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Incentive effects of tax transparency: Does country-by-country reporting call for arbitration? ☆

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ABSTRACT

The OECD proposes mandatory fiscal arbitration as a means of dispute resolution between tax authorities to avoid double taxation of multinational enterprises' profits. We investigate the effects of mandatory fiscal arbitration on tax-audit qualities in a two-country setting with country-by-country reporting (CbCR) and a tax rate differential. Our analytical model shows that tax-audit quality in the high-tax country increases under CbCR because finer information raises tax-audit effectiveness. In contrast, the low-tax country refrains from auditing as it benefits from profit shifting. While arbitration resolves double taxation, its effects on tax-audit quality depend on the procedure in place. An approach based on exogenous negotiation powers lowers audit quality, a final-offer arbitration preserves audit quality, and an independent-opinion arbitration with minimum-quality requirement offers the strongest audit incentives: even the low-tax country engages in auditing. Our findings contribute to the policy debate about interdependencies between firm-level tax policies, national fiscal enforcement, and international fiscal cooperation.

1. Introduction

Tax avoidance through transfer pricing by multinational enterprises (MNEs) has raised significant public attention in the last decade.¹ Information asymmetries about the true nature of MNEs' international business operations raise concerns that MNEs would not contribute their fair share to public expenditures (Leonhardt, 2016; Foley and Temple-West, 2023). Accordingly, the Organisation

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¹ See, for example, Cristea and Nguyen (2016) and Klassen et al. (2017) for overviews.

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for Economic Co-operation and Development (OECD) suggests increased tax transparency as a means to curb MNEs' profit shifting. In line with Action 13 of the OECD's 'Inclusive Framework on Base Erosion and Profit Shifting' (BEPS) that stipulates additional disclosure requirements, more than 110 countries have adopted country-by-country reporting (CbCR).² Recently, the European Union even extended transparency requirements to public CbCR (European Union, 2021).

In response, MNEs worry about an aggravated risk of double taxation caused by CbCR, as tax authorities could use the extended information endowment by adjusting transfer prices unilaterally to raise tax revenues. For example, Marie van Veen, former vice president of tax at DuPont, fears that "tax authorities [...] pull out what they like [...], without having a conversation with the company about what's really happening in each country", see Harpaz (2016). In its guidance on the use of the information contained in CbC reports (OECD, 2017, p. 9), the OECD also warns that CbC reports would "not contain detailed information on a particular entity's income and expenditure or transactions it has entered into with third parties or related parties." It stresses the lack of information on intra-group risk and the allocation of functions and assets in CbC reports. The OECD concludes that "tax adjustments based solely on information contained in a CbC Report [...] could result in an incorrect tax assessment [...] and possibly double taxation if this cannot be corrected." Similarly, Hanlon (2018) finds that corporate experts are afraid of an increase in controversy costs due to CbCR.

To better protect MNEs from double taxation, BEPS Action 14 calls for improved dispute resolution by introducing mandatory fiscal arbitration between the involved tax authorities.³ However, compared to the adoption of CbCR, the implementation of advanced arbitration procedures has evolved more slowly (OECD, 2024c). As arbitration eliminates double taxation, its introduction modifies MNEs' incentives for profit shifting. Tax authorities adjust their tax-audit strategies according to the enhanced information endowment through CbCR and the incentive effects resulting from the arbitration procedure in place. Since higher tax-audit quality reduces successful profit shifting as intended by the BEPS project, increasing tax-audit quality seems politically desirable.

Our paper addresses the tension between profit shifting, tax auditing, and arbitration. The research question is how information endowment and mandatory fiscal arbitration affect optimal tax-audit quality. We analyze simultaneously the effects of CbCR and arbitration on tax-audit incentives, total tax payments of MNEs, and the allocation of tax bases among the MNE-hosting countries. We are the first to analytically show the relevance of the arbitration procedure for the effectiveness of tax audits in a CbCR setting. Our contribution is threefold: First, we add to the tax-audit literature by emphasizing the impact of a finer information endowment on optimal tax-audit qualities. Besides CbCR, our approach can be extended to other information-enhancing initiatives, such as the automatic exchange of tax rulings and the substantial activities requirement in no or only nominal tax jurisdictions (OECD, 2019b). Second, we establish a link between selected arbitration procedures and optimal tax-audit policies. Third, we contribute to the tax policy discussion by highlighting the different incentives for countries with higher or lower tax rates resulting from alternative arbitration procedures.

In our model, crucial elements are the MNE, the tax authorities, and the applied arbitration procedure: The MNE operates in both a high-tax and a low-tax country. We use the terms high-tax and low-tax country in a relative sense, indicating that the high-tax country's tax rate exceeds the low-tax country's. Thus, the low-tax country is not necessarily a tax haven. Tax rate differentials always create an incentive for profit shifting.⁴ Due to tax audits and the resulting income corrections, the MNE does not always succeed in profit shifting. Real economic decisions such as investment and production decisions are not part of our model. Tax authorities decide whether to audit. Refraining from a tax audit avoids audit costs but implies that the MNE's report is not challenged. In contrast, if a tax audit takes place, the tax authorities further decide on the audit quality. Audit quality can be varied between a minimum quality level and perfect quality. If audit quality is not perfect, profit shifting can be overlooked, or the MNE can be wrongly accused of profit shifting. The latter of these model properties addresses the above-mentioned concerns that erroneous conclusions could be drawn based on CbC reports. We take a legalistic perspective and exclude mala fide audits, i.e., tax audits are prohibited if tax authorities can infer the true state of nature without an audit. An arbitration procedure will be initiated if demanded by the MNE that suffers from double taxation. The arbitration panel can use the MNE's report and the tax authorities' audit findings as information sources. Depending on the arbitration procedure, audit quality can be used as a tax allocation measure, potentially altering audit incentives.

The model proceeds in three steps: First, we analyze a benchmark scenario in which the two tax authorities receive information about domestic profits only. Thus, the tax authorities base their respective audit decisions on limited information. This reflects the world without CbCR and without arbitration. In the second scenario, tax authorities receive information about the global profit and its distribution, i.e., reported income in both the domestic and the foreign jurisdictions. Consequently, tax authorities base their audit decisions on finer information (see Blackwell, 1951, 1953) that allows a better assessment of the tax report's reliability. In a third scenario, in addition to CbCR, we introduce mandatory fiscal arbitration between the two tax authorities, which protects the MNE from double taxation.

Our results show that CbCR increases tax-audit quality in the high-tax country compared to the benchmark scenario, as audit effectiveness benefits from a finer information endowment. This is advantageous for the high-tax country that can secure a larger fraction of the total tax base. In contrast, the low-tax country has no incentives to conduct a tax audit in the benchmark scenario or under CbCR. Finally, the probability of conflicting assessments and double taxation increases under CbCR compared to the benchmark case. The high-tax country concludes more often that the MNE shifted profits and increases the tax base unilaterally. However, the low-tax country never reduces its tax base correspondingly.

² For an overview of the current state of the adoption process see OECD (2024a).

³ In this paper, we use the term arbitration as a short form of mandatory binding fiscal arbitration.

⁴ In contrast to the theoretical tax evasion literature founded by Allingham and Sandmo (1972) dealing with illegal and punishable tax underpayments (for a retrospective see Sandmo, 2005), we focus on tax avoidance by (legal) means of profit shifting to low-tax jurisdictions.

Arbitration prevents double taxation, reduces the total tax base, and thereby affects audit incentives. The impact of arbitration on tax-audit quality strongly depends on the procedure applied. Arbitration based on the countries' exogenous negotiation power decreases the tax-audit quality of the high-tax country. A final-offer procedure leads to the same equilibrium audit quality as without arbitration. The low-tax country does not audit in either setting. Only an independent-opinion procedure can induce an equilibrium in which both countries audit and choose a higher tax-audit quality than without arbitration.

We are the first to provide a consistent theory on the effects of private CbCR and arbitration on tax-audit quality that can be used as a basis for future empirical studies. Due to the lack of a sound theoretical foundation, prior studies do not base their hypotheses on an analytical model. We contribute to a novel stream of literature that focuses on the interplay between disclosure requirements, tax enforcement, and firm-level reporting policies (for earlier complementary empirical analyses, see, for example, Joshi, 2020; Bozanic et al., 2017; Kubick et al., 2016; Hoopes et al., 2012).

Our results speak to the relationship between public policy and the use of accounting as an information provision system⁵ in three ways. First, they show how improving the information endowment of tax authorities by finer tax accounting information, e.g., through CbCR, reduces information asymmetry between taxpayers and tax authorities. Since tax authorities can better allocate sparse tax-audit capacities, both the use of tax accounting information and the quality of enforcement are improved.⁶ Second, our results illustrate the interrelation between the quality of tax accounting information and fiscal arbitration, another public policy instrument to reallocate taxable profits that has been frequently discussed. They emphasize the connection between the selected arbitration procedure and optimal tax-audit quality. Third, in addition to the conventional tax assessment function, tax accounting serves as an information instrument resembling financial accounting because recipients other than the domestic tax administration receive decision-useful information from tax accounting.⁷ Our results show the interdependencies between the tax audits in various jurisdictions and their implications for the quality of accounting information.⁸

In the remainder of the paper, we first describe the relevant elements of the institutional setting and provide an overview of the related literature (Section 2). Section 3 introduces the main characteristics and assumptions of our analytical model. Section 4 presents our analysis in the national setting where each tax authority only learns about domestic profits. Section 5 analyzes a CbCR setting in which the MNE must disclose information on profits in both jurisdictions, but double taxation remains unresolved. Section 6 analyzes a setting with CbCR and arbitration, considering three different arbitration procedures. Section 7 concludes.

2. Institutional background

2.1. Country-by-country reporting

In general, the reporting requirements proposed by BEPS Action 13, as enacted by most participating countries, rest on three elements:

1. A master file providing a high-level overview. It displays information regarding global business operations, transfer pricing policies, and the ownership of intangibles.
2. Local files compiling detailed country- and transaction-specific transfer pricing documentation. They provide technical information for the review of applied transfer prices to the involved tax authorities.
3. The country-by-country reporting itself; tax authorities can perform a high-level risk assessment with the provided information. The CbC report has to be provided by entities with a consolidated annual group revenue of at least EUR 750 million (Council of the European Union, 2016).⁹ CbC reports include information about the global allocation of revenues, income, and income taxes paid and accrued. Further indicators for the significance of economic activities have to be provided for each jurisdiction.¹⁰ Prominent indicators are stated capital, tangible assets, and number of employees.¹¹ In general, submitted reports are confidential, but an automatic exchange of data is supposed to take place between the domestic country of the ultimate parent and the tax authorities of all MNE-hosting jurisdictions. As a consequence, tax authorities have access to tax information beyond their own jurisdiction. Typically, CbCR relies on reciprocity in the sense that participating countries send and receive CbC reports. However, a few non-reciprocal countries provide CbC reports to other countries but refrain from receiving other countries' CbC reports.¹²

⁵ See Stolowy et al. (2024, p. 4 ff.).

⁶ Chen et al. (2021) show that the adoption of XBRL for financial reporting and its impact on IRS scrutiny provides another example of the public policy relevance of information processing by tax authorities. In a similar vein, Xiao and Shao (2020) analyze the effects of a standardized tax information system on tax enforcement in China.

⁷ The potential decision usefulness of public CbCR for financial statement users is also highlighted by Brown et al. (2019).

⁸ For a theoretical model addressing the relation between tax and statutory audits, see Blaufus et al. (2024).

⁹ For US groups, a threshold of USD 850 million applies, see IRS (2016). Canada uses the same threshold as the EU, see Canada Revenue Agency (2020).

¹⁰ This includes measures such as tangible assets that are common in a formula apportionment context, see Martini et al. (2012).

¹¹ The informativeness of these indicators for tax purposes can be challenged. For instance, Eberhartinger and Petutschnig (2017) demonstrate ambiguity regarding the definition of the number of employees.

¹² The OECD classifies 16 out of 144 jurisdictions in the CbCR database as non-reciprocal. Non-reciprocal countries are Anguilla, Bahrain, Belize, Bermuda, British Virgin Islands, Cayman Islands, Curacao, Macau, Montserrat, Oman, Papua New Guinea, Qatar, Romania, Tunisia, Turks & Caicos Islands, United Arab Emirates. See OECD (2024b) and OECD (2023a). Of these, only Romania has a significant amount of transfer pricing-related arbitration cases (82 open cases out of 6,209 cases worldwide at the end of 2022); the next most relevant countries are Oman (4 cases) and Tunisia (3 cases). Therefore, we do not consider non-reciprocity in our model.

The following overview of empirical findings distinguishes between private and public CbCR. Although only the former is in the scope of our paper, the latter contributes to our understanding of incentive effects caused by CbCR.

Under private CbCR, fiscal information is disclosed exclusively to tax authorities. Analyzing a proprietary data set of more than 3,600 CbC reports from MNEs, Fuest et al. (2022) estimate a reduction of 15% of overall tax payments due to profit shifting despite the introduction of CbCR. They do so by identifying significant imbalances between the distribution of real economic activity indicators, such as employees or tangible assets, and the distribution of profits. The economic magnitude of their findings calls for an efficient application of scarce tax-audit capacity. In this vein, we analyze optimal tax-audit quality conditional on the information endowment. Bozanic et al. (2017) analyze the complementary effects of public and non-CbCR private tax information in the US and the impact of this information on IRS scrutiny. Their evidence suggests that disclosure requirements have an impact on tax enforcement. Although not based on a CbCR setting, this evidence is in line with our finding that tax authorities in the high-tax country increase tax-audit quality when receiving finer information under CbCR compared to the benchmark setting. Exploiting the disclosure threshold of EUR 750 million, Joshi (2020) finds a 1–2 percentage point increase in consolidated GAAP effective tax rates among affected firms and provides evidence for a decline in tax-motivated income shifting, in line with an anticipation of the new rulings by the affected companies.¹³ Pointing to potential double taxation and a higher tax-audit quality, our study offers an alternative explanation for increasing effective tax rates under CbCR. Hanlon (2018) provides a general discussion of the costs and benefits expected from CbCR. We extend this discussion by providing a formal theory that predicts the impact of CbCR on MNEs' and tax auditors' incentives (see also Evers et al., 2017, p. 13).

Going beyond the exchange of information between tax authorities, public CbCR in the EU requires MNEs to disclose fiscal information to all interested parties. The public CbCR directive was published in the Official Journal of the European Union on December 1, 2021. EU member states were obliged to transfer this directive into national law by June 2023 (European Union, 2021). Australia currently introduces a similar regulation (Parliament of Australia, 2024). Moreover, public CbCR is applied in selected sectors, such as the finance or the extractive and logging industries. In an event study based on the introduction of public CbCR in selected sectors, Dutt et al. (2019) find a slightly more negative investor reaction for banks with activities in selected tax havens and B2C banks. In an analysis of segment reporting and public CbCR, Brown et al. (2019) find a positive association between tax haven intensity and geographic segment aggregation. Consistent with profit-shifting activities, they find that EU banks report significantly higher profit margins and lower book effective tax rates for operations located in tax havens. The results of Joshi et al. (2020) suggest that an increase in fiscal transparency can deter tax-motivated income shifting but does not significantly influence the banks' overall tax avoidance. Overesch and Wolff (2021) examine implications of CbCR for tax avoidance of multinational banks with undisclosed tax haven accounts. They find that the tax expenses of these banks increased relative to multinational banks with no activities in tax havens and to domestic banks unaffected by public CbCR. Eberhartinger et al. (2021) show that the number of subsidiaries of European banks in tax havens declines significantly after the introduction of public CbCR, but only in tax havens that offer both tax shelter and financial secrecy. The effects are stronger for banks with high reputational risk. Johannesen and Larsen (2016) find that the stricter disclosure obligation for firms from the extractive sector is associated with decreases in firm value, indicating that CbCR contributes to reducing rents created by tax avoidance. Whereas our study focuses on the interaction between the MNE and the tax authorities and does not consider certain aspects of public CbCR, such as reputational effects, it can serve as a theoretical basis for future empirical studies in this area. For example, it provides insights into the interplay between profit-shifting activities of the MNE, tax enforcement, and resulting tax payments.

