty rate on different types of incomes. Panel (a) - (c) plot the treatment effect coefficients $\{\hat{\beta}_k\}_{k\geq 0}$ and 95% confidence bands associated with the event study $y_{it} = \alpha_i + \theta_{g(i)} + \sum_{k=-5}^{5} \gamma_k EventTime_{k(it)} + \sum_{k=-5}^{5} \beta_k Event\ Time_{k(it)} \cdot 1\{Penalty\ Year_i \geq 2016\} + \varepsilon_{it}$ for (a) the logarithm of wage and salary income, (b) the logarithm of self-employment income, and (c) the logarithm of capital income. Here, $\theta_{g(i)}$ represents a group fixed effect constructed via a Mahalanobis five-nearest neighbor matching procedure based on pre-event income declaration characteristics. All specifications include taxpayer fixed effects. Standard errors are clustered at the taxpayer level.

Figure 19: Income- and tax payment responses to the decrease in statutory penalty rate
Correlated Random Effects

(a) Income declared



(b) Income taxes paid



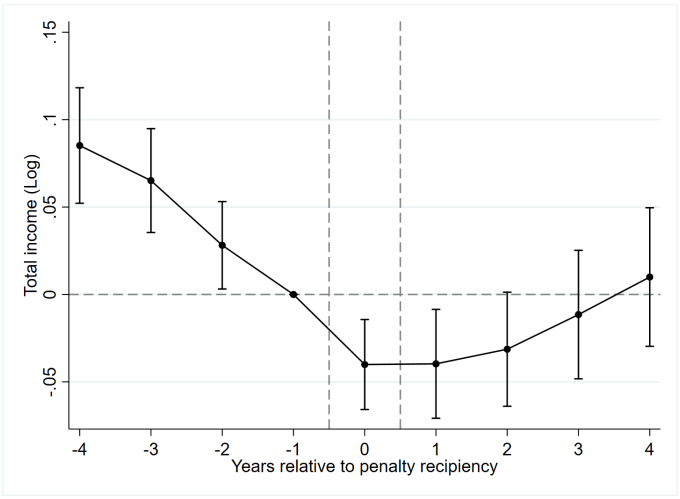
Note: These figures display the dynamic effects of the decrease in the statutory penalty rate on the logarithms of total declared income (Panel (a)) and income taxes paid (Panel (b)) using a Correlated Random Effects (CRE) design. Both panels plot the treatment effect coefficients $\{\hat{\beta}_k\}_{k\geq 0}$ and 95% confidence bands associated with the event study $y_{it} = \alpha_0 + \Gamma X_i + \sum_{k=-5}^{5} \gamma_k EventTime_{k(it)} + \sum_{k=-5}^{5} \beta_k Event\ Time_{k(it)} \cdot 1\{Penalty\ Year_i \geq 2016\} + \varepsilon_{it}$. Here, X_i represents a set of time-invariant characteristics consisting of measures of pre-event income. Standard errors are clustered at the taxpayer level.

Table 19: Income- and tax payment responses to the decrease in statutory penalty rate: Mahalanobis Matching and Correlated Random Effects (CRE)

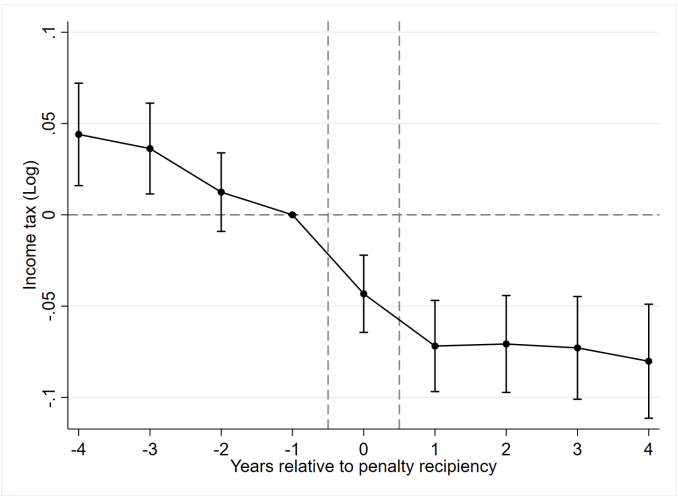
	(1)	(2)	(3)	(4)	(5)	(6)
	Total income Matching	Total income CRE	Log total income Matching	Log total income CRE	Log total tax Matching	Log total tax CRE
Treat x Post	-2.24e+04	-2.60e+04	-0.010	-0.071	-0.005	-0.091
	(8401.965)	(6413.882)	(0.011)	(0.012)	(0.010)	(0.010)
Post	64261.324	65790.953	0.016	0.104	0.068	0.182
	(5766.454)	(2188.324)	(0.007)	(0.006)	(0.006)	(0.005)
Treat		1.16e+05		0.084		0.144
		(6992.239)		(0.004)		(0.008)
Constant	7.94e+05	-3.51e+06	13.181	2.944	11.855	1.913
	(2740.695)	(81829.961)	(0.003)	(0.064)	(0.003)	(0.123)
N	466,771	348,216	464,940	346,695	453,661	331,372
Adj. R^2	0.682	0.237	0.508	0.400	0.650	0.352
Taxpayer FE	Y	N	Y	N	Y	N

Note: Odd-numbered columns display the estimated coefficients associated with the difference-in-differences model $y_{it} = \alpha_i + \theta_{g(i)} + \gamma \cdot 1\{Penalty\ Year_i \geq 2016\} + \delta \cdot 1\{Event\ Time_t \geq 0\} + \beta_k \cdot 1\{Penalty\ Year_i \geq 2016\} \cdot 1\{Event\ Time_t \geq 0\} + \varepsilon_{it}$. Here, $\theta_{g(i)}$ represents a group fixed effect constructed via a Mahalanobis five-nearest neighbor matching procedure with replacement based on pre-event income declaration characteristics. Even-numbered columns display the estimated coefficients associated with the correlated random effects model $y_{it} = \beta_0 + \Gamma X_i + \gamma \cdot 1\{Penalty\ Year_i \geq 2016\} + \delta \cdot 1\{Event\ Time_t \geq 0\} + \beta_k \cdot 1\{Penalty\ Year_i \geq 2016\} \cdot 1\{Event\ Time_t \geq 0\} + \varepsilon_{it}$. Here, X_i represents a set of time-invariant characteristics consisting of measures of pre-event income. Standard errors are clustered at the taxpayer level.

