

**Are Risk-based Tax Audit Strategies Rewarded?  
An Analysis of Corporate Tax Avoidance<sup>1</sup>**

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PRELIMINARY

**Abstract:** This paper examines the relation between risk-based tax audit strategies and corporate tax avoidance. Tax authorities have recently been implementing risk-based tax audit strategies as they expect that these strategies will curb non-compliance. This paper exploits information from the OECD database on risk profiling, predictive modeling, and internal intelligence functions across 54 countries from 2014 to 2017. Our results suggest that the employment of risk-based tax audits is associated with lower tax avoidance when controlling for enforcement, firm-specific, and country-specific factors. Cross-sectional tests indicate that risk-based tax audit strategies are effective tools to curb tax avoidance across firms of all sizes. In additional tests, we use country-level data on tax administration performance and find evidence that risk-based tax audits decrease the cost of tax enforcement and improve the performance of tax authorities. Overall, our findings indicate that risk-based tax audit strategies have an incremental effect on firms' tax avoidance.

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## 1. Introduction

We examine the relation between risk-based tax audit strategies, employed by tax authorities worldwide as a targeted tax audit procedure, and corporate tax avoidance. Risk-based tax audits, if harnessed properly, can improve audit effectiveness and help tax authorities adapt to ever-changing risk environments. However, the effect of risk-based tax audits depends on tax authorities' capacity to collect, probe, analyze, and detect potential non-compliance from various sources of data. Yet, it is unclear whether and to what extent risk-based tax audit strategies affect firms' tax behavior. This paper contributes to a better understanding of the *incremental* effectiveness of risk-based tax audits.

The gap in tax revenue from non-compliance, though hard to measure, is economically significant. In 2019, the U.S. Internal Revenue Service (IRS) reported the average annual gross tax gap for all the tax types (i.e., the difference between taxes owed and taxes paid) of \$441 billion for the tax years 2011 to 2013 (IRS, 2019). In the United Kingdom, the annual tax gap is estimated to be 5.6 percent of the true liability for 2017-2018 (HM Revenue & Customs, 2019). The size of the tax gap has attracted much attention from tax authorities and scholars and gave rise to more effective tax enforcement. For example, In 2017, one-half of 53 tax administrations reported the use of predictive risk-based analytical models for their audit case selection (OECD, 2017).

Since the drivers of taxpayers' compliance behaviors vary substantially across different types of taxpayers and are complex (Jackson and Milliron, 1986; Jimenez and Iyer, 2016; Slemrod, 2018), a single-component selection strategy seems less effective. Furthermore, as tax administration resources are limited, risk-based tax audits are assumed to improve audit-cost-effectiveness by devoting the resources to high-risk taxpayers with the highest potential for detecting non-compliance. Unlike random audits, risk-based tax audits rely on a comprehensive dataset of taxpayers' characteristics such as information from tax returns, historical audits, and

third party information and employ advanced analytics to trace cases with high potential for non-compliance. For example, almost C\$91 million (\$69 million) in 2018's federal budget in Canada were invested for tools to improve tax compliance, cumulatively C\$1.1 billion since the 2016 federal budget, especially for risk-based audit strategy (see International Tax Review, March 19, 2019).<sup>2</sup> Risk-based tax audit strategies help tax authorities to discover, identify, and target non-compliance cases. Risk classification is typically based on a combination of non-compliance factors: (1) firms' inherent risk as a function of size, complexity, nature of business and prior compliance behavior, and (2) firms' actions, attitude, as well as their internal control systems and processes to mitigate tax risk (HM Revenue & Customs, 2017).

Theory and empirical evidence on the relation between tax auditing and taxpayer behavior are mixed. Theoretical literature suggests a positive relation between tax audits and tax compliance (Allingham and Sandmo, 1972). Empirical studies, however, provide mixed evidence on the effect of tax audits (Beer et al., 2020; Gangl et al., 2014). For example, the findings of Mendoza et al. (2017) indicate that exceeding a threshold level of tax audits (measured by the number of verification actions by tax authorities per 100 taxpayers in each country) leads to a decrease in tax compliance, as it signals distrust to taxpayers. The effect of audits on the behavior of taxpayers seems to be attributed to the effectiveness of audits. For example, Gemmell and Ratto (2012) and Beer et al. (2020) report evidence that audits increase the subsequent compliance of non-compliant taxpayers, whereas they decrease the subsequent compliance of taxpayers who were found to be compliant. Relatedly conducting the laboratory experiment, Kasper and Alm (2020) find that audit effectiveness is an important determinant of the specific deterrent effect of audits.

While enforcement from the perspective of audit levels and penalties has been intensively studied (Allingham and Sandmo, 1972; Mendoza et al., 2017; Slemrod, 2019),

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<sup>2</sup> <https://www.internationaltaxreview.com>

alternative avenues to enhance enforcement and fight non-compliance are to date under-researched. This paper evaluates whether tax avoidance subsides when risk-based tax audit strategies are implemented by tax authorities. The first and perhaps more intuitive prediction is that corporations revise their perceptions regarding audit probability and effectiveness. Therefore, they reduce risky behaviors, implement better internal tax control systems, and become more diligent in their tax assessment when informed about the use of risk-based audits by tax authorities (public information, their experience, interaction with other firms, or tax professionals). However, there are several reasons to expect that corporations are insensitive to risk-based tax audits. For example, some firms may pay limited attention to audit strategies, and others face permanent audits (such as large businesses). Thus, they might not adjust their behavior in response to the risk-based tax audits. Risk-based tax audits may even increase tax avoidance if firms start or intensify building on tax advisors/tax professionals' expertise in facilitating tax avoidance outside the scope of risk-based tax audits due to the employment of risk-based audits.

To our knowledge, little is known about risk-based tax audit strategies, especially for firms. Alm and McKee (2004) use an experimental approach and find that the combination of risk-based and random audits are the most effective and sustainable mechanism in deterring individual tax evasion. Using administrative tax data of self-employed US taxpayers, Beer et al. (2020) find that improved targeting audits toward non-compliant taxpayers increase current and future compliance. Three studies explore the features of specific methods of risk-based tax audits: predictive modeling, risk-profiling, and data mining. Using an agent-based model and simulation analysis for individual behavior, Hashimzade et al. (2016) suggest that risk-based audits—more specifically, predictive analytics for audit selection—yield more revenue over random audits. Loyland et al. (2019) use Norwegian administrative data and empirically explore the individual behavioral responses of high-risk wage earners to audits. They find that the compliance effect of audits based on risk scores (predicted by machine learning) increases

significantly with the individual taxpayers' risk score. Hsu et al. (2015) explore the application of data mining in tax audits and argue that it increases efficiency in the audit selection process in Minnesota.

Noticeably, the existing evidence is more on individual responses; whether and how risk-based tax audits are related to firms' tax avoidance remains unexplored due to the data limitation. The effect of risk-based tax audits may be very different for firms (Hoopes et al., 2012). Firms may be either more or less sensitive to tax audit strategies. Firms may respond differently to audits than individuals due to different social norms and networks (Hasan et al., 2017), different costs of non-compliance (Hanlon et al., 2007; Hanlon and Slemrod, 2009; Jacob et al., 2019), and different risk-taking patterns in their tax behavior (Armstrong et al., 2019). Moreover, firms face the trade-off between financial and tax reporting decisions (Hanlon and Heitzman, 2010). Publicly traded firms that are exposed to capital market pressure may value accounting earnings more than tax payments and thus give up tax avoidance opportunities to inflate financial earnings, with the extreme ones paying taxes on allegedly fraudulent earnings (Erickson et al., 2004).

To analyze the association between risk-based tax audits and corporate tax behavior, we exploit annual data on audit selection strategies across 54 countries from 2014 to 2017 to proxy for risk-based tax audits. The data is publicly available from the *OECD Tax Administration Series*. We construct a binary measure for risk-based tax audits that equals one if the tax administration explicitly reports that they employ either risk profiling (business rules), or predictive modeling, or internal intelligence function in their audit case selection criteria.

In our primary analysis, we use a cross-country panel of 15514 firms from 54 countries between 2014 to 2017. We primarily gauge corporate tax avoidance<sup>3</sup> and measure it by the cash

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<sup>3</sup> We define tax avoidance behavior in line with prior literature as "any activity that reduces the firm's explicit taxes in any manner, including tax positions that may or may not be challenged" (Lisowsky et al., 2013). Some tax avoidance activities that were intended to be legal, however, may be challenged by the tax auditor and qualified as

taxes paid relative to the expected amount following Atwood et al. (2012). We control for the level of enforcement, other country-level controls such as corruption, and firm-specific variables that might affect tax avoidance. We expect and find evidence that the employment of risk-based tax audit strategies effectively is associated with a lower level of tax avoidance. In the robustness test, we use a difference-in-differences design and compare the changes in tax behavior for firms in countries switching to a risk-based tax audit with those for firms in countries that never implement risk-based tax audits. The results of the test confirm the previous results.

In supplementary analysis, we explore heterogeneity in the association of risk-based tax audits and tax avoidance and expect different tax behavior conditional on firms' perceived probability of getting audited, which is based on firm characteristics. Tax authorities, for example, often refer to firm size as a prominent indicator for a firm's non-compliance propensity. We find that the deterrence effect of risk-based tax audits holds for firms of all sizes. We interpret this finding as follows. Under risk-based tax audits, firms are not able to respond strategically by using size management (e.g., by under-reporting of revenue to stay below a size threshold) to avoid audits. Furthermore, we investigate how risk-based tax audits affect the performance and efficiency of tax administrations in different countries. Our findings suggest that the employment of risk-based tax audits is associated with the lower cost of tax collection and higher performance of tax administrations.

We contribute to the literature in two ways. First, by examining the *incremental* effect of risk-based tax audits for corporations, we extend the literature, which so far focuses on the effect of risk-based tax audits on individuals. We build on previous single-country studies on individuals (Alm and McClellan, 2012; Beer et al., 2020; Hashimzade and Myles, 2017;

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tax evasion during the audit process. Hence, from a tax administration perspective, corporate tax avoidance partially might be qualified as tax evasion (for more detail, see Figure 1).

Loyland et al., 2019) by studying corporations and a cross-country setting instead. We exploit the cross-country setting to alleviate generalizability concerns.

Second, we contribute to the literature regarding how tax enforcement changes corporate behavior (Atwood et al., 2012; DeBacker et al., 2015; Gupta and Lynch, 2015). More specifically, we extend the literature on tax enforcement and compliance (Slemrod, 2018) by examining the incremental effect of risk-based tax audit strategies and exploring how the effect is related to firm characteristics.

Our study sheds light on conditions under which risk-based audit strategies are effective. Our results suggest that given a certain audit level, the distribution of tax audits across different taxpayers has an incremental effect. Also, the employment of risk-based audits is associated with a lower cost of tax collection and higher performance of tax administrations. Taken together, risk-based audits allow for a more efficient allocation of limited resources to risky areas and areas with the most potential outcome, in line with Slemrod et al. (2001).<sup>4</sup> Therefore, we also contribute to analyses of the effectiveness of intervention activities (Keen and Slemrod, 2017) and answer DeBacker et al. (2015)'s call for a re-examination of tax enforcement.

## **2. Conceptual Framework**

### **2.1 Prior Research**

#### *Individual tax behavior*

The economics of crime model (Becker, 1968), which is often applied to tax evasion, argues that the deterrence effect of enforcement is shaped by both audit probability and penalty (Allingham and Sandmo, 1972; McCrary and Lee, 2009). Based on this deterrence effect, a rational individual weighs the expected benefit of tax evasion against the expected probability

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<sup>4</sup> As Slemrod and Yitzhaki (1987) point out, the optimal audit strategy is not the same as the revenue-maximizing strategy, administrative costs of tax audits should also be taken into consideration. Slemrod et al. (2001) argue that resources should be allocated differently across taxpayers with different risk levels.

of detection and penalties. Recent years have also seen growing academic and policy interest in the relation between enforcement and taxpayers' behavior, as enforcement is considered a crucial component to ensure tax compliance and combat evasion behavior (Slemrod, 2018).

Prior research has demonstrated the link between the strategic behavior of taxpayers and tax authorities. For example, recent studies examine how tax audits affect individual taxpayers' reporting behavior. Kleven et al. (2011) show through an audit experiment conducted in Denmark that audits increase the self-reported income of individual taxpayers significantly in the post-audit year. In the same vein, Advani et al. (2017) investigate how audits affect reporting behavior in the years after audits. Using administrative data from the UK, they find that the effect of audits is rather sustainable, and audits increase the reported tax liabilities among self-employed UK taxpayers for at least five years after an audit. Consistent with these findings, DeBacker et al. (2018) use IRS data and provide evidence that auditing increases the reported wage income of individual taxpayers over three years following an audit.

While the aforementioned archival studies provide evidence of the positive effect of enforcement on tax compliance among individual taxpayers, several experimental studies find opposite results. For instance, Mittone (2006) and Guala and Mittone (2005) show in behavioral studies that taxpayers increase their tax evasion subsequent to a tax audit, which is referred to as the "bomb crater effect". This effect can be explained by the misperception of audit chance, in which individuals underreport income because they underestimate the risk of future examination since an audit has not happened for a while or has recently happened (Mittone et al., 2017).

#### *Corporate tax behavior*

Recently, corporate tax avoidance (e.g., Apple, Amazon, Google) has received heightened attention from tax authorities and the public in recent years. Prior research has provided mixed evidence on the relation between tax audits and firms' tax avoidance behavior. Hoopes et al.