2.2. Fiscal arbitration

Double taxation occurs when one of the two involved countries increases the tax base unilaterally. This is rightfully done whenever transfer prices are not considered arms-length; see Article 9 para. 1 of the 'OECD Model Tax Convention on Income and on Capital' (MTC) (OECD, 2019a). In this case, MNEs can demand a corresponding tax base reduction in the other country (Article 9 para. 2 MTC). Given this offset fails for whatever reason, the MNEs can request a mutual agreement procedure (MAP) to eliminate double taxation (Article 25 MTC). However, tax authorities are not obligated to reach an agreement, and in 2022, only 59% of all MAPs ended with an agreement fully eliminating double taxation (OECD, 2023a). Empirically, the excessive duration of many MAPs and the large number of pending cases identify MAPs as an insufficient tool to overcome double taxation, creating long-term tax uncertainty for MNEs.¹⁴ If a MAP does not lead to an agreement within two years, Article 25 para. 5 MTC entitles the taxpayer to request binding arbitration. Existing double taxation treaties, however, do not always follow the MTC and do not necessarily apply mandatory binding arbitration.¹⁵

¹³ Exploiting the same disclosure threshold, De Simone and Olbert (2022) find evidence consistent with multinational firms adapting real investment decisions to reduce the appearance of tax aggressiveness. Given their sample periods - 2011-2017 in Joshi (2020) and 2012-2018 in De Simone and Olbert (2022) - the effects reported in these early studies are probably attributable to MNEs' anticipation of increased audit risk rather than actual audits. Future studies can investigate tax authorities' actual use of CbC data in tax audits.

¹⁴ For example, at the end of the 2022 reporting period, the OECD's statistics report a total number of 6,209 open transfer pricing cases out of a total of 9,228 cases (OECD, 2023a), of which 5,398 cases were received in 2016 or later. The average time for resolving transfer pricing cases in 2022 was 28.9 months. See also Appendix A for more details on the number and duration of arbitration cases.

¹⁵ Out of 140 countries surveyed by OECD (2024d), 41 responded "yes" to the question "Do all your jurisdiction's tax treaties contain a provision which would oblige your jurisdiction to make corresponding adjustments or to grant access to the MAP with respect to the economic double taxation that may otherwise result from a primary transfer pricing adjustment (i.e. is paragraph 2 of Article 9 of the OECD Model Tax Convention or the UN Model Double Taxation Convention included in all of your jurisdiction's tax treaties)?" However, not all of these 41 countries apply mandatory binding arbitration. Moreover, 58 of the 76 countries that responded with

To overcome dispute resolution problems, three important approaches have to be mentioned. First, BEPS Action 14 defines a minimum standard with regard to efficient MAP procedures. It should ensure that treaty obligations are fully implemented in good faith, that cases are resolved in a timely manner, that administrative processes are implemented to promote the prevention and timely resolution of treaty-related disputes, and that taxpayers can access a MAP when eligible. As a central element, the OECD recommends the introduction of mandatory binding arbitration. According to OECD (2023b), 4,485 out of 5,975 double taxation treaties, or 75%, are already in line with the minimum standard in BEPS action 14, and 627 double taxation treaties are currently being revised accordingly. Although the minimum standard in BEPS action 14 does not strictly require mandatory binding arbitration, 31 mostly large countries have chosen to apply it by 2021 (EY, 2021). Consequently, we take the OECD (2015b) recommendation of mandatory binding arbitration as a starting point for our analysis.

Second, BEPS Action 15 (OECD, 2015a) proposes the ‘Multilateral Convention to Implement Tax Treaty Related Measures to Prevent Base Erosion and Profit Shifting’ (OECD, 2016b), often referred to as ‘Multilateral Instrument’ (MLI), to modify a large number of bilateral double taxation treaties simultaneously. The MLI includes provisions on dispute resolution in Articles 16–26. Article 19 MLI regulates mandatory binding arbitration. How many jurisdictions finally decide to apply this instrument to implement binding arbitration remains to be seen.¹⁶

Third, within the EU, MNEs may also refer to another dispute resolution mechanism, namely the ‘Convention on the Elimination of Double Taxation’ (‘Union Arbitration Convention’) (European Union, 1990) which was extended by the ‘Directive on Tax Dispute Resolution Mechanisms in the European Union’ (European Union, 2017).

Having clarified MNEs’ options to initiate binding arbitration, we turn to the decision processes within an arbitration panel. Despite the extensive legal and procedural framework on MAPs and arbitration, little is known about the decision processes within an arbitration panel. Commonly, bilateral double taxation treaties define a default type of arbitration process. Article 23 para. 1 lit. c MLI suggests final-offer arbitration,¹⁷ in which the arbitration panel is limited to choosing one of the two solutions submitted by the two countries. However, countries can also decide that the arbitration panel can apply an independent-opinion approach¹⁸ in which the arbitration panel decides the case independently of the solutions proposed by the two countries (Article 23 para. 2 MLI). Out of 140 countries surveyed in OECD (2024e), 30 reported an arbitration profile. 21 countries mention final-offer arbitration as their default method, whereas only 9 tend to favor independent-opinion arbitration. However, most responding jurisdictions are also willing to accept the other arbitration method if that is the other country’s default approach.¹⁹ In both cases, the tax authorities typically justify their positions by means of tax assessment notices, the proceedings of tax audits, or position papers. Nevertheless, given the potentially different negotiation powers of the involved countries and the existence of other bilateral negotiations (horse trading), it is also possible that the resolution of a tax dispute is not purely driven by content-related considerations. Rather, resources available for arbitration procedures in the tax authorities and general foreign-policy issues can affect the outcome. It is also conceivable that several similar cases are negotiated jointly. Given the uncertainty about the arbitrator’s actual decision-making, we consider different procedures in our analysis.

We extend the existing literature on the effects of various fiscal arbitration procedures by focusing on an international context where taxable income is disputed between two tax authorities. Sansing (1997) analyzes the incentives to choose voluntary binding arbitration using an independent-opinion or final-offer approach over litigation in a two-player game between the government and the taxpayer. Based on a US setting, he extends the model of Samuelson (1991) by allowing for an endogenous choice of the arbitration method.

Besides considering the international disclosure and arbitration environment, our paper differs from the aforementioned studies by considering the choice of tax-audit quality by the two tax authorities. We thereby draw on the game-theoretical literature on tax compliance and tax audits, such as Graetz et al. (1986), Reinganum and Wilde (1986, 1988), Beck and Jung (1989), Sansing (1993), Rhoades (1999), Mills et al. (2010), and Reineke et al. (2023a,b), who analyze strategic interactions between an individual taxpayer and the tax authority. Form et al. (2024) find that the availability of dispute resolution procedures typically induces MNEs to set tax-aggressive transfer prices, but in some cases, induce the taxpayer to report more profit in the high-tax country. Our study is related to De Waegenaere et al. (2006, 2007) in that we analyze an international tax compliance game with two tax authorities and a taxpayer. De Waegenaere et al. (2006) investigate the effects of inconsistent transfer pricing rules on the tax authorities’ audit decision and the resulting tax liabilities. They find that the risk of double taxation through inconsistent transfer pricing rules has an ambiguous effect on the expected tax liability. De Waegenaere et al. (2007) analyze the use of Bilateral Advance Pricing Agreements to resolve transfer pricing disputes and avoid double taxation. We add to these studies by modeling the different information environments under a purely national and a CbCR setting and by considering arbitration as a conflict resolution mechanism.

“no” or with detailed explanations claim that most or almost all of their double taxation treaties include either a clause in accordance with Article 9 para. 2 MTC or provide access to a MAP. These numbers show the heterogeneous application of arbitration procedures.

¹⁶ The OECD MLI matching database shows how a specific bilateral double taxation treaty will be affected by the jurisdictions’ general MLI positions (OECD, 2022a).

¹⁷ Synonyms are last-best-offer arbitration, baseball arbitration, or winner-takes-all arbitration.

¹⁸ An alternative term is conventional arbitration. In our model, we analyze the special case of independent-opinion arbitration with minimum-quality requirement. In short, we refer to this approach as minimum-quality arbitration.

¹⁹ For further details see OECD (2016a) or European Union (2017, Article 10 para. 2).

3. The model

We consider an MNE with subsidiaries in countries H and L. Country H has a higher tax rate than country L. MNE’s subsidiaries generate profits $x = (x_H, x_L)$. Each profit amounts either to the low level of 1 or to the high level of 2, i.e., $x_H, x_L \in \{1, 2\}$. The probability of realizing a high profit in a particular country depends on country-specific factors such as business cycle, legal environment, and market conditions. The strictly positive variables $p_{ij}, i, j \in \{1, 2\}$, indicate the probabilities of realizing a specific profit combination. For instance, realizing low profits in country H and high profits in country L is indicated by p_{12} . Fig. 1 provides a timeline of the model.

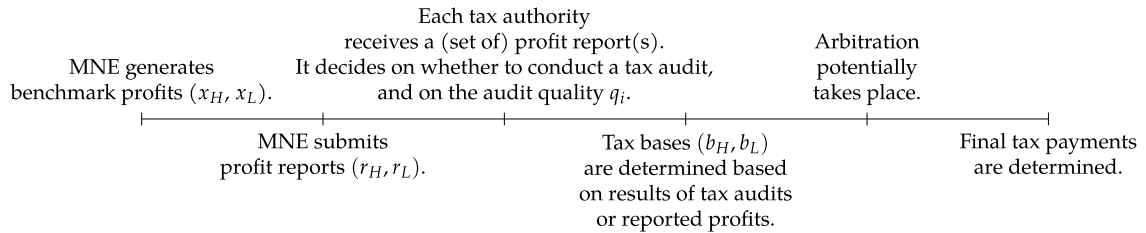


Fig. 1. Timeline of the model.

We interpret $x = (x_H, x_L)$ as benchmark profits in countries H and L. These profits reflect the allocation of total profits $x_H + x_L$ that would result from a widely accepted multilateral definition such as the OECD transfer pricing guidelines.²⁰ After realizing benchmark profits x , MNE decides on the profit report for tax purposes. The corresponding set of profit reports is denoted $r = (r_H, r_L)$. We impose two conditions on these reports: First, each report amounts either to the low- or to the high-profit level, i.e., $r_H, r_L \in \{1, 2\}$. Second, we focus on profit shifting and exclude tax evasion, i.e., $r_H + r_L = x_H + x_L$, which is in line with the aim of CbCR to avoid international profit shifting by MNEs.²¹ Moreover, focusing on profit shifting is adequate to analyze strategic interdependencies among tax authorities and the role of arbitration in international taxation. Profit shifting is achieved through accounting measures, in particular, transfer pricing.²² The tax authorities can only observe the reported profits r , but not MNE’s benchmark profits x . We assume that costs for profit shifting are negligible since MNE has to provide transfer pricing documentation in any case. Penalties do not arise since tax evasion is excluded.

MNE can exploit the tax rate differential between the two countries by shifting profits from H to L. The tax advantage of shifting one unit of profit from country H to country L amounts to $t_H - t_L > 0$, where t_i denotes country i ’s tax rate. We assume that MNE only shifts profits if it expects a strictly positive gain from doing so. Hypothetically, MNE may also shift profits from the low-tax to the high-tax country. However, no equilibrium with profit shifting to the high-tax country exists.²³ Thus, we do not consider the corresponding strategy profiles to simplify the presentation. Considering mixed profit-shifting strategies would not enhance our comparison of audit qualities under different institutional settings. If an MNE was indifferent in a given institutional setting, it would have strict preferences for or against profit shifting in all other settings, making a comparison meaningless. Overall, we focus on pure strategies, implying that the MNE’s decision is whether or not to shift profits.

Following the timeline of the model, Fig. 2 illustrates the auditing process. Tax authority i maximizes its tax revenues net of audit costs. It first decides whether or not to conduct a tax audit. If MNE’s profit report is not audited, it is taken as the tax base without modification. If a tax audit is conducted, it detects profit shifting, i.e., $r_i \neq x_i$, with probability q_i ; with the complementary probability $1 - q_i$ it does not. If there is no profit shifting, i.e., $r_i = x_i$, the audit will confirm this with probability q_i , while it will suggest profit shifting with the complementary probability $1 - q_i$. This means that the audit may produce false negatives and false positives in terms of profit shifting, considering the above-mentioned concerns expressed in the OECD guidance. As a higher probability q_i goes along with better detection of profit shifting, q_i is interpreted as tax-audit quality. Investing in high-quality tax audits increases the probability of tax authorities finding out whether reported profits equal the benchmark profits.

The costs of an audit amount to

$$\kappa_i(q_i) = \frac{1}{2} c_i q_i^2 \tag{1}$$

with $q_i \in [q_i^*, 1]$ and q_i^* as the minimum audit quality regarded acceptable.²⁴ Audit costs are borne by the respective tax authority i . Audit costs depend on the efficiency parameter $c_i > 0$ and audit quality q_i with $\kappa_i, \kappa_i', \kappa_i'' > 0$. We exclude trivial settings in which

²⁰ Note that x should not be interpreted as the ‘true’ profit allocation because in team production settings jointly generated profits can never be undisputedly allocated to the contributing parties. The infeasibility of an indisputable allocation follows from the fact that for real team production, the cross-derivative of the joint production function does not vanish. For technical proof, see Alchian and Demsetz (1972).

²¹ This assumption is similar to the model of De Waegenaere et al. (2006) with worldwide income as common knowledge. In contrast to their model, we do not consider penalties because tax planning does not reflect breaking the law but just using loopholes in the tax system, see van den Broek (2019, p. 321).

²² Transfer pricing and licensing are among the most important profit shifting channels for MNEs, see Heckemeyer and Overesch (2017).

²³ Proofs are available upon request.

²⁴ Costs arise from audit quality as a function of tax authorities’ allocation of resources. Thus, audit quality is the result of the audit effort.

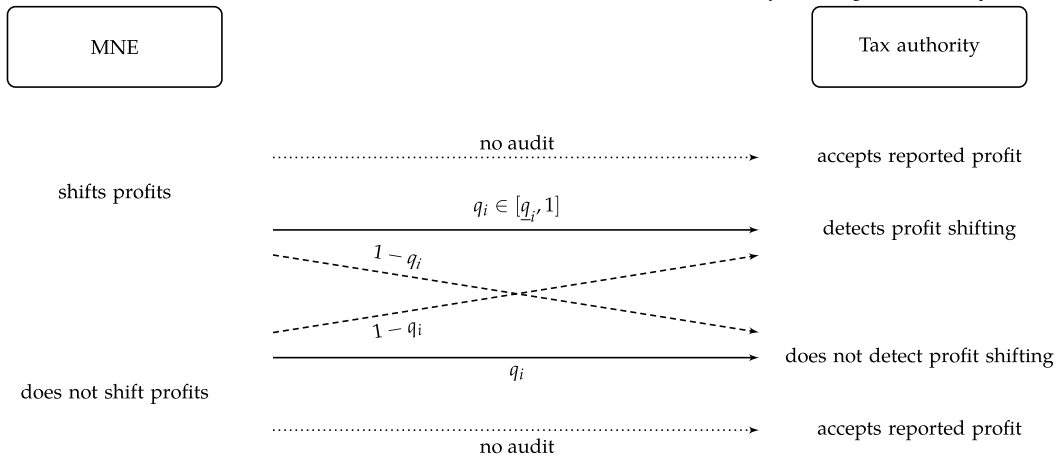


Fig. 2. Auditing process.

tax authorities would refrain from auditing due to excessive audit costs. This implies $\kappa_i(q_i) < t_i(2 - 1)$ for all feasible audit qualities which translates into the condition

$$c_i < 2t_i. \tag{2}$$

Nevertheless, condition (2) is not sufficient to conduct a tax audit. A tax authority refrains from auditing if the expected audit revenue does not exceed audit costs. For example, the possibility of detecting no profit shifting affects the expected audit revenue negatively. If a tax authority does not audit, no audit costs occur. Similar to MNE's profit-shifting decision, we assume that a tax authority will only conduct an audit if it strictly benefits from it.²⁵

Audit costs reflect the fact that tax authorities do not have unlimited resources.²⁶ They use their resources efficiently by taking into account the potential revenue consequences of correct or incorrect audits and the expectation of profit shifting. Such strategic audit behavior is known from the literature (see, for example, Blaufus et al., 2022; Reineke et al., 2023a,b and the references therein) and is supported by our anecdotal evidence.²⁷

We assume that tax-audit quality will never fall below a certain minimum level \underline{q}_i . Given the rule of law, we assume $\underline{q}_i = \frac{1}{2}$, so correct audits are at least as likely as false audits. For the same reason, we assume that audits are conducted in good faith (bona fide). This means that tax authorities will not audit if they know there is no profit shifting, even though they might benefit from wrongly accusing the MNE of profit shifting. This is especially the case if the relevant information set degenerates into the singleton $x = r = (1, 1)$. Although tax audits are always carried out in good faith, tax authorities anticipate their own error probabilities. They can benefit from erroneous audits since such audits can lead to higher tax revenues.