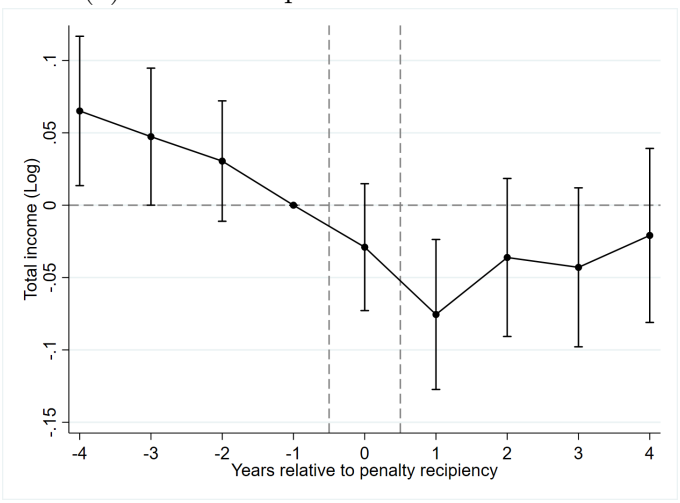
Figure 20: Response to the decrease in statutory penalty rate:
Household peers and business partners



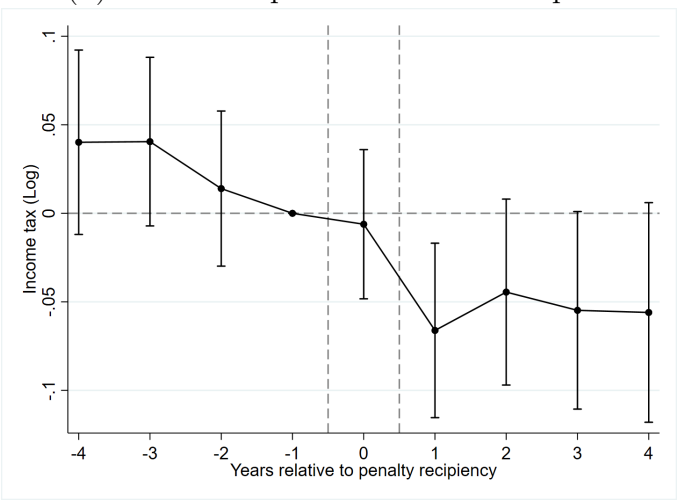
(a) Household peers: Income declared



(b) Household peers: Income taxes paid



(c) Business partners: Income declared

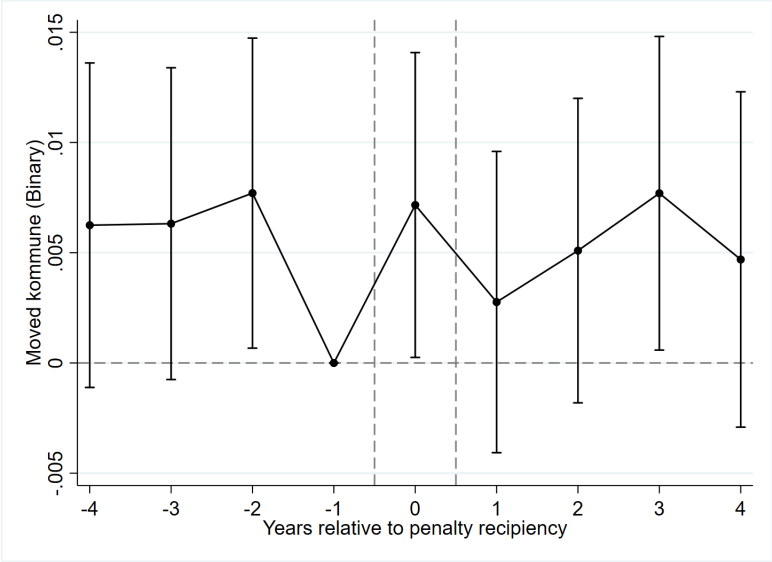


(d) Business partners: Income taxes paid

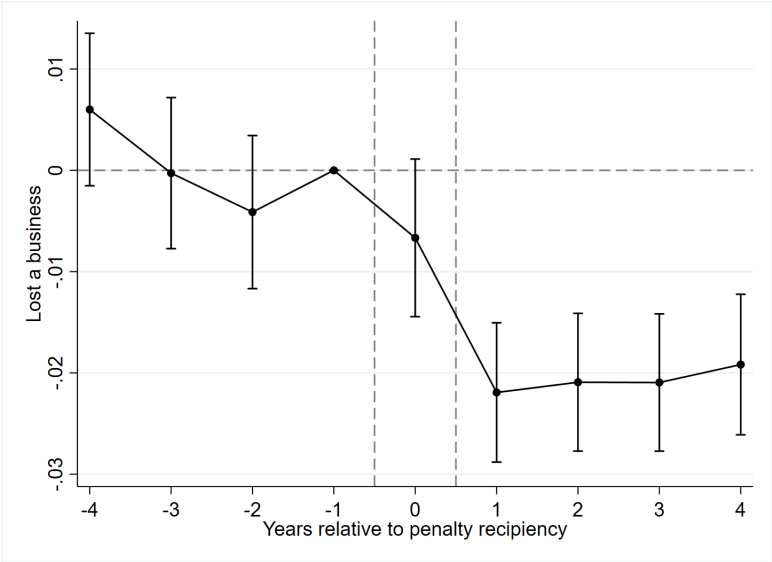
Note: These figures display the dynamic spillover effects of the decrease in the statutory penalty rate onto penalized taxpayers' household peers and business partners (based on holding at least 10% of ownership shares in the same business). Panel (a) - (d) plot the treatment effect coefficients $\{\hat{\beta}_k\}_{k\geq 0}$ and 95% confidence bands associated with the event study $y_{it} = \alpha_i + \sum_{k=-5}^{5} \gamma_k EventTime_{k(it)} + \sum_{k=-5}^{5} \beta_k Event\ Time_{k(it)} \cdot 1\{Penalty\ Year_i \geq 2016\} + \varepsilon_{it}$ for (a) the logarithm of total declared income by household peers, (b) the logarithm of income taxes paid by household peers, (c) the