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Dynamic effects of tax audits and the role of intentions☆

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ABSTRACT

Using a random audit program covering more than 17,000 tax returns, I study how tax audits affect the subsequent compliance behavior of self-employed with varying intentions to comply. Leveraging novel information provided by auditors on taxpayers' perceived willingness to comply, I find that unintentional non-compliers, driven by inattention or misunderstandings of the tax rules, exhibit higher compliance in subsequent years. This results in a revenue increase equivalent to 340% of the tax uncovered from the audit after 5 years. In contrast, intentional non-compliers who deliberately evade taxes and are typically targeted for operational audits do not respond to audits and have a low recovery rate for evaded taxes. Based on these findings, I illustrate how risk scores derived from pre-audit information can be used to target taxpayers expected to respond strongly to audits, leading to increased revenue gains of 87% compared to an approach that focuses on initial revenue from audits. Finally, I propose targeted and personalized guidance as a cheaper alternative to mitigate unintentional misreporting compared to expensive audits.

1. Introduction

In recent years, an emerging body of research has shown that tax audits can increase future taxpayer compliance and reduce evasion beyond the recovery of unpaid taxes (Kleven et al., 2011; DeBacker et al., 2018; Advani et al., 2023). While the results suggest that audits are effective in strengthening tax systems, even over the long run, little is known about how the behavioral responses vary across taxpayers and the factors influencing these variations. Understanding if and why taxpayers respond differently is important for at least two reasons. First, it can raise government revenue by enabling tax authorities to consider expected future compliance in audit selection, leading to a more efficient allocation of resources (Slemrod and Keen, 2017). Second, uncovering the determinants of non-compliance can help adopt new, cost-effective measures to reduce evasion beyond expensive audits (Alm, 2019).

In this paper, I provide new empirical evidence on how subsequent compliance responses to tax audits vary based on intentions to comply and underscore the importance of inattention and misunderstandings in complex tax regulations as determinants of non-compliance (Alm et al., 2010). This is done using waves of randomized audits by the Danish Tax Agency and leveraging novel information provided by compliance officers on taxpayers' perceived willingness to comply with tax rules. A primary difficulty in identifying the causal impact of audits on subsequent compliance behavior by taxpayers is that audits are often directed towards those who are perceived as non-compliant, resulting in selection bias (OECD, 2016). By focusing on random audits, I ensure that the audit selection process is exogenous, alleviating such concerns. To uncover the long-run effects of audits, I combine data on tax returns for the population of taxpayers in Denmark with data on more than 17,000 random audits of self-employed individuals collected in waves from 2006 to 2017. Concentrating on self-employed individuals is attractive, since they, like their peers in other advanced economies such as the United States and the United Kingdom, face limited third-party reporting and tax withholding, leading to higher rates of under-reporting (Advani, 2022; Kleven et al., 2011).

As a baseline, I follow the approach of Advani et al. (2023) and find that audits, on average, raise subsequent tax revenues, but the effect disappears after 3 years, leading to an increase of roughly 54% in total revenue gained due to changes in reporting behavior. Breaking down the impact by income sources shows that the tax increase is solely driven by higher reported profits from self-employment, which

indicates that audits have a stronger effect on reported income when there is less third-party reporting (Kleven et al., 2011; DeBacker et al., 2018).

Moving beyond the average effect of audits, I use novel information filed by the compliance officers indicating the severity of non-compliance (i.e., compliance ratings) to divide taxpayers into unintentional and intentional non-compliers based on taxpayers' perceived willingness to comply with tax rules. This division of taxpayers is motivated by the likely differences in audit responses. Audits may benefit unintentional non-compliers who under-report due to a lack of knowledge or confusion about tax rules by serving as a comprehensive guide for future compliance. In contrast, intentional non-compliers may respond differently depending on how their perceived risk of detection is affected by the audit process, which is influenced by factors such as the taxpayer's ability to evade and the auditor's knowledge and expertise, resulting in a less clear-cut outcome. Furthermore, as emphasized by Slemrod (2019), a limitation of existing studies using randomly selected audits to identify compliance responses is their potential inability to capture the behavior of taxpayers typically targeted for operational audits. Since the Danish Tax Authorities target intentional non-compliers for operational audits, this comparison effectively contrasts the responses of taxpayers typically subject to operational audits with those exhibiting higher compliance levels, offering valuable insights into the external validity of randomly selected audits.

To identify the compliance responses in both groups despite the endogenous assignment of compliance ratings, I use the difference-in-differences approach developed by Callaway and Sant'Anna (2020) and exploit the random timing of audits by comparing audited taxpayers and not-yet-audited taxpayers who ultimately have the same outcome. The results show that the long-run impacts of audits are driven entirely by unintentional non-compliers who under-report due to inattention and confusion of tax rules. Specifically, unintentional non-compliers exhibit compliance responses to audits leading to a significant increase in revenues, which after 5 years amounts to 340% of the tax uncovered from the audit. In contrast, there is no evidence of long-run responses to audits among taxpayers rated as intentional non-compliers who purposely evade taxes.[1] In fact, the increase in tax revenues among intentional non-compliers in the audit year corresponds only to 38% of the audit adjustment, suggesting a low recovery rate of evaded taxes. This confirms that the behavioral responses of those typically targeted for operational audits significantly differ from their more compliant peers, as pointed out by Slemrod (2019).

While existing work points to the importance of compliance responses (e.g. Kleven et al., 2011; DeBacker et al., 2018; Advani et al., 2023), my analysis goes further by revealing how audits promote sustained compliance only among taxpayers who unintentionally under-report. Although sustained compliance among this group may seem trivial in retrospect, they have been overlooked in research until now, despite representing 81% of self-employed individuals who under-report and comprising 49% of the tax gap in Denmark. According to the tax authorities, these individuals are willing to comply with tax regulations but fail to do so due to inattention or misunderstanding of complex tax rules. Interestingly, there is no clear dissimilarity in the income composition between unintentional and intentional non-compliant taxpayers, suggesting that differences in income types are not the driving factor of the distinct compliance responses across the groups (Advani et al., 2023). This finding is further corroborated by the consistent results obtained after reweighting taxpayers according to an array of sociodemographic and financial attributes, ensuring that the distribution of observed characteristics is the same between intentional and unintentional non-compliers.

Instead, and similar to the findings of Chetty et al. (2009), who observed that consumers tend to underreact to sales taxes that are not salient, these results can be explained by the fact that taxpayers who unintentionally under-report their income tend to overlook reporting taxes that are not immediately clear or well understood. However, once they are made aware of them through audits, their behavior adjusts accordingly. This finding reveals that audits can serve as personalized guidance to help the majority of under-reporting taxpayers accurately report their income in the future, which extends beyond the typical focus of audits solely as a deterrent measure (Allingham and Sandmo, 1972; Kleven et al., 2011; Advani et al., 2023; DeBacker et al., 2018), and shows the importance of inattention and misunderstandings of complex tax regulations as a determinant of non-compliance (Alm et al., 2010). A similar idea is explored in Nathan et al. (2020), where providing taxpayers with tailored informational letters about property tax appeals leads to a substantial increase in appeal rates, highlighting the impact of factors such as information complexity, salience, or confusion on taxpayer behavior.[2] On the contrary, the taxpayers who are least compliant and intentionally under-report do not respond at all, suggesting that those who are typically subject to operational audits are defiant and committed to rejecting their tax responsibilities.[3,4]

When examining the variation in the overall impact of audits in relation to the amount uncovered during the audits, it reveals a proportional relation of approximately 300% for unintentional non-compliers and 40% for intentional non-compliers. This result suggests that within each group, the tax uncovered from audits is a sufficient statistic for the total revenue-raising effect. Even though intentional non-compliers comprise the group with the largest audit corrections, the highest total revenue is generated by auditing unintentional non-compliers. Specifically, audits of unintentional non-compliers with the largest tax corrections (i.e., top 20%) yield the highest total revenue. This results in a cumulative increase in revenue of roughly 170,000 DKK or close to 280% of the initial tax uncovered. If the objective of the audit strategy is to generate revenue, a direct policy implication of these results is to boost revenues by targeting audits towards taxpayers who exhibit strong compliance responses. Using pre-audit information from tax returns, I demonstrate this by comparing an existing approach that uses risk scores to target the least compliant taxpayers for audits with a new approach that targets unintentional non-compliers. When comparing the two approaches on a hold-out sample, the new approach results in a substantial increase in revenue of 87%, when long-run effects are accounted for.

An unappealing consequence of the revenue-focused strategy is the need for tax authorities to redistribute audit resources from the least compliant taxpayers to more compliant ones, which may be perceived as unfair by the public and adversely affect general compliance (Murphy, 2004). Furthermore, although revenue is a primary concern for tax authorities, they often operate under a principle of proportionality, which states that more intrusive measures should not be employed if less intrusive measures are sufficient. Since the guidance provided by audits appears to be the driving factor of the long-run responses among unintentional non-compliers, targeted and personalized approaches to improve accurate tax filing, such as sending letters or emails to taxpayers addressing common misconceptions found during audits, can potentially serve as a more direct alternative to traditional audits. Such

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[1] A similar pattern is observed in the laboratory experiment by Kasper and Alm (2022), where it is found that relatively more compliant individuals respond more strongly to audits.

[2] In a different setting, van Dijk et al. (2020) show that accurately pre-filled tax returns boost compliance. This underscores the effectiveness of clear and personalized instructions for correct tax filing in improving overall compliance rates.

[3] These taxpayers make up 9.4% of all self-employed and 0.7% of all taxpayers in Denmark.

[4] Appendix H presents an economic framework that extends the work of Allingham and Sandmo (1972) by incorporating varying attitudes toward compliance and inattention to tax regulations, allowing for the study of audit response dynamics.

efforts are not only likely to be more viable but also offer a more cost-effective substitute for full-scale audits, making them an interesting avenue for future research.[5]

My paper contributes primarily to two literatures. First, it contributes to the large literature that aims to understand the determinants of taxpayer compliance. Previous work has extensively examined various factors that impact compliance, including information about the enforcement environment (e.g. Slemrod et al., 2001; Blumenthal et al., 2001; Bergolo et al., 2023; Holz et al., 2023), financial and non-financial penalties (e.g. Friedland et al., 1978; Alm et al., 1992; Fortin et al., 2007; Bø et al., 2015), the information available to tax authorities (e.g. Pomeranz, 2015; Carrillo et al., 2017; Kleven et al., 2011), and many more (see Alm, 2019, for a survey). However, as Alm (2019) highlights, aside from limited evidence from laboratory experiments that suggests more complicated tax rules have negative effects on compliance (e.g. Alm et al., 2010), little is known about how taxpayers' understanding – or lack thereof – of tax regulations influences compliance. My paper sheds light on this by showing the importance of inattention and misunderstandings of complex tax regulations as a key driver of non-compliance, which highlights the usefulness of tailored guidance as a remedy to reduce misreporting.