If the tax authority's audit finds a higher profit than reported by MNE, the audit overrules the taxpayer's report so that the taxable profit in the respective country is adjusted to the audit result. The tax bases after the auditing stage are denoted $b = (b_H, b_L)$. A divergent audit result does not cause a penalty for the taxpayer as we exclude tax evasion. However, inconsistent assessments by the two countries, which can be based on the results of the tax audits or the reported profits if no audit has taken place, may lead to double taxation. This imposes expected costs on MNE. Only in the case of mandatory arbitration can the taxpayer appeal against a tax audit, and both tax authorities have to guarantee a profit allocation that avoids double taxation.

4. National setting

The national setting reflects a pre-CbCR world where tax authorities do not share their respective information. An essential feature of the national setting is that each tax authority $i \in \{H, L\}$ only learns the domestic profit report r_i . We use this baseline information endowment as a reference point for the effects of CbCR without and with arbitration.

After MNE has generated the benchmark profits x , it determines its reporting strategy $r = (r_H, r_L)$. For $x = (2, 1)$, the MNE can either truthfully report the benchmark profits, i.e., $r = (2, 1)$, or engage in profit shifting by reporting $r = (1, 2)$. If H observes a profit report of $r_H = 1$, the underlying benchmark profits could be $x = (1, 1)$, $x = (1, 2)$, or $x = (2, 1)$. Note that only the third case reflects profit shifting to the low-tax country. If a profit of 2 is reported, the underlying benchmark profits could be $x = (2, 1)$ or $x = (2, 2)$.

²⁵ Recent survey data by the OECD (OECD, 2019c, see, for example, pp. 18, 36, 52) based on data from 58 tax administrations suggests that the vast majority of countries employ some sort of tax audit. On average, around 30% of the annual staff resources are engaged in tax audits and tax verification. With regard to large business taxpayers, 48 out of 55 tax administrations participating in the OECD survey even had specialized units in place.

²⁶ Limited audit resources are mentioned several times in OECD (2022b). See also Reineke et al. (2023a) and the references therein.

²⁷ In conversations with transfer pricing experts from MNEs and tax advisory firms, we learned that the quality of tax audits varies substantially across countries and audits. Further, some experts shared their perception that tax authorities sometimes vary audit quality deliberately to obtain higher tax revenues.

Here, reported profits always equal the benchmark profits. Moreover, it is not possible for MNE to shift profits if benchmark profits in both countries are the same since profit reports less than 1 or greater than 2 are not credible. Therefore, $r = x$ if $x = (1, 1)$ or $x = (2, 2)$.

Subsequently, both countries decide on tax audits simultaneously, i.e., without knowledge of the other country's audit decision. The outcome of a tax audit overrules the profit report. A possible double taxation is not resolved. Fig. 3 in Appendix B gives an overview of the players' actions and payoffs in this setting. There is no benefit for a tax authority from auditing a high profit report, $r_i = 2$: the tax base without audit is already high while auditing is costly.

Accordingly, the analysis focuses on three decisions: first, MNE decides whether or not to shift profits to the low-tax country if the benchmark profit is $x = (2, 1)$. Second, H decides whether to audit low profit reports, $r_H = 1$. If an audit takes place, the audit quality q_H has to be determined. H's audit decision is not obvious since a low profit report does not necessarily imply a profit shift. The reason is that H cannot tell from the profit report $r_H = 1$ alone whether the underlying benchmark profits are $x = (1, 1)$, $x = (1, 2)$, or $x = (2, 1)$, and only $x = (2, 1)$ implies profit shifting for $r_H = 1$. Third, L's audit decision is similar to H's decision problem but implies fewer incentives for an audit as L benefits from a profit shift. The following proposition describes the resulting equilibrium.

Proposition 1. *In the national setting, let MNE shift profits to the low-tax country L. Then, tax authority H audits only low profit reports, i.e., $r = (1, \cdot)$, at quality level*

$$q_H^{nat} = \min \left\{ \max \left\{ \tilde{q}_H^{nat}, \frac{1}{2} \right\}, 1 \right\} \tag{3}$$

with inner solution

$$\tilde{q}_H^{nat} = \frac{t_H}{c_H} \frac{p_{21} - p_{11} - p_{12}}{p_{11} + p_{12} + p_{21}}, \tag{4}$$

whereas tax authority L does not audit any profit report. These reporting and auditing strategies form an equilibrium, if and only if $q_H^{nat} < 1 - \frac{t_L}{t_H}$. The resulting expected tax payment for MNE is

$$T_{MNE}^{nat} = t_H [(p_{11} + p_{12})(2 - q_H^{nat}) + p_{21}(1 + q_H^{nat}) + 2p_{22}] + t_L [p_{11} + 2(p_{12} + p_{21} + p_{22})]. \tag{5}$$

Proof. See Appendix B. \square

Analyzing equation (4) shows that audit quality in the high-tax country increases with a higher benefit-cost ratio, i.e., for a higher tax rate or lower audit cost. As expected, audit quality also increases as the only state for which profit shifting occurs becomes more likely, i.e., p_{21} increases. The opposite occurs for higher probabilities of the other states. The level of the low-tax country's tax rate and the tax rate differential do not affect audit quality.

In more detail, three forces are leading to H's choice q_H^{nat} of the audit quality in reaction to MNE's profit shift. The first is the benefit from detecting profit shifting and reverting it. Profit shifting happens for $x = (2, 1)$, so p_{21} can be interpreted as the ex-ante probability of profit shifting and the associated benefit for H is $p_{21}q_H t_H$. The second force is the benefit from audits erroneously indicating profit shifting. Such false positive audits are possible for $x = (1, 1)$ and $x = (1, 2)$ and relate to the probabilities p_{11} and p_{12} . H is not able to distinguish these cases from the actual profit-shifting case $x = (2, 1)$ due to its imperfect information about benchmark profits. The ex-ante probability of this benefit is $(1 - q_H)(p_{11} + p_{12})$, and the corresponding benefit is $(1 - q_H)(p_{11} + p_{12})t_H$. Obviously, the benefit from erroneous audits decreases in the audit quality. Audit costs are the third force with expected value $\frac{1}{2}(p_{11} + p_{12} + p_{21})c_H q_H^2$. They are driven by the audit quality and are reflected in (4) by the cost parameter c_H . Audit quality q_H^{nat} strikes the optimal trade-off between the first force on the one hand and the other two forces on the other.

Besides the inner solution, the optimal trade-off involves two corner solutions, namely $q_H^{nat} = \frac{1}{2}$ and $q_H^{nat} = 1$. In the former case, H has no motivation to increase tax-audit quality above the legal minimum since the probability of profit shifting is relatively low. Yet, H still prefers a tax audit with minimum quality over no audit. This is due to the benefit of erroneous audits. In case of an erroneous audit, the high-tax country H wrongly adjusts the reported profits upwards. In contrast, conducting no audit is equivalent to accepting MNE's report as it is. The other corner solution, $q_H^{nat} = 1$, can arise for very low audit costs c_H . However, in this case, profit shifting does not occur because MNE anticipates that profit shifting is detected and leads to double taxation.

An equilibrium with profit shifting only occurs if H's audit quality is sufficiently small. This is because too high an audit quality discourages MNE from profit shifting. Specifically, MNE's incentive to shift profits is to benefit from the tax rate differential. This expected benefit decreases in H's audit quality. MNE's costs of profit shifting arise from the exposure to double taxation. The expected costs increase in H's audit quality. The benefit of profit shifting outweighs its costs if H's audit quality is sufficiently low, which leads to the equilibrium condition $q_H < 1 - \frac{t_L}{t_H}$.

From L's perspective, there is no point in auditing MNE's tax report. Either the report already implies the maximum feasible tax base, so there is no benefit for L from auditing, or L knows that the low profit report is not distorted so that an audit would be malicious; a behavior that we rule out by assumption.

Finally, we point out that there is no equilibrium without profit shifting. This is because any audit in reaction to MNE not shifting profits would be a waste of resources, so that both H and L refrain from auditing. However, in the absence of audits, it is best for MNE to shift profits.

5. Country-by-country reporting without arbitration

Requiring MNEs to disclose information about their profits in both jurisdictions, the CbCR setting provides a finer information endowment than the national setting. Consequently, both tax authorities learn not only about domestic-reported profits but also about foreign-reported profits. The finer information allows for more effective audit resource allocation, which potentially raises audit quality and, thus, the risk of double taxation.²⁸ In this setting, no effective arbitration rules exist, so double taxation remains unresolved.

Technically, if profits $r = (1, 1)$ are reported, H can be sure that no profit shifting has occurred.²⁹ Compared to the national setting, H can exclude one combination of benchmark profits. By contrast, uncertainty remains about the underlying benchmark profits if profits of $r = (1, 2)$ are reported, which can occur if $x = (1, 2)$ or $x = (2, 1)$. L – having the same information endowment – still has no incentive to audit.

Proposition 2. *Under country-by-country reporting without arbitration, let MNE shift profits to the low-tax country L. Then, tax authority H audits only the profit report $r = (1, 2)$ at quality level*

$$q_H^{cbc} = \min \left\{ \max \left\{ \bar{q}_H^{cbc}, \frac{1}{2} \right\}, 1 \right\} \tag{6}$$

with inner solution

$$\bar{q}_H^{cbc} = \frac{t_H}{c_H} \frac{p_{21} - p_{12}}{p_{12} + p_{21}}, \tag{7}$$

whereas tax authority L does not audit any profit report. These reporting and auditing strategies form an equilibrium, if and only if $q_H^{cbc} < 1 - \frac{t_L}{t_H}$. The resulting expected tax payment for MNE is

$$T_{MNE}^{cbc} = t_H [p_{11} + p_{12}(2 - q_H^{cbc}) + p_{21}(1 + q_H^{cbc}) + 2p_{22}] + t_L [p_{11} + 2(p_{12} + p_{21} + p_{22})]. \tag{8}$$

Proof. See Appendix C.1. □

As in the national setting, the level of L’s tax rate or the tax rate differential do not affect audit quality according to (7). The effect of finer information under CbCR compared to the national setting can be seen from the fact that H’s optimal audit quality q_H^{cbc} does not depend on p_{11} anymore. This is because, under CbCR, benchmark profits $x = (1, 1)$ are disclosed by means of the associated profit report $r = (1, 1)$. The finer information endowment allows H to better target its audits at profit shifting. Tax audits become more effective as H better identifies those cases where conducting an audit is advantageous. As a result, H’s optimal audit quality increases, i.e.,

$$\bar{q}_H^{cbc} > \bar{q}_H^{nat} \text{ and } q_H^{cbc} \geq q_H^{nat}. \tag{9}$$

Thus, our model results show that the political objective of increasing tax-audit effectiveness through more comprehensive information is reached. This leads to more comprehensive audits, even if the tax authorities do not use CbC reports improperly, as feared by Hanlon (2018).³⁰

In terms of double taxation, the introduction of CbCR has two effects. On the one hand, the higher audit quality under CbCR raises the probability that H correctly detects profit shifting, which, in turn, implies double taxation. The probability increases by $p_{21}(q_H^{cbc} - q_H^{nat})$. This is clearly in line with the BEPS project’s objective of curbing profit shifting. On the other hand, CbCR reduces the risk of erroneous identification of profit shifting and the implied double taxation. For benchmark profits $x = (1, 1)$, the risk is eliminated completely, which decreases the probability of double taxation by $p_{11}(1 - q_H^{nat})$. For benchmark profits $x = (1, 2)$, the decreasing effect on the probability amounts to $p_{12}(q_H^{cbc} - q_H^{nat})$. In sum, the overall effect on the probability of double taxation is positive iff the condition

$$p_{21}(q_H^{cbc} - q_H^{nat}) > p_{11}(1 - q_H^{nat}) + p_{12}(q_H^{cbc} - q_H^{nat}) \tag{10}$$

holds. The following lemma shows that this condition holds if the inner solutions (4) and (7) for H’s audit quality are applied. It also states that the increase in audit quality and thus the increase in double taxation is detrimental to MNE. This is a direct consequence of the increased and unresolved double taxation.

²⁸ See, e.g., Tørsløv et al. (2023, p. 501) justifying this assumption.

²⁹ Fig. 4 in Appendix C.1 depicts how the introduction of CbCR changes the information sets of both countries. CbCR also allows H to distinguish between reported profits of $r = (2, 1)$ and $r = (2, 2)$. However, this distinction does not affect H’s decision on tax-audit quality since, without arbitration, there are no incentives for the high-tax country to audit a report that indicates high profits.

³⁰ For example, IRS (2022, p. 4) states: “Even though the audit process is a key resource, tax administrations lack the tools for early detection of aggressive tax planning strategies. Timely, targeted, and comprehensive information is essential to enable governments to effectively identify compliance risk areas”.

Lemma 1. Comparing the equilibrium under country-by-country reporting without arbitration with the equilibrium in the national setting, the following properties hold for the inner solutions \bar{q}_H^{nat} and \bar{q}_H^{cbc} of tax authority H's audit quality:

1. The probability of double taxation from correct (erroneous) identification of profit shifting is greater (smaller).
2. The overall probability of double taxation and MNE's expected tax payment are greater.

Proof. See Appendix C.2. \square

When it comes to H's corner solutions for audit quality, the situation may differ from that described in Lemma 1. For example, if both q_H^{nat} and q_H^{cbc} are set to the lowest possible quality level of $\frac{1}{2}$, which may be the case for small values of p_{21} , there will be no increase in audit quality as a result of CbCR. The only difference CbCR then makes is that it avoids double taxation for $x = (1, 1)$. In terms of expression (10), this means that its right-hand side predominates.

Empirical research may examine our finding that CbCR implies changes in conflicting assessments of the tax authorities more closely. In the following section, however, we explore the question of how double taxation can be resolved through arbitration and what impact this has on audit quality.

6. Country-by-country reporting with arbitration

6.1. Introduction

Effective fiscal arbitration is a means to avoid double taxation. Therefore, we analyze the joint effects of CbCR and mandatory binding fiscal arbitration. As the applied arbitration procedures (see Section 2.2) are crucial for the arbitration outcome, we model alternative approaches. First, we consider a predetermined split of the disputed tax base according to exogenously given negotiation powers of the countries (Section 6.2). Second, we endogenize the arbitration outcome by applying two stylized approaches that rely on the quality of the preceding audit (Sections 6.3 and 6.4).