(2012) examine how IRS monitoring affects corporate tax avoidance and find that when the probability of an audit is high, public corporations in the US engage in less tax avoidance. Gupta and Lynch (2015) examine the impact of changes in state-level tax enforcement expenditure and find evidence that higher enforcement expenditure is effective at improving aggregate state-level tax collection. Nessa et al. (2020) show a positive relation between IRS enforcement resources and aggregate corporate tax collection for large businesses and international corporate taxpayers. Atwood et al. (2012) investigate the impact of home-country tax system characteristics on corporate tax avoidance and provide evidence that firms avoid more taxes when their home country's perceived enforcement is lower. These studies provide that enforcement reduces firms' tax avoidance.

On the other hand, DeBacker et al. (2015) find evidence that tax audits may increase tax avoidance for corporate taxpayers. Using the IRS data, they find that corporations in the U.S pay less taxes after an audit and increase their tax payments before they are re-audited. Their results imply that corporations gradually become more tax aggressive following an audit and then eventually decrease their aggressiveness. This result is consistent with the bomb crater effect on individual taxpayers. Finley (2019) analyzes the effects of tax audits depending on the type of settlement the firms receive. Their findings indicate that subsequent to a favorable settlement, firms increase their tax avoidance, while firms with less favorable tax settlements stick to their prior tax avoidance strategies. Slemrod et al. (2001) argue that firms may behave like high-income individuals and engage in even more aggressive tax avoidance when an audit's likelihood is high to have room for negotiating with the goal of minimizing their after-tax liability, assuming that the audit will not detect and punish all the tax avoidance (Slemrod et al., 2001).

## *Reconciliation of individual and corporate tax behavior*

Taken together, while the majority of prior studies suggest that tax audits decrease tax avoidance and increase tax compliance, some studies, especially behavioral ones, indicate an opposite impact (for an overview, see Table A1 in the Appendix).<sup>5</sup>

One explanation for the mixed evidence is the misperceived probability of being audited. Tax audits increase-rather than decrease-tax avoidance when taxpayers underestimate the risk of subsequent audits (Kastlunger et al., 2009) or when enforcement is less effective than expected, i.e., non-compliance was not detected (Beer et al., 2020; Gemmell and Ratto, 2012). Another explanation is the effect of the non-linear weighting of probabilities: taxpayers may overweight low probabilities but under-weight high probabilities (Dhimi and al-Nowaihi, 2007). To attenuate this misperception or weighting effect of future audits and to make enforcement more visible, tax authorities can announce and implement an effective audit selection strategy such as risk-based tax audit strategies to focus on high-tax risk firms.

## **2.2 Hypothesis Development**

Prior research has usually examined the reporting behavior of individuals who were selected based on random audits (Advani et al., 2017; DeBacker et al., 2018; Kleven et al., 2011). However, in reality, tax authorities in the world rely increasingly on case selection systems based on risk-based tax audits, which target taxpayers with a rather high likelihood of non-compliance.

Firms consider and weigh the marginal benefits against the expected cost of tax avoidance. An audit imposes costs potentially in the form of adjustment, fines, penalties, and interests. For the cost-benefit analysis, firms estimate the probability of audit using the available information set and adjust their behavior accordingly.

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<sup>5</sup> Here, we only reconcile the relation between tax auditing and non-compliance/tax avoidance behavior for the two streams of research; we do not reconcile tax evasion and tax avoidance.

Firms can obtain information about the use of risk-based tax audits in various ways: First, general information about audit case selection strategies is provided by tax administration to the taxpayers (especially for corporations). Second, in the course of a risk-based tax audit, firms may receive further information about the criteria of the administration's risk assessment. Lastly, firms could attain information regarding risk assessment criteria by interaction with peer firms, or indirectly through tax professionals who serve as an information hub (Battaglini et al., 2019; Hoopes et al., 2012). This information can also be diffused through social networks in the business process: for example, via (1) common analyst, audit, board of directions, banks; (2) supply chain; (3) executive network; (4) industry network.<sup>6</sup>

The targeted focus of risk-based tax audits potentially provides a strong deterrence effect for tax avoidance. By using risk-based tax audits, tax administrations allocate more resources to the high-risk taxpayer and thus incur lower opportunity costs. A firm's perceived audit effectiveness may increase as the tax administration becomes more efficient in targeting non-compliance. Thus, the likelihood of high-risk tax positions being scrutinized and, in turn, the inherent tax benefits being eliminated under risk-based tax audits might give rise to more compliance. Unaggressive taxpayers will remain low levels of tax avoidance to avoid increasing the risk of being audited. In turn, aggressive taxpayers may consider a future risk-based tax audit more likely, and reduce tax avoidance accordingly.

Second, a taxpayer's probability of being audited and the chance of non-compliance positions being discovered under risk-based audits depends also on its behavior in relation to its peers' behavior. The larger the deviation of a taxpayer's behavior from the average tax

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<sup>6</sup> Three audit effects are identified in prior literature based on taxpayers' information: induced, subsequent period, and group effects (Bloomquist, 2004). First, the induced effect explains the changes in compliance behavior as a result of changes in the enforcement level (for example, changes in audit level or audit rate) (see, e.g., Atwood et al., 2012; Mendoza et al., 2017). Second, the subsequent period effect describes behavioral changes in compliance due to prior tax audits. The experience of being audited provides specific information to the taxpayers about the ability of the tax administration to detect non-compliance and about the tax administration's main focus. Lastly, the group effect refers to the changes in tax behavior of taxpayers appertaining to the communication and learning from the audit experience of other taxpayers and their peers.

behavior of its peers, the higher the probability of being subject to a targeted audit. In other words, the so-defined “audit probability” depends on both the firm’s tax strategy and the aggregate tax strategy decisions over the population of all firms. Thus, firms are expected to anticipate the actions of other firms to assess their own risk of being audited. This risk assessment is subject to substantial uncertainty. Hence, uncertainty-adverse firms will prefer safer choices and reduce tax avoidance. We would expect herding tax avoidance behavior in order to reduce the risk of future audits (Tan and Yim, 2014). For example, Riedel et al. (2019) find that audits have a positive effect on tax reporting of non-audited neighbor firms. To conclude, firms gather information about audit procedures enabling them to estimate their probability of audit and respond strategically to risk-based tax audits.

Risk-based audits may affect corporate taxpayers in other ways. First, some countries incorporate the existence or design of the tax control framework by firms in their risk-based audit selection criteria. Firms may respond by enhancing their tax risk management system and thereby induce both lower audit probabilities and lower tax avoidance (Chen et al., 2020). This practice may also make tax issues more salient: firms learn more about tax risks and managers understand better about the key risk areas. In this way, firms respond more substantially and tax risks may be taken into more consideration when making corporate decisions.

Taken all together, when corporations receive the information on the use of risk-based tax audits and its effectiveness, they are expected to become less tax aggressive, implement better internal tax control systems, and become more diligent in their tax assessment. Based on this rationale and prior findings, we conjecture the following:

*H1: The employment of risk-based tax audits is associated with lower levels of tax avoidance.*

We expect that on average, risk-based tax audits have a strong deterrence effect for tax avoidance and thus are negatively associated with tax avoidance.

Although this prediction is both intuitive and in line with the literature, we expect that some firms are insensitive to risk-based tax audits. For example, small businesses may pay limited attention and are not able to draw differentiated conclusions from information on the employment of risk-based tax audits. Moreover, as large businesses typically are permanently and comprehensively audited, these firms might not expect to experience an increase in challenging tax issues under a risk-based approach. Thus, they might not adjust their tax behavior in response to the employment of risk-based tax audits. Furthermore, some large firms participate in co-operative compliance programs and enjoy the benefit of no or less comprehensive post-filing audits. In all these cases, risk-based tax audits may have no effect.

Risk-based tax audits could also relate to higher levels of tax avoidance because firms may change their cost/benefit consideration in employing tax professionals under risk-based tax audits. Belnap et al. (2020) find that audited firms are more likely to change tax preparers.<sup>7</sup> Some tax service providers, for example, the Big 4, have intelligence tax products that assist firms to solve automated tax compliance problems. The service includes trend analysis, and the timely detection of potential errors, risks, or abnormal conditions, which helps firms better cope with risk-based tax audits. Consequently, firms may start or intensify to build on tax advisors/tax professionals' expertise in facilitating tax avoidance outside the scope of risk-based tax audits. These firms might benefit from the technical expertise to implement tax avoidance schemes, deal with tax audits, and defend tax positions. In addition, firms in a country with more information about the key parameters or criteria in risk-based tax audits may behave strategically and use more tax avoidance techniques without triggering an audit. We address these possibilities in our cross-sectional tests on subsamples.

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<sup>7</sup> The tax preparer's effect on compliance is ambiguous and fosters a median stance (Marchese and Venturini, 2020).

### **3. Data and Research Methodology**

#### **3.1 Measuring Risk-based Tax Audits**

Risk-based tax audits employ advanced analytical techniques, which include the process of applying statistical and automated machine-learning techniques to uncover insights from data to evaluate non-compliance. Many administrations use advanced case selection strategies, for example, predictive modeling, and risk-profiling to improve the match of audits and taxpayers' specific risks (OECD, 2017).

Most countries worldwide now use risk-based tax audit strategies to determine their tax audit cases, in combination with random selection (see Figure 3). Countries disclose general information on their risk-based tax audit strategies on their websites and report to the OECD. However, the exact details on audit case selection and risk criteria are kept confidential to prevent taxpayers from acting strategically to avoid being audited (Khwaja et al., 2011). For example, tax administrations provide information about their approaches in risk-based tax audits. However, they usually refrain from providing technical details (particularly if the information is related to the computation of risk scores such as size). Table A2 in the Appendix provides general information about risk-based tax audit experiences in selected OECD countries.

For example, in Canada, the Canadian Revenue Agency (CRA) extracts data from several CRA systems and links it to a comprehensive dataset of taxpayers' information (filing and assessment information, risk profiles, historical audits, collections, and appeal information) to determine high-risk taxpayers in SMEs. Then the mining/machine learning algorithms, including cluster analysis, decision trees, neural networks, and deep learning, are employed to develop predictive models and to score and identify the highest risk taxpayers (OECD, 2019).

To proxy for risk-based tax audits, we exploit information on audit case selection from the OECD database, published by *Tax Administration Comparative Reports Series*.<sup>8</sup> For details on case selection methods reported by the tax authorities to the OECD, see Table 1. The OECD reports 19 items for tax audit case selection; out of these 19 items, 3 are the most common methods for risk-based tax audits (Khwaja et al., 2011; OECD, 2019, 2017, 2004).<sup>9</sup> Specifically, the following items are considered as risk-based tax audits strategies in our study: risk profiling - business rules, risk profiling - predictive modelling, and internal intelligence function. These items are widely used by tax administrations, so their coverage in the OECD report across countries is very high, allowing us to use it in the cross-section. Therefore, we argue that these three strategies out of the 19 disclosed by OECD are also the most relevant and explicit ones for risk-based tax audits selection. Other items, if used in risk-based audits, either serve as inputs of risk-profiling or represent specific rules or procedures (see Appendix Figure A2 for details). In detail, our binary measure for risk-based tax audits equals one if the tax administration explicitly reports that they employ either risk profiling (business rules), or predictive modeling, or internal intelligence function in their audit case selection criteria.

We use a binary indicator variable because it is easier for interpretation. We do not use a contentious variable to avoid double counting. Although it is unclear for which kind of taxes these methods are used, we assume that tax authorities at least partially use these methods for corporate income taxes. To validate this measure on the use of risk-based tax audits by tax administrations, we compare our measure with the information from the OECD reports, tax authorities' websites, PwC summaries, and the World Bank website for all the countries. Our additional search confirms the information in the OECD database for most countries. In case of disparities, we gather more information from tax authorities' websites in both English and the

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<sup>8</sup> <https://www.oecd.org/tax/forum-on-tax-administration/publications-and-products/comparative/>

<sup>9</sup> There is no global definition of risk-based tax audits, and different countries may have different approaches and different understandings of the content of risk-based tax audits. In this paper, we aim to find items that are generally accepted as risk-based tax audits (e.g., by OECD and World Bank) and comparable among countries.

official language of the specific country, check papers and reports written by employees in tax authorities or other insiders, and talked to the tax administration of specific countries and other experts such as tax advisors. After gathering the details of a country’s audit case selection strategy, we modify the dataset if the OECD data is not accurate (for two countries only).<sup>10</sup> The map of risk-based tax audits proxied by our revised dataset by countries can be found in Figure 3.