Second, I extend the strand of work that uses random audit data to study the long-run effects of tax audits. This strand was pioneered by Kleven et al. (2011), who conducted a large-scale field experiment in Denmark and showed that taxpayers increased their reported liability by 40% of the missing tax uncovered from the audit one year later. More recently, DeBacker et al. (2018) and Advani et al. (2023) discovered that tax audits generate long-run revenue gains by altering tax reporting behavior, with the effect varying depending on income source stability. In a related paper, Boning et al. (2023) find that tax audits lead to a sustained increase in future tax payments resulting in additional taxes that are 3.2 times higher than the tax initially uncovered. Building upon this work, my paper provides novel insights into compliance responses by taxpayers, revealing significant heterogeneity in their behaviors based on their intentions to comply. Specifically, I find that taxpayers typically targeted for operational audits exhibit distinct behavioral responses compared to the majority of under-reporting taxpayers, highlighting a constraint in extrapolating the average effects of randomly selected audits (Slemrod, 2019). Additionally, I show how incorporating compliance responses into audit selection strategies raises revenue compared to existing tax audit strategies that focus on the immediate effect prevalent in developed countries (OECD, 2016; World Bank, 2011).

2. Institutional context and data

2.1. The danish tax compliance analysis

The data on random audits were collected through the Compliance Analysis program administered by the Danish Tax Agency. As part of the program, the Danish Tax Agency conducts (stratified) random audits of self-employed taxpayers to collect information on compliance levels in Denmark, along with predictors of non-compliance that can be used to improve operational audits. The Compliance Analysis program was launched in 2006, in partnership with Kleven et al. (2011), and has

been conducted roughly every other year since then, albeit on a smaller scale. Internal reports by the Danish Tax Agency confirm that the audit process in the Compliance Analysis has remained consistent throughout the period under consideration, alleviating concerns of intertemporal instability in the process.

The Compliance Analysis for year t begins in the summer of year $t + 1$ after tax filings have been completed. Self-employed individuals must submit a tax assessment that covers both personal and business accounts, which becomes available in March in year $t + 1$. Income earned in year t must be filed no later than 1 July in year $t + 1$, and tax returns for year t are generated soon after. The Tax Agency then selects a (stratified) random subset of self-employed individuals for audits, as well as a smaller replacement sample to account for unforeseen events that prevent an audit from taking place (e.g., emigration, death, bankruptcy, etc.).[6] Importantly, random audits and replacement samples (hereafter compliance audits) are selected before operational audits, and individuals selected cannot be subjected to an operational audit within the same tax year. However, there are no restrictions on individuals being subjected to operational (or random audits) in previous or subsequent years.[7]

The audits are wide in scope and cover both personal and business accounts (except for excise duties, custom duties, and transfer pricing).[8] To facilitate this, an initial screening is conducted, where documentation for both personal and business accounts is requested. The screening is followed by further inspection if irregularities are found, which may include caseworkers visiting the business (i.e., field audits). To ensure high quality and consistency in audits, the Danish Tax Agency operates under the four-eyes principle, necessitating the involvement of at least two compliance officers for each audit. An audit may lead to an adjustment of the final tax return and a tax correction. In case of under-reporting, tax liabilities are increased accordingly, and a fine may be imposed if the under-reporting is seen as deliberate evasion. Notably, taxpayers who are found to have under-reported can defer the payment by utilizing tax regulations to offset some or all of the extra taxes uncovered during the audit, at the expense of higher taxes in subsequent years.[9]

2.2. Tax evasion among self-employed

I have access to data from the Compliance Analysis program for the tax years 2006, 2008, 2010, 2012, 2014, and 2017, consisting of a total of 17,444 completed audits of self-employed individuals. The compliance audit only focuses on the tax year being reviewed, and past tax returns are not examined. After each audit, the Danish Tax Agency records the tax correction, which measures the total tax uncovered during the audit. This is calculated by adding up the tax value of all errors found on the tax return, taking into account any impact from errors that spill over to other parts of the tax return. In addition, each

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[5] Opting for guidance, rather than audits, to enhance compliance among unintentional non-compliers, may entail different responses because guidance may not be as salient as audits or may lack the seriousness or potential penalties associated with an audit. Appendix F provides a separate analysis of the effects of guidance on compliance based on the introduction of the S15 scheme in 2013, which provided small businesses with pre-filled tax returns to simplify their tax filings. Comparing the audit outcomes of taxpayers enrolled in the S15 scheme with the outcomes of taxpayers who would have been enrolled in the S15 scheme if it had existed earlier implies that guidance positively impacts compliance levels.

[6] Self-employed individuals are defined as those declaring business-related earnings or losses *and* having fewer than 250 employees. While the cutoff is set at 250 employees, most self-employed individuals (84.3%) operate one-person companies, and 99% of self-employed individuals have fewer than 20 employees. Figure A2 in Appendix A breaks down pre-audit earnings for self-employed subjects to random audits. More details about the definition of self-employed can be found in Appendix B.

[7] Operational audits are a potential source of confounding when estimating the long-run effects of audits. However, the low incidence of targeted audits suggests that they should have negligible effects on the overall estimates. Specifically, targeted audits comprise only 0.5% to 1.5% of all self-employed individuals per year, as shown by Figure A1 in Appendix A.

[8] If the business is registered to pay VAT, the audit includes an examination of the VAT returns. However, VAT returns are not considered in this paper due to data limitations.

[9] Detailed examples of the two most common methods to defer the missing tax uncovered can be found in Appendix D.

taxpayer's compliance is evaluated on a scale of 0 to 6. The ratings are used to monitor attitudes towards compliance in Denmark and are employed as a measure to prioritize operational audits. A rating of 0 indicates the most serious instances of non-compliance, while a score of 6 signifies full adherence to tax regulations. Specifically, ratings 0, 1, and 2 pertain to taxpayers who lack the will to comply (i.e., intentional non-compliers), while ratings 3 and 4 pertain to taxpayers who misreport due to a lack of knowledge or misunderstandings of the rules, considered unintentional non-compliers. During the evaluation period, the compliance officer follows a set of yes-or-no questions to assess the taxpayer, ensuring consistent ratings over time and among different compliance officers. Additionally, as an additional measure to promote uniformity, every tax center appoints a dedicated individual who consistently reviews all cases and provides continuous feedback to the compliance officers.[10] When compliance officers determine whether tax errors result from intentional actions or unintentional misunderstandings, they focus on taxpayers' understanding of income tax rules and deductions. They check if errors persist despite awareness, relying on their correspondence with the taxpayers during the audit, the type and systematic nature of errors, and records from previous interactions (e.g., past audits) to make judgments.[11]

Table 1 provides summary statistics of the level of non-compliance among self-employed based on this data. All statistics are calculated using population weights to reflect averages in the full population of self-employed. Throughout the paper, monetary variables are deflated to 2015-DKK using the Consumer Prices Index (CPI). Table 1 reveals that 52% of self-employed taxpayers tend to under-report their tax liabilities, while 41% report accurately, and only 7% report an excess amount of taxes. Notably, self-employed taxpayers in Denmark, as well as their counterparts in advanced economies such as the United States and the United Kingdom, encounter limited third-party reporting and tax withholding. Coupled with the fact that self-employed taxpayers are often faced with more complex tax rules, high rates of non-compliance are to be expected. Similar rates of non-compliance are found among self-assessed taxpayers (which includes self-employed) in the UK (Advani et al., 2023). The median compliance rating of 3 suggests that despite the tendency of many self-employed individuals to under-report their taxes, most self-employed are categorized as unintentionally non-compliant. This is further supported by Fig. 1, which displays that the majority of self-employed taxpayers receive a compliance rating of either 3 or 4. This indicates that the high levels of non-compliance are not driven by an inclination to evade taxes but instead are due to a lack of understanding or misconceptions about the tax regulations. With this in mind, the low share of over-reporters indicates that even unintentional misreporters tend to disproportionately make mistakes that favor their financial interests. However, the net value of the tax uncovered from audits conceals errors that increase taxpayers' tax liability. Because these increases in tax payments are smaller than errors in other factors decreasing tax payments, the net tax uncovered from audits is positive. Table A1 in Appendix A shows that 50.6% of unintentional non-compliers make errors that lead to overpayments of their tax liabilities, and that for every dollar of under-reported taxes,

Table 1
Tax evasion among self-employed.

| Share of returns with	Mean	Std. dev,
Under reporting	0.52	0.50
Accurate reporting	0.41	0.50
Over reporting	0.07	0.25
Additional tax (1000's DKK)	**Mean**	**Std. dev.**
All filers	14.77	96.76
Under reporters	29.42	131.71
Distribution of additional tax if under reporting	**Mean**	**Std. dev.**
Share 1–1000 DKK	0.06	0.24
Share 1001–10,000 DKK	0.49	0.50
Share 10,001–100,000 DKK	0.39	0.49
Share 100,001+ DKK	0.06	0.23
Compliance rating	**Mean**	**Std. dev.**
All filers	3.95	1.40
Under reporters	3.03	0.79
Compliance rating	**Median**	**MAD**
All filers	3.00	0.06
Under reporters	3.00	0.01
Observations		17,444

Notes: The table presents statistics that measure the degree of non-compliance among self-employed individuals subject to a random audit. Observations are weighted using population weights for the year of the audit. "Std. dev." refers to the standard deviation, while "MAD" refers to the mean absolute deviation. All monetary quantities are measured in DKK (deflated to 2015-DKK).

they over-report 68 cents (more than twice as much as intentional non-compliers). The asymmetry in the tax value of errors leading to over- and under-payment of taxes is due to the tax regulations. As an example, operating equipment that costs less than 32,000 DKK (as of 2023; the threshold changes every year) is valid for a write-off, while operating equipment that costs more than 32,000 DKK is eligible for deduction at a maximum rate of 25% each year. If someone is in doubt about whether a piece of equipment is valid for deductions and how to deduct it, they may end up writing off the full amount of expensive operating equipment, thereby using the deductions too soon and under-reporting taxes by an amount equal to 75% of the value in that tax year. In contrast, not deducting anything only leads to an over-payment of taxes corresponding to 25% of the value. Hence, even if they flipped a coin when in doubt, it would lead to disproportionately more under-reporting.[12]

Looking at the intensive margin, the average amount under-reported is 14,770 DKK, which, when aggregated to the population of self-employed individuals, corresponds to a yearly tax gap of 5.6 billion DKK or 9% of the total tax liabilities for self-employed taxpayers. With an average cost of randomly selected audits of self-employed taxpayers of 16,000 DKK,[13] they lead to a revenue deficit of 1230 DKK per random audit when only considering the direct effect. This highlights the costly nature of audits and the necessity to allocate resources efficiently or adopt new and more cost-effective measures. The large variation in the under-reported amounts shown in Table 1 suggests a potential for targeting audits towards taxpayers where the expected audit adjustment is greatest. In particular, the mean additional taxes owed by those found to under-report amount to 29,420 DKK. Furthermore, the distribution of under-reporting is heavily skewed. In over half of the cases involving under-reporting, the tax uncovered from the audit is less than 10,000 DKK, whereas approximately 6% under-report more than 100,000 DKK. Focusing solely on the missing tax uncovered from audits is, however, likely to understate the total revenue-raising effect of audits if taxpayers show increased compliance in subsequent years. As will be evident in

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[10] All cases are reviewed, and if there are errors in the ratings during the review, they are corrected. These corrections take place before the case is finalized, ensuring that the reported ratings undergo a quality assurance process before being definitively reported. Data on the number of cases that the dedicated individual overturns is not available. However, one of the dedicated individuals stated that she considers the ratings stable across caseworkers, and the number of cases she overturns in a year is limited to 3–5 cases a year, out of a typical load of 90–100, implying high consistency in ratings across auditors.