Thereby, we follow the widespread categorization in final-offer arbitration and independent-opinion (or conventional) arbitration. Under final-offer arbitration, arbitration outcomes are restricted to the tax bases that either H or L propose. Alternatively, we model an independent-opinion approach by allowing the arbitration panel to deviate from both solutions proposed by the tax authorities.

Table 5 in Appendix D determines the cases for which MNE requests fiscal arbitration to avoid double taxation. If the profit reports read $r = (1, 1)$ or $r = (2, 2)$, both tax authorities understand that the underlying benchmark profits do not allow profit shifting. Hence, tax audits are mala fide in the former case and unnecessary in the latter case, and both tax authorities accept the reported profits. Consequently, double taxation does not occur. In contrast, reported profits $r = (1, 2)$ can result from truthful reporting or profit shifting, with $x = (1, 2)$ and $x = (2, 1)$. Double taxation occurs, and MNE requests arbitration only if both countries claim a tax base of 2. This implies that an arbitration procedure is triggered only in the case of a dispute between tax authorities.

6.2. Negotiation-power arbitration

The split of the disputed tax base between H and L could arguably be determined by the political and economic influence of the two countries or resources available for arbitration. Therefore, we start our analysis by considering an arbitration mechanism that merely reflects the negotiation powers of the two countries. In contrast to the following sections, we assume this case to be independent of audit quality.³¹ Let $\alpha \in [0, 1]$ represent the negotiation power of country H relative to the negotiation power $1 - \alpha$ of country L. Consequently, the tax bases b_i for countries H and L resulting from negotiation-power arbitration are

$$b_H^{neg} = 1 + \alpha \text{ and } b_L^{neg} = 2 - \alpha. \tag{11}$$

Due to the use of exogenous (political and economic) allocation factors, negotiation-power arbitration does not provide incentives to increase audit quality as compared to CbCR without arbitration. This implies that L still refrains from auditing.³² This result is consistent with the small number of actual arbitration cases with below-average tax rate countries as reported in Appendix A. From H's perspective, arbitration reduces the marginal benefit of a tax audit to the fraction α as H cannot benefit from double taxation anymore. In the course of equalizing marginal benefits and costs, the optimal tax-audit quality q_H^{neg} is also reduced to the fraction α due to the quadratic cost function. Thus, H audits the low profit report $r = (1, 2)$ with quality

$$q_H^{neg} = \min \left\{ \max \left\{ \bar{q}_H^{neg}, \frac{1}{2} \right\}, 1 \right\} \tag{12}$$

with inner solution

$$\bar{q}_H^{neg} = \alpha \frac{t_H}{c_H} \frac{p_{21} - p_{12}}{p_{12} + p_{21}}. \tag{13}$$

³¹ This generic type of arbitration might also be viewed as mediation instead of arbitration in a strict sense.

³² The corresponding formal result and its proof are provided in Appendix D.2.

Compared to (7), expression (13) shows that the audit quality in H weakly decreases compared to a CbCR setting without arbitration. H even abstains from an audit if its negotiation power is too small, i.e., $\alpha \leq \frac{1}{4} \frac{c_H}{t_H}$.

6.3. Final-offer arbitration

Next, we analyze an arbitration approach that still restricts the outcome to the suggestions of either tax authority H or L. However, the allocation of the disputed tax base now depends on tax-audit quality. More specifically, we think of each tax authority claiming the double-taxed profit to the arbitration panel. In support of their claims, the tax authorities disclose their tax-audit results. They also disclose the hitherto private audit qualities q_i in the form of tax assessment notices, the proceedings of tax audits, a position paper, or similar documents. By analyzing and interpreting these documents the arbitration panel can infer the tax authorities' true audit qualities. The higher the audit quality, the more the panel is convinced of the corresponding proposal.³³ In accordance with Article 23 para. 1 MLI, the panel ultimately chooses the proposal of the tax authority with the higher audit quality.³⁴

Assuming that the tax base in country i is evenly split if audit qualities coincide, we apply the following rule for the tax base after final-offer arbitration, b_i^{fo} :

$$b_i^{fo} = \begin{cases} 2 & \text{if } q_i > q_j \\ \frac{3}{2} & \text{if } q_i = q_j \\ 1 & \text{if } q_i < q_j. \end{cases} \quad (14)$$

Strictly speaking, this rule only applies if both tax authorities conduct an audit. If just one authority audits, we assume that it automatically wins the arbitration. Accordingly, we assume $(b_i, b_{-i}) = (2, 1)$ if only i audits. If there is no audit at all, there is no double taxation and thus no arbitration.

The analysis of this quality-driven arbitration approach endogenizes audit quality. It considers the fact that H's tax base not only depends on its own audit quality but also on L's audit policy and vice versa. Although the resulting audit decisions equal those under negotiation-power arbitration with $\alpha = 1$, see (13), they follow from a fundamentally different mechanism.

Proposition 3. *Under country-by-country reporting with final-offer arbitration, let MNE shift profits to the low-tax country L. Then, tax authority H audits only the profit report $r = (1, 2)$ at quality level*

$$q_H^{fo} = \min \left\{ \max \left\{ \tilde{q}_H^{fo}, \frac{1}{2} \right\}, 1 \right\} \quad (15)$$

with inner solution

$$\tilde{q}_H^{fo} = \frac{t_H}{c_H} \frac{p_{21} - p_{12}}{p_{21} + p_{12}}, \quad (16)$$

whereas tax authority L does not audit any profit report. These reporting and auditing strategies form an equilibrium, if and only if $q_H^{fo} \in \left[\frac{2t_L}{c_L + 2t_L}, 1 \right)$. The resulting expected tax payment for MNE is

$$T_{MNE}^{fo} = t_H \left[p_{11} + p_{12} \left(2 - q_H^{fo} \right) + p_{21} \left(1 + q_H^{fo} \right) + 2p_{22} \right] + t_L \left[p_{11} + p_{12} \left(1 + q_H^{fo} \right) + p_{21} \left(2 - q_H^{fo} \right) + 2p_{22} \right]. \quad (17)$$

Proof. See Appendix D.3. \square

The optimal audit quality of H remains unchanged compared to the CbCR setting without arbitration, and L continues to abstain from auditing. Therefore, the disputed tax base is shifted to the high-tax country. In contrast to CbCR without arbitration, double taxation is avoided under final-offer arbitration at the expense of lower tax revenue for L.³⁵

Given that L does not audit, H's decision problem concerning its audit quality remains the same as under CbCR without arbitration. Consequently, q_H^{bc} and q_H^{fo} coincide, see (6) and (15). The reason why L still does not audit is twofold: First, due to its lower tax rate, it has weaker incentives than H to increase audit quality and win the arbitration. Second, a higher audit quality helps H secure its tax base under profit shifting. In contrast, L would reduce its own tax base by increasing audit quality. As it is useless to compete in a winner-takes-all tournament and lose it, L does not participate in the first place. Suggesting that the low-tax country has little incentive to engage in arbitration, this result is consistent with the low number of empirically observable arbitration cases between countries with above-average and below-average tax rates as reported in Appendix A. However, owing to the relative definition of the terms high-tax and low-tax country in our model, and considering that the magnitude of the tax rate differential does not affect

³³ Our setting resembles the situation described in Farber (1980, p. 688). The important difference is that in our setting, the generation of the final offers determines the arbitrator's decision-making as the split is done in accordance with audit qualities.

³⁴ Our model differs from Samuelson (1991) in that we do not use strategic offers and that private information is disclosed to rather than inferred by the arbitration panel.

³⁵ For a similar result, see Doeleman et al. (2024).

audit quality according to (16), we cannot predict whether arbitration predominantly takes place between high-tax countries and countries with only slightly lower tax rates or with tax havens.

6.4. Independent-opinion arbitration with minimum-quality requirement

Our third approach differs from the previous ones in that the arbitrator does not have to choose one of the tax authorities' proposals. Instead, we consider an independent-opinion approach in which the arbitrator has more discretion.

We assume that H and L have to present their evidence to an arbitrator who has specific expectations regarding the quality of the evidence produced, i.e., the audit quality q_i . Specifically, each country gets awarded half of the disputed tax base of 1 if its tax-audit quality meets or exceeds the threshold of the arbitrator, $\hat{q} \in [\frac{1}{2}, 1]$. If the audit quality falls short of the threshold, the country is just awarded the undisputed tax base of 1. Thus, the tax base is determined according to the following rule:

$$b_i^{min} = \begin{cases} \frac{3}{2} & \text{if } q_i \geq \hat{q} \\ 1 & \text{otherwise.} \end{cases} \quad (18)$$

The case "otherwise" in (18) applies to both an insufficient audit quality and the decision not to audit. The exact value of \hat{q} is unknown to the tax authorities due to the vagueness of the specific legal requirements, but it is common knowledge that \hat{q} follows a continuous uniform distribution on the interval $[\frac{1}{2}, 1]$. We call this approach minimum-quality arbitration for short.

According to (18), both countries continue to receive at least the undisputed taxable profit of 1. The maximum sum of profits awarded to both tax authorities continues to be 3, which makes double taxation impossible. However, in contrast to the previous arbitration approaches, the overall tax base will be lower than 3 if at least one country fails to comply with the auditor's quality requirement. This feature can be interpreted as a penalty for a lack of audit quality. Penalties in case of non-compliance and the definition of minimum information requirements are a common element of established arbitration processes (see, for example, Art. 19 para. 10 MLI or ECOA, 2022, Art. 16.2).

Proposition 4. *Under country-by-country reporting with minimum-quality arbitration, let MNE shift profits to the low-tax country L. There are settings of tax rates and cost parameters such that tax authority H audits only the profit report $r = (1, 2)$ at quality level*

$$q_H^{min} = \min\{\bar{q}_H^{min}, 1\} \quad (19)$$

with inner solution

$$\bar{q}_H^{min} = \frac{t_H(3p_{12} - p_{21})}{4t_H(p_{12} - p_{21}) + 2c_H(p_{12} + p_{21})}, \quad (20)$$

whereas tax authority L does not audit any profit report. These reporting and auditing strategies form an equilibrium.

Proof. See Appendix D.4.2. \square

First of all, the proposition states that there are parameter settings such that the unilateral audit behavior persists under minimum-quality arbitration. However, as the expression \bar{q}_H^{min} for the inner solution differs from $\bar{q}_H^{bc} = \bar{q}_H^{fo}$, there exist parameters for which minimum-quality arbitration implies a higher audit quality than all the other settings. Specifically, we derive in Appendix D.4.3 that $\bar{q}_H^{min} > \bar{q}_H^{bc}$ is equivalent to

$$\frac{t_H}{c_H} > \frac{(3p_{21} - 5p_{12})(p_{12} + p_{21})}{4(p_{21} - p_{12})^2}, \quad (21)$$

if $3p_{12} > p_{21}$; for $3p_{12} < p_{21}$, the direction of inequality in (21) reverses.

At first glance, the increase in audit quality seems surprising as the maximum tax base for each country is limited to $b_H = \frac{3}{2}$ under minimum-quality arbitration as opposed to $b_H = 2$ under the other settings. Here, the elevated minimum quality comes into play. Under the minimum-quality approach, the expected minimum quality amounts to $E(\hat{q}) = \frac{3}{4}$, which can be higher than the optimal audit quality under the other settings.

Finally, Lemma 2 illustrates that depending on the parameter setting, minimum-requirement arbitration can also motivate both tax authorities to audit.

Lemma 2. *Under country-by-country reporting with minimum-quality arbitration, let MNE shift profits to the low-tax country L. There are combinations of tax rates and cost parameters with bilateral audits in equilibrium. The corresponding inner solutions are described by the reaction functions*

$$\bar{q}_H^{min}(q_L) = \frac{t_H \left[q_L \left(\frac{5}{2}p_{12} + \frac{3}{2}p_{21} \right) - p_{12} - \frac{1}{2}p_{21} \right]}{2t_H [q_L(p_{12} + p_{21}) - p_{21}] + c_H(p_{12} + p_{21})} \quad (22)$$

and

$$\tilde{q}_L^{min}(q_H) = \frac{t_L [p_{12} - q_H (p_{12} + 3p_{21})]}{4t_L [p_{12} - q_H (p_{12} + p_{21})] - 2c_L (p_{12} + p_{21})}. \quad (23)$$

These reporting and auditing strategies form an equilibrium.

Proof. See Appendix D.4.4. \square

Two properties are crucial to understanding this result. As a necessary condition, the tax base under the minimum-quality approach, b_i^{min} , weakly increases in the audit quality q_i , see (18). This property also holds for final-offer arbitration. In contrast to final-offer arbitration, there is no competition for the disputed tax base under the minimum-quality approach.³⁶ This increases L's chances to benefit from increasing its audit quality. For specific parameter settings, these benefits outweigh the disadvantages of an audit for L, which are twofold: Apart from causing audit costs, a higher audit quality reduces L's tax base by increasing the probability of detecting profit shifting and, thus, the probability of arbitration occurring in the first place. This probability effect is not favorable for L which, as the low-tax country, benefits from profit shifting. In a nutshell, L is actually not interested in providing high-quality audits, but the arbitration rule compels it to do so to secure at least some tax base.

To further explore the bilateral audit equilibrium and to prove its existence, we refer to the following numerical example as the general closed-form solution to the equilibrium conditions is prohibitively complicated: $p_{11} = p_{22} = 0.25$, $p_{12} = 0.282$, $p_{21} = 0.218$, $t_H = 0.281$, $t_L = 0.14$, $c_H = 0.117$, and $c_L = 0.0234$. Solving (22) and (23) for this parameter setting yields $q_H^{min} \approx 0.749$ and $q_L^{min} \approx 0.78$.³⁷ This example gives rise to three observations: First, it shows that, in contrast to final-offer arbitration, equilibria with tax audits in both countries exist under minimum-quality arbitration. Second, depending in particular on the audit cost parameters c_H and c_L , L might even audit at a higher quality level than H. Third, as already shown for the unilateral audit by the high-tax country H, it is possible that H's audit quality increases compared to the CbCR setting without arbitration (see (6)). For the numerical setting at hand, we have $q_H^{min} \approx 0.749 > 0.5 = q_H^{bc}$.

7. Conclusion

This paper analytically investigates the effects of increased tax transparency. Specifically, we analyze the effects of CbCR and different fiscal arbitration approaches on MNEs' reporting policies and tax-audit quality. In doing so, we jointly investigate two central elements of the BEPS Action Plan that were initially designed to interact with each other. Other EU or OECD initiatives to improve the information endowment of tax authorities, such as the automatic exchange of tax rulings or the substantial activities requirement for no or only nominal tax jurisdictions, have similar properties to the CbCR setting analyzed in our model framework.

Our model considers an MNE operating in two countries with different tax rates. Given the initial profit allocation, the MNE decides whether to shift profits under three alternative scenarios, which differ regarding the tax authorities' information endowment and the avoidance of double taxation. In our main scenario, we analyze three alternative arbitration approaches reflecting conflict resolutions based on either negotiation power or tax-audit quality. The approaches are in line with the common categorization in final-offer arbitration and independent-opinion arbitration. For each approach, both tax authorities decide on their optimal tax-audit qualities by taking into account the marginal benefits and costs of stricter tax enforcement.

In equilibrium, the MNE shifts profits regardless of the magnitude of the tax rate differential. Increased fiscal transparency due to CbCR leads to a higher tax-audit quality in the high-tax country. Here, the expected benefits of auditing increase because tax authorities can identify more precisely the cases that are prone to profit shifting. Therefore, the allocation of scarce tax-audit capacities can be improved. In contrast, the low-tax country has no incentives to conduct a tax audit. As a consequence, conflicting assessments leading to double taxation occur more frequently under CbCR than in the national setting. Therefore, we expect an increase in the number of arbitration cases. Whereas CbCR does not affect tax revenues in the low-tax country, the tax revenue in the high-tax country typically increases. This is due to a higher likelihood of correctly identifying profit shifting, which dominates the countervailing effect of less frequent erroneous identification of profit shifting. Fiscal arbitration avoids double taxation, which leads to lower total tax revenues.