logarithm of total declared income by business partners, and (d) the logarithm of income taxes paid by business partners. All specifications include taxpayer fixed effects. Standard errors are clustered at the taxpayer level.

Figure 21: Welfare responses to the decrease in statutory penalty rate

(a) Changing municipality of residence

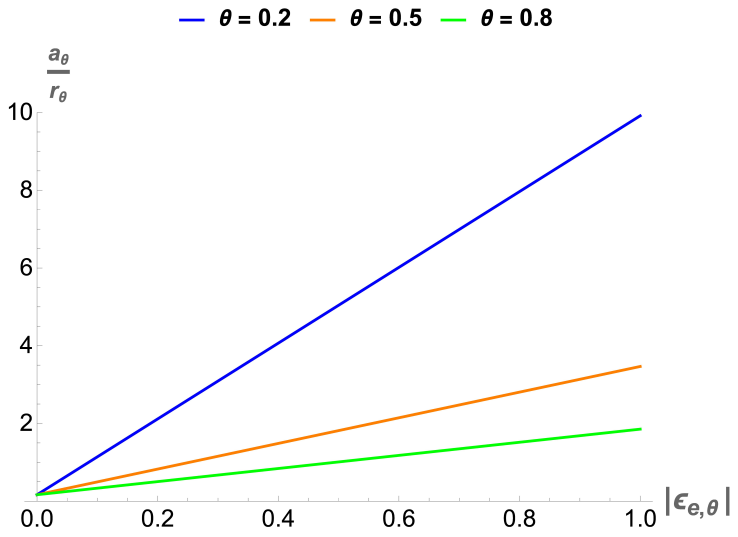


(b) Losing stakes in a business



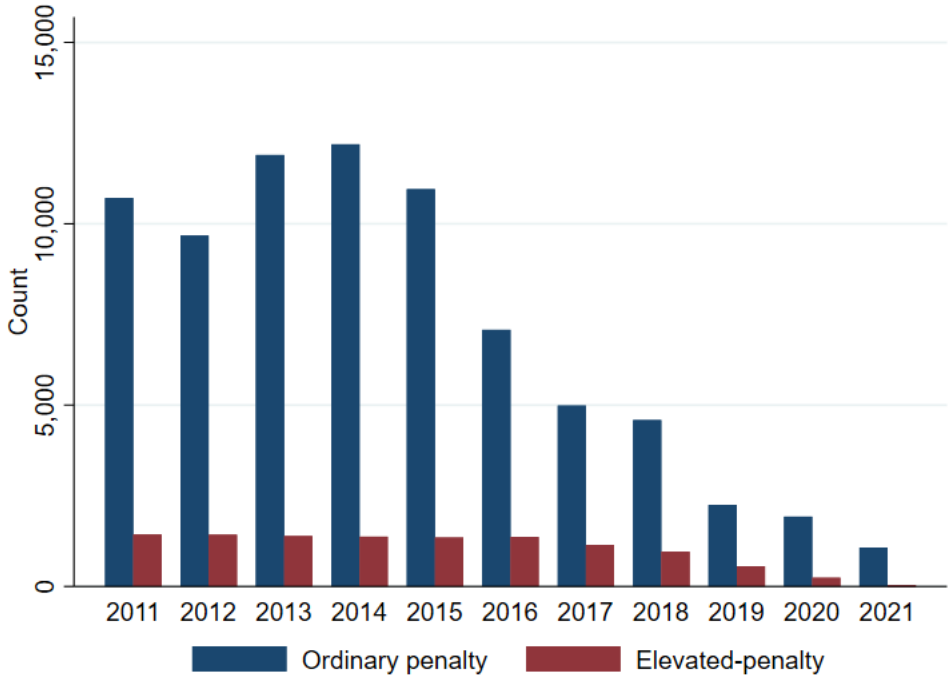
Note: These figures display the dynamic effects of the decrease in the statutory penalty rate on a taxpayer's likelihood of changing municipality of residence (Panel (a)) and the likelihood of losing 100% direct ownership shares in a business (Panel (b)). Both panels plot the treatment effect coefficients $\{\hat{\beta}_k\}_{k\geq 0}$ and 95% confidence bands associated with the event study $y_{it} = \alpha_i + \sum_{k=-5}^{5} \gamma_k EventTime_{k(it)} + \sum_{k=-5}^{5} \beta_k Event\ Time_{k(it)} \cdot 1\{Penalty\ Year_i \geq 2016\} + \varepsilon_{it}$. All specifications include taxpayer fixed effects Standard errors are clustered at the taxpayer level.