[11] The ratings were inspired by the ATO compliance model (Braithwaite and Braithwaite, 2000). A detailed description of the compliance ratings is available in Appendix C, including examples of intentional and unintentional non-compliers. Only compliance audits are rated, not operational audits.

[12] Bergolo et al. (2021) also examine differences in errors that lead to downward and upward adjustments of income as a means to determine if under-reporting is deliberate evasion or if it is due to asymmetries in mistakes and tax regulations.

[13] The cost has been deflated to 2015-DKK using the Consumer Price Index (CPI) (The Economic Council, 2011).
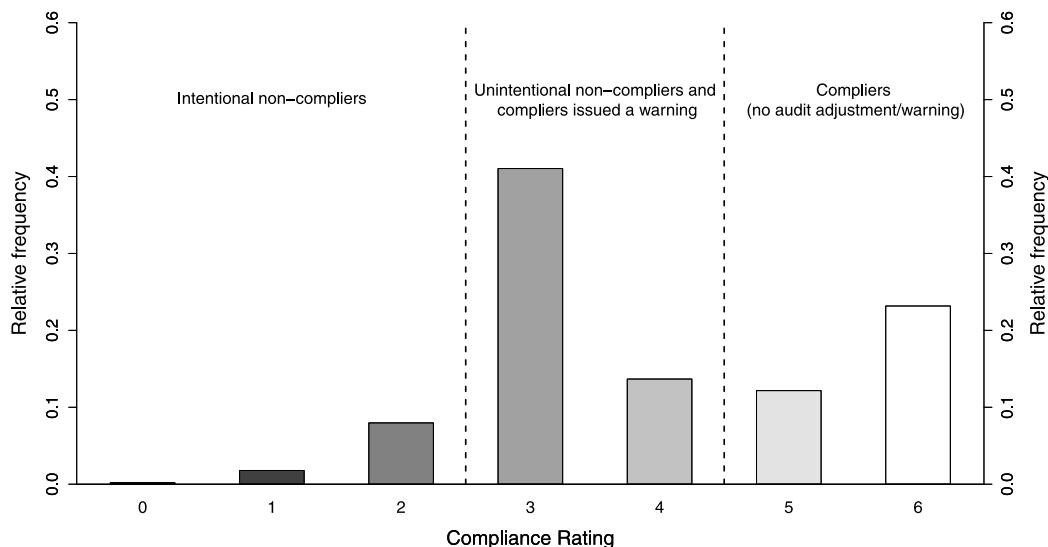
Fig. 1. Compliance ratings. Notes: The figure presents relative population frequencies of compliance ratings based on the outcomes of 17,444 compliance audits. Ratings 5 and 6 refer to taxpayers who are willing and capable of reporting correctly (no adjustment or injunction). Ratings 3 and 4 pertain to taxpayers who have misreported due to a lack of knowledge or misunderstandings of the rules and are considered unintentional (i.e., unintentional non-compliers). Ratings 0, 1, and 2 refer to intentional non-compliers who are unwilling to report correctly, resulting in one or more serious mistakes that trigger an audit adjustment, and in some cases, a criminal investigation. See Appendix C for more details.

the next sections where I turn to estimating the long-run effects of tax audits, this is true for unintentional non-compliers.

3. Estimating compliance responses to tax audits

To estimate the long-run impacts of tax audits, I combine the random audit data on self-employed individuals from the Compliance Analysis with data on tax returns from 2004 to 2020 obtained from the Danish Tax Agency, thereby generating a panel of individual taxpayers over time. Notably, all audits are initiated before tax filings are due the following year, and 89% are completed at this point. If the outcome of a tax audit is the driver of the behavioral response, this effect should be almost entirely visible in the data for the tax year immediately following the audit. Additionally, if the correspondence with the tax authority induces increased compliance, this effect should be fully detectable at this point. Thus, when estimating the behavioral effects of tax audits, I use the number of years since the tax year of the audited return as my timing convention. Importantly, I have access to tax returns for the entire population of taxpayers in Denmark. If some individuals cease being self-employed, they will still be present in the data as long as they are required to pay taxes (such as wage earners, unemployment benefit recipients, pensioners, students receiving study grants, etc.). Consequently, survivorship bias is only an issue to the extent that taxpayers lose tax liability in Denmark, either due to their passing away or because they permanently leave the country.[14]

To estimate the compliance responses to tax audits, I utilize the difference-in-differences approach developed by Callaway and Sant'Anna (2020). After accounting for stratification, there are no systematic factors that led individuals to be selected for audit in one year over another, and the random timing of audits can be utilized by comparing audited taxpayers and not-yet-audited taxpayers. The method developed by Callaway and Sant'Anna (2020) is well-suited for this purpose as it can handle heterogeneous treatment effects, which is a problem for traditional difference-in-differences

estimators in staggered rollout settings, as highlighted by multiple studies (Borusyak et al., 2021; de Chaisemartin and D'Haultfœuille, 2020; Goodman-Bacon, 2021; Callaway and Sant'Anna, 2020; Sun and Abraham, 2021; Wooldridge, 2021). This approach also allows for a credible estimation of how compliance responses differ across audit outcomes by comparing the changes in taxes for individuals who were audited and found to have a specific outcome (such as under-reporting) with the changes in taxes for individuals who will be audited and found to have the same outcome in the future. This accounts for the fact that audit outcomes are non-random and related to an array of observed and unobserved confounding factors such as sex, industry, region, attitude towards risk, honesty and fairness, ability to evade, etc.[15] (Slemrod, 2019; Advani, 2022).

For the estimated effects to reflect the true effects of audits, it is necessary that the change in taxes over time that the audited group would have experienced if they had not been audited is the same as the change in taxes that the not-yet-audited group actually experienced (i.e., the parallel trends assumption). To account for the tendency that those not yet audited by time t are younger as well as less likely to be self-employed[16] than the audited by time t, I include age, business age, and a dummy variable indicating whether the taxpayer was defined as self-employed or not as covariates and rely on a conditional parallel trends assumption.[17] Then, for each group (i.e., each wave of the Compliance Analysis), I calculate the group-time average effects of audits:

$$ATT(g,t) = \mathbb{E}\left[\frac{G_g}{\mathbb{E}[G_g]}(Y_t - Y_{g-1} - m_{g,t}(X))\right] \qquad (1)$$

Where G_g is a binary variable equal to one if an individual is audited in period g, t is calendar time, and $m_{g,t}(X) = \mathbb{E}[Y_t - Y_{g-1}|X, A_t = 0, G_g = 0]$ is an outcome regression for the not-yet-audited by time

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[14] To fully lose tax liability in Denmark, the taxpayer must not own a home (e.g., house, summer house, or apartment) in Denmark nor receive any Danish income. Of the individuals selected for compliance audits, 97.0% remain observable in the data 5 years after the audit, indicating that this is rare.

[15] Internal reports from the Danish Tax Agency on Compliance Analysis confirm that the audit process remained unchanged throughout the study period, alleviating concerns about potential changes in detection rates and compliance ratings that could have influenced the types of taxpayers found to be non-compliant or rated as intentionally non-compliant.

[16] See Figure A3 in Appendix A.

[17] The variables are recorded prior to the audit. Figure A6 in Appendix A shows that the results are robust to the exclusion of control variables.
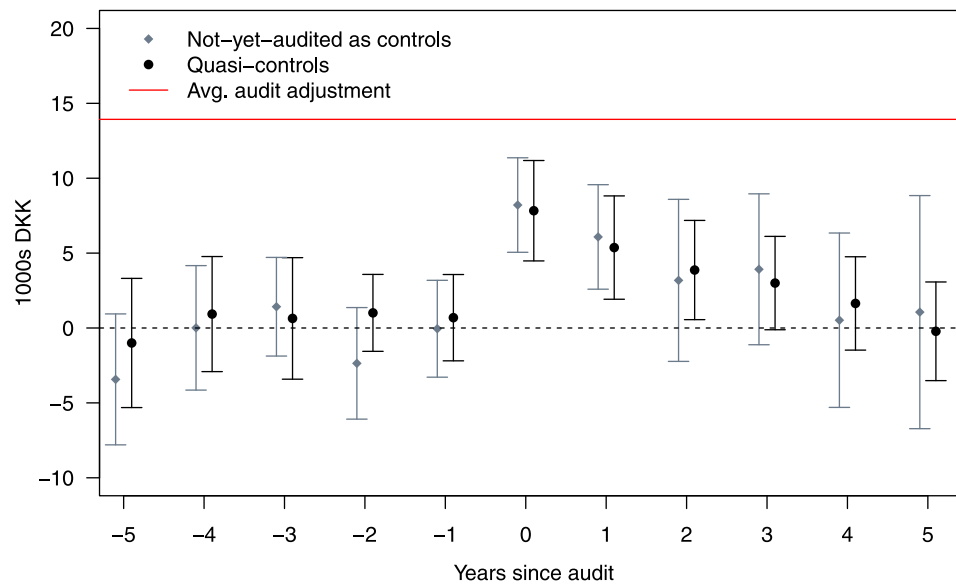
Fig. 2. Average effects of audits on total tax. Notes: The figure reports the effects of audits on total taxes measured in 1000's DKK (deflated to 2015-DKK). Quasi-controls refers to estimates of the overall effects of audits using the approach described in Appendix I (2,168,527 observations in total). The regression includes tax-year dummies, and controls for variables used for stratification i.e. tax center dummies, regional dummies, a dummy indicating whether the business has employees or not, and dummy indicating whether or not the self-employed files under the S15 scheme (all recorded prior to the audit). Not-yet-audited as controls refers to estimates of the average effects of audits using the approach described in Section 3 which only used self-employed who were subject to an audit (206,999 observations in total). Here observations are weighted using population weights for the year of the audit and age, business age, and a dummy indicating self-employment status recorded prior to audit are included as controls. The diamonds and dots represent point estimates, and the vertical lines represent 95% confidence intervals based on standard errors clustered by taxpayer. The red line measures the average audit adjustment.

t group, where A_t denotes audit status, and X includes age, business age, and a dummy indicating self-employment status.[18] The group-time average effect represents the average effect of audits on taxpayers in group g at time t and corresponds to a simple difference-in-differences with two groups and two periods. To account for stratification, I use population weights computed by the Danish Tax Agency when estimating (1), which ensures the treatment effects reflect averages in the full population of self-employed. The group-time effects are then aggregated to estimate the overall dynamic effects of audits:

$$\theta(e) = \sum_{g \in \{'06,'08,'10,'12,'14,'17\}} \mathbb{1}\{g + e \leq T\} \mathbb{P}(G = g | G + e \leq T) ATT(g, g + e)$$

(2)

Where $e = t - g$ denotes years since the audit, G is the period when an individual is audited, and T is the latest year considered. Since all individuals in the sample are audited eventually, I cannot identify effects beyond 2016, and all subsequent years are trimmed. The parameter $\theta(e)$ captures the average effect on total taxes owed e years since the audit among those actually audited. For inference, a cluster-robust bootstrap procedure is utilized with clustering at the taxpayer level.[19] As in DeBacker et al. (2018) and Advani et al. (2023), I trim the data in event time, focusing on the period from 5 years before the audit to 5 years after the audit. Moreover, I trim the top 1% of observations with the largest tax payments within each year to get rid of extreme observations that make estimates imprecise.[20]

As an alternative approach to identify the dynamic effects of audits, I also adopt the method presented in Advani et al. (2023) and use quasi-control groups to estimate the compliance responses to tax audits.