In sum, these results suggest that the effects of a richer information endowment on tax-audit quality can be partially reversed or reinforced by fiscal arbitration. An arbitration procedure based on negotiation power reduces the high-tax country's audit quality compared to CbCR without arbitration. Under a final-offer approach, by contrast, the high-tax country maintains the same equilibrium audit quality, which allows it to secure the disputed profit. Reversing profit shifting, the avoidance of double taxation is borne by the low-tax country. In contrast, an independent-opinion approach with minimum-quality requirement allows the low-tax country to secure a part of the disputed profit. It permits an equilibrium with both countries auditing and may even imply that the high-tax country increases its audit quality over and above the level under CbCR without arbitration. The strong dependence of audit qualities on the applied arbitration procedure underlines that the mere introduction of mandatory arbitration produces ambiguous results. Thus, our findings call for a more detailed regulation or a strategic choice of arbitration procedures by the involved countries.

³⁶ The reaction functions (22) and (23) show that both audit qualities depend on each other. This is because the probability of ending up in arbitration depends on both audit qualities; see Case 4 in Table 5.

³⁷ The solution satisfies the second-order conditions (86) and (94) as well as the equilibrium conditions $T_H^{min}|_{q_H, q_L} > T_H^{min}|_{\sim q_H, q_L}$ and $T_L^{min}|_{q_H, q_L} > T_L^{min}|_{q_H, \sim q_L}$.

Our study provides a theoretical explanation for the impact of fiscal transparency on profit shifting. It provides testable hypotheses that can be analyzed in future empirical studies. By allowing for a more effective use of tax audits, fiscal transparency leads to a higher tax-audit quality which in turn helps to reveal profit shifting to the low-tax country. Empirical studies could investigate this mechanism by analyzing the association between fiscal transparency measures, indicators for the quality of tax enforcement such as the number of annual tax audits or the tax enforcement budget, and the effective tax rate. Our results suggest that under a more transparent tax regime, both the aforementioned indicators of tax audit quality and MNEs' effective tax rate should increase. Moreover, empirical studies should shed light on the details of international fiscal arbitration proceedings, which lead to very different results according to our analysis. For instance, empirical analyses could explore whether jurisdictions choose their default arbitration procedure strategically; data on arbitration procedures are publicly available (see OECD, 2024e). Our analytical results also suggest that characteristics such as the state of the economy and firms' expected profitability serve as moderators in determining whether the choice of an arbitration procedure affects tax audit quality positively or negatively. Going beyond the accounting effects analyzed in our study, real effects of arbitration mechanisms also seem to be a fruitful field for future empirical studies (Zhang, 2023).

Given our focus on the decision effects of different institutional settings, we are agnostic regarding the welfare effects of higher tax-audit qualities. It remains an open question whether curbing profit shifting and increasing tax revenues outweighs higher audit costs and potential adverse real effects if profits were endogenously determined. Lastly, our theoretical insights could be transferred to other improvements in governments' exchange of information. For example, the application of a substantial activities requirement for selected low-tax jurisdictions provides tax authorities with more comprehensive information to conduct risk assessments and apply controlled foreign company, transfer pricing, and other provisions.

We model the increased information endowment of tax authorities due to CbCR by focusing on reported profits. Future analyses could take potential interdependencies between various pieces of information, for example, assets, payroll, and revenues, as well as their impact on the quality of tax audits into account. We understand CbCR as a way for tax authorities to receive finer information compared to national fiscal reports. Since we also exclude mala fide audits, our model does not consider the risk of tax authorities making improper use of CbCR information. Investigating in more detail the processing of CbCR information, future studies could allow for this risk. Moreover, our model refers to the private exchange of information between the MNE and the tax authorities. Allowing for public CbCR with its potential reputation effects for taxpayers and the corresponding impact on tax enforcement could also be an interesting extension of our study.

Another route for future research is initiated by Tørsløv et al. (2023), who explain the persistence of profit shifting by tax audit departments' capacity constraints. They argue that fiscal authorities focus on profit-shifting cases with countries having comparable tax rates. This enforcement focus leaves global tax revenues constant but consumes scarce tax audit capacities, which could be used to challenge tax havens instead. In contrast to Tørsløv et al., we focus strictly on deliberate profit shifting, restrict our parties' objectives to optimizing strategies, and allow for variable tax audit qualities. Despite the different settings, the evidence provided in Appendix A is consistent with both theories.

Finally, our stylized model of arbitration procedures is sufficient to analyze the economic incentives of the involved parties. Nevertheless, it seems promising to consider a variety of additional economic and institutional details, including sequential interactions of the tax authorities, the composition of the arbitration panel, the formation of its expectations, and a multi-period time horizon, to shed further light on the real effects of arbitration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Arbitration statistics

The following tables provide an overview of the distribution of arbitration cases between countries depending on their tax rates and between OECD and non-OECD countries. The tables are based on OECD (2023a). We limit our analysis to the 30 countries with the largest number of transfer pricing-related arbitration cases at the end of 2022. These 30 countries account for almost 95% (5,882 of 6,209) of all cases. Of the 5,882 cases, 5,387 were started in 2016 or later and follow a standardized reporting scheme. Detailed country information is available for 4,746 cases; the other 641 cases are summarized as "Treaty Partners" and, therefore, cannot be allocated to a particular jurisdiction. Numbers are added up country-wise rather than consolidated, meaning that cases are double-counted if two countries with mutual arbitration cases are both included in the top-30 list.

Table 1 displays the total number of arbitration cases of the 30 countries with the highest caseload. In our model setting, the country with the higher tax rate has more incentives to engage in arbitration than the country with the lower tax rate. Therefore, we report both the corporate income tax (CIT) rate of the top-30 countries in 2022 and their respective number of open arbitration cases concerning counterpart countries with a CIT rate below a certain threshold. We use three different thresholds to identify countries with relatively low tax rates: (1) the median of the corporate income tax (CIT) rates (including regional and local surcharges) of 140 jurisdictions surveyed by the OECD (23%), (2) the mean CIT rate (21%), and (3) the minimum tax rate according to the OECD global minimum tax (15%). It is not observable from these OECD arbitration statistics which country's tax audit induced the MNE to initiate arbitration.

Table 1
Arbitration cases of top-30 countries (as of 2022).

No.	Country	CIT rate (nominal, %)	Cases in 2022		Cases open		Cases open (started after 2015)			
			Started	Closed	Number	Time (months)	Total	with countries whose CIT rates are below		
							Median CIT (23%)	Mean CIT (21%)	Minimum CIT (15%)	
1	Italy	27.8	309	270	707	29.03	689	204	180	36
2	Germany	29.9	325	272	677	25.37	650	185	151	2
3	France	25.8	234	152	646	30.94	555	84	79	0
4	India	25.2	89	122	557	48.97	342	83	83	0
5	Spain	25.0	201	149	494	25.85	482	94	88	15
6	United States	25.8	145	129	440	42.88	420	57	51	10
7	United Kingdom	19.0	120	126	297	31.69	293	36	27	7
8	Switzerland	19.7	81	57	226	21.34	220	17	13	0
9	Netherlands	25.8	76	92	167	19.62	165	17	17	0
10	Belgium	25.0	61	36	157	26.58	153	6	6	0
11	Sweden	20.6	34	87	142	28.82	133	24	9	0
12	Austria	25.0	74	40	129	30.46	119	26	26	0
13	Canada	26.2	34	42	126	23.53	124	13	13	0
14	Korea	27.5	34	47	120	37.28	116	24	20	0
15	Denmark	22.0	61	143	112	22.03	110	30	30	3
16	Portugal	31.5	28	5	88	29.02	83	0	0	0
17	Poland	19.0	17	11	86	29.32	76	0	0	0
18	Japan	29.7	36	39	85	30.63	79	0	0	0
19	Romania	16.0	46	37	82	n. a.	57	3	0	0
20	Ireland	12.5	28	37	77	26.96	77	10	7	0
21	China	25.0	16	12	68	39.19	65	6	6	0
22	Mexico	30.0	17	18	61	34.51	59	7	7	0
23	Luxembourg	24.9	14	10	56	34.08	54	0	0	0
24	Finland	20.0	31	25	54	27.09	50	11	9	0
25	Slovak Republic	21.0	24	5	53	33.43	49	0	0	0
26	Brazil	34.0	7	7	42	37.57	38	0	0	0
27	Czechia	19.0	14	6	38	29.87	35	0	0	0
28	Australia	30.0	13	10	36	34.76	35	0	0	0
29	Israel	23.0	29	6	30	17.06	30	4	4	0
30	Indonesia	22.0	9	6	29	45.83	29	9	9	0
Sum			2,207	1,998	5,882		5,387	950	835	73
Percentage of 4,746 identifiable bilateral cases								20.02	17.59	1.54

Table 1 indicates that the distribution of arbitration cases is highly asymmetric. As mentioned, the top-30 countries account for 95% of all transfer pricing-related arbitration cases starting in 2016 or later. The top-10 countries alone account for 70%. In contrast, the median case number for all 140 countries surveyed by the OECD at the end of 2022 was 1. 68 out of 140 surveyed countries did not report a single case, among them tax havens such as Bahamas, Bermuda, Cayman Islands, Guernsey, and Jersey. This observation could be related to incentives resulting from low tax rates, but also to other factors such as the need for sufficient resources to engage in arbitration. Tørsløv et al. (2023) focus on the resource argument and show that arbitration cases occur primarily between two high-tax countries rather than between high-tax countries and tax havens. The columns “Cases started” and “Cases closed” in Table 1 show how cases accumulated in 2022. The column “Time” shows the average duration of the cases closed in 2022 for each of the top-30 countries. The mean and the median of about 30 months – not to mention the maximum of more than 48 months – illustrate that the uncertain outcome of long-term arbitration cases imposes considerable tax uncertainty on MNEs.

The evidence from Table 1 suggests that arbitration is primarily a phenomenon between countries with above-average CIT rates. The fraction of arbitration cases with below-median CIT rate countries in all arbitration cases only amounts to 20.02%. Not more than 1.54% of the top-30 countries’ arbitration cases are taking place with countries having a CIT rate of below 15%.

Table 2 summarizes the pairwise combinations of arbitration cases for the top-30 countries, considering their own tax rates and the respective tax rates of their counterparts. Again, the results show that arbitration predominantly takes place between countries with above-average CIT rates. Specifically, more than two-thirds of all arbitration cases occur between countries whose tax rates meet or exceed the mean CIT rate of 21%. More than 97% of all arbitration cases take place between countries with a tax rate of at least 15%. Moreover, most arbitration cases (almost 80%) occur between OECD countries, as Table 3 shows.

This distribution of arbitration cases is consistent with our theoretical result that countries with a lower tax rate do not have major incentives to engage in arbitration. However, substantial tax rate differentials can exist even between two high-tax countries, as the maximum tax rate in the 140 countries surveyed by the OECD is 35% (Colombia, Malta) compared to the median of 23%. Therefore, our theoretical results regarding the audit incentives under different arbitration procedures are also relevant for arbitration cases between two countries with above-average tax rates. The resulting incentives depend on whether a tax rate differential exists, but not on whether the country with the lower tax rate is a tax haven.

Table 2

Arbitration counterparts of top-30 countries depending on tax rate (as of 2022).

Top-30 countries	Counterpart countries		Sum
	Above median	Below median	
Above median	64.12%	17.07%	81.18%
Below median	15.87%	2.95%	18.82%
Sum	79.98%	20.02%	100.00%

Arbitration cases depending on CIT rate (median CIT rate of 23%)

Top-30 countries	Counterpart countries		Sum
	Above mean	Below mean	
Above mean	67.24%	16.22%	83.46%
Below mean	15.17%	1.37%	16.54%
Sum	82.41%	17.59%	100.00%

Arbitration cases depending on CIT rate (mean CIT rate of 21%)

Top-30 countries	Counterpart countries		Sum
	Above minimum	Below minimum	
Above minimum	97.26%	1.54%	98.80%
Below minimum	1.20%	0.00%	1.20%
Sum	98.46%	1.54%	100.00%

Arbitration cases depending on CIT rate (minimum CIT rate of 15%)

Table 3

Arbitration cases of top-30 countries with OECD and non-OECD countries (as of 2022).

Top-30 countries	Counterpart countries		Sum
	OECD	Non-OECD	
OECD	79.44%	10.70%	90.14%
Non-OECD	9.50%	0.36%	9.86%
Sum	88.94%	11.06%	100.00%

Table 4 displays the evolution of open arbitration cases between 2015 and 2022. The data show that the total number of arbitration cases increased substantially after the introduction of CbCR, which is consistent with our model results. However, due to incomplete data and changes in the OECD reporting standards in 2015/16, the numbers are not fully comparable to the 2022 figures. As the OECD statistics before 2016 do not systematically distinguish between transfer price-related and other arbitration cases, Table 4 focuses on the total number of open arbitration cases. Considering only countries that report data both in 2015 and in 2022, total cases grew from 6,089 in 2015 to 10,131 in 2022, i.e., by 66%. The table also reports whether arbitration cases occurred between OECD or non-OECD countries; the composition of arbitration cases was not disclosed in more detail in the OECD data before 2016.

The 2015 figures from Table 4 are in line with Table 3. More than 90% of identifiable arbitration cases occur between the top-30 countries and OECD countries. Consequently, the distribution of arbitration cases did not shift after the introduction of CbCR. The only countries in the top-30 list sometimes referred to as tax havens are Switzerland, the Netherlands, and Luxembourg. Of these countries, only the Netherlands exhibits an above-average increase in total arbitration cases (104% > 66%). Consequently, the introduction of CbCR does not seem to affect these jurisdictions abnormally.

Table 4
Number of total MAP cases (not only TP cases), end inventory, order of countries according to Table 1.

Country	OECD	2022	2021	2020	2019	...	2015	of which		increase 2015–2022 (%)
								OECD	non-OECD	
Italy	yes	942	926	995	887		319	302	17	195.30%
Germany	yes	1,431	1,423	1,422	1,242		1,147	1,079	68	24.76%
France	yes	1,074	982	983	902		566	502	64	89.75%
India	no	697	754	873	951		n.a.	n.a.	n.a.	n.a.
Spain	yes	889	757	567	440		93	81	12	855.91%
United States	yes	658	691	940	1,022		998	n.a.	n.a.	−34.07%
United Kingdom	yes	650	637	642	560		229	199	30	183.84%
Switzerland	yes	421	417	430	377		328	319	9	28.35%
Netherlands	yes	528	478	361	316		259	207	52	103.86%
Belgium	yes	851	693	652	563		632	616	16	34.65%
Sweden	yes	330	335	312	239		192	172	20	71.88%
Austria	yes	279	249	286	310		185	160	25	50.81%
Canada	yes	192	195	163	162		272	260	12	−29.41%
Korea	yes	178	198	168	156		139	101	38	28.06%
Denmark	yes	203	260	250	209		84	68	16	141.67%
Portugal	yes	175	127	94	73		31	28	3	464.52%
Poland	yes	195	167	157	153		42	42	0	364.29%
Japan	yes	98	106	103	84		95	43	52	3.16%
Romania	no	120	112	100	61		n.a.	n.a.	n.a.	n.a.
Ireland	yes	144	149	151	86		28	26	2	414.29%
China	no	179	160	152	122		99	79	20	80.81%
Mexico	yes	75	76	64	51		15	15	0	400.00%
Luxembourg	yes	224	212	197	211		137	136	1	63.50%
Finland	yes	135	121	132	97		95	65	30	42.11%
Slovak Republic	yes	68	55	41	41		21	21	0	223.81%
Brazil	no	49	48	29	24		11	n.a.	n.a.	345.45%
Czechia	yes	67	57	48	48		33	31	2	103.03%
Australia	yes	55	63	51	35		22	19	3	150.00%
Israel	yes	41	16	15	13		17	14	3	141.18%
Indonesia	no	46	44	47	58		n.a.	n.a.	n.a.	n.a.
Sum		10,994	10,508	10,425	9,493		6,089	4,585	495	
								90.26%	9.74%	

Appendix B. Proof for the national setting (Proposition 1)

The first step of the proof is to assume that MNE shifts profits to the low-tax country. Second, given that strategy, we derive the best audit responses for H and L. Third, given these audit strategies, we check whether the initially assumed profit shift is a best response for MNE to these audit strategies. See Fig. 3 for the underlying game tree.