Figure 22: Rationalization of existing penalty rates



Appendix A Additional descriptive results

Figure A.1: Penalties by type and year



Note: This figure displays the occurrence of ordinary rate- and elevated penalty assignments by year over the 2011-2021 period.

Table A.1: Descriptive statistics about ordinary-regime penalties by regime
Panel (a): Ordinary penalty regime

	Mean	SD	p10	p50	p90	N
Penalty amount	21,071	117,171	0	7,000	45,075	88,521
Penalty amount (log)	9.19	1.26	7.62	9.13	10.8	77,442
Positive penalty amount (binary)	.87	.33	0	1	1	88,521
Penalty share of income	97.8	1,889	0	.02	.15	81,265
Penalty share of income (winsorized)	.09	.21	0	.02	.15	81,265

Panel (b): Elevated penalty regime

	Mean	SD	p10	p50	p90	N
Penalty amount	54,168	304,803	0	18,703	123,737	11,251
Penalty amount (log)	10.4	1.19	8.87	10.4	12	8,124
Positive penalty amount (binary)	.72	.45	0	1	1	11,251
Penalty share of income	527	4,904	0	.06	4.14	10,258
Penalty share of income (winsorized)	.24	.36	0	.06	1	10,258

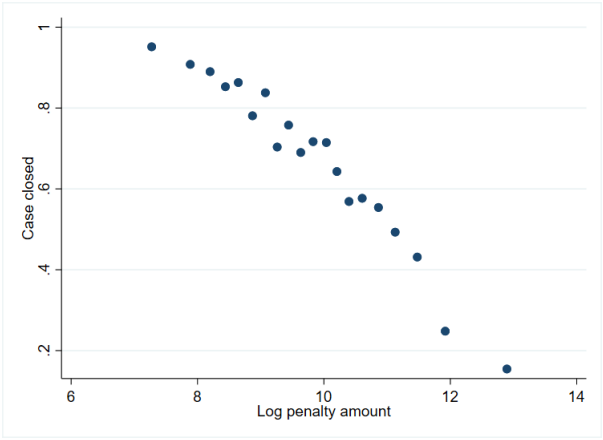
This table displays descriptive statistics on tax noncompliance penalties for the ordinary-rate regime (Panel (a)) and the elevated-rate regime (Panel (b)).

Table A.2: Summary statistics on appeals outcomes (ordinary penalties)

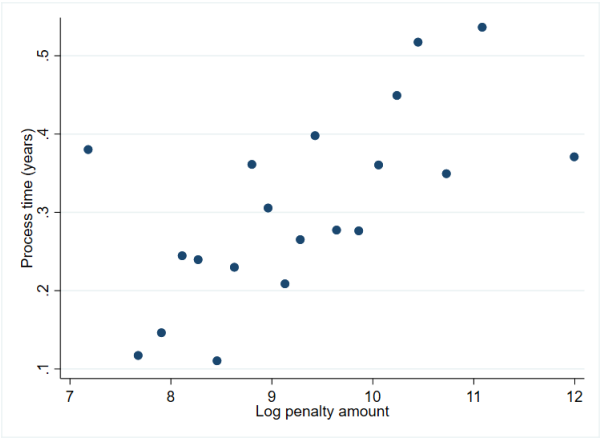
Variable	Mean	SD	N
All appeals			
Has a closing	.823	.382	1,596
Collected	.632	.483	1,596
Years to initial audit ruling	3.18	1.89	1,596
Conditional on closing			
Penalty is at least partially removed	.197	.398	1,596
Penalty is not removed	.764	.425	1,314
Process time (years)	.289	.769	1,314
Process time (log years)	-1.98	1.78	727
Share removed	.122	.316	1,579
Share removed (conditional on some forgiveness)	.613	.45	314

Note: This table displays descriptive statistics on appeals outcomes pertaining to ordinary-rate penalties, separately for all appeals between 2011 and 2021 and for those appeals for which a closing date is observed.

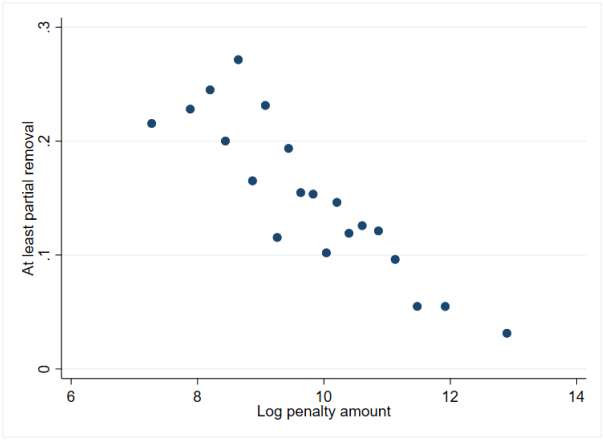
Figure A.2: Appeals outcomes versus log penalty size



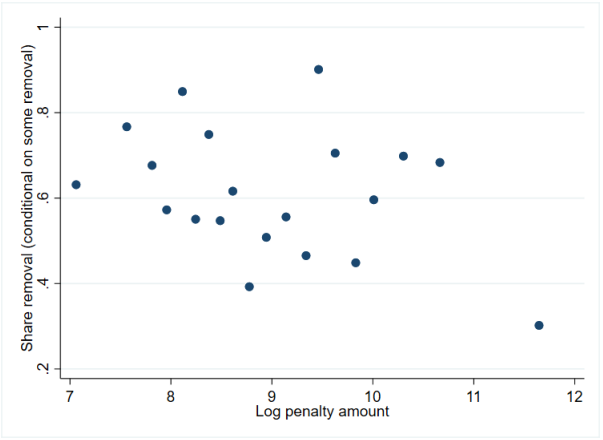
Panel (a): Case has closing



Panel (b): Final processing time (years)