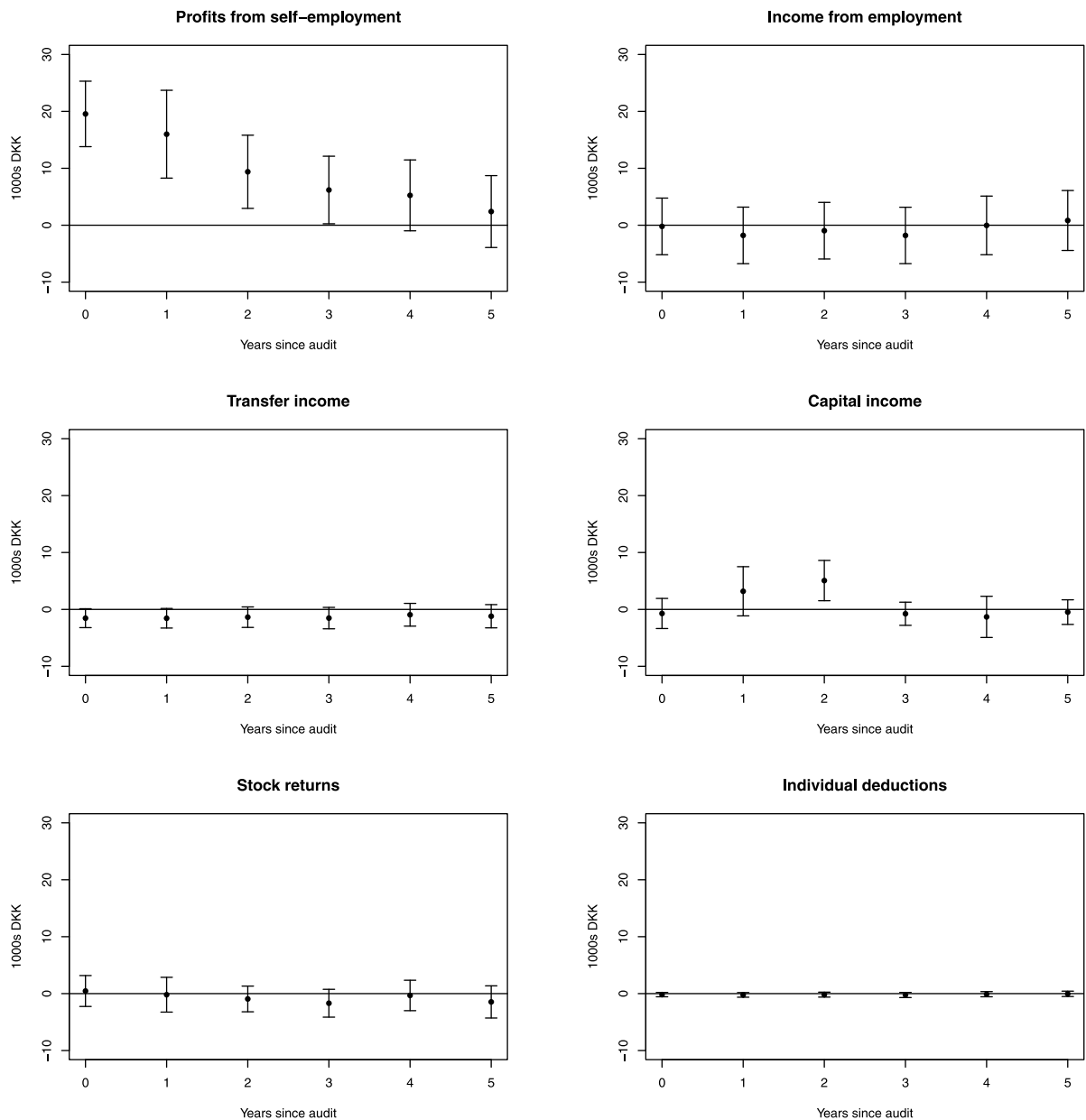Appendix I provides a detailed description of this approach, including several robustness checks.

4. The effects of tax audits

4.1. Overall impact of audits

Fig. 2 presents estimates of the average effects of audits on total taxes.[21,22] Following an audit, taxes increase, reaching their peak during the audit year before gradually declining to pre-audit levels after 5 years. The increase in taxes in the audit year, amounting to 8210 DKK, is lower than the average amount of taxes uncovered from audits. As emphasized in Section 2 and further discussed in Appendix B, taxpayers have the option to defer taxes uncovered during an audit. This indicates that taxpayers utilize this ability and defer approximately 41% of the tax uncovered from audits to later years, thereby smoothing out the additional tax burden. Considering this, audits result in a cumulative increase of 22,970 DKK after 5 years, or 1.65 times the tax uncovered from the audit, demonstrating a positive shift in taxpayers' reporting behavior in the subsequent years. The size and duration of the estimated effects align with previous studies (Advani et al., 2023; DeBacker et al., 2018). Moreover, Fig. 3 reveals that the observed increase in taxes is driven by an increase in profits from self-employment. In line with Kleven et al. (2011), DeBacker et al. (2018), this shows that the impact of audits on reported income is greater when there is less third-party reporting.

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[21] Figure A4 in Appendix A illustrates the effect of audits on total earnings.
[22] The approach outlined in Section 3 and the approach by Advani et al. (2023), outlined in Appendix I, generate highly similar estimates of the long-run effects of audits. The only difference is that using not-yet-treated as controls leads to less precise estimates due to the smaller sample size. Specifically, the total effect according to the approach using quasi-controls is 1.54 times the uncovered tax. The similarity between the methods, along with the absence of pre-audit trends, supports the validity of the empirical strategies.

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[18] Not all self-employed register their business, and business age is only available for those that do. For the remaining, I normalize the age of business to −1.
[19] All quantities are computed using the DID package in *R* (Callaway and Sant'Anna, 2021).
[20] Table A2 in Appendix A shows that the results are robust to alternative levels of trimming.

Fig. 3. Effects of audits by income source. Notes: The figure reports the effects of audits on different income sources (outlined above each subplot) measured in 1000's DKK (deflated to 2015-DKK). The estimates are obtained using quasi-controls as described in Appendix I (2,168,527 observations in total). The regression includes tax-year dummies, and controls for variables used for stratification i.e. tax center dummies, regional dummies, a dummy indicating whether the business has employees or not, and a dummy indicating whether or not the self-employed files under the S15 scheme (all recorded prior to the audit). The dots represent point estimates, and the vertical lines represent 95% confidence intervals based on standard errors clustered by taxpayer.

4.2. Impact by audit outcome

Fig. 4 shows how the compliance response varies across audit outcomes by comparing how taxes change for someone audited and found to have a particular outcome (e.g., under-reporting) with how taxes change for someone who will be audited and found to have the same outcome in the future. I find large and persistent increases in taxes for those found to under-report, while there is no change in taxes for those found to report accurately or report too much. Specifically, for those found to under-report, the tax increase reaches its peak at 15,470 DKK in the year and remains elevated for the subsequent five years post-audit. This results in a cumulative tax increase of 53,120 DKK, equivalent to 1.92 times the initially uncovered tax during the audit. Next, similar to Advani et al. (2023), the absence of a response from compliant taxpayers indicates that the audit process alone may not be

enough to influence their behavior.[23] If taxpayers wrongly classified as compliant were to realize that audits are less effective than previously believed, they might subsequently decrease their tax payments. However, the results suggest that this is not the case.[24] Finally, the lack of a response from individuals who over-report taxes should be interpreted with caution due to the limited number of over-reporting taxpayers, which makes the estimates susceptible to influence from outliers. Figure A5 in Appendix A presents estimates with higher levels of trimming. While the effects remain insignificant, they do indicate a decline in tax

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[23] Advani et al. (2023) also assess the impact of audits conditional on the audit outcome using a slightly different approach.