Given that MNE shifts profits, H’s expected tax revenue net of the costs for auditing low profit reports at quality level q_H amounts to

$$T_H^{nat} \Big|_{q_H} = t_H [p_{11}(2 - q_H) + p_{12}(2 - q_H) + p_{21}(1 + q_H) + 2p_{22}] - \frac{1}{2}(p_{11} + p_{12} + p_{21})c_H q_H^2. \tag{24}$$

The corresponding first-order and second-order derivatives regarding audit quality are

$$\frac{\partial T_H^{nat} \Big|_{q_H}}{\partial q_H} = t_H(-p_{11} - p_{12} + p_{21}) - (p_{11} + p_{12} + p_{21})c_H q_H \tag{25}$$

and

$$\frac{\partial^2 T_H^{nat} \Big|_{q_H}}{\partial q_H^2} = -(p_{11} + p_{12} + p_{21})c_H < 0. \tag{26}$$

Given the first-order derivative, the only stationary point of $T_H^{nat} \Big|_{q_H}$ is the inner solution \tilde{q}_H^{nat} according to (4). From the second-order derivative, we learn that $T_H^{nat} \Big|_{q_H}$ is strictly concave so \tilde{q}_H^{nat} is the unique global unrestricted maximizer of $T_H^{nat} \Big|_{q_H}$. Observe that \tilde{q}_H^{nat} might be outside the assumed interval of feasible audit-quality levels. Similarly, if it were possible to audit with zero quality, H’s expected net tax revenue would be

$$T_H^{nat} \Big|_{q_H=0} = t_H(2p_{11} + 2p_{12} + p_{21} + 2p_{22}), \tag{27}$$

whereas

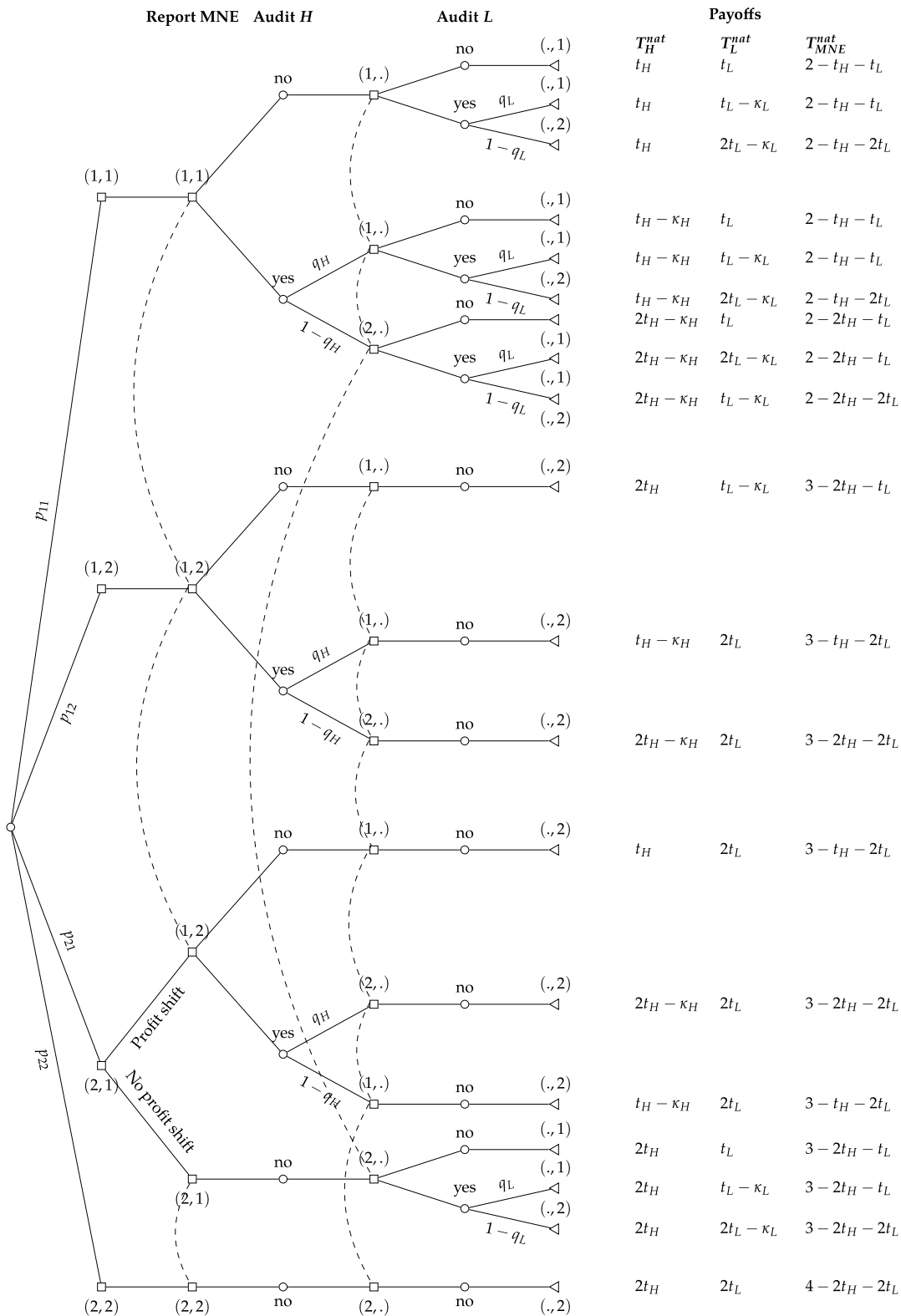


Fig. 3. National setting.

$$T_H^{nat} \Big|_{-q_H} = t_H (p_{11} + p_{12} + p_{21} + 2p_{22}) \tag{28}$$

is the expected (net) tax revenue from not auditing at all. Thus, it would be better for H to audit with zero quality than not performing the audit.

If \tilde{q}_H^{nat} is a feasible audit-quality level, i.e., $\tilde{q}_H^{nat} \in [\frac{1}{2}, 1]$, auditing at this level is H's globally optimal strategy. This is due to the uniqueness of the stationary point \tilde{q}_H^{nat} , the concavity of $T_H^{nat} \Big|_{q_H}$, and the fact that not auditing is less profitable. For the same reasons, $q_H = 1$ is the global optimizer for $\tilde{q}_H^{nat} > 1$. With respect to the remaining case, i.e., $\tilde{q}_H^{nat} < \frac{1}{2}$, H's optimal audit quality is at the minimal level of $\frac{1}{2}$. To see this, calculate the expected net tax revenue for $q_H = \frac{1}{2}$ as

$$T_H^{nat} \Big|_{q_H=\frac{1}{2}} = t_H \left[\frac{3}{2}(p_{11} + p_{12} + p_{21}) + 2p_{22} \right] - \frac{1}{8}(p_{11} + p_{12} + p_{21})c_H, \tag{29}$$

which exceeds the alternative of not auditing, i.e., $T_H^{nat} \Big|_{-q_H}$, if and only if $c_H < 4t_H$. As this condition is weaker than assumption (2), H goes for auditing with minimal quality. Summing up, H's optimal reaction to MNE's profit shift is to audit low profit reports with quality q_H^{nat} according to (1).

Now, take L's perspective. When profits are shifted, L receives a low profit report, $r = (\cdot, 1)$, only for benchmark profits $x = (1, 1)$. In this case, there is no profit shifting, and L would only benefit from erroneous audit results. Such malicious audits are ruled out by assumption. For all other cases, L receives high profit reports, $r = (\cdot, 2)$, and thereby has no incentive to audit. Consequently, L never audits, and its expected (net) tax revenue amounts to

$$T_L^{nat} \Big|_{-q_L} = t_L(p_{11} + 2p_{12} + 2p_{21} + 2p_{22}). \tag{30}$$

Finally, we show that profit shifting is an optimal response of MNE to H auditing low profit reports with quality q_H^{nat} and L refraining from auditing. Assume $x = (2, 1)$ was reached. With profit shifting, MNE's partial expected tax payment amounts to

$$q_H^{nat}(2t_H + 2t_L) + (1 - q_H^{nat})(t_H + 2t_L) = (1 + q_H^{nat})t_H + 2t_L. \tag{31}$$

Without profit shifting to the low-tax country, the partial expected tax payment is

$$2t_H + t_L, \tag{32}$$

which is higher than under profit shifting, if and only if $q_H^{nat} < 1 - \frac{t_L}{t_H}$.

Appendix C. Proofs for country-by-country reporting without arbitration

C.1. Proof of Proposition 2

The proof of Proposition 2 under CbCR follows the same steps as the proof of Proposition 1 in the national setting (see Appendix B). As malicious audits are ruled out by assumption, we mainly have to remove the audits of report $r = (1, 1)$ from the proof of Proposition 1 to prove Proposition 2. Fig. 4 helps to keep track of the sequential game.

H's best audit response to MNE shifting profits to the low-tax country is to audit the low profit report $r = (1, 2)$ at quality level q_H^{cbc} according to (6)–(7). This can be concluded from the following expressions, which correspond to (24)–(26) and (27)–(29):

$$T_H^{cbc} \Big|_{q_H} = t_H [p_{11} + p_{12}(2 - q_H) + p_{21}(1 + q_H) + 2p_{22}] - \frac{1}{2}(p_{12} + p_{21})c_H q_H^2, \tag{33}$$

$$\frac{\partial T_H^{cbc} \Big|_{q_H}}{\partial q_H} = t_H(-p_{12} + p_{21}) - (p_{12} + p_{21})c_H q_H, \tag{34}$$

$$\frac{\partial^2 T_H^{cbc} \Big|_{q_H}}{\partial q_H^2} = -(p_{12} + p_{21})c_H < 0, \tag{35}$$

$$T_H^{cbc} \Big|_{q_H=0} = t_H (p_{11} + 2p_{12} + p_{21} + 2p_{22}), \tag{36}$$

$$T_H^{cbc} \Big|_{-q_H} = t_H (p_{11} + p_{12} + p_{21} + 2p_{22}), \tag{37}$$

$$T_H^{cbc} \Big|_{q_H=\frac{1}{2}} = t_H \left[p_{11} + \frac{3}{2}(p_{12} + p_{21}) + 2p_{22} \right] - \frac{1}{8}(p_{12} + p_{21})c_H. \tag{38}$$

For L's audit reaction, nothing changes compared to the national case, so L refrains from auditing.

As to MNE's profit shifting given H's and L's above audit strategies, there is a caveat: we have not yet specified whether L goes for an audit of $r = (2, 1)$ for this report does not occur under profit shifting; it is off the equilibrium path. In the proposition, we

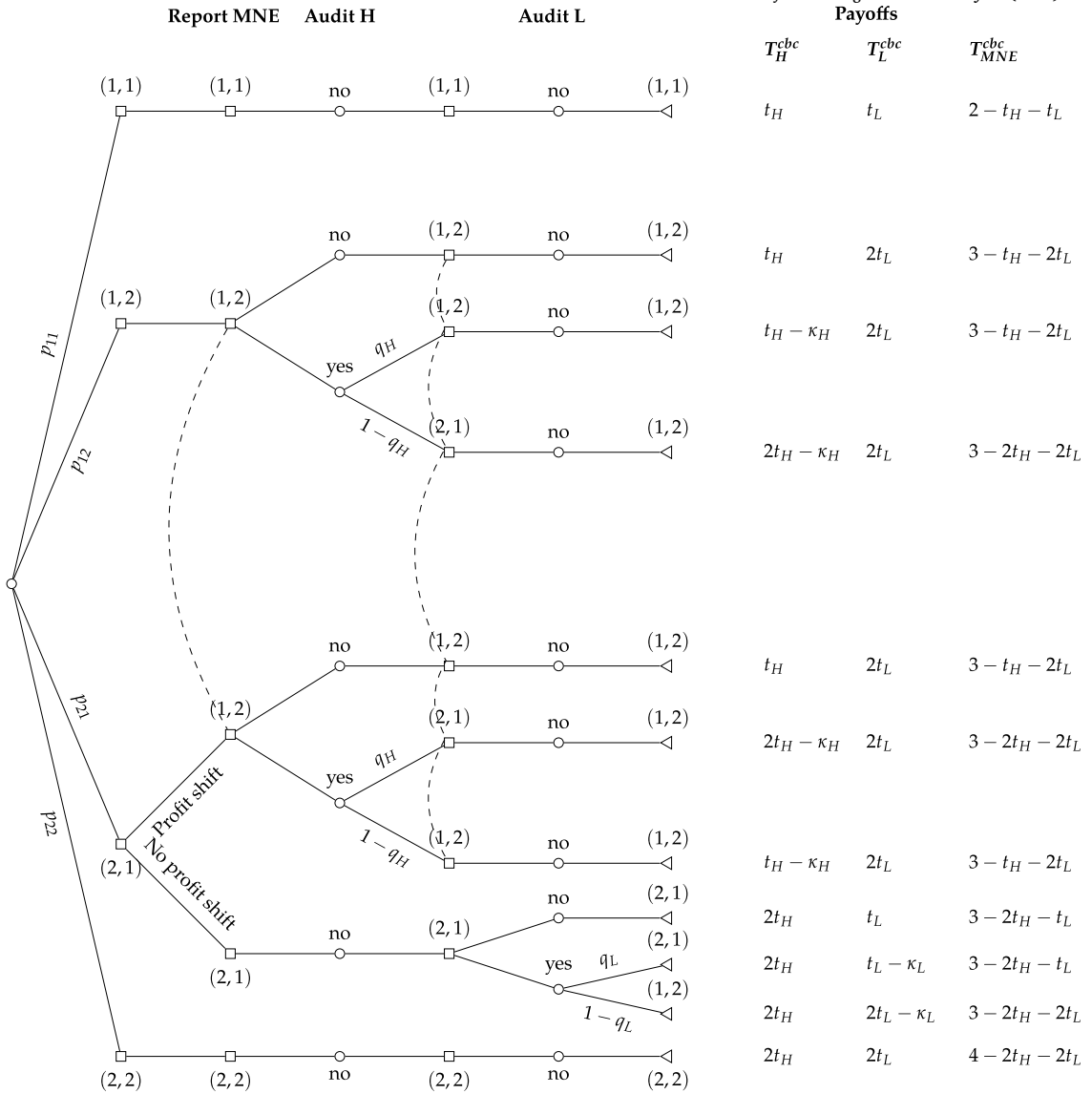


Fig. 4. CbC reporting without fiscal arbitration.

assume that L does not audit such reports and thus does not audit whenever the profit reported for its own jurisdiction is low. Since this reaction is the same as in the national setting, the check whether the derived audit strategies are consistent with the assumed profit-shifting strategy in the proof of Proposition 1 equally applies here provided that \tilde{q}_H^{nat} is substituted for \tilde{q}_H^{cbc} .

There are other equilibria. In particular, it can be shown that L auditing $r = (2, 1)$ is part of an equilibrium, if and only if $q_H^{cbc} < 1 - q_L \frac{t_L}{t_H}$. However, such equilibria differ only off the equilibrium path and entail identical expected payoffs.

C.2. Proof of Lemma 1

Property 1 refers to the signs of the three terms in condition (10). The first and the third term are strictly positive due to $q_H^{cbc} = \tilde{q}_H^{cbc} > \tilde{q}_H^{nat} = q_H^{nat}$. The second term is strictly positive as $q_H^{nat} \in [\frac{1}{2}, 1)$ according to Proposition 1.