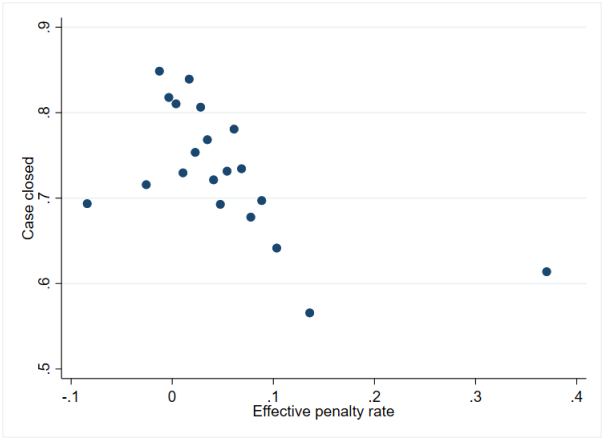
Panel (c): Has any penalty removal



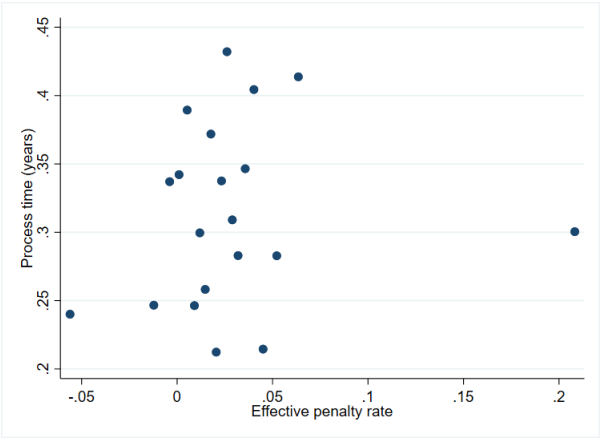
Panel (d): Share removed (conditionally positive)

Note: These figures show binned scatter plots of different indicators of appeals outcomes against the logarithm of penalty size. Panel (a) uses a binary variable equal to one if a case has an observed closing date, while Panel (b) draws on the final processing time of the appeal (measured in years). Panels (c) and (d) use a binary variable indicating whether any penalty has been removed and the removed share (conditional on being positive), respectively.

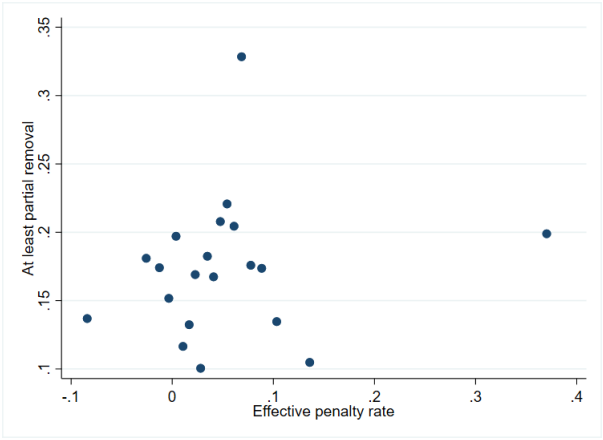
Figure A.3: Appeals outcomes versus penalty rate



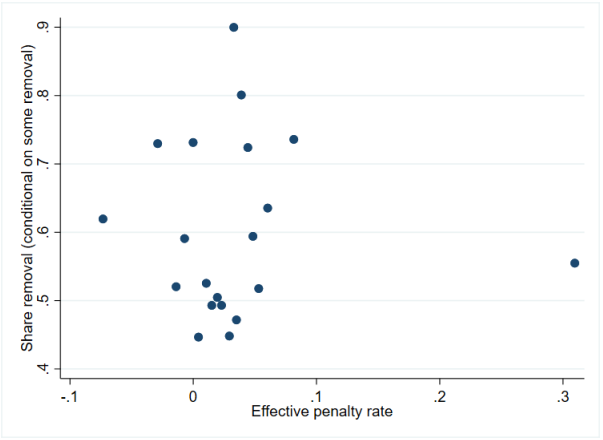
Panel (a): Case has closing



Panel (b): Final processing time (years)



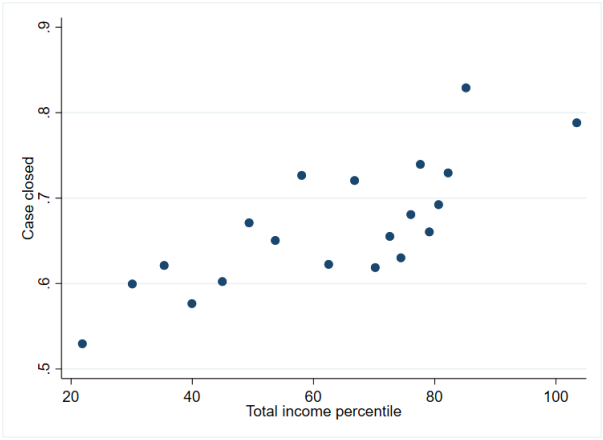
Panel (c): Has any penalty removal



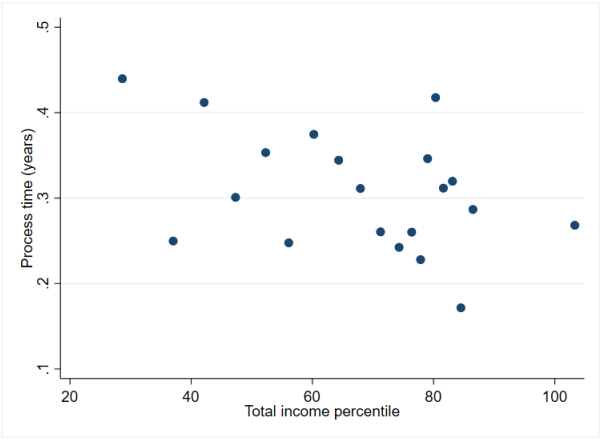
Panel (d): Share removed (conditionally positive)

Note: These figures show binned scatter plots of different indicators of appeals outcomes against the effective penalty rate. Panel (a) uses a binary variable equal to one if a case has an observed closing date, while Panel (b) draws on the final processing time of the appeal (measured in years). Panels (c) and (d) use a binary variable indicating whether any penalty has been removed and the removed share (conditional on being positive), respectively.