[24] Using non-random operational audits, Beer et al. (2020) find audits of self-employed reduce tax reports in the short-run for those who were found to be compliant.

payments from the audit year onwards, suggesting that over-reporters adjust their behavior by lowering tax payments.[25]

4.3. Impact by taxpayer intentions

In this section, I examine how taxpayers' responses vary across their intentions to comply with tax regulations. Based on the compliance officers' ratings, I divide taxpayers into two groups based on their motivational posture: intentional non-compliers (ratings 0, 1, or 2) and unintentional non-compliers (ratings 3 or 4). This division of taxpayers is motivated by the likely distinct audit responses between these groups. Unintentional non-compliers who under-report due to a lack of knowledge or confusion about the tax rules may benefit from audits, which serve as comprehensive guidance, leading to enhanced compliance in the future. In contrast, intentional non-compliers may respond differently depending on how their perceived risk of detection is affected by the audit process, which is influenced by factors such as the taxpayer's ability to evade and the auditor's knowledge and expertise, resulting in a less clear-cut outcome. Furthermore, as highlighted by Slemrod (2019), a limitation of existing studies using randomly selected audits to identify the long-run effects of audits is their likely inability to capture the behavior of taxpayers typically targeted for operational audits. In other words, randomly selected taxpayers are not representative of those who are typically subject to audit, and their behavioral response may not be representative of those who are usually targeted for operational audits (Slemrod, 2019). Since the Danish Tax Authorities employ a risk-based model that targets taxpayers with a rating of 0, 1, or 2 for operational audits, the division of taxpayers into unintentional and intentional non-compliers effectively compares the behavioral responses of taxpayers typically subject to operational audits with those who demonstrate higher compliance levels, shedding light on the external validity of the compliance responses of randomly selected audits. To estimate how the long-run responses vary across the two groups, I use the methodology from Section 3 and compare the tax changes of an audited taxpayer who under-reports and receives a particular compliance rating (e.g., 3 or 4) with those of a not-yet-audited taxpayer with a similar outcome in the future.[26],[27]

Fig. 5 depicts contrasting compliance responses across intentional and unintentional non-compliers. Intentional non-compliers increase tax payments by 29,610 DKK in the year of the audit, corresponding to 38% of the tax uncovered from the audit, before returning to pre-audit levels in subsequent years, indicating no sustained increase in compliance. In contrast, unintentional non-compliers increase tax payments by 11,970 DKK following an audit, and the elevated tax payments persist for 5 years after the audit, resulting in a cumulative effect of 58,400 DKK or 341% of the audit adjustment. Although it cannot definitively be concluded that intentional and unintentional non-compliers respond differently (due to overlapping confidence intervals for all periods except −4 and 0), the distinct behavioral patterns do imply differences in audit impact, indicating that those typically

subject to operational audits behave differently from their more compliant peers.[28],[29] Notably, intentional non-compliers defer 62% of the additional tax burden before returning to pre-audit levels, resulting in a low recovery rate of taxes.[30] This discrepancy is driven by the ability of self-employed taxpayers to offset the increase in tax liabilities to later years through existing tax regulations. For instance, the rules regarding subsequent changes in deductions allow taxpayers to modify previously filed deductible expenses and depreciation to an extent that fully or partially offsets the additional tax liabilities, using unused or future deductible expenses and depreciation (see Appendix D for more details). Consistent with this, Figure A16 in Appendix A illustrates that unintentional non-compliers significantly reduce business costs and deductions after an audit, whereas intentional non-compliers show no such impact.[31] In fact, point estimates suggest an increase in business-related costs and deductions for intentional non-compliers. This aligns with Carrillo et al. (2017), implying that those intentionally evading adjust certain costs to offset the additional revenue.

Similar to the ideas of Chetty et al. (2009), these results are consistent with the tendency of taxpayers who unintentionally under-report their income to overlook taxes that are not immediately clear or well-understood. However, when they become aware of these obligations through audits, their behavior adjusts accordingly. Indeed, Alm (2019) highlights the knowledge that taxpayers have – or do not have – about the tax system as an important factor in determining compliance, but underlines that apart from limited laboratory experiments (e.g. Alm et al., 2010) the impacts are unresolved.[32] My findings suggest that audits can serve as personalized guidance to assist the majority of under-reporting taxpayers in accurately reporting their income in the future, which extends beyond the traditional focus of audits on deterring tax evasion (Allingham and Sandmo, 1972; Kleven et al., 2011; Advani et al., 2023; DeBacker et al., 2018), and contribute to the understanding of inattention and misunderstandings of complex tax regulations as a key driver of non-compliance.

To see this, I present a simple economic framework in Appendix H, building upon Allingham and Sandmo (1972). This framework incorporates varying attitudes towards compliance and inattention to tax regulations and allows for the study of audit response dynamics. In addition to providing a simple framework consistent with the results presented, the model predicts that intentional non-compliers who under-report less than they believe will adjust their tax payments post-audit to offset additional tax liabilities incurred due to misunderstandings of tax regulations. Figure A21 illustrates the effects of

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[25] Another way to study over-reporting behavior is by examining the 233 taxpayers randomly audited multiple times. Among them, 24 over-reported once, and only 2 of these (about 8% unweighted and 5.4% when using population weights) over-reported twice. This suggests that over-reporters are not more prone to continuing to over-report than the general population.

[26] Table A3 and Figure A7 in Appendix A confirm that the main findings remain consistent with no groupings, which primarily reduces the statistical power due to fewer observations.

[27] I focus on unintentional non-compliers with a rating of 3 or 4 who under-reported taxes. A total of 1234 taxpayers who received a rating of 3 solely due to poor bookkeeping or accounting practices, without under-reporting, are excluded, since Fig. 4 shows that accurate reporting taxpayers do not respond to audits.

[28] A similar pattern is observed in the laboratory experiment conducted by Kasper and Alm (2022), where it is found that relatively more compliant taxpayers exhibit the strongest behavioral response to audits.

[29] In Appendix E, I analyze the stability of compliance ratings with taxpayers facing random audits in different years. It reveals a noticeable level of inertia in the ratings, with roughly 6 in 10 receiving the same rating in both years. However, those consistently labeled as unintentional non-compliant reduced under-reporting by 65% in re-audits, while those consistently classified as intentional non-compliers increased their under-reporting by 131%, which is consistent with the observed patterns in Fig. 5.

[30] Adding the statistically insignificant but economically pronounced increase of 8680 DKK one year after the audit leads to a total increase in tax payments corresponding to 49% of the tax uncovered from the audit, in which case 51% is deferred.

[31] Results are based on taxpayers who file supplementary financial information. Only self-employed individuals with net revenue exceeding 300,000 DKK are required to file supplementary financial information.
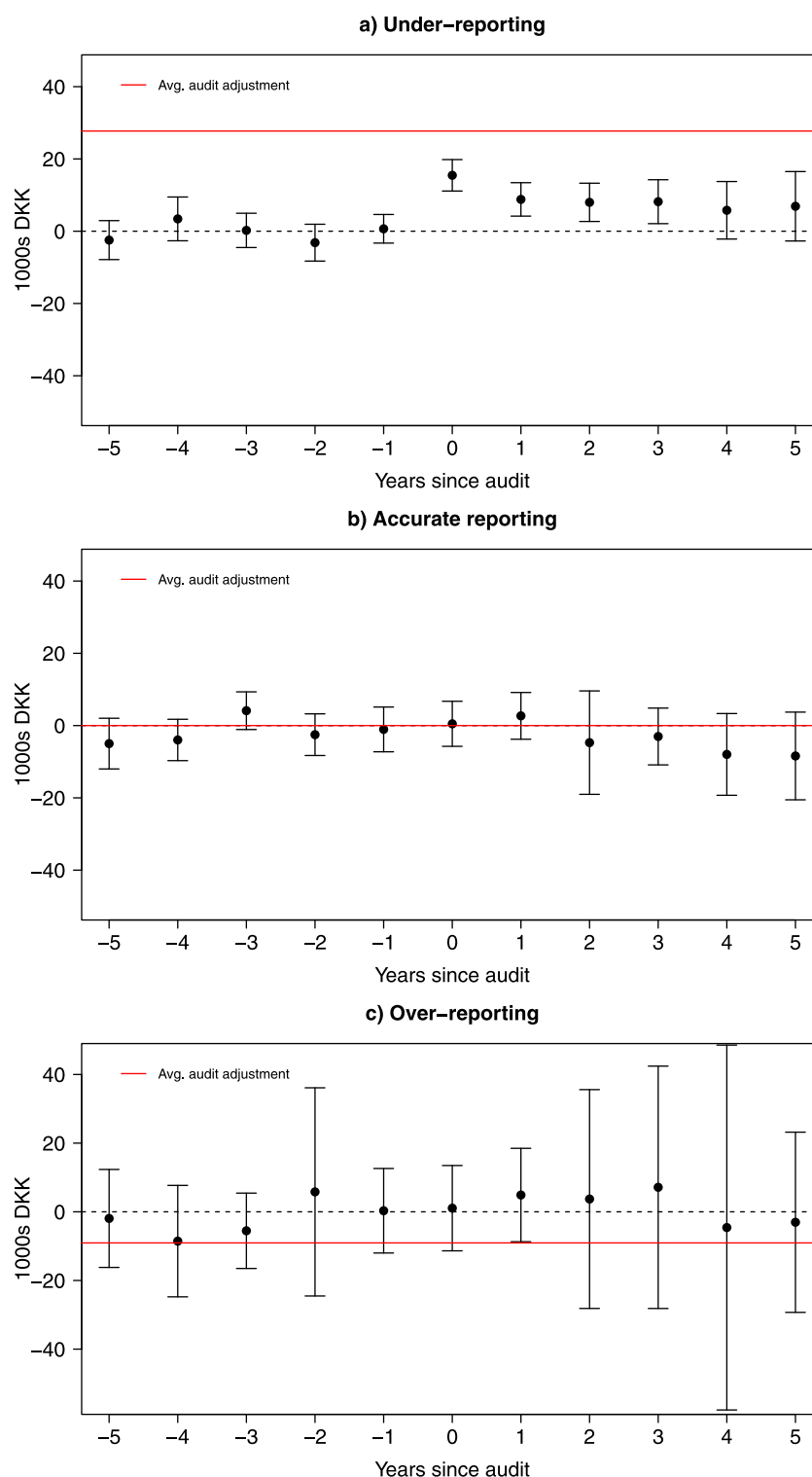
[32] Appendix G shows that unintentional non-compliers exhibit the least bunching around the top and middle tax kinks in Danish Tax Schedule compared to intentional non-compliers and fully compliant taxpayers. This shows that unintentional non-compliers demonstrate a lower level of responsiveness to the marginal incentives which aligns with the notion of a higher degree of inattention or misunderstanding of tax rules among unintentional non-compliers.

Fig. 4. Effects of audits by audit outcome. Notes: The figure reports estimates of the effect of audits on total taxes measured in 1000's DKK (deflated to 2015-DKK) among self-employed who were found to (a) under-report, (b) report accurately, and (c) over-report, respectively. The estimates are obtained using the approach described in Section 3, using only self-employed who were subject to an audit and conditional on audit outcomes (206,999 observations in total). Observations are weighted using population weights for the year of the audit. Moreover, age, business age, and a dummy indicating self-employment status recorded prior to the audit are included as controls. The dots represent point estimates, and the vertical lines represent 95% confidence intervals based on standard errors clustered by taxpayer. The red lines measures the average audit adjustment.