Property 2 with respect to the overall probability of double taxation is equivalent to condition (10) evaluated for $q_H^{cbc} = \tilde{q}_H^{cbc}$ and $\tilde{q}_H^{nat} = q_H^{nat}$ which can be reformulated as

$$(p_{21} - p_{12})(\tilde{q}_H^{cbc} - \tilde{q}_H^{nat}) > p_{11}(1 - \tilde{q}_H^{nat}). \tag{39}$$

Exploiting

$$\bar{q}_H^{cbc} - \bar{q}_H^{nat} = \frac{t_H}{c_H} \frac{2p_{11}p_{21}}{(p_{12} + p_{21})(p_{11} + p_{12} + p_{21})} = \frac{2p_{11}p_{21}}{(p_{12} + p_{21})(p_{21} - p_{11} - p_{12})} \bar{q}_H^{nat} \quad (40)$$

leads to

$$(p_{21} - p_{12}) \frac{2p_{11}p_{21}}{(p_{12} + p_{21})(p_{21} - p_{11} - p_{12})} \bar{q}_H^{nat} > p_{11}(1 - \bar{q}_H^{nat}) \quad (41)$$

as an equivalent of (39). Similar substitutions as in (40) allow us to transform (41) into

$$\frac{2p_{21}}{p_{11} + p_{12} + p_{21}} \bar{q}_H^{cbc} + \bar{q}_H^{nat} > 1. \quad (42)$$

This condition is true for two reasons. First, in equilibrium, we have $\bar{q}_H^{cbc}, \bar{q}_H^{nat} \geq \frac{1}{2}$. Second, the first factor in (42) is strictly greater than 1 as $p_{21} > p_{11} + p_{12}$ which must hold for \bar{q}_H^{nat} not falling below $\frac{1}{2}$.

The property of MNE's increasing expected tax payment is equivalent to that of the increasing probability of double taxation because the tax increase is determined by double taxation. To understand this, calculate

$$\begin{aligned} T_{MNE}^{cbc} - T_{MNE}^{nat} &= t_H [p_{11} + p_{12}(2 - q_H^{cbc}) + p_{21}(1 + q_H^{cbc})] - t_H [(p_{11} + p_{12})(2 - q_H^{nat}) + p_{21}(1 + q_H^{nat})] \\ &= t_H [(p_{21} - p_{12})(q_H^{cbc} - q_H^{nat}) - p_{11}(1 - q_H^{nat})] \end{aligned} \quad (43)$$

and realize from the last line that $T_{MNE}^{cbc} > T_{MNE}^{nat}$ for the inner solutions is equivalent to condition (39).

Appendix D. Proofs for country-by-country reporting with arbitration

D.1. Introduction

Table 5 gives an overview of all situations associated with tax report $r = (1, 2)$. The table breaks down into four cases, reflecting that both tax authorities may or may not conduct a tax audit. The outcome of any arbitration depends on the specific arbitration procedure in place. Specifically, the final tax bases b_H and b_L hinge on the countries' negotiation powers or their audits, depending on the considered arbitration procedure.

The tax authorities' incentives to audit and to increase audit quality depend not only on the arbitration outcome but also on the timing of audits. In the following, we continue under our previous assumption that the tax authorities decide on their audits once, individually, simultaneously, and before arbitration is initiated.

D.2. Negotiation-power arbitration

Proposition 5. *Under country-by-country reporting with negotiation-power arbitration, let MNE shift profits to the low-tax country L. Then, tax authority H audits only the low profit report, i.e., $r = (1, 2)$, at quality level*

$$q_H^{neg} = \min \left\{ \max \left\{ \bar{q}_H^{neg}, \frac{1}{2} \right\}, 1 \right\} \quad (44)$$

with inner solution

$$\bar{q}_H^{neg} = \alpha \frac{t_H}{c_H} \frac{p_{21} - p_{12}}{p_{12} + p_{21}} \quad (45)$$

if $\alpha > \frac{1}{4} \frac{c_H}{t_H}$; otherwise H does not audit. Tax authority L does not audit any profit report. These reporting and auditing strategies form equilibria.

The proof parallels the corresponding proof under CbCR without arbitration in Appendix C.1. It is easy to integrate arbitration as its outcome does not depend on H and L's audit strategies but only on their exogenous bargaining powers. This means that best audit strategies do not depend on each other and that there is still no point for H and L in auditing profits reported as high.

For L, auditing still has no benefit so L always refrains from auditing. H's best audit response to MNE shifting profits is to audit profit report $r = (1, 2)$ at quality level q_H^{neg} according to (44)–(45) if $\alpha > \frac{1}{4} \frac{c_H}{t_H}$; otherwise H does not audit, i.e., $q_H^{neg} = \neg q_H$. This can be concluded from the following expressions, which correspond to (33)–(38):

$$T_H^{neg} \Big|_{q_H, \neg q_L} = t_H (p_{11} + p_{12}[1 + \alpha(1 - q_H)] + p_{21}(1 + \alpha q_H) + 2p_{22}) - \frac{1}{2}(p_{12} + p_{21})c_H q_H^2, \quad (46)$$

$$\frac{\partial T_H^{neg}}{\partial q_H} \Big|_{q_H, \neg q_L} = \alpha t_H (-p_{12} + p_{21}) - (p_{12} + p_{21})c_H q_H, \quad (47)$$

$$\frac{\partial^2 T_H^{neg}}{\partial q_H^2} \Big|_{q_H, \neg q_L} = -(p_{12} + p_{21})c_H < 0, \quad (48)$$

Table 5
Determining cases for fiscal arbitration.

Case 1: No tax audits, i.e., $(q_H, q_L) = (\neg q_H, \neg q_L)$										
Case	1.1				1.2					
Benchmark profits (x_H, x_L)	(1, 2)				(2, 1)					
Tax reports (r_H, r_L)	(1, 2)				(1, 2)					
Arbitration	No				No					
Tax bases (b_H, b_L)	(1, 2)				(1, 2)					
Probability	p_{12}				p_{21}					
Case 2: Tax audit only by country H, i.e., $(q_H, q_L) = (q_H, \neg q_L)$										
Case	2.1a	2.1b			2.2a	2.2b				
Benchmark profits (x_H, x_L)	(1, 2)	(1, 2)			(2, 1)	(2, 1)				
Tax reports (r_H, r_L)	(1, 2)	(1, 2)			(1, 2)	(1, 2)				
Result audit H	(1, ·)	(2, ·)			(2, ·)	(1, ·)				
Arbitration	No	Yes			Yes	No				
Tax bases (b_H, b_L)	(1, 2)	(b_H, b_L)			(b_H, b_L)	(1, 2)				
Probability	$p_{12}q_H$	$p_{12}(1-q_H)$			$p_{21}q_H$	$p_{21}(1-q_H)$				
Case 3: Tax audit only by country L, i.e., $(q_H, q_L) = (\neg q_H, q_L)$										
Case	3.1a	3.1b			3.2a	3.2b				
Benchmark profits (x_H, x_L)	(1, 2)	(1, 2)			(2, 1)	(2, 1)				
Tax reports (r_H, r_L)	(1, 2)	(1, 2)			(1, 2)	(1, 2)				
Result audit L	(·, 2)	(·, 1)			(·, 1)	(·, 2)				
Arbitration	No	No			No	No				
Tax bases (b_H, b_L)	(1, 2)	(1, 2)			(1, 2)	(1, 2)				
Probability	$p_{12}q_L$	$p_{12}(1-q_L)$			$p_{21}q_L$	$p_{21}(1-q_L)$				
Case 4: Tax audits by both countries, i.e., $(q_H, q_L) = (q_H, q_L)$										
Case	4.1a	4.1b	4.1c		4.1d	4.2a	4.2b		4.2c	4.2d
Benchmark profits (x_H, x_L)	(1, 2)	(1, 2)	(1, 2)		(1, 2)	(2, 1)	(2, 1)		(2, 1)	(2, 1)
Tax reports (r_H, r_L)	(1, 2)	(1, 2)	(1, 2)		(1, 2)	(1, 2)	(1, 2)		(1, 2)	(1, 2)
Result audit H	(1, ·)	(1, ·)	(2, ·)		(2, ·)	(2, ·)	(2, ·)		(1, ·)	(1, ·)
Result audit L	(·, 2)	(·, 1)	(·, 2)		(·, 1)	(·, 1)	(·, 2)		(·, 1)	(·, 2)
Arbitration	No	No	Yes		No	No	Yes		No	No
Tax bases (b_H, b_L)	(1, 2)	(1, 2)	(b_H, b_L)		(2, 1)	(2, 1)	(b_H, b_L)		(1, 2)	(1, 2)
Probability	$p_{12}q_Hq_L$	$p_{12}q_H(1-q_L)$	$p_{12}(1-q_H)q_L$		$p_{12}(1-q_H)(1-q_L)$	$p_{21}q_Hq_L$	$p_{21}q_H(1-q_L)$		$p_{21}(1-q_H)q_L$	$p_{21}(1-q_H)(1-q_L)$

$$T_H^{neg} \Big|_{q_H=0, \neg q_L} = t_H (p_{11} + p_{12}(1 + \alpha) + p_{21} + 2p_{22}), \tag{49}$$

$$T_H^{neg} \Big|_{\neg q_H, \neg q_L} = t_H (p_{11} + p_{12} + p_{21} + 2p_{22}), \tag{50}$$

$$T_H^{neg} \Big|_{q_H=\frac{1}{2}, q_L} = t_H \left[p_{11} + (p_{12} + p_{21})(1 + \frac{\alpha}{2}) + 2p_{22} \right] - \frac{1}{8}(p_{12} + p_{21})c_H. \tag{51}$$

The no-audit condition $\alpha \leq \frac{1}{4} \frac{c_H}{t_H}$ is equivalent to $T_H^{neg} \Big|_{\neg q_H, \neg q_L} \geq T_H^{neg} \Big|_{q_H=\frac{1}{2}, \neg q_L}$. It says that H finds it optimal not to audit if the gain from arbitration is too low.

We start the check whether MNE shifts profits given these audit strategies in the first place with the no-audits case. Without any audit, it is obviously best for MNE to shift profits to benefit from the tax rate differential. Thus, there is a no-audits equilibrium with profit shifting.

The other equilibrium implies audits by H at quality level q_H^{neg} according to (44). Then, we have to compare at $x = (2, 1)$ the partial expected payment

$$t_H + 2t_L + \alpha q_H^{neg} (t_H - t_L) \tag{52}$$

for profit shifting and

$$2t_H + t_L \tag{53}$$

for no profit shifting. The difference of (52) and (53), i.e., $-(t_H - t_L)(1 - \alpha q_H^{neg})$, is always negative. This confirms the other equilibrium.

As under CbCR without arbitration, see Appendix C.1, it is possible, but just as pointless, to vary L's reaction to the off-the-equilibrium-path report $r = (2, 1)$.

D.3. Final-offer arbitration (Proposition 3)

The proof falls into three steps. First, we determine L's best audit reaction to all of H's possible audit decisions. Second, we identify the audit equilibrium by examining H's best reactions to L's best reactions. Observe that we do not have to determine H's best reaction to all of L's possible audit decisions but only to L's best reactions. Third, we check whether the initial assumption of MNE's profit shift is consistent with the audit equilibrium.

We begin the first step by assuming that H audits the profit report $r = (1, 2)$ at a given quality level q_H and looking at L's corresponding expected net tax revenues from auditing at quality level q_L , i.e.,

$$T_L^{fo} \Big|_{q_H, q_L} = t_L (p_{11} + p_{12}[2q_H + (1 - q_H)q_L]b_L^{fo} + (1 - q_H)(1 - q_L)) + p_{21}[q_H q_L + q_H(1 - q_L)b_L^{fo} + 2(1 - q_H)] + 2p_{22} - \frac{1}{2}(p_{12} + p_{21})c_L q_L^2 \tag{54}$$

and the expected tax revenue from not auditing, i.e.,

$$T_L^{fo} \Big|_{q_H, \neg q_L} = t_L [p_{11} + 2p_{12}q_H + p_{12}(1 - q_H) + p_{21}q_H + 2p_{21}(1 - q_H) + 2p_{22}]. \tag{55}$$

In combination with the partial derivatives

$$\frac{\partial T_L^{fo}}{\partial q_L} \Big|_{q_H, q_L} = t_L (b_L^{fo} - 1)[p_{12}(1 - q_H) - p_{21}q_H] - (p_{12} + p_{21})c_L q_L, \tag{56}$$

$$\frac{\partial^2 T_L^{fo}}{\partial q_L^2} \Big|_{q_H, q_L} = -(p_{12} + p_{21})c_L < 0, \tag{57}$$

and

$$\frac{\partial T_L^{fo}}{\partial b_L^{fo}} \Big|_{q_H, q_L} = t_L [p_{12}(1 - q_H)q_L + p_{21}q_H(1 - q_L)], \tag{58}$$

we make three observations. First, for given b_L^{fo} , $T_L^{fo} \Big|_{q_H, q_L}$ is strictly concave in q_L and its global maximizer is $(b_L^{fo} - 1)\tilde{q}_L^{fo}(q_H)$ with

$$\tilde{q}_L^{fo}(q_H) = \frac{t_L p_{12}(1 - q_H) - p_{21}q_H}{c_L p_{12} + p_{21}} \tag{59}$$

as L's optimal audit quality in case of winning the arbitration. Note that this observation does not consider the restriction $q_L \in [\frac{1}{2}, 1]$. Also note that the partial derivatives ignore the dependence of b_L^{fo} on q_H and q_L according to (14). Second, $T_L^{fo} \Big|_{q_H, q_L}$ increases in b_L^{fo} for given $q_L \in [0, 1]$ unless $q_H = 1$ in case of which the effect of b_L^{fo} vanishes. Third, $T_L^{fo} \Big|_{q_H, 0} = T_L^{fo} \Big|_{q_H, \neg q_L}$ because $q_L = 0$ implies losing the arbitration, i.e., $b_L^{fo} = 1$. Similar to the first observation, this observation is technical as $q_L = 0$ violates the restriction $q_L \in [\frac{1}{2}, 1]$.

Now, we integrate the dependence of b_L^{fo} on q_H and q_L as well as the restriction $q_L \in [\frac{1}{2}, 1]$ to determine L's best reaction, $q_L^{fo}(q_H)$, to H's possible audit-quality decisions $q_H \in [\frac{1}{2}, 1]$ on the basis of the above observations. We start by assuming $q_H < 1$.

For $q_H < \tilde{q}_L^{fo}(q_H)$, we have $q_L^{fo}(q_H) = \min\{\tilde{q}_L^{fo}(q_H), 1\}$. This is the inner solution $(b_L^{fo} - 1)\tilde{q}_L^{fo}(q_H)$ for winning the arbitration and taking into account the constraint $q_L \leq 1$. Not winning the arbitration or no audit imply less expected net taxes for L.

For $q_H \geq \tilde{q}_L^{fo}(q_H)$, winning the arbitration means that L must up its audit quality above the inner optimum $\tilde{q}_L^{fo}(q_H)$. Due to the strict concavity of $T_L^{fo} \Big|_{q_H, q_L}$ in q_L , L keeps the increase in quality minimal. Consequently, L's optimal audit quality can be stated as $q_L^{fo}(q_H) = q_H + \iota$ with $\iota \rightarrow 0^+$. The marginal additional quality ι allows L to win the arbitration but can be neglected in the evaluation of the objective functions. At the same time, L's audit quality must not be too high. Otherwise, L prefers not to audit to save on audit costs. The corresponding condition is $q_H < \frac{2t_L}{c_L + 2t_L}$ which follows from simplifying $T_L^{fo} \Big|_{q_H, q_H} > T_L^{fo} \Big|_{q_H, \neg q_L}$. The threshold value is greater than $\frac{1}{2}$ due to assumption (2).