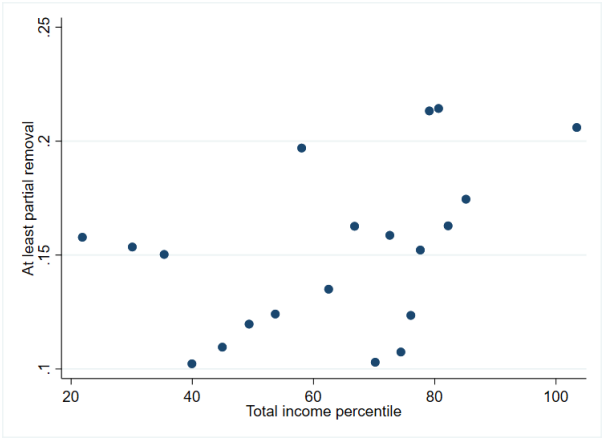
Figure A.4: Appeals outcomes versus taxpayer income rank



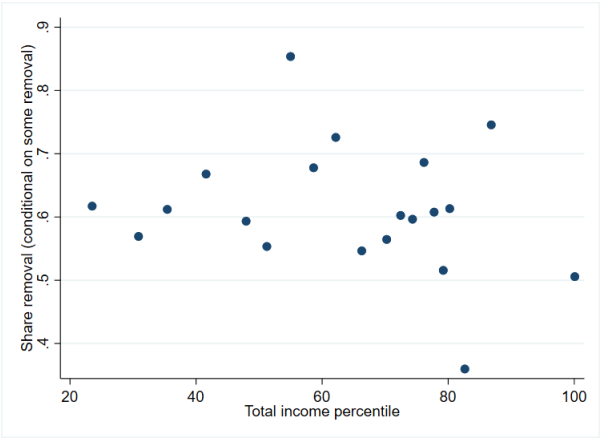
Panel (a): Case has closing



Panel (b): Final processing time (years)



Panel (c): Has any penalty removal



Panel (d): Share removed (conditionally positive)

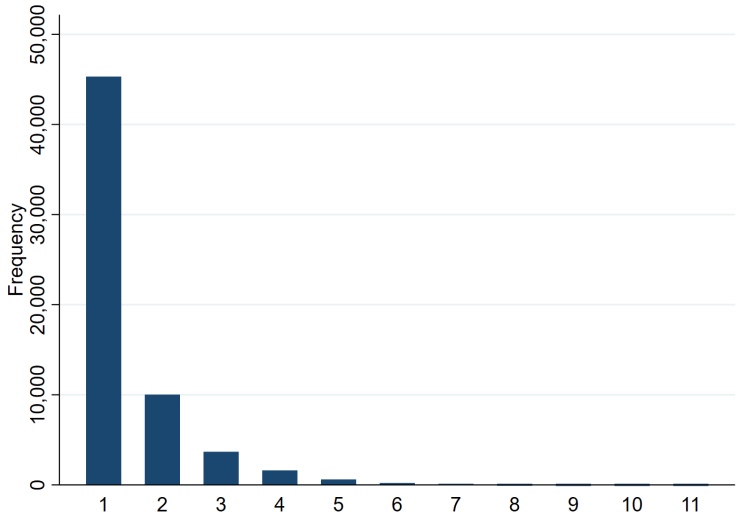
Note: These figures show binned scatter plots of different indicators of appeals outcomes along the income rank. Panel (a) uses a binary variable equal to one if a case has an observed closing date, while Panel (b) draws on the final processing time of the appeal (measured in years). Panels (c) and (d) use a binary variable indicating whether any penalty has been removed and the removed share (conditional on being positive), respectively.

Table A.3: Summary statistics on appeals outcomes (elevated penalties)

Variable	Mean	SD	N
All appeals			
Has a closing	.439	.497	610
Collected	.382	.486	610
Years to initial audit ruling	5.07	2.16	610
Conditional on closing			
Penalty is at least partially removed	.0721	.259	610
Penalty is not removed	.862	.346	268
Process time (years)	.456	1.07	268
Process time (log years)	-1.38	1.59	152
Share removed	.043	.193	602
Share removed (conditional on some forgiveness)	.588	.438	44

Note: This table displays descriptive statistics on appeals outcomes pertaining to elevated-rate penalties, separately for all appeals between 2011 and 2021 and for those appeals for which a closing date is observed.

Figure A.5: Number of penalties assigned per taxpayer (11 years)



Note: This figure shows the number of years in which an individual received any tax noncompliance penalty over the 2011-2021 period.

Appendix B Additional quasiexperimental results

Appendix C Income underreporting, audits, and penalties with two underreporting vehicles and legal expense reimbursement

Consider an identical setup to Section 2, except that for that in the case of litigation, the unsuccessful party pays the legal expenses of the successful party.