a) Intentional non−compliers

b) Unintentional non−compliers
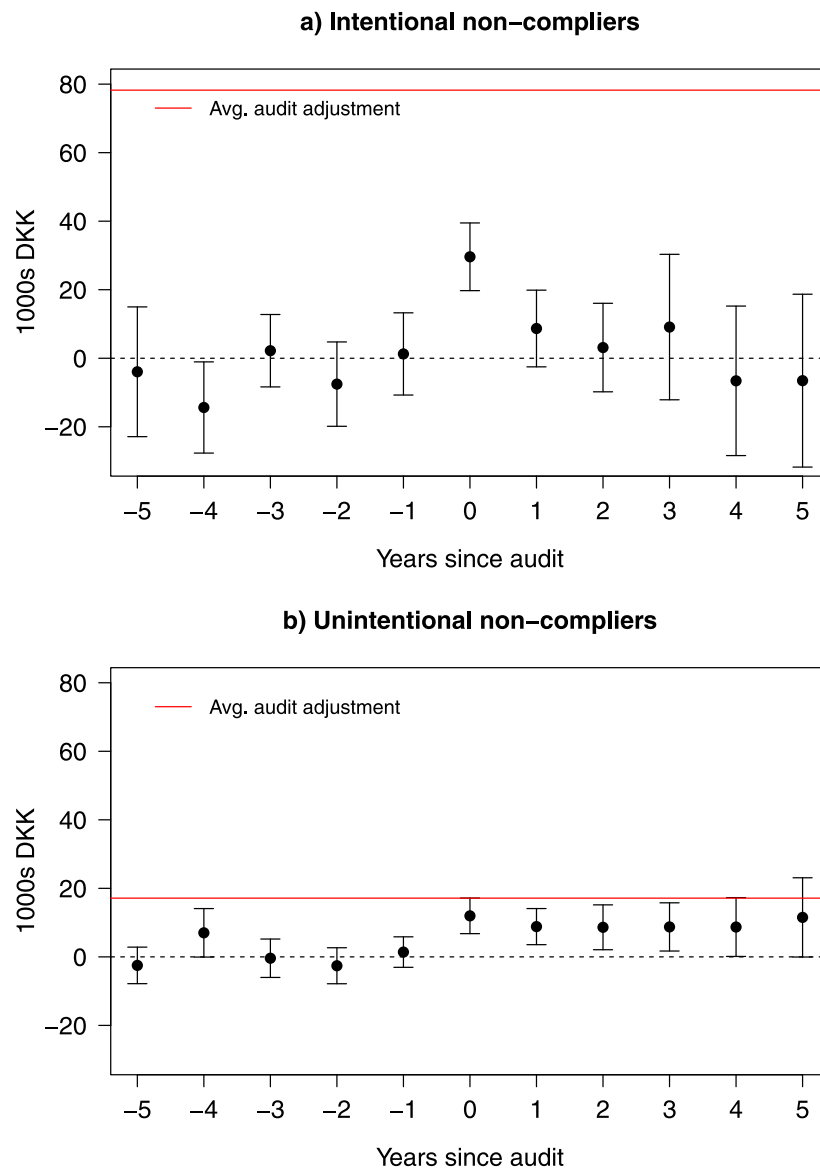
Fig. 5. Effects of audits by intentional and unintentional non-compliers. Notes: The figure reports estimates of the effect of audits on total taxes measured in 1000's DKK (deflated to 2015-DKK) among self-employed who (a) intentionally (i.e., received a compliance rating of 0, 1, or 2) and (b) unintentionally (i.e., received a compliance rating of 3 or 4) under-reported taxes, respectively. The estimates are obtained using the approach described in Section 3, using only self-employed who were subject to an audit and conditional on compliance ratings. Observations are weighted using population weights for the year of the audit. Moreover, age, business age, and a dummy indicating self-employment status recorded prior to the audit are included as controls. Testing the null hypothesis of parallel trends in the pre-audit years using a Wald test cannot be rejected in any of the specifications. The dots represent point estimates, and the vertical lines represent 95% confidence intervals based on standard errors clustered by taxpayer. The red lines measures the average audit adjustment.

tax audits among intentional non-compliers with and without errors that increased their tax liabilities (i.e., negative adjustment of net income). While the results entail uncertainty, point estimates align with model predictions. Tax payments among intentional non-compliers with negative adjustments drop by an amount equal to the tax value of the negative adjustments when compared to pre-audit levels, while the tax payments among intentional non-compliers with no negative adjustments return to pre-audit levels. This finding suggests that some taxpayers decrease compliance after an audit, in line with what has been labeled the "bomb crater" effect (Mittone, 2006; Maciejovsky et al., 2007; Kastlunger et al., 2009).

While opting for guidance, rather than audits, to enhance compliance among unintentional non-compliers may entail different responses, as guidance may not be as salient as audits or may lack the seriousness or potential penalties associated with an audit, previous research suggests that this is a promising approach. For instance, van

Dijk et al. (2020) show that accurately pre-filled tax returns boost compliance, underscoring the effectiveness of clear and personalized instructions for correct tax filing in improving overall compliance rates (Appendix F provides a separate analysis of the effects of guidance on compliance based on the introduction of the S15 scheme, which is discussed further discussed in Section 5.3). In a different setting, Nathan et al. (2020) found that providing taxpayers with tailored informational letters about property tax appeals leads to a substantial increase in appeal rates, highlighting the impact of factors such as information complexity, salience, or confusion on taxpayer behavior. Further exploration of the impact of personalized guidance, such as sending letters or emails to taxpayers addressing common misconceptions identified during audits, on tax compliance represents an intriguing area for future research.

In contrast, taxpayers who intentionally under-report continue to evade taxes, suggesting that those who are typically subject to operational audits are defiant and committed to rejecting their tax responsibilities. In this case, conducting regular re-audits may be necessary to ensure ongoing compliance within this group.[33]

4.4. Alternative potential mechanisms

This section considers various alternative potential mechanisms that could drive the observed results. This includes taxpayers' ability to carry forward historic losses, taxpayers' transitions out of self-employment, as well as accounting for tax center fixed effects, variations in income compositions across taxpayers, and differences in taxpayer characteristics.

First, the difference between uncovered and paid taxes may be driven by taxpayers' ability to carry forward net losses from business activities in previous years to offset income in the audit year. If intentional non-compliers are more frequently in loss positions, the increase in income following an audit may be counteracted by deductions they can now claim, which were not available to them before. However, Table 2 shows that intentional non-compliers are less likely to experience losses compared to unintentional non-compliers, suggesting this is not the case. Moreover, Figure A15 in Appendix A depicts little to no change in the response when focusing only on taxpayers with no net loss 5 years prior to the audit, which suggests that historic net losses are not driving the differences between uncovered and paid taxes.

Second, if intentional non-compliers are more likely to leave self-employment for lower-earning jobs following an audit, thereby reducing tax payments, this could explain the missing behavioral response. Figure A9 in Appendix A estimates the effect of tax audits on the extensive margin. It shows that 2%–5% of unintentional non-compliers cease self-employment, while roughly 15%–25% of intentional non-compliers stop being self-employed. This indicates that tax audits discourage self-employment activities, but the effect is more pronounced among those engaging in business activities with the intention to evade.[34] To examine whether this is the driver behind the distinct compliance responses, Figure A10 in Appendix A plots the compliance responses across intentional and unintentional non-compliers, focusing only on taxpayers who are defined as self-employed during the full period (i.e., balanced in self-employment status). The results remain similar to and not significantly different from those in Fig. 5, suggesting that the shifting out of self-employment is not a significant driver of the observed effect.

Third, compliance officers in specific tax centers may share beliefs about whether regulations result from intentional actions. This could lead to systematic variations among taxpayers with identical compliance ratings but associated with different tax centers. To address this concern Figure A8 in Appendix A presents estimates where tax center dummies are included as controls, which ensures that comparisons between audited and not-yet-audited taxpayers are made within tax centers. The results are virtually unchanged indicating the absence of confounding heterogeneity in grading across centers.

Fourth, variations in income composition, rather than taxpayers' perceived willingness to comply with tax regulations, may drive the distinct compliance responses. Previous studies indicate that the stability of income influences the long-run effects of audits, with more stable sources of income resulting in more sustained responses (Advani et al., 2023; DeBacker et al., 2018). To examine this Table 2 compares income compositions between intentional and unintentional non-compliers. The income composition is very similar, except for stock income which makes up a lower share of total income among intentional non-compliers.[35] Moreover, intentional non-compliers are less likely to report non-zero income from volatile sources like stocks, as well as more stable sources such as transfer income and employment income.[36] The similarity in income composition and likelihood of reporting stable versus unstable income sources between intentional and unintentional non-compliers indicate that income stability is not a determining factor for observed compliance differences.[37]

Fifth, compliance officers may hold a general belief that young, unmarried males, are less willing to adhere to tax regulations and thus more likely to classify them as intentional non-compliers. These beliefs may stem from prior evidence (e.g., Alm et al., 2017; Erard and Ho, 2001), and raise concerns about selection on observables as an alternative explanation for the distinct compliance responses observed among the groups. Indeed, Table 2, reveals that intentional non-compliers are slightly younger, more likely to be male, and less likely to be married, which matches the characteristics of non-compliant taxpayers found in previous studies (Alm, 2019). To tackle this concern, I reweight individuals based on socio-demographic and financial characteristics to ensure that the distribution of observed characteristics is the same across intentional and unintentional non-compliers (Rosenbaum, 1991; Hansen, 2004; Stuart and Green, 2008). Specifically, I reweight unintentional non-compliers and intentional non-compliers such that age, sex, marital status, along with all the financial characteristics presented in Table 2, closely match each other.[38] I then proceed to estimate the compliance responses of intentional and unintentional non-compliers using the weighted samples. As depicted by Figures A12 and A14 in Appendix A, the results exhibit a striking resemblance to the previous results, suggesting that the effects are not driven by differences in observable characteristics.[39]

5. Revenue gains from targeting tax audits

5.1. Prioritizing unintentional non-compliance

The preceding section highlights the large impact of behavioral responses on the overall revenue impact of audits for unintentional non-compliers. Fig. 6 examines how the total effect of audits varies with the amount uncovered from audits.[40] As evident, the total effect

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[33] The effect of reaudits may proof to be larger than the increase in tax payments observed among intentional non-compliers in the audit year if they learn from the increased probability of audit and change future compliance. However, in a laboratory experiment, Kastlunger et al. (2009) found such learning effects to be small in general. In line with this, Appendix E uses data on random reaudits to demonstrate that the majority of intentional non-compliers remain intentional non-compliers and increase evasion substantially, suggesting that the primary effect of re-audits would be driven by the increase in tax payments directly following the audit.

[34] I also find a drop in self-employment among fully compliant taxpayers similar to that of unintentional non-compliers. This finding is consistent with Belnap et al. (2022), who argue that the administrative costs of an audit also negatively affect business survival.

[35] While not statistically significant, negative capital income appears to make up a larger (negative) share of income among intentional non-compliers.

[36] Table A4 in Appendix A presents the autocorrelation for each income source.

[37] This is further corroborated by the consistent results obtained after matching socio-demographic and financial characteristic of intentional and unintentional non-compliers as discussed below.

[38] I use full matching as presented in Ho et al. (2011). Figures A11 and A13 in Appendix A displays the standardized mean difference for each variable before and after reweighing. The plots indicate highly balanced distributions across intentional and unintentional non-compliers (Ho et al., 2007).

[39] There is a small reduction of precision resulting from the decrease in the effective sample sizes.

[40] For unintentional non-compliers the total effect is defined as the cumulative effect after 5 years. Due to the absence compliance responses for intentional non-compliers, the total effect is defined as the effect in the year of the audit. Including the lagged (and insignificant) effects for intentional non-compliers leads to a sharp increase in the confidence intervals (while leaving the point estimates roughly unchanged), thereby masking the fact there is evidence of positive and significant payments in the year of the audit. Figure A17 in Appendix A illustrates this.