< Insert Table 1 about here >

### 3.2 Research Design

We explore the relation between the use of risk-based tax audits and the measure of tax avoidance. We estimate the following model using least squares pooling, where  $i$  denotes firm,  $j$  denotes country, and  $t$  denotes time:

$$Tax\ Avoid_{i,j,t} = \beta_0 + \beta_1 Risk\_basedAudit_{j,t} + \beta_2 Enforcement_{j,t} + X_{i,j,t} + \varepsilon_{i,t} \quad (1)$$

The dependent variable is tax avoidance. We define tax avoidance behavior in line with prior literature as “any activity that reduces the firm’s explicit taxes in any manner, including tax positions that may or may not be challenged” (Lisowsky et al., 2013).<sup>11</sup> We use the tax

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<sup>10</sup> We only change the data for risk-based tax audits from the OECD database for Germany, China, and Kenya, Thailand. Risk-based audit indicators are missing for Kenya and Thailand for 2014 and 2015 in the OECD database, and we change it to 0 according to our hand-collected information. We correct the risk-based audit variable for Germany to 0 (Germany indicated as 1 for all four years in the OECD database), and China, which should be 0 for all years (China indicated 1 for 2014 and 0 for 2015, 2016, 2017 in the OECD database). In the case of Germany, audit cases are selected based on size and industry. In the case of China, early actions to categorize taxpayers are based on size and industry. In July 2015, the State Tax Authority launched the "1,000 Enterprises Initiative", focusing on identifying the task risks, assisting the enterprises to improve their tax control systems of the largest business groups in terms of size, turnover and tax contribution in China (including private enterprise, multinationals and all state-owned enterprises), and providing better service to reduce disputes. The collected data serves as inputs for risk profiling and modelling for different industries, supporting the tax credit rating for other taxpayers and helping to generate industry benchmarks. This "1,000 Enterprises Initiative" represents the start of the risk-based audit approach, and is only available for the biggest enterprise. Only in 2018, the nationwide platform for internal monitoring designed for all personals at tax authorities was established, a step forward towards identifying risks automatically from all data sources in all activities.

<sup>11</sup> In the prior literature, the terms “tax avoidance”, “tax aggressiveness”, “tax non-compliance” and “tax evasion” are all used to describe aspects of tax planning aimed at lowering the tax burden. Firms’ intentions about tax avoidance and tax evasion typically cannot be observed. Thus, in an empirical study distinguishing between not-intended and intended tax evasion is notoriously hard. In turn, in our empirical design, we cannot differentiate between tax planning activities as part of a firm’s compliant tax planning strategy that will be considered compliant tax planning in an audit and those activities that are considered tax evasion.



avoidance measure developed by Atwood et al. (2012), which is the difference between taxes calculated at the statutory tax rate and taxes actually paid. We follow De Simone et al. (2019) and calculate it as  $[(PTI * \text{Statutory Tax Rate}) - CTP] / PTI$ , where PTI equals to pre-tax earnings (PI) less special items (SPI) and current taxes paid CTP equals to total tax expense (TXT) less deferred taxes (TXDI). Hence, *Tax Avoid.* increases in increasing avoidance behavior of firms. This measure takes into account different statutory tax rates between countries over time and thus is suitable for international samples.

The variable of interest in our analysis is *Risk-based Audit* at the country-year level. This binary indicator variable equals one if a risk-based tax audit strategy is employed and zero otherwise. As outlined in our hypothesis, we expect a negative relation between risk-based tax audits and tax avoidance. That is, we predict that the coefficient of *Risk-based Audit*,  $\beta_1$ , is negative for *Tax Avoid.* We also control for the enforcement level. We explore whether the employment of risk-based tax audits has an additional effect on firm tax behavior, given the level of enforcement. We follow Alexander et al., (2020)<sup>12</sup> and measure *Enforcement* as the total number of employees in tax administrations divided by active firms (corporate income taxpayers) in the countries, per country per year.<sup>13</sup> To facilitate the interpretation, the Enforcement measure is multiplied by 100 so that it can be interpreted as the total number of employees in tax administrations per 100 firms. We replace the missing data for enforcement with the nearest observation following Alexander et al. (2020). Thus, we capture different human resources of tax administrations to perform audits with higher scores of enforcements, indicating stronger tax enforcement. Similar to our main variable of interest, and in line with previous studies, we expect a negative relation to *Tax Avoid.*

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<sup>12</sup> They measured enforcement as the ratio of citizens to tax staff at the central government tax agency and convert this ratio into tax staff per 1,000 inhabitants.

<sup>13</sup> If the number of active taxpayers is missing, we replace it with the number of total taxpayers.

We include a set of time-varying control variables ( $X_{i,j,t}$ ), both at the country level and at the firm level, to alleviate the concern that the result is driven by other factors. We include the country's GDP per capita and GDP growth as indices for market size and overall economic activity, and corruption as a proxy for the institutional framework of the country. Furthermore, we include a set of control variables in order to account for firm characteristics. We include firm profitability (measured by pre-tax ROA, prior loss, sales growth), leverage (measured by the sum of long-term and short-term debt), R&D (measured by R&D expense), cash holding (measured by cash and equivalents). Pre-tax ROA equals pre-tax income divided by lagged total assets. We include firms size (Ln assets) to control for differences in tax planning related to scale. These variables affect tax avoidance, according to prior literature (Edwards et al., 2016; Law and Mills, 2017). In addition, PP&E also indicates tax avoidance opportunities (Chen et al., 2010; De Simone et al., 2019). Furthermore, we include the Worldwide Governance Indicators (WGI) into our regression. Lastly, we account for industry and year fixed effects in all regressions to control for unobservable tax-related differences across time and industry affecting our results.

### **3.3 Sample and Data**

We obtain the audit case selection and enforcement data from the *OECD's Tax Administration Comparative Series* from 2014 to 2017 to construct our variable of interest *Risk-based audit* and key control variable *Enforcement*.

Furthermore, the data for the statutory tax rate is taken from KPMG, which provides information on all corporate income taxes and related taxes on corporate profits across countries. We use other country-level control variables such as the annual level of GDP per capita and GDP growth from the World Bank.

Our primary analysis (equation (1)) is at the firm level. We start from all the firm-year observations in Compustat North America and Compustat Global from 2014 to 2017 for those

countries with sufficient audit selection and enforcement data in the OECD series. Financial reporting data from Compustat Global are translated into US dollars using yearly exchange rates from the World Bank. We exclude firms with negative pre-tax income from our sample, following prior literature (Atwood et al., 2012). We drop all observations that do not have sufficient data to construct variables in equation (1).

After our screening procedure, the final sample includes 43812 unique firm-year observations across 54 countries between 2014 and 2017 for firm-level regressions.

We add country characteristics representing the quality of governance from the Worldwide Governance Indicators (WGI). The indicators consist of six dimensions: voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, the rule of law, and control of corruption. Furthermore, we use tax administration and tax performance data from USAID's Collecting Taxes Database (CTD), which provides comparable information relating to tax administration systems in an internationally comparative context. The data is publicly available from the USAID DRM website.<sup>14</sup> Details of variables definitions are presented in Table 2.

< Insert Table 2 about here >

### **3.4 Descriptive Statistics**

Our sample comprises both developed and developing countries. Table 3 reports descriptive statistics for *Tax Avoid* and *STR* by country. Countries with the most observations in our sample are from China (11,838 firms), followed by the United States (9,679 firms), Canada (2,016 firms), United Kingdom (1,782 firms). Firms from the United States and Malta show the highest tax avoidance, 0.188 and 0.108, respectively. In Comparison, Portugal and Korea report the lowest level of tax avoidance. Moreover, Table 3 reports considerable variation in the corporate

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<sup>14</sup> <https://www.usaid.gov/what-we-do/economic-growth-and-trade/domestic-resource-mobilization>

tax rate in our sample, with the highest rate for the USA (40 percent) and the lowest rate for Bulgaria (10 percent).

< Insert Table 3 about here >

Table 4 reports summary statistics for firm-level variables. We winsorize all firm-level variables at the 1 percent and 99 percent levels. The mean (median) of tax avoidance is 0.044 (0.063), indicating some level of tax avoidance in our sample consistent with prior research (e.g., Atwood et al., 2012). Sample firms report average (median) Pre-tax ROA of 9.5 (6.9) percent and Sales growth of 14.5 (7.1) percent. Around 9.5 percent of the firm-year observations show a prior year accounting loss.

< Insert Table 4 about here >

Table 5 displays the Pearson correlations for our variables used to test our hypothesis. Consistent with De Simone et al. (2019), the correlation between Tax Avoid and statutory corporate tax rate (STR) is positive and significant, indicating that firms are more likely to avoid when the economic benefit is high. We also observe a significant positive correlation between *Tax Avoid.* and *Sales growth*, *PP&E*, *leverage* and *R&D*. Notably, *Risk-based Audit* and *Enforcement* are negatively correlated.

<Insert Table 5 about here >

## 4. Results

### 4.1 Primary Result: Tax Avoidance

We investigate whether and how the employment of risk-based tax audits is associated with tax avoidance at the firm level. Table 6 displays the results of our estimate of equation (1). It is a pooled firm-country-year regression across countries on our full sample. Our outcome variable, *Tax Avoid*, decreases when firms engage in less tax avoidance activities. Column (1) report the results of our baseline model. We observe a negative and significant coefficient estimate for

*Tax Avoid*, suggesting that the employment of risk-based tax audit strategies is associated with a lower level of tax avoidance. The coefficient -0.037 indicates that the employment of risk-based tax audits is associated with a 3.7 percentage point reduction in tax avoidance.

Relatedly, we also observe a negative and significant coefficient estimate on  $\ln(\text{Enforcement})$  in both columns, which suggests that firms engage in less tax avoidance when tax enforcement is stronger. This is consistent with prior literature (Atwood et al., 2012; Hoopes et al., 2012), who find evidence of the effectiveness of enforcement to curb tax avoidance. For example, Hoopes et al., (2012) show that firms undertake less tax avoidance when tax enforcement is stronger. With regard to other control variables, R&D is positively related to tax avoidance, consistent with Dyreng et al. (2017) and De Simone et al. (2019).

In column (2), we add additional control variables at the country level to control for the effect of a country's governance level: Voice and Accountability, Government Effectiveness, Political Stability, Rule of Law and Regulatory Quality from the World Bank Worldwide Governance Indicators (WGI). These variables reflect the citizen's perception of participating in selecting the government; the quality of public services, the risk of political instability; the extent to which agents have confidence in and abide by the rules of society respectively; and the ability of the government to formulate and implement policies and regulations. The higher score, the better governance one country has. We continue to observe a significant relation between *Risk-based Audit* and *Tax Avoid* after adding additional controls, which suggests that the results are consistent.

<Insert Table 6 about here >

#### **4.2 Cross-sectional Tests: Firm Characteristics**

While the negative association mentioned above speak to the effect of risk-based tax audits on average, the effect might vary with respect to firms' different characteristics. In this section, we analyze the potential heterogeneous effect of risk-based tax audits depending on the firm size.

One of the criteria to select the firms for tax audits in countries around the world is the size of firms. The majority of tax administrations in advanced economies have established Large taxpayers Units (LTUs) to manage their largest taxpayers (OECD, 2017). Firms are selected for LTU based on certain size thresholds, including sales, income, total assets, taxable profit, and the number of employees (OECD, 2017). The size classes and threshold differ significantly in different countries.<sup>15</sup>

While tax administrations have different treatments for large taxpayers and small and medium-sized enterprises, it is unclear how large firms react to risk-based audits. On the one hand, some countries employ risk-based audits in LTUs first and have a stronger focus on large taxpayers. In this case, large firms respond to risk-based audits more strongly than other firms. On the other hand, in some countries, large corporations are audited permanently. The use of risk-based tax audits should affect their behavior to a lower extent than others as under audit certainty audits barely have a deterrence effect (Ayers et al., 2019), or may even increase the incentives for uncertain tax avoidance (Mills and Sansing, 2000).<sup>16</sup> However, large firms use complex financial instruments and arrangements that could be hard to detect under random audits (even with 100% audit probability). But under risk-based tax audits, not only audit probability is different, but also audit intensity differs. Tax administrations could improve the detection of risky taxpayers as well as non-compliance and risky cases by use of risk-based tax audit strategies.

Similarly, the effect on small firms is ambiguous. Bachas et al. (2018) find evidence that audit probability increases with the firm-size. In addition, the audit intensity across different

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<sup>15</sup> For instance, the German tax authority divides firms into four size classes, i.e., very small, small, medium and large based on revenue and taxable profit, while other tax administrations might differentiate between two size-classes.

<sup>16</sup> Mills and Sansing (2000) argue that taxpayers are expected to claim more tax benefits under a permanent tax audit to create aggressive issues for negotiations with the tax administrations. These taxpayers assume that the tax administration in such a setting will not detect and punish all tax avoidance (Slemrod et al. 2001), which leads to higher levels of tax avoidance.

size-classes also varies in terms of audit depth. Given that tax audits are attributed to the substantial costs for firms and could lead to additional tax expenses, firms try to avoid tax audits. Hence, firms could strategically respond to avoid tax audits. For instance, Almunia and Lopez-Rodriguez (2018) find significant evidence on downward size management by Spanish firms and show that firms strategically bunch below a certain threshold to avoid stricter tax audits. Under Risk-based tax audits, the probability and intensity of audits do not depend only on size but on the combination of non-compliance factors such as complexity, nature of business and, firms prior compliance behavior. Therefore, we expect that risk-based tax audits have a deterrence effect on firms of all sizes.

Small firms may pay limited attention and are not able to draw differentiated conclusions from information on the implementation of risk-based tax audits. Conversely, it is also possible that they change their cost/benefit consideration in employing tax professionals under risk-based tax audits. These professionals provide technical expertise to implement tax avoidance schemes, which offset the deterrent effect of risk-based audits.

Taken together, ex-ante it is unclear how the effect of risk-based audit differs across different size groups. In order to test the potential heterogeneous effects of different firm size groups, we split the sample into three size groups (*Ln Assets*) within country-year.