For $q_H = 1$, L prefers not to audit because L would have to draw level with H, implying that both audits are perfect and that the tax assessments lead to the benchmark profits. However, the same result can be reached by L without incurring audit costs by not conducting the audit. Last, as profit shifting is directed to the low-tax country L, there is no gain from auditing for L if the high-tax country H does not audit.

In summary, we have

$$q_L^{fo}(q_H) = \begin{cases} \min\{\tilde{q}_L^{fo}(q_H), 1\}, & \text{if } q_H < \min\{\tilde{q}_L^{fo}(q_H), 1\} \\ q_H + t, & \text{if } \tilde{q}_L^{fo}(q_H) \leq q_H < \frac{2t_L}{c_L + 2t_L} \\ \neg q_L, & \text{otherwise (including } q_H \in \{1, \neg q_H\}) \end{cases} \quad (60)$$

as L's optimal reaction to H auditing with quality $q_H \in [\frac{1}{2}, 1]$ or not auditing.

In the second step, we turn to H's reaction to L's reaction to identify the equilibrium in the audit game. From (60), we learn that there are only equilibria with L either conducting an audit and winning the arbitration or not conducting an audit. Since it is never optimal for H to conduct an audit and lose the arbitration, there are two candidates for an equilibrium: (1) H audits with a sufficiently high quality, i.e., $q_H \geq \frac{2t_L}{c_L + 2t_L}$, while L does not audit, or (2) both H and L do not audit. Both candidates imply that L does not audit.

Under final-offer arbitration, H wins the arbitration and enforces its audit result if it is the only country to conduct an audit. Although this is not the same as under CbCR without arbitration in terms of L's tax base, it is in terms of H's tax base. Consequently, $T_H^{fo}|_{q_H, \neg q_L}$ is equal to $T_H^{cbc}|_{q_H}$ according to (33). Thus, we can refer to Proposition 2 for H's reaction under final-offer arbitration, i.e., $q_H^{fo}(\neg q_L) = q_H^{cbc}$. This reaction implies that there is no equilibrium with both H and L not auditing.

Now, we conclude the second step of the proof by stating the unique equilibrium of the audit game between H and L based on the optimal reactions $q_L^{fo}(q_H)$ and $q_H^{fo}(\neg q_L)$ as

$$(q_H^{fo}, q_L^{fo}) = \left(\min\left\{ \max\left\{ \tilde{q}_H^{fo}, \frac{1}{2} \right\}, 1 \right\}, \neg q_L \right) \quad (61)$$

with \tilde{q}_H^{fo} following definition (16). The equilibrium hinges on the condition

$$q_H^{fo} \geq \frac{2t_L}{c_L + 2t_L}. \quad (62)$$

In the third and final step, we identify the conditions under which the assumption of profit shifting by MNE is consistent with the above equilibrium audit strategies combined with the assumption that both H and L do not audit the off-equilibrium report $r = (2, 1)$. The approach is the same as in the national setting and under CbCR without arbitration, see the proofs of Propositions 1 and 2, but has to be modified for the resolution of double taxation through arbitration. We have to compare

$$q_H^{fo}(2t_H + t_L) + (1 - q_H^{fo})(t_H + 2t_L) = (1 + q_H^{fo})t_H + (2 - q_H^{fo})t_L \quad (63)$$

for profit shifting, which is the analogue of (31) in the national setting, and

$$2t_H + t_L \quad (64)$$

for no profit shifting, which is the same as in the national setting, see (32). The former expression falls short of the latter, meaning that MNE shifts profit if and only if $q_H^{fo} < 1$. This confirms that profit shifting is the optimal reporting strategy given the assumed audit strategies.

D.4. Independent-opinion arbitration with minimum-quality requirement

D.4.1. Introduction

The expected tax base of country $i \in \{H, L\}$ resulting from arbitration based on definition (18) amounts to

$$E(b_i^{fo}) = \text{prob}(q_i < \hat{q}) + \frac{3}{2} \text{prob}(q_i \geq \hat{q}) = \frac{1}{2} + q_i \quad (65)$$

due to the uniform distribution of \hat{q} . This expression can be used to arrive at the expected net tax revenues in the four audit cases from Table 5, i.e.,

$$T_H^{min} \Big|_{\neg q_H, \neg q_L} = t_H(p_{11} + p_{12} + p_{21} + 2p_{22}), \quad (66)$$

$$T_L^{min} \Big|_{\neg q_H, \neg q_L} = t_L(p_{11} + 2p_{12} + 2p_{21} + 2p_{22}), \quad (67)$$

$$T_H^{min} \Big|_{q_H, \neg q_L} = t_H \left[p_{11} + p_{12} \left(\frac{1}{2} + \frac{3}{2} q_H - q_H^2 \right) + p_{21} \left(1 - \frac{1}{2} q_H + q_H^2 \right) + 2p_{22} \right] - \frac{1}{2} (p_{12} + p_{21}) c_H q_H^2, \quad (68)$$

$$T_L^{min} \Big|_{q_H, \neg q_L} = t_L [p_{11} + p_{12}(1 + q_H) + p_{21}(2 - q_H) + 2p_{22}], \quad (69)$$

$$T_H^{min} \Big|_{\neg q_H, q_L} = t_H(p_{11} + p_{12} + p_{21} + 2p_{22}), \quad (70)$$

$$T_L^{min} \Big|_{\neg q_H, q_L} = t_L(p_{11} + 2p_{12} + 2p_{21} + 2p_{22}) - \frac{1}{2} (p_{12} + p_{21}) c_L q_L^2, \quad (71)$$

$$T_H^{min} \Big|_{q_H, q_L} = t_H \left(p_{11} + p_{12} \left[2 - \frac{3}{2} q_L + \left(\frac{5}{2} q_L - 1 \right) q_H - q_L q_H^2 \right] + p_{21} \left[1 + \left(\frac{3}{2} q_L - \frac{1}{2} \right) q_H + (1 - q_L) q_H^2 \right] + 2p_{22} \right) - \frac{1}{2} (p_{12} + p_{21}) c_H q_H^2, \tag{72}$$

and

$$T_L^{min} \Big|_{q_H, q_L} = t_L \left(p_{11} + p_{12} \left[1 + q_H - \frac{1}{2} (1 - q_H) q_L + (1 - q_H) q_L^2 \right] + p_{21} \left[2 - \frac{3}{2} q_H + \frac{3}{2} q_H q_L - q_H q_L^2 \right] + 2p_{22} \right) - \frac{1}{2} (p_{12} + p_{21}) c_L q_L^2. \tag{73}$$

D.4.2. Unilateral audit by high-tax country (Proposition 4)

We start by determining conditions for which H audits (1, 2)-reports provided that L does not audit. Given that L does not audit, H's expected net tax revenues from auditing at quality level q_H are given by $T_H^{min} \Big|_{q_H, \neg q_L}$ according to (68). The corresponding partial derivatives with respect to q_H are

$$\frac{\partial T_H^{min} \Big|_{q_H, \neg q_L}}{\partial q_H} = t_H \left[p_{12} \left(\frac{3}{2} - 2q_H \right) + p_{21} \left(2q_H - \frac{1}{2} \right) \right] - (p_{12} + p_{21}) c_H q_H \tag{74}$$

with stationary point

$$\tilde{q}_H^{min} = \frac{t_H (3p_{12} - p_{21})}{4t_H (p_{12} - p_{21}) + 2c_H (p_{12} + p_{21})} \tag{75}$$

and

$$\frac{\partial^2 T_H^{min} \Big|_{q_H, \neg q_L}}{\partial q_H^2} = 2t_H (p_{21} - p_{12}) - c_H (p_{12} + p_{21}). \tag{76}$$

From (76) follows that \tilde{q}_H^{min} is a maximizer, if

$$c_H > 2t_H \frac{p_{21} - p_{12}}{p_{12} + p_{21}}, \tag{77}$$

which is equivalent to $T_H^{min} \Big|_{q_H, \neg q_L}$ being strictly concave in q_H . Assume that (77) holds, i.e., $T_H^{min} \Big|_{q_H, \neg q_L}$ is strictly concave and unimodal. It is possible that the inner solution \tilde{q}_H^{min} is not feasible. Then, H prefers $q_H = \frac{1}{2}$ for $\tilde{q}_H^{min} < \frac{1}{2}$ and $q_H = 1$ for $\tilde{q}_H^{min} > 1$. However, $q_H = \frac{1}{2}$ always yields lower expected net tax revenues for H than no audit, which can be learned from

$$T_H^{min} \Big|_{q_H = \frac{1}{2}, \neg q_L} - T_H^{min} \Big|_{\neg q_H, \neg q_L} = -\frac{1}{8} (p_{12} + p_{21}) c_H < 0. \tag{78}$$

Auditing at $q_H = 1$, in turn, is preferable to no audit if and only if

$$T_H^{min} \Big|_{q_H = 1, \neg q_L} - T_H^{min} \Big|_{\neg q_H, \neg q_L} = \frac{1}{2} p_{21} t_H - \frac{1}{2} (p_{12} + p_{21}) c_H > 0 \tag{79}$$

which is equivalent to

$$c_H < t_H \frac{p_{21}}{p_{12} + p_{21}}. \tag{80}$$

Assume that (80) holds, i.e., $T_H^{min} \Big|_{q_H = 1, \neg q_L} > T_H^{min} \Big|_{\neg q_H, \neg q_L}$. From property (78) and assumptions (77) and (80) follows

$$q_H^{min}(\neg q_L) = \min \{ \tilde{q}_H^{min}, 1 \} \tag{81}$$

as H's optimal audit reaction to L not auditing.

The next step is to find conditions under which L finds it optimal not to audit in reaction to H auditing at quality level $q_H^{min}(\neg q_L)$. We do so by means of the condition

$$T_L^{min} \Big|_{q_H, \neg q_L} - T_L^{min} \Big|_{q_H, q_L} \geq 0 \tag{82}$$

with $T_L^{min} \Big|_{q_H, \neg q_L}$ and $T_L^{min} \Big|_{q_H, q_L}$ as given by (69) and (73). The partial derivatives of $T_L^{min} \Big|_{q_H, q_L}$ with respect to q_L are

$$\frac{\partial T_L^{min} \Big|_{q_H, q_L}}{\partial q_L} = t_L \left[p_{12} (1 - q_H) \left(2q_L - \frac{1}{2} \right) + p_{21} q_H \left(\frac{3}{2} - 2q_L \right) \right] - (p_{12} + p_{21}) c_L q_L \tag{83}$$

with stationary point

$$\tilde{q}_L^{min}(q_H) = \frac{t_L [p_{12} - q_H (p_{12} + 3p_{21})]}{4t_L [p_{12} - q_H (p_{12} + p_{21})] - 2c_L (p_{12} + p_{21})} \quad (84)$$

and

$$\frac{\partial^2 T_L^{min} |_{q_H, q_L}}{\partial q_L^2} = 2t_L [p_{12} - q_H (p_{12} + p_{21})] - c_L (p_{12} + p_{21}). \quad (85)$$

Strict concavity of $T_L^{min} |_{q_H, q_L}$ is equivalent to

$$c_L > 2t_L \left(\frac{p_{12}}{p_{12} + p_{21}} - q_H \right) \quad (86)$$

and implies that $\tilde{q}_L^{min}(q_H)$ is a maximizer. We require this condition for all $q_H \in (\frac{1}{2}, 1]$. As the right-hand side of (86) decreases in q_H , we evaluate it for $q_H = \frac{1}{2}$ to arrive at the condition

$$c_L \geq t_L \frac{p_{12} - p_{21}}{p_{12} + p_{21}}. \quad (87)$$

We assume that (87) holds, so that $T_L^{min} |_{q_H, q_L}$ is strictly concave for all $q_H \in (\frac{1}{2}, 1]$. Now, suppose $q_L = \tilde{q}_L^{min}(q_H)$. Then, the no-audit condition (82) is satisfied for $q_H = q_H^{min}(\neg q_L) = 1$, if and only if

$$c_L \geq t_L \frac{p_{21}}{4(p_{12} + p_{21})}. \quad (88)$$

Similarly, for $q_H = q_H^{min}(\neg q_L) = \tilde{q}_H^{min}(\neg q_L)$, we get

$$c_L \geq \frac{t_L (p_{12} + p_{21}) [2c_H p_{12} + (p_{12} - p_{21}) t_H]^2}{8t_H (3p_{12} - p_{21}) p_{21} [c_H (p_{12} + p_{21}) + 2t_H (p_{12} - p_{21})]}. \quad (89)$$

In sum, if conditions (77), (80), (87), (88), and (89) hold, the equilibrium of the audit game is $q_H = q_H^{min}(\neg q_L)$ and $q_L = \neg q_L$. Observe that these conditions are sufficient but not necessary for the described equilibrium.

As the last step, we look at MNE's strategy if only H audits. We can easily see that the expected after-tax profit for the MNE is higher if it shifts profit. This confirms that profit shifting to the low-tax country is the optimal reporting strategy given the assumed audit strategies.

D.4.3. Comparison of audit qualities

We compare the audit qualities focusing on inner solutions, i.e., \tilde{q}_H^{min} versus \tilde{q}_H^{cbc} according to (20) and (7). The condition for a higher audit quality under minimum-quality arbitration than under CbCR without arbitration reads

$$\tilde{q}_H^{min} = \frac{t_H (3p_{12} - p_{21})}{4t_H (p_{12} - p_{21}) + 2c_H (p_{12} + p_{21})} > \frac{t_H}{c_H} \frac{p_{21} - p_{12}}{p_{12} + p_{21}} = \tilde{q}_H^{cbc}. \quad (90)$$

Both sides of the inequality are positive as they represent feasible audit qualities. On the right-hand side, this means $p_{21} > p_{12}$. On the left-hand side, the numerator and the denominator both have to be either positive or negative. Assume that both are positive, i.e., $3p_{12} > p_{21}$. Then, (90) can be transformed into

$$\frac{t_H}{c_H} > \frac{(3p_{21} - 5p_{12})(p_{12} + p_{21})}{4(p_{21} - p_{12})^2}. \quad (91)$$

If both are negative, i.e., $3p_{12} < p_{21}$, the direction of inequality (91) reverses.

D.4.4. Both countries conduct tax audits (Proposition 2)

If both countries audit, H expects net tax revenues of $T_H^{min} |_{q_H, q_L}$ according to (72). The partial derivatives of (72) with regard to q_H are

$$\frac{\partial T_H^{min} |_{q_H, q_L}}{\partial q_H} = t_H \left(p_{12} \left[\frac{5}{2} q_L - 1 - 2q_L q_H \right] + p_{21} \left[\frac{3}{2} q_L - \frac{1}{2} + 2(1 - q_L) q_H \right] \right) - (p_{12} + p_{21}) c_H q_H \quad (92)$$

with stationary point

$$\tilde{q}_H^{min}(q_L) = \frac{t_H \left[q_L \left(\frac{5}{2} p_{12} + \frac{3}{2} p_{21} \right) - p_{12} - \frac{1}{2} p_{21} \right]}{2t_H [q_L (p_{12} + p_{21}) - p_{21}] + c_H (p_{12} + p_{21})} \quad (93)$$

and

$$\frac{\partial^2 T_H^{min} |_{q_H, q_L}}{\partial q_H^2} = 2t_H [p_{21} - q_L(p_{12} + p_{21})] - (p_{12} + p_{21})c_H. \quad (94)$$

The second derivative shows that $\tilde{q}_H^{min}(q_L)$ is a maximizer if

$$c_H > 2t_H \left(\frac{p_{21}}{p_{12} + p_{21}} - q_L \right). \quad (95)$$

We already know L's reaction function \tilde{q}_L^{min} from (84) in Appendix D.4.2.

Data availability

No data was used for the research described in the article.

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