Table 2
Comparison of intentional and unintentional non-compliers.

	Unintentional non-compliers	Intentional non-compliers	Difference
Total income	441.80	414.24	−27.57
	(7.81)	(20.23)	(21.68)
Share of income from			
Stocks (%)	1.83	0.53	−1.29**
	(0.61)	(0.15)	(0.62)
Profits from self-employment (%)	62.35	67.16	4.80
	(8.57)	(7.01)	(11.07)
Transfers (%)	16.67	17.46	0.79
	(1.37)	(7.95)	(8.07)
Individual deductions (%)	−9.14	−10.03	−0.89
	(2.22)	(0.75)	(2.34)
Capital (%)	−7.60	−15.43	−7.83
	(5.29)	(4.27)	(6.80)
Employment (%)	35.88	40.30	4.42
	(12.11)	(2.80)	(12.43)
Share reporting non-zero income from			
Stocks (%)	28.01	17.88	−10.14***
	(0.76)	(1.31)	(1.52)
Profits from self-employment (%)	95.74	95.13	−0.61
	(0.33)	(0.80)	(0.86)
Transfers (%)	30.59	22.64	−7.95***
	(0.79)	(1.43)	(1.63)
Individual deductions (%)	97.29	97.54	0.25
	(0.29)	(0.50)	(0.58)
Capital (%)	97.20	97.38	0.17
	(0.32)	(0.50)	(0.59)
Employment (%)	52.83	47.07	−5.76**
	(0.82)	(1.72)	(1.91)
Age	50.24	46.17	−4.07***
	(0.21)	(0.41)	(0.46)
% Male	69.31	77.96	8.65***
	(0.79)	(1.42)	(1.63)
% Married	64.50	53.54	−10.96***
	(0.79)	(1.71)	(1.89)
% in loss	10.99	7.55	−3.44***
	(0.52)	(0.83)	(0.98)
Observations	5906	1326	7232

Notes: The table summarizes and compares characteristics of self-employed who intentionally (i.e., received a compliance rating of 0, 1 or 2) and unintentionally (i.e., received a compliance rating of 3 or 4) under-reported taxes. All quantities are measured in the year of the audit (post-audit) to reflect true quantities (i.e. not subject to evasion/under-reporting). Income sources are ordered by autocorrelation across time (from low to high). The difference is obtained by regressing the respective covariate on a dummy indicating intentional non-compliance. Individual deductions exclude the personal allowance. Observations are weighted using population weights for the year of the audit. Standard errors are robust to heteroscedasticity in parentheses. The asterisks indicate p-values from a two-sided t-test with * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

relative to the audit adjustment remains fairly stable at around 300% for unintentional non-compliers and around 40% for intentional non-compliers, indicating a proportional relationship between the total effect and the tax uncovered from audit across both groups. This result show that within each group, it is sufficient to target audits based on the expected tax uncovered from audit to achieve the highest revenue gains. In particular, the largest total increase is observed among unintentional non-compliers where the tax uncovered belongs to the top quintile among this group, and amounts to an increase in revenues of 172,190 DKK or close to 280% of the tax uncovered from audit.[41] This response is more than twice as large as the response of intentional non-compliers in the top quintile, and close to six times larger than the revenue-raising effect of audits among *all* intentional non-compliers. This latter comparison is particular interesting since the top quintile of unintentional non-compliers make up 8.35% of all self-employed

while intentional non-compliers make up 9.42%. Under the assumption of equal audit costs, it would require roughly the same amount of resources to audit each group. However, auditing the top quintile of unintentional non-compliers would lead to a 4.37 billion DKK increase in revenues compared to auditing all intentional non-compliers, which underlines how policymakers can achieve greater revenue gains by auditing taxpayers who exhibit strong compliance responses. This result does, however, rely on the assumption that tax authorities can accurately distinguish intentional and unintentional non-compliance. In practice, audits are targeted based on risk scores computed using information from pre-audit tax returns. Although this approach leads to imperfect selection, the subsequent section illustrates that the overall conclusion remains.

5.2. Audit allocation using ex-ante information

Recognizing that most tax authorities use risk scores computed with pre-audit information to identify taxpayers for audits (OECD, 2016; Løyland et al., 2019; World Bank, 2011), this section compares the revenue-raising effects of a model prioritizing the expected tax uncovered from audits and a model prioritizing audits based on the total effect, including behavioral responses. Specifically, I compare an

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[41] The tax uncovered among unintentional non-compliers in the top quintile corresponds to 80% of the tax uncovered among intentional non-compliers. This suggests that the driving factor behind compliance responses is not the variation in the amount uncovered during audits but rather the willingness to adhere to tax rules.

a) Total effect

b) Total effect relative to audit adjustment
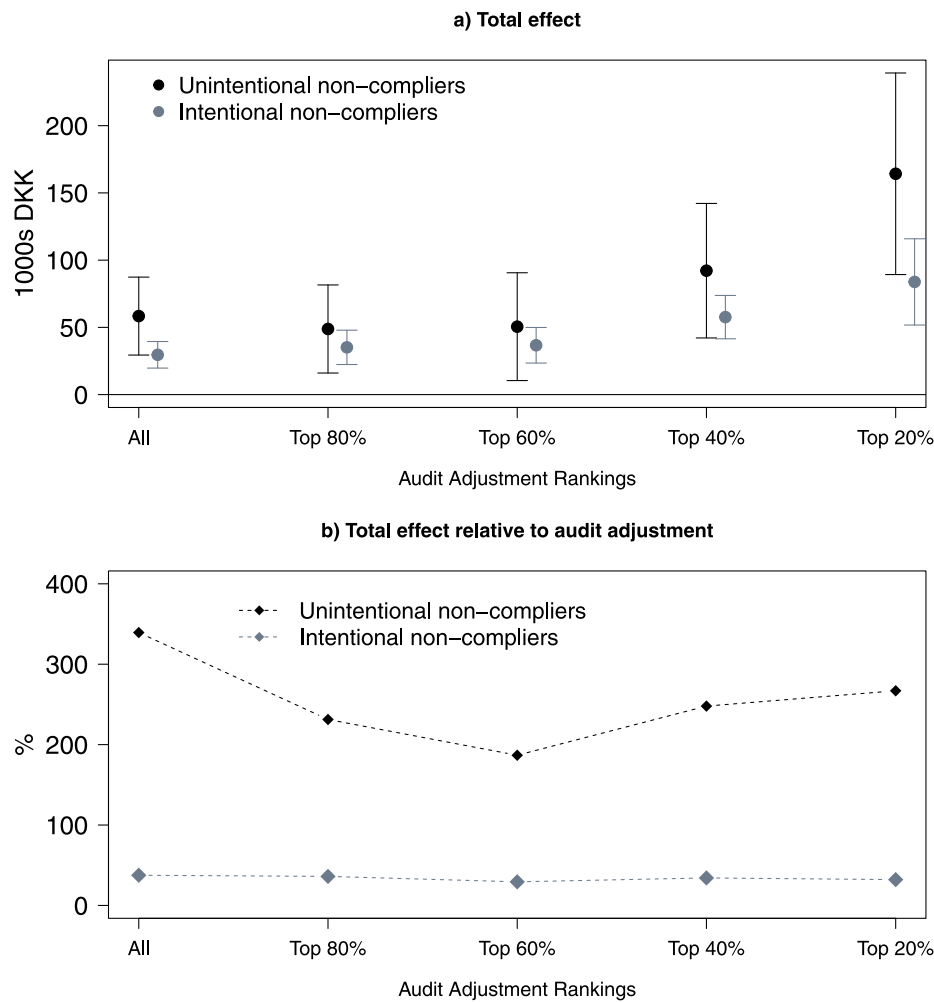
Fig. 6. Ranked effects for intentional and unintentional non-compliers. Notes: The figure reports (a) estimates of the cumulative effects of audits on total taxes measured in 1000's DKK (deflated to 2015-DKK), and (b) estimates of the cumulative effect relative to the tax uncovered from audit, for intentional non-compliers (who received a compliance rating of 0, 1, or 2) and unintentional non-compliers (who received a compliance rating of 3 or 4), respectively. For unintentional non-compliers the total effect is defined as the cumulative effect after 5 years. Due to the absence of any dynamic responses for intentional non-compliers, the total effect is defined as the effect in the year of the audit. The estimates are obtained using the approach described in Section 3, conditioning on compliance ratings and different percentiles of the tax uncovered from audit. Observations are weighted using population weights for the year of the audit. Moreover, age, business age, and a dummy indicating self-employment status recorded prior to audit included as controls. Testing the null hypothesis of parallel trends in the pre-audit years using a Wald test cannot be rejected in any of the specifications. The dots represent point estimates, and the vertical lines represent 90% confidence intervals based on standard errors clustered by taxpayer.

existing approach that targets intentional non-compliance (taxpayers rated 0, 1, or 2) with a new model that targets unintentional non-compliance (taxpayers rated 3 or 4) whose unpaid taxes fall within the top quintile. I employ the XGBoost machine-learning algorithm by Chen and Guestrin (2016) to fit the models, using a rich set of variables from tax returns filed in the audit year and the preceding year. To test how well the models work on unseen data, I split it into two sets. I train the models with data from 2006–2012 and test them on data from 2014–2017.[42]

Fig. 7 compares the models by plotting the average audit adjustment and average total effect (i.e., accounting for compliance responses) against the number of audits ranked by risk scores according to each

model, respectively. Moreover, Table A5 in Appendix A presents metrics of model performances.[43] From Table A5 it is evident that both models obtain fairly low precision rates. As anticipated in the previous section, this underscores the challenges tax authorities encounter in accurately identifying the relevant taxpayer types based on pre-audit information. However, despite the low precision rate, Fig. 7a showcases that both models provide sufficient information to effectively rank taxpayers, leading to above-average corrections, with a slight edge for the model that targets unintentional non-compliance when auditing 10% of taxpayers with the highest risk scores.[44] The variations in

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[42] This way, about 80% of the data is for training, and 20% is for testing. The hyperparameters are tuned using 5-fold cross-validation to maximize the area under the precision–recall curve (PRAUC) on the training data. Due to class imbalance (roughly 1 in 10 for both models) the inverse proportion of class frequencies are used as weights under training.

[43] Figure A18 in Appendix A presents variable importance's of the ten most important variables for each model. It is clear that the primary predictors for both models are the various accounts that disclose income and losses. 5 out of 10 of the primary predictors overlap across the models. One exception is self-reported income which is the main predictor for detecting intentional non-compliance, whereas lagged business earnings are the primary predictor for identifying unintentional non-compliance.