Table 7 presents the regression results of equation (1) for dependent variable *Tax Avoid* based on different sizes: large, medium, small. Interestingly, the results suggest that risk-based tax audits have a deterrence effect on all firms. Moreover, the effect is more pronounced for large firms, suggesting that risk-based tax audits increase control over the large taxpayers and improve the compliance of this group.

Note that Compustat only covers public firms, and thus small firms in our sample may already have a relatively larger size than private firms. As such, our result should be interpreted with caution.

<Insert Table 7 about here >

### 4.3 Robustness Tests: Difference-in-difference

To alleviate the concern that the result is driving by confounding factors, we use a different identification strategy and focus on countries that switch to a risk-based tax audit in our sample period. Using a difference-in-difference design, we compare the changes in tax avoidance for firms in countries switched to risk-based tax audits (treatment group) with changes for firms in countries that never implement risk-based audits (control group).

China, Czech Republic, Germany, Japan, and Korea do not use risk-based audits between 2014 to 2017. Georgia, Greece, Kenya, Thailand and Turkey start to employ risk-based audits in 2016. The US started a risk-based audit in 2015; however, because tax avoidance of US firms is too different from that of other countries in our sample and may affect the parallel trend assumption, we exclude it from the difference-in-difference test. Untabulated tests show that our result is robust with US firms. Accordingly, 2014 and 2015 serve as the pre-treatment years; while 2016 and 2017 serve as the post-treatment years.

The model is as follows:

$$TaxAvoid_{ijt} = \beta_0 + \beta_1 Treat_{ij} * Post_t + \delta X_{ijt} + \mu_i + \theta_t + \varepsilon_{ijt} \quad (2)$$

Our dependant variable is *Tax Avoid* and our coefficient of interest is the interaction term  $Treat_{ij} * Post_t$ , representing the relative change in tax avoidance between treated and control firms. We include firm- and country-specific characteristics that are used in our primary tests. Our models also include indicator variables for firm fixed effects to absorb unobservable time-invariant firm characteristics and year fixed effects to control for common time trends.

Figure 2 shows that before 2016—the year in which some countries switch to risk-based audit—there is a parallel trend in *Tax Avoid* between the treatment group and the control group. This provides comfort regarding the parallel trend assumption.



Table 8 shows the results of our difference-in-difference specification. The negative and significant coefficient of *Treat\*Post* suggests that relative to firms in the control group, treated firms reduce tax planning after a risk-based audit is introduced in the country. Our analysis confirms that the introduction of risk-based audits is associated with a decrease in tax avoidance.

<Insert Table 8 about here >

#### 4.4 Additional Tests: Tax Administration Performance

Next, we use country-level analysis to examine how risk-based tax audits affect the performance and efficiency of tax administrations in different countries. We employ the data from USAID, which compares the administrative frameworks, functions and performance of different tax administrations. To test for the association between risk-based tax audits and tax administration performance, we estimate the following regression at the country level:

$$\begin{aligned}
 &Tax\ Admin\ Performance_{j,t} \\
 &= \beta_0 + \beta_1 Risk\_basedAudit_{j,t} + \beta_2 Enforcement_{j,t} + \delta X_{j,t} + \varepsilon_{j,t} \quad (3)
 \end{aligned}$$

Where  $j$  is the country identifier, and  $t$  is the time identifier. *Tax Admin Performance* is one of three indicators: cost of collection, tax effort, and tax buoyancy which is described in detail below. We control for enforcement level and country characteristics (WGI governance measures). We also include country and year fixed effects.

We first use the cost of collection indicator, capturing the efficiency of tax authorities at using their financial resources to collect tax revenue. Our measure for the cost of collection (*Cost*) reflects the ratio of the total annual tax administration expenditures (budget) to the net tax revenue collected by the tax administration (it is expressed in percentage). A higher score indicates higher collection costs. The data is available for two points in time over the sample

period (in 2015 and 2017). Therefore, we replace the missing cost of collection data for 2014 with 2015 value, and for 2016 with 2017 value.

On the one hand, the employment of risk-based tax audits at the first stage is related to substantial costs in terms of data and IT systems. On the other hand, it decreases the enforcement cost by devoting the resources to the high-risk taxpayers. Hence, we test how the employment of risk-based tax audits influences the cost of collecting taxes. The results in column (1) of Table 9 indicate a lower cost of collection (-0.243) with the use of risk-based tax audits. More specifically, the employment of risk-based tax audits is associated with a lower cost of collection per 100 units of tax revenue. Whereas the positive coefficient estimate for *Enforcement*, suggesting that the cost of collection increases with higher enforcement levels (more tax administration employees per 100 firms). This result is consistent with OECD (2019), which shows that the use of automated risk management informed by advanced analytics reduces the cost per audit substantially.

Our second dependent variable, *Tax Effort* is attributed to the tax performance of tax administrations, which estimate what a country could potentially collect in taxes regarding its macroeconomic, demographic, and institutional features. The *Tax Effort* indicator equals the actual value of tax as a percent of GDP to tax capacity. In other words, it indicates how much tax revenue a country collects relative to its tax capacity (predicted value of tax as a percent of GDP regarding several factors such as macroeconomic, demographic, and institutional characteristics of a country). For example, a tax effort of 1.0 shows that a country is collecting exactly its predicted capacity. We replace the missing data for *Tax Effort* with the nearest observation. We expect that the employment of risk-based tax audits will increase the extent that a country could collect tax revenue to its full capacity with respect to its characteristics. Results reported in columns (2) and (3) of Table 9 also show that the use of risk-based tax audits

by tax administrations positively affects the *Tax Effort* in a country and could facilitate the tax collection of a country to reach its full potential.

The third indicator, *Tax Buoyancy*, provides insights on the extent to which tax collection responds to changes in the tax base measured by GDP. *Tax Buoyancy* is measured by the percent change of tax revenue divided by the percent change of the tax base or GDP. It is calculated based on 10-year rolling averages of the country's tax performance and economic growth. Therefore, we examine whether the employment of risk-based tax audits is associated with higher tax buoyancy. We expect that the employment of risk-based tax audits by tax administration could increase the tax revenue in proportion to an increase in GDP. Column (4) of Table 9 presents the results of the effect of risk-based audits on *Tax Buoyancy*. Specifically, the coefficient estimate on *Tax Buoyancy* is significantly positive. It means that the employment of risk-based tax audits is associated with an increase in the tax revenue at a faster rate relative to the growth in GDP.

Overall, we provide evidence that the employment of risk-based tax audits for selecting the firms decreases the cost of enforcement and improves the performance of tax authorities.

<Insert Table 9 about here >

## **5. Conclusion**

We conduct a cross-country study to explore whether and to what extent risk-based tax audits strategies are associated with firms' tax avoidance, after controlling for enforcement and other country characteristics. We use annual country-level OECD on audit case selection strategies across 54 countries from 2014 to 2017. We measure risk-based tax audits by the reported employment of risk profiling (business rules), predictive modeling, and internal intelligence function, in tax administrations' audit case selection criteria. Our results indicate that the employment of risk-based tax audits shows negative associations with corporate tax avoidance. We exploit a difference-in-difference design in robustness tests and compare the tax behavior

of firms in countries that switch to risk-based audits and firms in countries that never use risk-based audits (first difference) before and after the introduction of risk-based audit (second difference). The result is consistent with our primary analysis.

In cross-sectional tests, we show that risk-based tax audit strategies are effective tools to curb tax avoidance for firms in different size so that they could deter the strategic responses to audits, such as bunching below a certain threshold. We also find evidence that the use of risk-based tax audit strategies by tax administrations decreases the cost of enforcement and improves the performance of tax authorities.

However, it is important to emphasize that we cannot, nor do we attempt to infer any causality between the employment of risk-based tax audit strategies and corporate tax avoidance behavior. Instead, we attempt to paint a consistent picture of the association between the use of risk-based tax audit strategies and tax avoidance, which tax administrations actively seek to combat. To the best of our knowledge, this is the first cross-country study to examine the effect of risk-based tax audits on corporate tax avoidance. Our results indicate that tax administrations worldwide should increase their efforts in implementing and refining the risk assessment of firms to better target high-risk taxpayers.

While we were able to find cross-country data on risk-based tax audits, we acknowledge limitations in our measure of risk-based tax audits, which may imply that our results might be over/understated. We only could include case section strategies as included in the OECD questionnaire and as self-reported by tax administrations. Even though we are aware of the caveats, as the OECD's Tax Administration Comparative Information Series is the only source of cross-country data on risk-based tax audits. We believe that our risk-based tax audit measure will path the way for a more detailed measurement of risk-based audits for further research. Moreover, our results provide early insights into the effect of risk-based audits and will fuel future research on this topic and relevant questions.

## References

- Advani, A., Elming, W., Shaw, J., 2017. The Dynamic Effects of Tax Law, Institute for Fiscal Studies.
- Alexander, A., De Vito, A., Jacob, M., 2020. Corporate tax reforms and tax-motivated profit shifting: evidence from the EU. *Account. Bus. Res.* 50, 309–341. <https://doi.org/10.1080/00014788.2020.1712649>
- Allingham, M.G., Sandmo, A., 1972. Income tax evasion: A theoretical analysis. *J. Public Econ.* 1, 323–338. <https://doi.org/10.4324/9781315185194>
- Alm, J., McClellan, C., 2012. Tax morale and tax compliance from the firm’s perspective. *Kyklos* 65, 1–17. <https://doi.org/10.1111/j.1467-6435.2011.00524.x>
- Alm, J., McKee, M., 2004. Tax compliance as a coordination game. *J. Econ. Behav. Organ.* 54, 297–312. <https://doi.org/10.1016/j.jebo.2003.02.003>
- Almunia, M., Lopez-Rodriguez, D., 2018. Under the radar: The effects of monitoring firms on tax compliance. *Am. Econ. J. Econ. Policy* 10, 1–38.
- Armstrong, C.S., Glaeser, S., Huang, S., Taylor, D.J., 2019. The economics of managerial taxes and corporate risk-taking. *Account. Rev.* 94, 1–24. <https://doi.org/10.2308/accr-52193>
- Atwood, T.J., Drake, M.S., Myers, J.N., Myers, L.A., 2012. Home country tax system characteristics and corporate tax avoidance: International evidence. *Account. Rev.* 87, 1831–1860. <https://doi.org/10.2308/accr-50222>
- Ayers, B.C., Seidman, J.K., Towery, E.M., 2019. Tax Reporting Behavior Under Audit Certainty. *Contemp. Account. Res.* 36, 326–358. <https://doi.org/10.1111/1911-3846.12439>
- Bachas, P., Jaef, R.N.F., Jensen, A., 2018. Size-dependent tax enforcement and compliance: global evidence and aggregate implications. The World Bank.
- Battaglini, M., Guiso, L., Lacava, C., Patacchini, E., 2019. Tax Professionals: Tax-Evasion Facilitators or Information Hubs?, National Bureau of Economic Research. <https://doi.org/10.3386/w25745>
- Becker, G.S., 1968. Crime and Punishment : An Economic Approach. *J. Polit. Econ.* 76, 169–217.
- Beer, S., Kasper, M., Kirchler, E., Erard, B., 2020. Do audits deter or provoke future tax noncompliance? Evidence on self-employed taxpayers. *CESifo Econ. Stud.* 66, 248–264.
- Beer, S., Kasper, M., Kirchler, E., Erard, B., 2019. Do Audits Deter or Provoke Future Tax Noncompliance? Evidence on Self-employed Taxpayers. *IMF Work. Pap.* 19. <https://doi.org/10.5089/9781513515373.001>

- Belnap, A., Hoopes, J.L., Maydew, E.L., Turk, A., 2020. Real Effects of Tax Audits: Evidence from Firms Randomly Selected for IRS Examination. <https://doi.org/10.1017/CBO9781107415324.004>
- Chen, H., Yang, D., Zhang, X., Zhou, N., 2020. The moderating role of internal control in tax avoidance: evidence from a COSO-Based internal control index in China. *J. Am. Tax. Assoc.* 42, 23–55. <https://doi.org/10.2308/atax-52408>
- Chen, S., Chen, X., Cheng, Q., Shevlin, T., 2010. Are family firms more tax aggressive than non-family firms? *J. financ. econ.* 95, 41–61.
- Cowell, F., 2004. Carrots and Sticks in Enforcement, in: Aaron, H., Slemrod, J. (Eds.), *The Crisis in Tax Administration*. pp. 230–275.
- De Simone, L., Stomberg, B., Brian, W., Simone, L. De, Stomberg, B., Williams, B., 2019. Does Tax Enforcement Disparately Affect Domestic versus Multinational Corporations around the World? <https://doi.org/10.1017/CBO9781107415324.004>
- DeBacker, J., Heim, B.T., Tran, A., 2015a. Importing corruption culture from overseas: Evidence from corporate tax evasion in the United States. *J. financ. econ.* 117, 122–138. <https://doi.org/10.1016/j.jfineco.2012.11.009>
- DeBacker, J., Heim, B.T., Tran, A., Yuskavage, A., 2018. Once bitten, twice shy? The lasting impact of enforcement on tax compliance. *J. Law Econ.* 61, 1–35. <https://doi.org/10.1086/697683>
- DeBacker, J., Heim, B.T., Tran, A., Yuskavage, A., 2015b. Legal enforcement and corporate behavior: An analysis of tax aggressiveness after an audit. *J. Law Econ.* 58, 291–324. <https://doi.org/10.1086/684037>
- Dhimi, S., al-Nowaihi, A., 2007. Why do people pay taxes? Prospect theory versus expected utility theory. *J. Econ. Behav. Organ.* 64, 171–192. <https://doi.org/10.1016/j.jebo.2006.08.006>
- Edwards, A., Schwab, C., Shevlin, T., 2016. Financial Constraints and Cash Tax Savings. *Account. Rev.* 91, 859–881. <https://doi.org/10.2308/accr-51282>
- Erickson, M., Hanlon, M., Maydew, E.L., 2004. How much will firms pay for earnings that do not exist? Evidence of taxes paid on allegedly fraudulent earnings. *Account. Rev.* 79, 387–408. <https://doi.org/10.2308/accr.2004.79.2.387>
- Finley, A.R., 2019. The impact of large tax settlement favorability on firms' subsequent tax avoidance. *Rev. Account. Stud.* 24, 156–187.
- Gangl, K., Torgler, B., Kirchler, E., Hofmann, E., 2014. Effects of supervision on tax compliance: Evidence from a field experiment in Austria. *Econ. Lett.* 123, 378–382. <https://doi.org/10.1016/j.econlet.2014.03.027>