The taxpayer can either concede the alleged underpayment plus fee or engage in litigation at cost $\alpha + F$ with probability of success $r(\alpha, \beta; \theta, z)$. The taxpayer ultimately bases her litigation decision and effort (extensive and intensive margins) to maximize payoff:

$$\begin{cases} \textbf{No litigation: } -\Big(T(x+z)-T(x)+\phi(z;x)\Big) \ w.p.\ 1 \\ \\ \textbf{Litigation win: } -F, \ w.p.\ 1-r(\alpha^*,\beta;\theta,z) \\ \\ \textbf{Litigation loss: } -\Big(T(x+z)-T(x)+\phi(z;x)+F+\alpha+\beta\Big), \ w.p.\ r(\alpha^*,\beta;\theta,z) \end{cases}$$

Conditional on litigation, the taxpayer chooses litigation effort to maximize

$$-F - r(\alpha)(\Lambda+\alpha+\beta)$$

for the stakes of the negative outcomes (from the taxpayer's perspective) $\Lambda := T(x^*+z^*) - T(x^*) + \phi(z^*;x^*)$ and shorthand $r(\alpha) := r(\alpha,\beta;\theta,z)$ for the probability that the taxpayer loses (i.e. that the tax authority wins). Importantly, the taxpayer takes all other arguments in her litigation failure probability, including tax authorities' litigation efforts, as exogenous to her litigation effort. This setup yields a first-order condition for optimal litigation effort:

$$\begin{aligned} &\underbrace{\frac{\partial r(\alpha)}{\partial \alpha}(\Lambda+\alpha+\beta)+r(\alpha)}_{-f} = 0 \\ &\implies \underbrace{\varepsilon_{r,\alpha^*}}_{<0}\underbrace{(1+\frac{\Lambda+\beta}{\alpha^*})}_{>1} = -1. \end{aligned}$$

At the optimal level of litigation on the intensive margin, the product of the elasticity of taxpayer loss probability with respect to taxpayer litigation expenses and a second piece: one plus the ratio of the sum of alleged tax deficiency, penalty, and tax litigation expense to the taxpayer's litigation expense, equals negative one.

As a more direct expression of optimal litigation expense,

$$\alpha^* = \frac{-\varepsilon_{r,\alpha^*}}{1+\varepsilon_{r,\alpha^*}} \cdot (\Lambda+\beta), \tag{39}$$

with taxpayer optimal litigation expense increasing in the elasticity of taxpayer loss probability with respect to taxpayer litigation expenses (where $-1 < \varepsilon_{r,\alpha^*} < 0$ for an interior solution) as well as in alleged tax deficiency, penalty, and tax authority litigation expense. This result here implies that the taxpayer's optimal litigation expense is an affine transformation of the penalty schedule; however, this result also relies on the linearity of disposable income in the taxpayer's utility function.

The second-order condition for this interior solution to produce a maximum is:

$$\begin{aligned}\frac{\partial^2 r(\alpha)}{\partial \alpha^2}|_{\alpha^*} \cdot (\Lambda + \alpha^* + \beta) + 2\frac{\partial r(\alpha)}{\partial \alpha}|_{\alpha^*} > 0 \\ \implies \varepsilon_{\frac{\partial r}{\partial \alpha},\alpha^*} < \frac{-2\alpha^*}{\Lambda + \alpha^* + \beta}.\end{aligned}$$

This expression reveals that at an optimum the elasticity of the derivative of the litigation loss probability function (from the perspective of the taxpayer) is bounded below $\frac{-2\alpha^*}{\Lambda+\alpha^*+\beta}$.

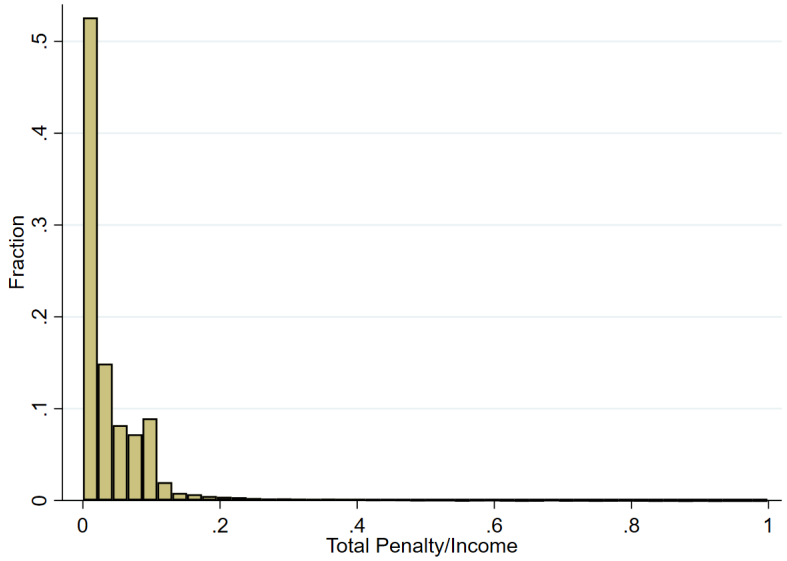
Applying the implicit function theorem to the first-order condition allows us to gauge the response of optimal litigation effort as the penalty varies (considering a perturbation of the linear component of the penalty rate):

$$\begin{aligned}\frac{\partial \alpha^*}{\partial \phi} &= -\frac{f_\phi}{f_\alpha} \\ &= \frac{-\frac{\partial r(\alpha^*)}{\partial \alpha^*}|_{\alpha^*}}{\frac{\partial^2 r(\alpha)}{\partial \alpha^2}|_{\alpha^*} \cdot (\Lambda + \alpha^* + \beta) + 2\frac{\partial r(\alpha)}{\partial \alpha}|_{\alpha^*}} > 0 \\ &= \frac{-1}{\varepsilon_{\frac{\partial r(\alpha^*)}{\partial \alpha},\alpha^*}(1 + \frac{\Lambda+\beta}{\alpha^*}) + 2} > 0.\end{aligned}$$