[44] As illustrated in Figure A19 in Appendix A, the higher average audit correction obtained by targeting unintentional non-compliers is driven by a single outlier in the test set who experienced an audit adjustment exceeding

a) Audit adjustment

b) Total effect
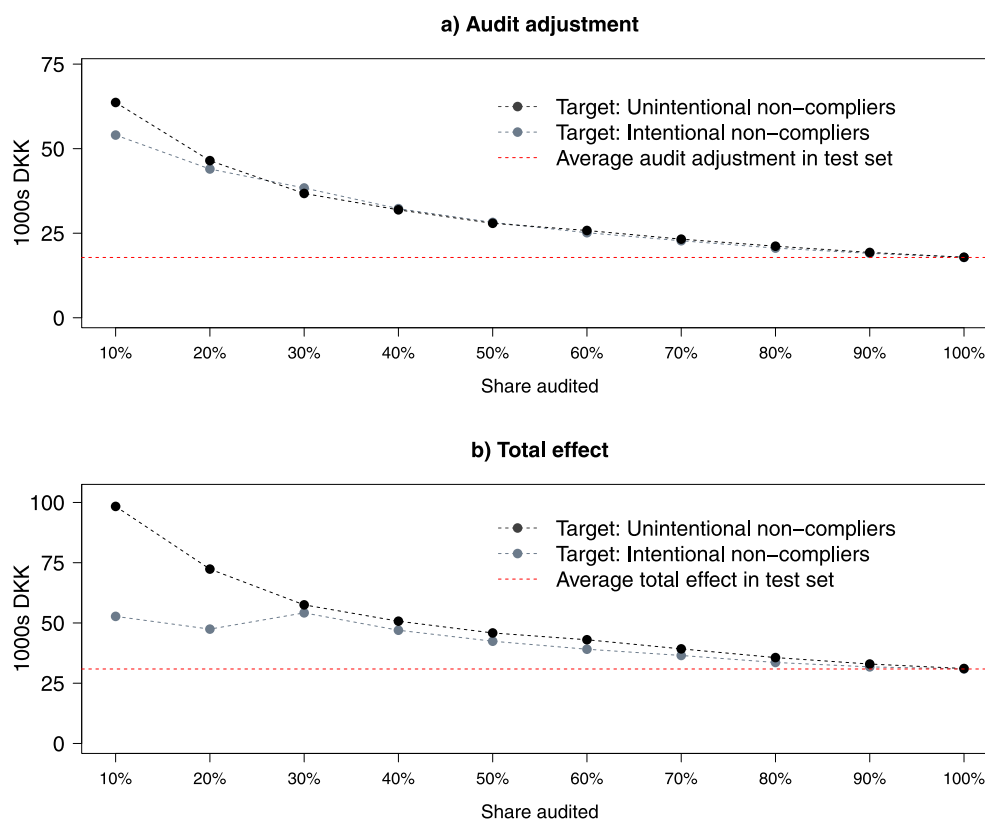
Fig. 7. Different targeting strategies. Notes: The top plot shows the average audit adjustment (i.e. tax uncovered from audit) while the bottom plot shows the average cumulative effect on total tax (i.e. accounting for long-run responses) measured in 1000's DKK (deflated to 2015-DKK) against share of audited taxpayers in the test set. Compliance audits from 2006–2012 are used for model fitting and data from 2014–2017 for model evaluation i.e., the test set. Taxpayers in the test set are ranked (from high to low) based on risk scores computed using a prediction model that (i) target intentional non-compliers (rate 0,1, or 2), and a prediction model that (ii) target unintentional non-compliers (rate 3 or 4) whose unpaid taxes fall within the top quintile, respectively. The dots represent point estimates which are computed using population weights and plotted against the share of taxpayers audited. The red lines measures the average audit adjustment, and the average total effect, respectively.

performance between the models vanish when auditing the top 20% or more of the taxpayers with the highest risk scores. This suggests that the distinct targeting strategies yield similar outcomes in terms of uncovering under-reported tax.

Turning to the total effect of audits reveals a different picture.[45] Fig. 7b presents the results after accounting for compliance responses. Targeting unintentional non-compliers leads to a substantial increase in revenue, while targeting intentional non-compliers results in a slight decrease in revenue compared to the audit adjustment. Auditing the top 10% of taxpayers with the highest risk scores according to the model that targets unintentional non-compliers results in an average total revenue gain of 98,360 DKK, which is 87% higher than the average total revenue gain from auditing the top 10% with the highest risk scores according to the model that targets intentional non-compliers.

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4 million DKK. After removing this observation, the performance advantage shifts, resulting in a slight edge favoring the model targeting intentional non-compliers.

[45] The total effect is computed based on the results of Section 5.1, indicating a proportional relationship between the tax uncovered from the audit and the total revenue in each group. Audits of unintentional non-compliers yield a 340% higher revenue effect compared to the tax uncovered from the audit, while audits of intentional non-compliers result in a total effect corresponding to 38% of the tax uncovered. Figure A20 in Appendix A demonstrates the robustness of the results under pessimism in the face of uncertainty. For unintentional non-compliers, the *lower* bound of the 95% confidence interval of the estimated revenue-raising effect is used, while for intentional non-compliers, the *upper* bound of the estimated revenue-raising effect is used. In this case, targeting the top 10% unintentional non-compliers with the highest risk scores increases revenue by 51%.

Interestingly, the higher revenue gains from targeting taxpayers with strong compliance responses persist even after auditing the top 30% of taxpayers with the highest risk scores, highlighting the sustained efficacy of the approach. These findings underline the potential for policymakers to achieve greater revenue gains by targeting audits towards taxpayers who exhibit significant compliance responses.

5.3. Considerations beyond revenue

The previous section highlighted how tax authorities can target audits towards taxpayers who are expected to demonstrate strong compliance responses to increase revenue. However, this revenue-focused strategy entails an unappealing consequence, since tax authorities need to reallocate audit resources from the least compliant taxpayers to those who are more compliant. This redistribution of resources is likely to be perceived as unfair by the general public, and may not be a viable option to policymakers. Specifically, if taxpayers do not trust the tax administration to collect tax fairly, this may influence general taxpayer behavior adversely and increase non-compliance (Murphy, 2004; Walsh, 2012). Moreover, while revenue is a primary concern for tax authorities, they also often operate under the principle of proportionality. This principle dictates that more invasive measures should not be employed if less intrusive measures can achieve the desired results.

As discussed in Section 4.3, my findings strongly suggest that the guidance provided through audits drives the long-run compliance behavior of unintentional non-compliant taxpayers. Therefore, it is natural to consider targeted and personalized guidance as a direct alternative to audits for this specific group of taxpayers. Implementing such efforts is not only likely to be more viable but they are also likely to

offer a cost-effective substitute for conducting full-scale audits. Indeed, as highlighted by OECD (2010), tax administrations have tended to overlook initiatives that help non-compliers who would have complied if only it had been easier, and they suggest further research be undertaken to better understand how to mitigate the issue of unintentional non-compliance. My results suggest that customized guidance plays a promising role in addressing this issue by addressing the underlying causes of unintentional non-compliance and in promoting improved compliance.[46] The positive effects of guidance is also corroborated in Appendix F which provides an analysis of the effects of guidance on compliance based on the introduction of the S15 scheme in 2013. The scheme provided small businesses with pre-filled tax returns to simplify their tax filings. While the results are noisy, comparing the audit outcomes of taxpayers enrolled in the S15 scheme with the outcomes of taxpayers who would have been enrolled in the S15 scheme if it had existed earlier implies that guidance positively impacts compliance levels.

Customized guidance may in turn generate additional revenue, which can then be redirected towards public funding or expanding the overall audit program. One strategy to expanding the audit program is to increase the frequency of re-audits for intentional non-compliant taxpayers. In contrast to unintentional non-compliers who demonstrate responsiveness to guidance, intentional non-compliers exhibit no compliance responses. As a result, conducting regular re-audits becomes crucial to ensure ongoing compliance within this group. While focusing audits on intentional tax evaders may not generate the largest revenue increases per audit, it can potentially enhance citizens' sense of justice and trust in the tax system, thereby increasing overall welfare (Hendren and Sprung-Keyser, 2020; Murphy, 2004).

6. Concluding remarks

This paper highlights the effectiveness of audits in promoting tax compliance and increasing revenues in the long-run among taxpayers who unintentionally fail to comply with tax regulations. Using data from random audits conducted by the Danish Tax Agency between 2006 and 2017, I find that audits prompt significant responses among unintentional non-compliers who under-report taxes due to inattention or misunderstandings, resulting in a substantial increase in revenues. Conversely, the taxpayers typically targeted for operational tax audits, i.e., intentional non-compliers who purposely evade taxes, show limited responsiveness to audits and a low recovery rate of evaded taxes.

Although previous research has highlighted the importance of compliance responses to tax audits, I am the first to reveal large differences in these responses, influenced by taxpayers' perceived willingness to comply, as indicated by compliance ratings. Additionally, my findings underscore the role of inattention and misconceptions about intricate tax regulations as a critical contributor to non-compliance, and demonstrate how audits can serve as personalized guidance to help taxpayers comply in the future, thereby contributing to the understanding of the determinants of long-run compliance behavior by taxpayers. Finally, this paper provide useful insights for tax authorities seeking to improve tax enforcement by demonstrating how policymakers can use risk scores to effectively target audits towards non-compliant taxpayers who exhibit significant compliance responses, leading to greater revenue gains.

While raising revenue is crucial to enforcement agencies, it is also important to consider other welfare implications of audits when allocating resources and determining the number of audits to conduct (Slemrod and Yitzhaki, 1987; Hendren and Sprung-Keyser, 2020, 2022). For

instance, targeting unintentional non-compliers for audits may generate the highest revenue, but it may not be considered fair by the public. In contrast, focusing on intentional tax evaders can potentially enhance citizens' sense of justice and trust in the tax system thereby increasing welfare. In this context, I emphasize the potential of personalized guidance as a direct and potentially cost-effective substitute to auditing unintentional non-compliant individuals. Further exploration of the impact of personalized guidance, such as sending letters or emails to taxpayers addressing common misconceptions identified during audits, on tax compliance represents an intriguing area for future research (see e.g., Nathan et al., 2020, for related work.)

Other ways tax audits can impact welfare include raising effective tax rates thereby reducing economic activity (Belnap et al., 2022), or by prompting taxpayers to adopt more costly forms of evasion or avoidance to circumvent tax payments (Alstadsæter et al., 2022). In contrast, audits may also boost productivity by deterring individuals from professions that are worthwhile only when evading taxes. Quantifying the welfare impact of tax audits is another interesting area to investigate (Boning et al., 2023).

Declaration of competing interest

Data availability

The data that has been used is confidential.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jpubeco.2024.105121.

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[46] An alternative to guidance is the simplification of the tax system, including tax forms and laws. This approach offers a broader scope but may face practical or political limitations, making it less feasible. Additionally, it is impractical to specifically target the taxpayers who benefit the most from these broad reforms. Nonetheless, this is advocated for by Reeson and Dunstall (2009), who examines the Australian tax system.

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