- Gemmell, N., Ratto, M., 2012. Behavioral responses to taxpayer audits: Evidence from random taxpayer inquiries. *Natl. Tax J.* 65, 33–58. <https://doi.org/10.17310/ntj.2012.1.02>
- Guala, F., Mittone, L., 2005. Experiments in economics: External validity and the robustness of phenomena. *J. Econ. Methodol.* 12, 495–515. <https://doi.org/10.1080/13501780500342906>
- Gupta, S., Lynch, D.P., 2015. The Effects of Changes in State Tax Enforcement on Corporate Income Tax Collections. *J. Am. Tax. Assoc.* 38, 125–143. <https://doi.org/10.2308/atax-51301>
- Hanlon, M., Heitzman, S., 2010. A review of tax research. *J. Account. Econ.* 50, 127–178. <https://doi.org/10.1016/j.jacceco.2010.09.002>
- Hanlon, M., Mills, L., Slemrod, J., 2007. An Empirical Examination of Corporate Tax Noncompliance, in: *Taxing Corporate Income in the 21st Century*.
- Hanlon, M., Slemrod, J., 2009. What does tax aggressiveness signal? Evidence from stock price reactions to news about tax shelter involvement. *J. Public Econ.* 93, 126–141. <https://doi.org/10.1016/j.jpubeco.2008.09.004>
- Hasan, I., Hoi, C.-K.K.S., Wu, Q., Zhang, H., 2017. Does Social Capital Matter in Corporate Decisions? Evidence from Corporate Tax Avoidance. *J. Account. Res.* 55, 629–668. <https://doi.org/10.1111/1475-679X.12159>
- Hashimzade, N., Myles, G., 2017. Risk-based Audits in a Behavioral Model. *Public Financ. Rev.* 45, 140–165. <https://doi.org/10.1177/1091142115602062>
- Hashimzade, N., Myles, G.D., Rablen, M.D., 2016. Predictive analytics and the targeting of audits. *J. Econ. Behav. Organ.* 124, 130–145. <https://doi.org/10.1016/j.jebo.2015.11.009>
- HM Revenue & Customs, 2019. Measuring tax gaps 2019. Tax gap estimates for 2017-18.
- Hoopes, Jeffrey L.; Mescall, Devan; Pittman, Je.A., 2012. Do IRS Audits Deter Corporate Tax Avoidance? *Account. Rev.* 87, 1603–1639. <https://doi.org/10.16194/j.cnki.31-1059/g4.2011.07.016>
- Hoopes, J.L., Mescall, D., Pittman, J.A., 2012. Do IRS Audits Deter Corporate Tax Avoidance? *Account. Rev.* 87, 1603–1639. <https://doi.org/10.16194/j.cnki.31-1059/g4.2011.07.016>
- Hsu, K.-W., Pathak, N., Srivastava, J., Tschida, G., Bjorklund, E., 2015. Data Mining Based Tax Audit Selection: A Case Study of a Pilot Project at the Minnesota Department of Revenue BT - Real World Data Mining Applications, in: Abou-Nasr, M., Lessmann, S., Stahlbock, R., Weiss, G.M. (Eds.), . Springer International Publishing, Cham, pp. 221–245. [https://doi.org/10.1007/978-3-319-07812-0\\_12](https://doi.org/10.1007/978-3-319-07812-0_12)
- IRS, 2019. Federal Tax Compliance Research : Tax Gap Estimates for Tax Years 2011 – 2013.

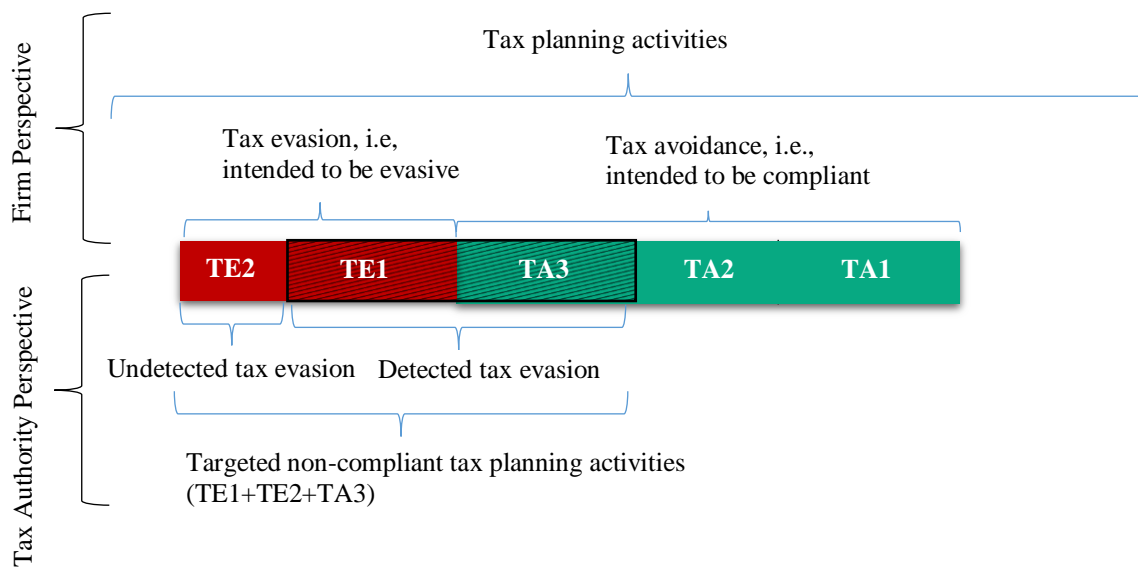
- Jackson, B.R., Milliron, V.C., 1986. Tax compliance research: Findings, problems, and prospects. *J. Account. Lit.* 5, 125–165.
- Jacob, M., Rohlfing-Bastian, A., Sandner, K., 2019. Why do not all firms engage in tax avoidance? *Rev. Manag. Sci.* 1–37.
- Jimenez, P., Iyer, G.S., 2016. Tax compliance in a social setting: The influence of social norms, trust in government, and perceived fairness on taxpayer compliance. *Adv. Account.* 34, 17–26.
- Kasper, M., Alm, J., 2020. Audits, Audit Effectiveness, and Post-audit Tax Compliance. <https://doi.org/10.2139/ssrn.3695035>
- Kastlunger, B., Kirchler, E., Mittone, L., Pitters, J., 2009. Sequences of audits, tax compliance, and taxpaying strategies. *J. Econ. Psychol.* 30, 405–418. <https://doi.org/10.1016/j.joep.2008.10.004>
- Keen, M., Slemrod, J., 2017. Optimal tax administration. *J. Public Econ.* 152, 133–142. <https://doi.org/10.1016/j.jpubeco.2017.04.006>
- Khwaja, M.S.M.S., Awasthi, R., Loeprick, J., Awasth, R., Loeprick, J., 2011. Risk-Based Tax Audits: Approaches and Country Experiences. The International Bank for Reconstruction and Development / The World Bank. <https://doi.org/10.1596/978-0-8213-8754-2>
- Kleven, H.J., Knudsen, M.B., Kreiner, C.T., Pedersen, Sø., Saez, E., 2011. Unwilling or Unable to Cheat? Evidence From a Tax Audit Experiment in Denmark. *Econometrica* 79, 651–692. <https://doi.org/10.3982/ecta9113>
- Law, K.K.F., Mills, L.F., 2017. Military experience and corporate tax avoidance. *Rev. Account. Stud.* 22, 141–184. <https://doi.org/10.1007/s11142-016-9373-z>
- Lisowsky, P., Robinson, L., Schmidt, A., 2013. Do Publicly Disclosed Tax Reserves Tell Us About Privately Disclosed Tax Shelter Activity? *J. Account. Res.* 51, 583–629. <https://doi.org/10.1111/joar.12003>
- Loyland, K., Raaum, O., Torsvik, G., Ovrum, A., 2019. Compliance effects of risk- based tax audits.
- Marchese, C., Venturini, A., 2020. Tax Preparers and Tax Evasion: Punishing Tax Payers or Tax Preparers? *FinanzArchiv* 76, 191. <https://doi.org/10.1628/fa-2020-0001>
- McCrary, J., Lee, D.S., 2009. The deterrence effect of prison: Dynamic theory and evidence.
- Mendoza, J.P., Wielhouwer, J.L., Kirchler, E., 2017. The backfiring effect of auditing on tax compliance. *J. Econ. Psychol.* 62, 284–294. <https://doi.org/10.1016/j.joep.2017.07.007>
- Mills, L.F., Sansing, R.C., 2000. Strategic Tax and Financial Reporting Decisions: Theory and Evidence. *Contemp. Account. Res.* 17, 85–106. <https://doi.org/10.1111/j.1911-3846.2000.tb00912.x>



- Mittone, L., 2006. Dynamic behaviour in tax evasion: An experimental approach. *J. Socio. Econ.* 35, 813–835.
- Mittone, L., Panebianco, F., Santoro, A., 2017. The bomb-crater effect of tax audits: Beyond the misperception of chance. *J. Econ. Psychol.* 61, 225–243. <https://doi.org/10.1016/j.joep.2017.04.007>
- Nessa, M., Schwab, C.M., Stomberg, B., Towery, E.M., 2020. How do IRS resources affect the corporate audit process? *Account. Rev.* 95, 311–338. <https://doi.org/10.1017/CBO9781107415324.004>
- OECD, 2019. *Tax Administration 2019: Comparative Information on OECD and other Advanced and Emerging Economies*. Paris.
- OECD, 2017. *Tax Administration 2017: Comparative Information on OECD and other Advanced and Emerging Economies*.
- OECD, 2004. *Compliance Risk Management: Audit Case Selection Systems*. Inf. Note 127, 45.
- Riedel, N., Strohmaier, K., Lediga, C., 2019. *Spatial Tax Enforcement Spillovers: Evidence from South Africa?* Verein für Socialpolitik / German Economic Association.
- Slemrod, J., 2019. Tax Compliance and Enforcement. *J. Econ. Lit.* 57, 81–102. <https://doi.org/10.1093/acprof:oso/9780190619725.003.0006>
- Slemrod, J., 2018. Tax Compliance and Enforcement, *Journal of Economic Literature*. <https://doi.org/10.1093/acprof:oso/9780190619725.003.0006>
- Slemrod, J., Blumenthal, M., Christian, C., 2001. Taxpayer response to an increased probability of audit: evidence from a controlled experiment in Minnesota. *J. Public Econ.* 79, 455–483.
- Slemrod, J., Yitzhaki, S., 1987. The Optimal Size of a Tax Collection Agency. *Scand. J. Econ.* 89, 183–192. <https://doi.org/10.2307/3440063>
- Tan, F., Yim, A., 2014. Can strategic uncertainty help deter tax evasion? An experiment on auditing rules. *J. Econ. Psychol.* 40, 161–174. <https://doi.org/10.1016/j.joep.2012.11.005>

# Figure 1

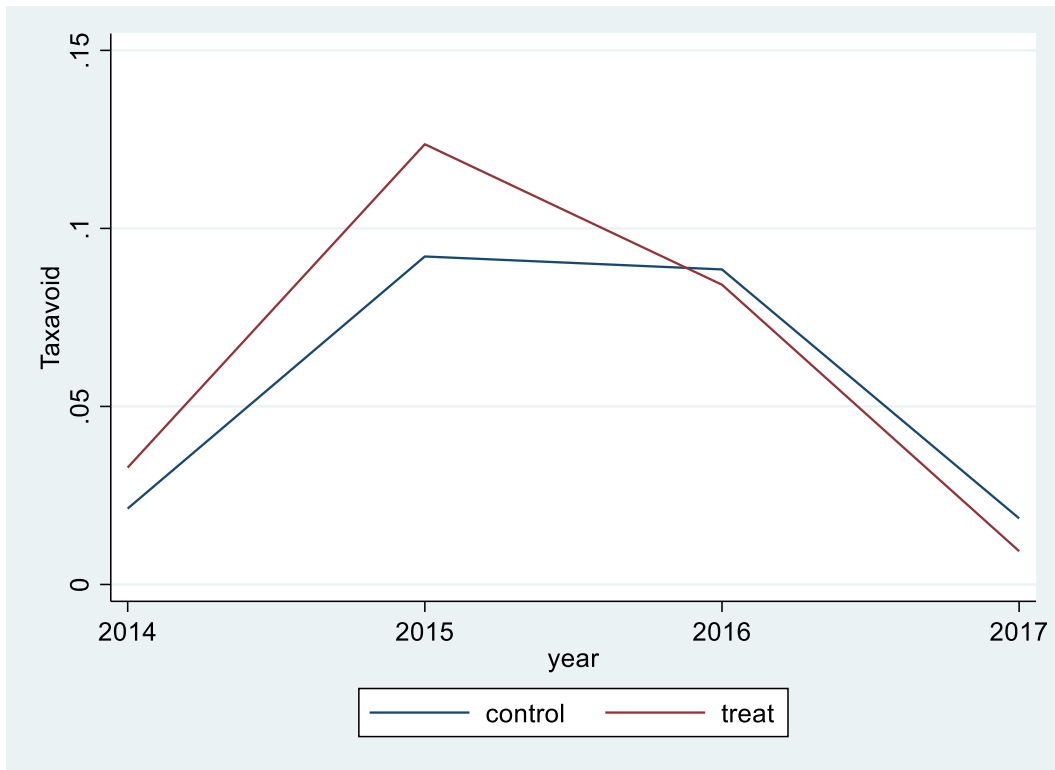
## Explanation of Non-compliance and Tax Avoidance