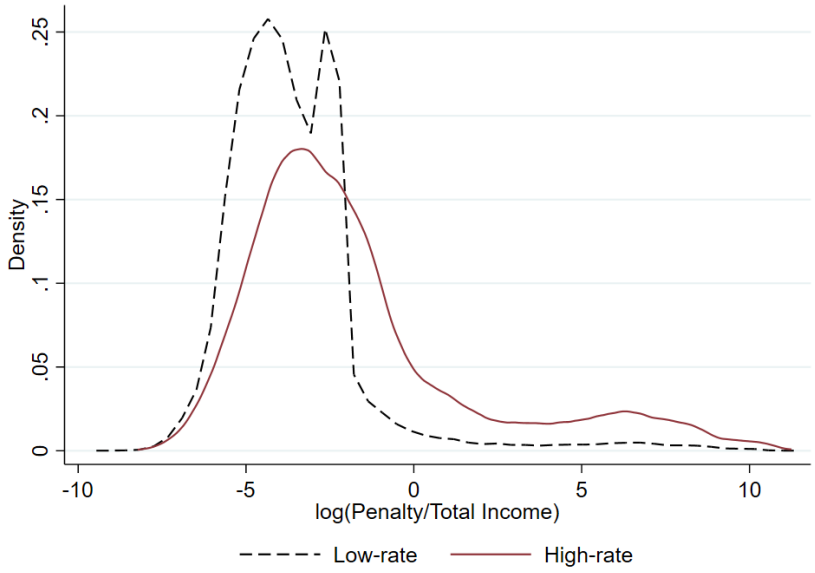
This comparative static generates an important piece of intuition: that optimal litigation effort/expenses is increasing in the penalty rate.

Figure A.6: Distribution of effective penalty rates

(a) Any penalty (< 100%)

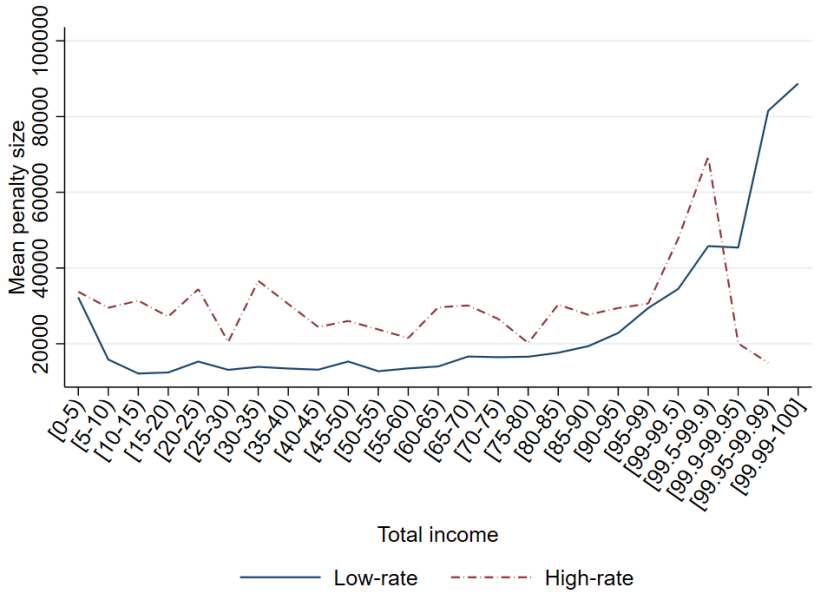


(b) Log penalty rate, by ordinary/elevated statutory rate



Note: These figures plot the distribution of observed empirical penalty rates from 2011 to 2015. Effective penalty rate is defined as income tax penalty amount divided by gross income and differs from statutory penalty defined as penalty amount divided by underreported base. Panel (a) plots all penalty rates observed less than one; Panel (b) plots the logarithm of the observed effective penalty rate without restriction of the value, distinguishing between the ordinary and elevated penalty rate regimes.

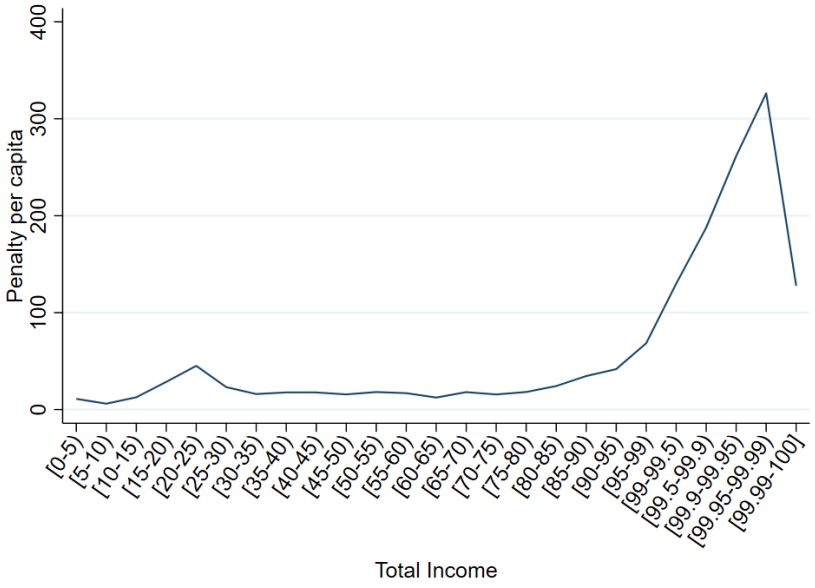
Figure A.7: Conditional distribution of penalty size



Note: This figure shows the distribution of penalty size along income rank conditional on non-zero penalty recipiency.

Figure A.8: Penalties raised

(a) Per capita



(b) Total



Note: These figures plot the distribution of penalties raised in terms of NOK 2015. Panel (a) plots all penalty rates observed less than one; Panel (b) plots the logarithm of the observed penalty rate without restriction of the value, distinguishing between the ordinary and elevated penalty rate regimes.