Notes: This figure illustrates different components of tax avoidance and tax evasion from both the firms' and tax authorities' perspective. By definition, firms' tax avoidance activities are intended to be compliant. From a firms' perspective, tax avoidance can be split into three parts: tax avoidance, which after a tax audit, does not experience a post-audit adjustment (Tax avoidance 1), tax avoidance, which after a tax audit, leads to a post-audit adjustment (Tax avoidance 2), and: tax leads to a post-audit adjustment and is qualified as tax evasion by the tax authority (Tax avoidance 3). Furthermore, tax planning activities might be intended to be non-compliant (tax evasion). This tax evasion might either be detected or undetected under a tax audit. Detected tax evasion may arise from the firm's tax-avoiding or tax evasion activities.

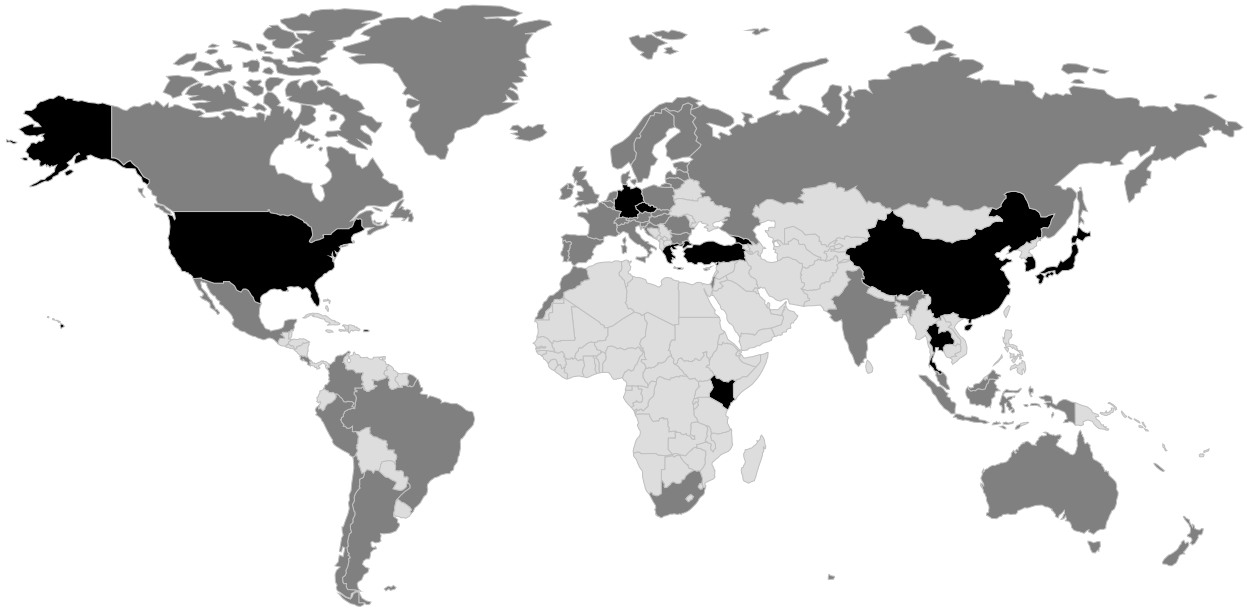
**Figure 2**

**Difference-in-difference**

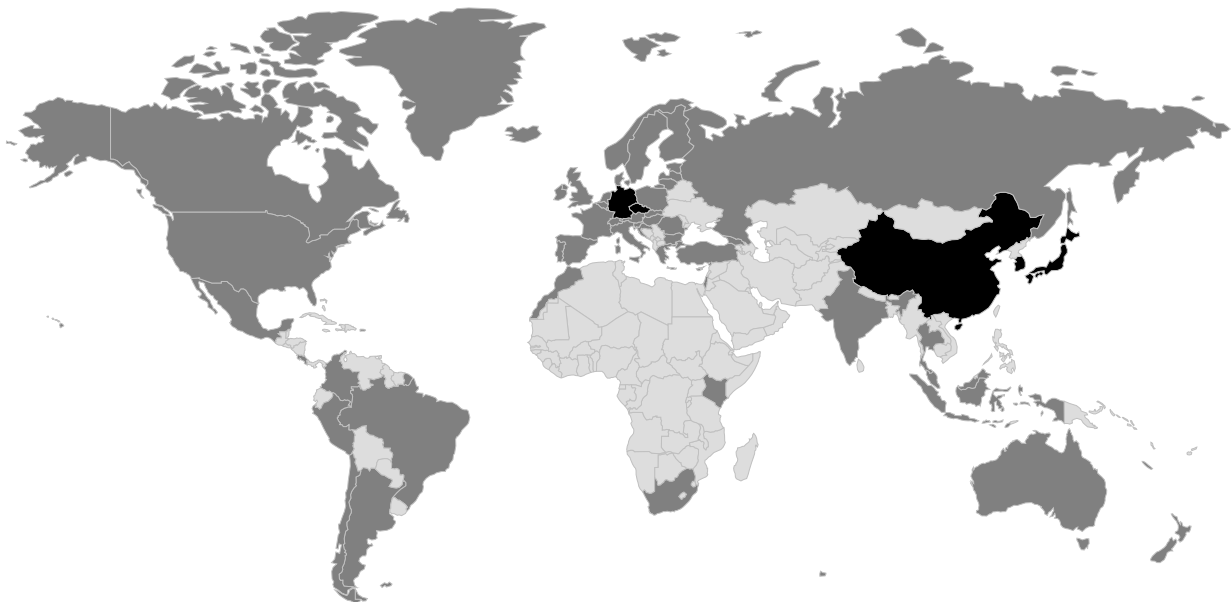


**Figure 3**

**Risk-based Tax Audit Across Countries 2014**



**Risk-based Tax Audit Across Countries 2017**



**Table 1: Audit Case Selection Strategies-OECD**

Examples of audit case selection published by OECD

Item	Rating
Risk-based Audit Selection	
(1) Economic sector	1 – Yes   0 – No
(2) Location	1 – Yes   0 – No
(3) Taxpayer category	1 – Yes   0 – No
(4) Ownership in a corporate entity	1 – Yes   0 – No
(5) Taxpayer behavior	1 – Yes   0 – No
(6) Frequency (time between audits)	1 – Yes   0 – No
<b>(7) Risk profiling - business rules</b>	1 – Yes   0 – No
<b>(8) Risk profiling - predictive modelling</b>	1 – Yes   0 – No
<b>(9) Internal intelligence function</b>	1 – Yes   0 – No
(10) Third party information	1 – Yes   0 – No
(11) Commercial register	1 – Yes   0 – No
(12) Collected tax	1 – Yes   0 – No
(13) Significant changes to taxpayer	1 – Yes   0 – No
(14) Audits as a result of BEPS or ATP issues	1 – Yes   0 – No
(15) Audits as a result of international EOI	1 – Yes   0 – No
(16) Tax control framework based “audits”	1 – Yes   0 – No
(17) Compliance checks	1 – Yes   0 – No
(18) Information cross checking	1 – Yes   0 – No
(19) Random Audit	1 – Yes   0 – No

Source: The OECD's Tax Administration Comparative Information Series, 2014-2019

**Table 2: Variable Definition**

<b>Panel A: Firm-level variables</b>		
<b>Variable</b>	<b>Definitions</b>	<b>Source</b>
<i>Tax Avoid</i>	$[(PTI * \text{Statutory Tax Rate}) - CTP] / PTI$ , where PTI = pre-tax earnings (PI) less special items (SPI), STR is the combined average statutory corporate income tax rate at all layers of government in the country during the year $t$ , obtained from KPMG, and CTP = current taxes paid, measured as total tax expense (TXT) less deferred taxes (TXDI). Based on De Simone et al., (2019) and Atwood et al. (2012)	Compustat
<i>Pre-Tax ROA</i>	Pre-tax Income (PI) scaled by lagged total assets (AT).	Compustat
<i>Prior Loss</i>	A dummy variable, equal to 1 if the firm had negative <i>Pre-Tax ROA</i> in the previous year and 0 otherwise	
<i>Sales Growth</i>	Percentage change in Sales (SALE) from year $t-1$ to year $t$ .	Compustat
<i>PP&amp;E</i>	Net property, plant, and equipment (PP&ENT) scaled by lagged total assets (AT).	Compustat
<i>Leverage</i>	Sum of long-term and short-term debt, scaled by lagged total assets, set to 0 if missing	Compustat
<i>R&amp;D</i>	R&D Expense in year $t$ scaled by lagged total assets, set to zero if missing	Compustat
<i>Cash</i>	Cash and equivalents scaled by lagged total assets, set to zero if missing	Compustat
<i>Ln Assets</i>	Natural log of total assets	Compustat
<b>Panel B: Country-level variables</b>		
<b>Variable</b>	<b>Definitions</b>	<b>Source</b>
<i>Risk-based Audit</i>	An indicator variable equal to one if risk profiling - business rules or risk profiling - predictive modelling or Internal intelligence function equal to one from OECD audit case selection data.	OECD's Tax Administration Comparative Information Series
<i>Enforcement</i>	The number of full-time employees in tax administration/total number of active firms (corporate income tax payers) multiplied by 100. If the number of active taxpayers is missing, we replace it with the number of total taxpayers	OECD's Tax Administration Comparative Information Series
<i>Statutory tax rate</i>	The average statutory corporate income tax rate in the country at year $t$	KPMG
<i>Ln (GDP per capita)</i>	Natural logarithm of per-capita GDP	World Bank
<i>GDP Growth</i>	The percentage change in GDP in a country from year $t-1$ to $t$	World Bank
<i>Control of Corruption</i>	A yearly estimate of perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption	World Bank Worldwide Governance Indicators (WGI)

<i>Voice and Accountability</i>	A yearly estimate of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media	World Bank Worldwide Governance Indicators (WGI)
<i>Political Stability</i>	A yearly estimate of citizens perception of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism	World Bank Worldwide Governance Indicators (WGI)
<i>Government Effectiveness</i>	A yearly estimate which captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies	World Bank Worldwide Governance Indicators (WGI)
<i>Regulatory Quality</i>	Yearly estimate which captures the perception of the ability of the government to formulate and implement policies and regulations	World Bank Worldwide Governance Indicators (WGI)
<i>Rule of Law</i>	Yearly estimate which captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence	World Bank Worldwide Governance Indicators (WGI)
<i>Cost</i>	The ratio of the cost of administering the tax system to the total revenues collected by the tax administration. It is expressed as a percentage or as the cost of collecting 100 currency units of tax revenue.	USAID's Collecting Taxes Database (CTD)
<i>Tax Effort</i>	Yearly estimate, which compares the actual value of tax as a percent of GDP to tax capacity.	USAID's Collecting Taxes Database (CTD)
<i>Tax Buoyancy</i>	The percent change of tax revenue divided by the percent change of the tax base or GDP.	USAID's Collecting Taxes Database (CTD)

**Table 3: Mean of Selected Variables by Country**

<b>Country</b>	<b>Tax Avoid.</b>	<b>STR</b>	<b>No. of Firms</b>
Argentina	0.008	0.35	158
Australia	0.061	0.30	1,040
Austria	0.028	0.25	175
Belgium	0.080	0.34	233
Brazil	0.089	0.34	471
Bulgaria	-0.055	0.10	103
Canada	0.089	0.27	2,016
Chile	-0.038	0.23	307
China	0.007	0.25	11,838
Colombia	-0.066	0.27	101
Croatia	0.048	0.20	133
Cyprus	-0.037	0.13	78
Czech Republic	-0.006	0.19	34
Denmark	-0.006	0.23	202
Estonia	0.016	0.20	48
Finland	-0.052	0.20	314
France	0.060	0.33	1,317
Germany	-0.011	0.30	1,151
Greece	-0.042	0.28	239
Hong Kong	-0.056	0.17	436
Hungary	-0.072	0.16	46
Iceland	0.030	0.20	24
Indonesia	-0.068	0.25	767
Ireland	-0.067	0.13	154
Israel	0.006	0.25	659
Italy	-0.079	0.30	636
Japan	0.010	0.33	865
Kenya	-0.069	0.30	71
Korea	-0.109	0.23	18
Latvia	0.071	0.15	45
Lithuania	0.010	0.15	88
Luxembourg	-0.009	0.29	124
Malaysia	-0.048	0.24	1,121
Malta	0.108	0.35	28
Mexico	-0.093	0.30	217
Morocco	-0.002	0.31	154
Netherlands	0.008	0.25	319
New Zealand	0.016	0.28	227
Norway	0.008	0.26	199
Peru	-0.060	0.29	181
Poland	-0.004	0.19	1,404
Portugal	-0.112	0.21	111
Romania	-0.070	0.16	141
Russia	-0.041	0.20	487
Singapore	-0.061	0.17	1,096
Slovak Republic	0.017	0.22	13
Slovenia	-0.005	0.18	60
South Africa	0.010	0.28	442
Spain	-0.033	0.27	322
Sweden	0.008	0.22	650
Thailand	0.022	0.20	753
Turkey	0.014	0.20	535
United Kingdom	0.003	0.20	1,782
United States	0.188	0.40	9,679



**Table 4: Descriptive Statistics**

<b>Variable</b>	<b>Obs.</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>P25</b>	<b>P50</b>	<b>P75</b>
<i>Tax Avoid.</i>	43812	0.044	0.255	-0.021	0.063	0.161
<i>Pre-tax ROA</i>	43812	0.095	0.094	0.035	0.069	0.122
<i>Prior loss</i>	43812	0.095	0.293	0.000	0.000	0.000
<i>Sales growth</i>	43812	0.145	0.376	-0.008	0.071	0.192
<i>PP&amp;E</i>	43812	0.303	0.262	0.087	0.238	0.456
<i>leverage</i>	43812	0.249	0.233	0.054	0.207	0.372
<i>R&amp;D</i>	43812	0.016	0.033	0.000	0.000	0.019
<i>Cash</i>	43812	0.194	0.213	0.051	0.125	0.258
<i>Ln (Assets)</i>	43812	6.268	2.176	4.910	6.190	7.634
<i>Risk-based Audit</i>	43812	0.604	0.489	0.000	1.000	1.000
<i>Ln (Enforcement)</i>	43812	0.512	0.821	-0.298	0.730	0.956
<i>STR</i>	43812	28.223	7.418	25.000	25.000	33.860
<i>Ln (GDP per capita)</i>	43812	9.958	0.954	8.897	10.496	10.843
<i>GDP Growth</i>	43812	3.710	2.410	2.210	2.881	6.737
<i>Corruption</i>	43812	0.766	0.946	-0.270	1.259	1.497
<i>Voice and Accountability</i>	43812	0.209	1.221	-1.505	1.004	1.110
<i>Political Stability</i>	43812	0.203	0.670	-0.499	0.336	0.678
<i>Government Effectiveness</i>	43812	1.029	0.656	0.408	1.352	1.554
<i>Regulatory Quality</i>	43812	0.847	0.855	-0.148	1.157	1.628
<i>Rule of Law</i>	43812	0.817	0.955	-0.263	1.413	1.645
<i>Transparency</i>	43504	4.725	1.398	3.552	4.770	5.652
<i>Governments Decisions</i>	43504	4.832	1.197	4.408	4.864	5.466

All the continuous variables are winsorised at the 1st and 99th percentiles

**Table 5: Correlations**

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1) <i>Tax Avoid.</i>	1.000														
2) <i>Risk-based Audit</i>	0.038*	1.000													
3) <i>Ln (Enforcement)</i>	-0.172*	-0.284*	1.000												
5) <i>Prior loss</i>	0.001	0.092*	-0.050*	-0.077*	1.000										
6) <i>Sales growth</i>	0.038*	-0.066*	0.024*	0.285*	0.101*	1.000									
7) <i>PP&amp;E</i>	0.018*	-0.002	0.030*	-0.009	0.013*	0.090*	1.000								
8) <i>Leverage</i>	0.047*	0.114*	-0.112*	-0.104*	0.065*	0.189*	0.240*	1.000							
9) <i>R&amp;D</i>	0.049*	-0.173*	0.053*	0.198*	0.001	0.120*	-0.174*	-0.161*	1.000						
10) <i>Cash</i>	-0.003	-0.223*	0.049*	0.415*	-0.015*	0.246*	-0.181*	-0.210*	0.333*	1.000					
11) <i>Ln (Assets)</i>	0.060*	-0.031*	-0.203*	-0.186*	-0.108*	-0.033*	0.096*	0.278*	-0.087*	-0.193*	1.000				
12) <i>STR</i>	0.285*	0.050*	-0.523*	0.002	0.020*	-0.045*	-0.085*	0.130*	0.065*	-0.074*	0.291*	1.000			
13) <i>Ln (GDP per capita)</i>	0.175*	0.509*	-0.383*	-0.034*	0.088*	-0.079*	-0.113*	0.127*	-0.029*	-0.181*	0.187*	0.460*	1.000		
14) <i>GDP Growth</i>	-0.110*	-0.584*	0.364*	0.032*	-0.093*	0.094*	0.038*	-0.130*	0.117*	0.231*	-0.094*	-0.383*	-0.683*	1.000	
15) <i>Corruption</i>	0.133*	0.485*	-0.295*	-0.029*	0.079*	-0.074*	-0.106*	0.089*	-0.025*	-0.165*	0.116*	0.284*	0.931*	-0.590*	1.000

\* shows significance at the .05 level

**Table 6: Risk-based Tax Audits and Tax Avoidance**

<b>VARIABLES</b>	<b>(1) Tax Avoid.</b>	<b>(2) Tax Avoid.</b>
<i>Risk-based Audit</i>	-0.037** (0.014)	-0.032*** (0.010)
<i>Ln (Enforcement)</i>	-0.031** (0.013)	-0.027*** (0.010)
<i>Pretax ROA</i>	0.312*** (0.086)	0.298*** (0.092)
<i>Prior loss</i>	-0.005 (0.014)	-0.006 (0.014)
<i>Sales growth</i>	0.008* (0.004)	0.011** (0.005)
<i>PP&amp;E</i>	0.063*** (0.018)	0.070*** (0.016)
<i>leverage</i>	-0.021 (0.033)	-0.028 (0.033)
<i>R&amp;D</i>	0.404*** (0.085)	0.280*** (0.075)
<i>Cash</i>	-0.048** (0.024)	-0.038* (0.019)
<i>Ln (Assets)</i>	-0.001 (0.002)	-0.003** (0.001)
<i>Ln (GDP per capita)</i>	0.080** (0.038)	0.038** (0.019)
<i>GDP Growth</i>	0.003 (0.004)	0.005 (0.004)
<i>Corruption</i>	-0.040 (0.033)	-0.085** (0.040)
<i>Voice and Accountability</i>		-0.012 (0.013)
<i>Government Effectiveness</i>		-0.069 (0.043)
<i>Political Stability</i>		-0.040** (0.020)
<i>Rule of Law</i>		0.283*** (0.054)
<i>Regulatory Quality</i>		-0.122*** (0.026)
Constant	-0.791** (0.369)	-0.385** (0.181)
Observations	43,812	43,812
R-squared	0.107	0.127
Industry FE	yes	yes
Year FE	yes	yes

This table presents the results of equation (1). The dependent variable is *Tax Avoid.*, measured as the difference between taxes calculated at the statutory tax rate and taxes that are actually paid, based on De Simone et al. (2019) and Atwood et al. (2012). Our main variable of interest, *Risk-based Audit*, is an indicator variable equal to one if risk profiling - business rules, risk profiling - predictive modelling or Internal intelligence function equal to one from OECD audit case selection data. All continuous variables are winsorised at the 1% and 99% level. Variables are defined in Table 2. Industry and year fixed effects are included in all regressions. We report robust standard errors clustered at the country level in parentheses. \*, \*\*, and \*\*\* denote significance at the 10%, 5%, and 1% levels, respectively.

**Table 7: Risk-based Tax Audit and Firm Size**

VARIABLES	(1) Small Firms Tax Avoid.	(2) Medium Firms Tax Avoid.	(3) Large Firms Tax Avoid.
<i>Risk-based Audit</i>	-0.036** (0.014)	-0.036*** (0.014)	-0.051*** (0.017)
<i>Ln (Enforcement)</i>	-0.014 (0.012)	-0.028** (0.012)	-0.052*** (0.014)
<i>Pretax ROA</i>	0.273*** (0.050)	0.405*** (0.093)	0.290 (0.185)
<i>Prior loss</i>	0.025* (0.013)	-0.013 (0.023)	-0.044*** (0.012)
<i>Sales growth</i>	0.013* (0.007)	0.004 (0.007)	0.016 (0.010)
<i>PP&amp;E</i>	0.036** (0.015)	0.049*** (0.017)	0.086*** (0.031)
<i>leverage</i>	-0.009 (0.012)	-0.024 (0.038)	-0.022 (0.055)
<i>R&amp;D</i>	0.615*** (0.119)	0.241** (0.107)	0.094 (0.086)
<i>Cash</i>	-0.022 (0.016)	-0.029 (0.025)	-0.099* (0.050)
<i>Ln (Assets)</i>	-0.010** (0.004)	0.000 (0.004)	0.001 (0.002)
<i>Ln (GDP per capita)</i>	0.058* (0.035)	0.067** (0.033)	0.112** (0.044)
<i>GDP Growth</i>	0.000 (0.004)	0.003 (0.004)	0.003 (0.005)
<i>Corruption</i>	-0.034 (0.033)	-0.034 (0.028)	-0.046 (0.036)
<i>Constant</i>	-0.515 (0.311)	-0.664** (0.313)	-1.176*** (0.436)
Observations	14,604	14,604	14,604
R-squared	0.076	0.091	0.202
industry FE	yes	yes	yes
year FE	yes	yes	yes

This table presents the results of equation (1) split by size quantile. The dependent variable is *Tax Avoid.*, measured as the difference between taxes calculated at the statutory tax rate and taxes that are actually paid, based on De Simone et al. (2019) and Atwood et al. (2012). Our main variable of interest, Risk-Based Audit, is an indicator variable equal to one if risk profiling - business rules, risk profiling - predictive modelling or Internal intelligence function equal to one from OECD audit case selection data. All continuous variables are winsorised at the 1% and 99% level. Variables are defined in Table 2. Industry and year fixed effects are included in all regressions. We report robust standard errors clustered at the country level in parentheses. \*, \*\*, and \*\*\* denote significance at the 10%, 5%, and 1% levels, respectively.

**Table 8: Difference-in-difference**

VARIABLES	(1) Tax Avoid.
<i>Treat*Post</i>	-0.030** (0.015)
<i>Ln (Enforcement)</i>	-3.278 (2.503)
<i>Pretax ROA</i>	0.525*** (0.061)
<i>Prior loss</i>	0.001 (0.017)
<i>Sales growth</i>	0.017** (0.008)
<i>PP&amp;E</i>	-0.053** (0.027)
<i>leverage</i>	-0.031 (0.025)
<i>R&amp;D</i>	-0.190 (0.198)
<i>Cash</i>	-0.037*** (0.013)
<i>Ln (Assets)</i>	-0.004 (0.010)
<i>Ln (GDP per capita)</i>	0.039 (0.149)
<i>GDP Growth</i>	0.010* (0.005)
<i>Corruption</i>	-0.068 (0.107)
<i>Constant</i>	-0.286 (1.347)
<hr/>	
Observations	15,521
R-squared	0.046
Number of firm	5,131
firm FE	yes
year FE	yes

Notes: Our dependant variable is *Taxavoid* and our coefficient of interest is the interaction term *Treat\*Post*, representing the relative change in tax avoidance between treated and control firms. We include firm- and country-specific characteristics that are used in our primary tests. Our models also include indicator variables for firm fixed effects to absorb unobservable time-invariant firm characteristics, and year fixed effects to control for common time trends.

**Table 9: Risk-based Tax Audit and Tax Administration Performance**

VARIABLES	(1) Cost	(2) Tax Effort With Imputation	(3) Tax Effort Without Imputation	(4) Tax Buoyancy
<i>Risk-based Audit</i>	-0.243** (0.108)	0.051* (0.029)	0.075** (0.033)	0.075* (0.040)
<i>Ln (Enforcement)</i>	0.108*** (0.036)	0.030 (0.020)	0.026 (0.021)	0.010 (0.015)
<i>Voice and Accountability</i>	0.316*** (0.109)	0.035 (0.037)	0.020 (0.040)	0.106* (0.053)
<i>Political Stability</i>	0.158* (0.089)	-0.037 (0.028)	-0.092*** (0.024)	0.026 (0.041)
<i>Government Effectiveness</i>	0.852*** (0.275)	-0.185** (0.082)	-0.178* (0.105)	0.213 (0.164)
<i>Regulatory Quality</i>	-0.134 (0.215)	-0.147*** (0.051)	-0.140*** (0.051)	-0.010 (0.113)
<i>Rule of Law</i>	-0.577* (0.313)	0.049 (0.072)	0.152 (0.099)	-0.138 (0.136)
<i>Corruption</i>	0.022 (0.190)	0.159** (0.060)	0.096 (0.075)	-0.092 (0.089)
<i>Ln (GDP per capita)</i>	-0.409*** (0.125)	0.089** (0.035)	0.079** (0.036)	0.006 (0.046)
<i>GDP Growth</i>	-0.007 (0.013)	-0.009** (0.004)	-0.015** (0.008)	-0.003 (0.004)
<i>Constant</i>	4.623*** (1.151)	-0.190 (0.308)	-0.118 (0.311)	-0.132 (0.405)
Observations	196	200	68	216
R-squared	0.412	0.498	0.559	0.099
year FE	yes	yes	yes	yes

Notes: This table presents the results of equation (3). In column (1), the dependent variable is *Cost*, equals the ratio of the cost of administering the tax system to the total revenues collected by the tax administration. In column (2) and (3), the dependent variable is *Tax Effort*, which compares the actual value of tax as a percent of GDP to tax capacity. In column (4), the dependent variable is *Tax Buoyancy*, which equals the percent change of tax revenue divided by the percent change of the tax base or GDP. Our main variable of interest, *Risk-based Audit*, is an indicator variable equal to one if risk profiling - business rules or risk profiling - predictive modelling or Internal intelligence function equal to one from OECD audit case selection data. Variables are defined in Table 2. Year fixed effects are included in all regressions. We report robust standard errors clustered at the country level in parentheses. \*, \*\*, and \*\*\* denote significance at the 10%, 5%, and 1% levels, respectively.

## Appendix

**Table A1: Reconciliation of Individual and Corporate Tax Behavior**

	<i>individual tax behavior</i>	<i>corporate tax behavior</i>
a positive association between tax audits and compliance	Kleven et al. (2011) Advani et al. (2017) DeBacker et al. (2018)	Hoopes et al. (2012) Gupta and Lynch (2015) Atwood et al. (2012)
a negative association between tax audits and compliance	Mittone (2006) Guala & Mittone (2005)	DeBacker et al. (2015) Finley (2019)

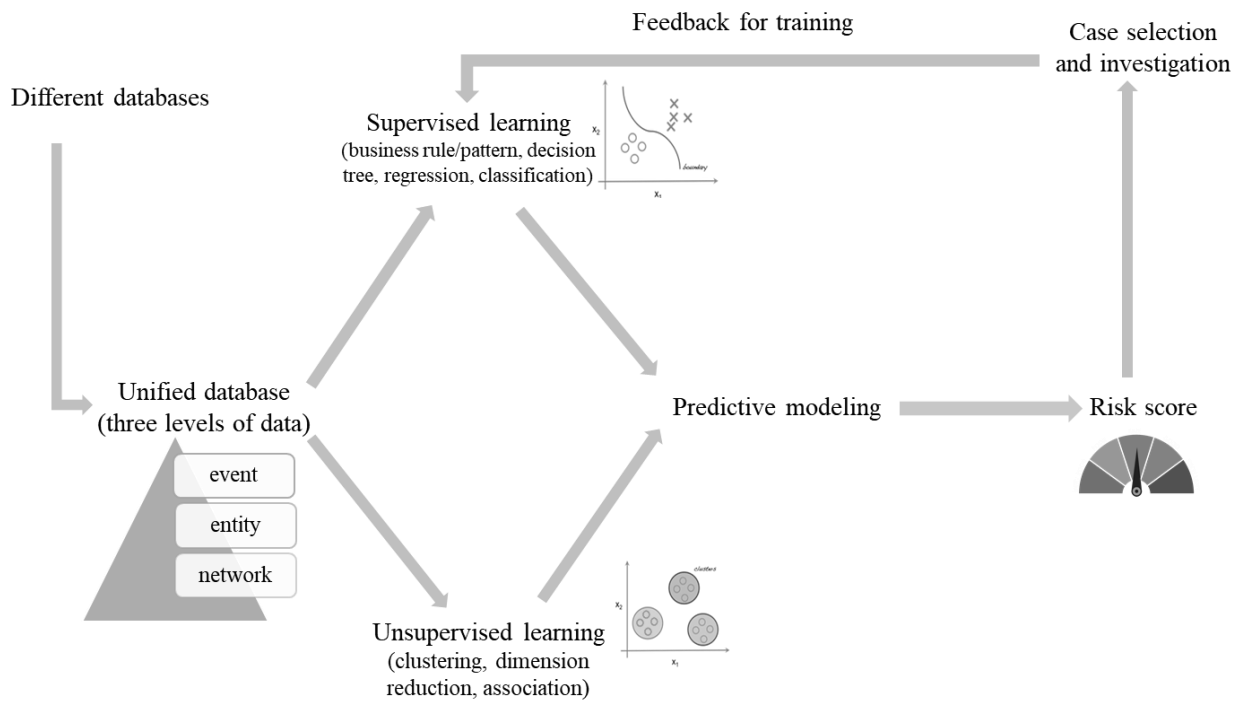
**Table A2: Risk-based Tax Audit - Country Experiences**

<b>Country</b>	<b>Risk-based tax audits</b>
Australia	The Australian Tax Office uses a risk-based approach to increase the detection capability of the revenue authority. It employs a range of activities aimed at preventing, deterring, detecting, and dealing with the risks of non-compliance. This risk-based approach includes techniques such as qualitative, quantitative assessment, and probability forecasts using predictive techniques.
Austria	Austria uses risk analysis systems using tax returns and case history information and evaluates/compares this information to assign risk levels to each taxpayer.
Bulgaria	Risk analysis and risk criteria at the national level. In Bulgaria, past taxpayer data, supplemented with external data, are gathered to create risk scores and categories. The risk-assessment employs the point systems, which generates points based on different criteria and determines the taxpayers' total risk score.
Canada	Audit selection based on data-mining techniques (neural networks, decision trees) In Canada, data is extracted from several systems to identify the highest risk taxpayers in the small and medium enterprises (SME) population. Data mining/machine learning algorithms, including cluster analysis, decision trees, neural networks, and deep learning, are used in developing the SME predictive models for income.
France	Audit selection is based on data-mining and other statistical tools.
Malaysia	Data-driven audit case selection (automated audit selection). The risk-based audit techniques also include advanced analytics using statistical models.
Netherlands	Dutch Tax and Customs Administration gathers and analyzes many types of information at the central level, including the industry sector-related information, information from tax returns, compliance surveys, risk database, third-party information, and information from other authorities. It employs risk-based approaches, such as data-matching and advanced analytics.
Sweden	In Sweden, risk-based tax audits are employed using data at both central and regional levels. The risk-based tax audit techniques include data-matching and predictive techniques such as predictive models to identify unreported income.
Turkey	Risk-based audits are centralized at the national level. Risk-based audit techniques based on data mining.
United Kingdom	HM Revenue and Customs employs extensive data-matching and data-mining techniques (including decision trees and neural networks), score-based risk assessment, using statistical tools.

Source: Khwaja et al. (2011), (OECD, 2004, 2016, 2017, 2019), Tax administrations websites



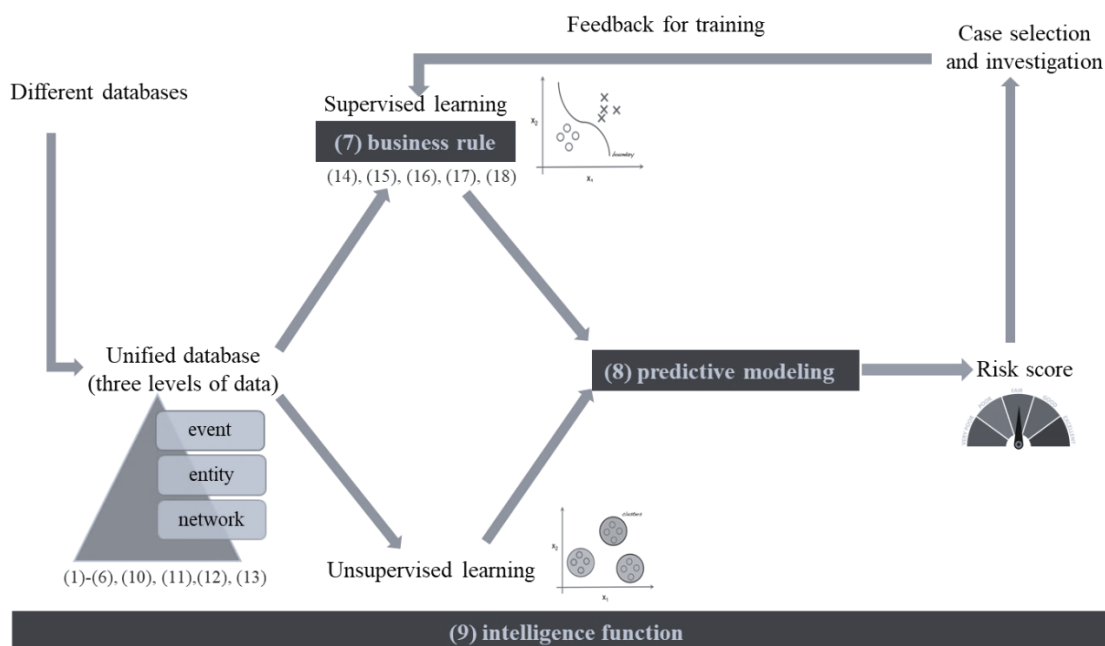
**Figure A1: Example of the Risk-based Audit Process**



Note: Risk-based tax audits use a comprehensive dataset of taxpayers' information, employ advanced analytical techniques which include the process of applying statistical and automated machine-learning techniques to trace and identify risky cases

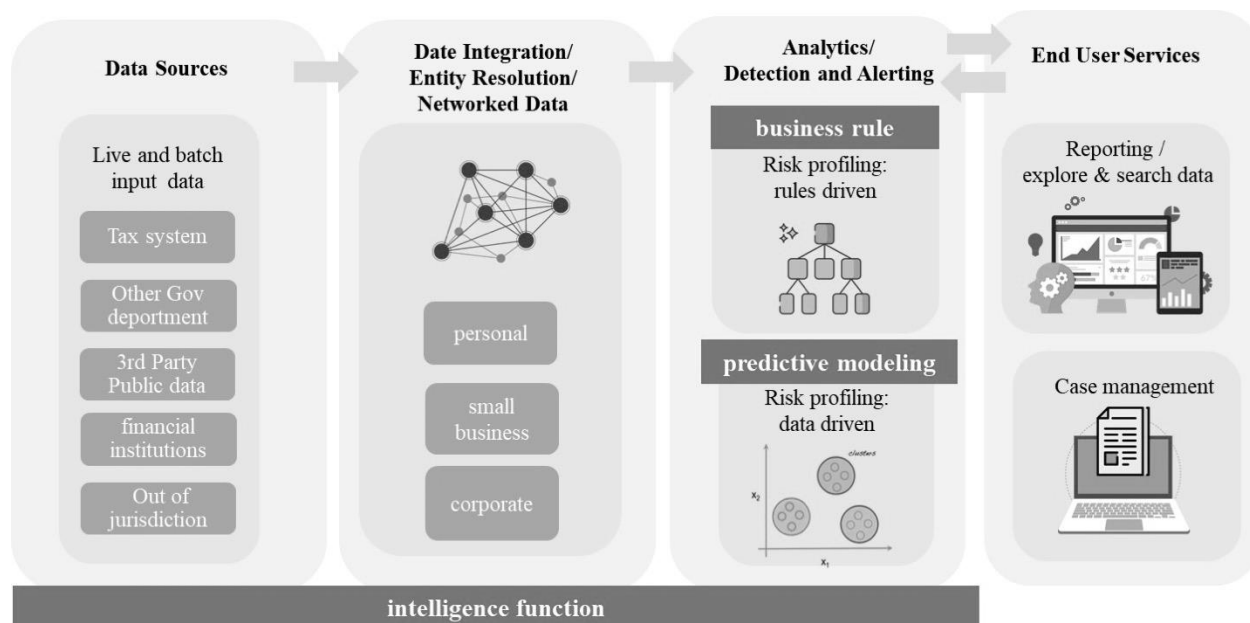
**Figure A2: Example of the Risk-based Audit Measure and Other Items in OECD Audit**

**Case Selection Strategies**



Note: Numbers represent OECD Audit Case Selection Strategies items in Table 1. Our measure of risk-based audit include: (7) Risk profiling - business rules, (8) risk profiling - predictive modelling, and (9) internal intelligence function. Risk-Based Audit Selection. Other items are: (1) Economic sector(2) Location, (3) Taxpayer category, (4) Ownership in a corporate entity, (5) Taxpayer behaviour, (6) Frequency (time between audits), (7) Third party information , (8) Commercial register, (9) Collected tax, (10) Significant changes to taxpayer, (11) Audits as a result of BEPS or ATP issues, (12) Audits as a result of international EOI, (13) Tax control framework based "audits", (14) Compliance checks, (15) Information cross checking, (16) Random Audit

**Figure A3: Example of the Risk-based Audit Measure**



Note: Numbers represent OECD Audit Case Selection Strategies items in Table 1. Our measure of risk-based audit include: (7) Risk profiling - business rules, (8) risk profiling - predictive modelling, and (9) internal intelligence function. Risk-Based Audit Selection. Other items are: (1) Economic sector(2) Location, (3) Taxpayer category, (4) Ownership in a corporate entity, (5) Taxpayer behaviour, (6) Frequency (time between audits), (7) Third party information , (8) Commercial register, (9) Collected tax, (10) Significant changes to taxpayer, (11) Audits as a result of BEPS or ATP issues, (12) Audits as a result of international EOI, (13) Tax control framework based "audits", (14) Compliance checks, (15) Information cross checking, (16) Random Audit