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The global minimum tax ☆

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ABSTRACT

This paper studies how the *global minimum tax* shapes national tax policies and welfare in a formal model of international tax competition with heterogeneous countries. The net welfare effect is generally ambiguous from the perspective of non-havens. On the one hand, the global minimum tax raises their welfare by curbing profit shifting, which boosts government revenue. One the other hand, it lowers their welfare by increasing equilibrium tax rates in havens, which transfers resources from non-haven firms to haven governments. The net welfare effect is unambiguously positive when the global minimum rate is so high that profit shifting ends.

1. Introduction

The recent academic literature offers a dismal diagnosis of the global corporate tax system. Multinational firms book a significant share of their profits in tax havens with low effective taxation and governments respond to the increasing cross-border mobility of profits by cutting corporate tax rates in a fierce race-to-the-bottom. Both developments contribute to the erosion of effective tax rates on firm profits with adverse consequences for efficiency and equity (Tørsløv, Wier and Zucman, 2018; Devereux et al., 2020a).

This diagnosis has caught the attention of policymakers and a major reform of the international tax system is under way. A key element of the reform, agreed by more than 100 countries in October 2021, is a global minimum tax on profits at the rate of 15%. The minimum tax will primarily be enforced through top-up taxes in the home countries of multinational firms: If Google's profits in Bermuda are effectively taxed at 1%, the U.S. will impose an additional 14% tax to bring the total tax rate up to 15%.

The global minimum tax is designed to have several positive effects in countries adversely affected by profit shifting. First, it should mechanically increase tax payments from firms that shift profits to low-tax environments. Second, it should induce firms to reduce profit shifting, further boosting government revenue and curbing the wasteful use of resources for tax planning. Third, it should ease the constraints on policy from international tax competition and thus enable countries to tax multinational profits at higher rates and redistribute more. Early estimates set the revenue gain from the first mechanism alone to around $50 billion per year in the United States (Clausing et al., 2021) and even more in the European Union (Barake et al., 2021).

In this paper, we study how the global minimum tax shapes national tax policies and welfare in a formal model of international tax competition. The key advantage of the formal model over more casual analysis is that it treats not just firm behavior, but also national tax policies as endogenous to changes in the international tax system. Our results highlight that precisely the endogenous policy response in tax havens poses a risk from the perspective of other countries: The global minimum tax could trigger a coordinated tax rate increase in tax havens, which would be costly for multinational firms in other countries and may imply that the overall effect on these countries' welfare is negative.

The model includes two types of countries: *non-havens* where multinational firms conduct real economic activity and *havens* where they operate empty shell companies for the purpose of profit shifting. Governments choose tax policies with the aim of maximizing national welfare while taking as given the international tax architecture, including the global minimum rate. Multinational firms choose where to book profits with the aim of maximizing global after-tax profits. The formal analysis proceeds by, first, determining the non-cooperative equilibrium in corporate

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tax rates with and without a global minimum tax and, then, identifying how the global minimum tax affects equilibrium welfare.

Absent a global minimum tax, the policy equilibrium involves zero tax rates in havens and positive tax rates in non-havens. On the one hand, havens have no domestic tax base and therefore use the corporate tax rate to compete for foreign profits. As firms only shift profits to the haven with the lowest rate, havens compete their tax rates down to zero. On the other hand, non-havens choose the tax rate that balances the social costs and benefits of taxation given the profit shifting opportunities created by havens. A higher rate involves a mechanical transfer from firm owners to the government, a potential equity gain, but also induces more profit shifting, an efficiency loss.

Introducing a global minimum tax, a new policy equilibrium emerges where all havens optimally set tax rates at the level of the global minimum rate. Intuitively, the global minimum tax puts a floor under the race-to-the-bottom because havens with a tax rate below the global minimum are no more attractive from the perspective of profit-shifting firms than havens with a tax rate exactly at the global minimum.[1]

Equipped with this understanding of the policy equilibrium, we show that a marginal increase in the global minimum rate affects welfare in non-havens through two channels. First, it *lowers* welfare by raising the equilibrium tax rate in havens and thus increasing the total tax liabilities of firms. The mechanical effect on firms' tax liabilities represents a loss of private consumption for the owners, which lowers welfare in non-havens. Second, it *raises* welfare by narrowing the tax differential between havens and non-havens and thus deterring profit shifting. The behavioral effect on government revenue represents a gain of public consumption in non-havens, which raises welfare. All other effects on welfare cancel out by application of the envelope theorem. It follows that the net effect of raising the global minimum tax rate on welfare in non-havens is ambiguous. The effect is more likely to be positive when profit shifting responds strongly to changes in tax incentives and when the government places low weight on the marginal private consumption of firm owners.

We adapt this framework for the analysis of non-marginal reforms and use it to determine parametric conditions under which a global minimum tax rate of 15% improves welfare in non-havens with an initial corporate tax rate of 25%. When the private consumption of firm owners has zero social value, the welfare effect is positive even if profit shifting is almost perfectly inelastic. In this case, the revenue gain in non-havens is small, but the net effect on welfare is positive because the corresponding decrease in private consumption has no weight in the welfare function. Increasing the social weight on firm owners, shifted profits need to be more elastic for the reform to be welfare-improving. When the private consumption of firm owners has the same social value as public funds, the required semi-elasticity of profit shifting is 4.

While the welfare effect of the imminent global tax reform depends crucially on the sensitivity of shifted profits with respect to the potential marginal tax saving, no existing studies provide estimates of this parameter. The empirical profit shifting literature is largely focused on the sensitivity of profits reported in non-havens to tax differentials, with typical estimates of the semi-elasticity around 0.8 (Heckemeyer and Overesch, 2017). A recent paper shows that the amount of profits booked in a haven is highly sensitive to the haven's own tax rate (Garcia-Bernardo and Janský, 2021); however, this estimate conflates relocations of profits across havens, which may be very large if havens are close-to-perfect substitutes, and changes in overall profit shifting to havens, which is the margin that matters for welfare in non-havens.

While these results highlight the risk that a global minimum tax may reduce welfare in havens if the rate is relatively low, our final analysis shows that the welfare effect is unambiguously positive when the rate is sufficiently high. In this case, multinational firms abandon profit shifting altogether and non-havens achieve the first-best allocation. First, the sum of private and public consumption is maximized, as firms waste no resources on profit shifting and havens capture no revenue. Second, the split between private and public consumption is fully efficient, as the tax instrument is not associated with a marginal deadweight loss.

It is important to bear in mind when assessing the results that the analysis has clear limitations. Notably, we assume for simplicity that firms' true profits are fixed and therefore effectively ignore the effects of the global tax environment on the allocation of real production factors. Under the alternative assumption that firms can freely allocate productive capital to the countries where the after-tax return is highest, the welfare analysis would be complicated by policy externalities across non-havens.

The paper contributes to a canonical literature on tax coordination (e.g. Kanbur and Keen, 1993) and an emerging literature on the global minimum tax discussing its institutional design and implementation (e.g. Devereux et al., 2020b; Englisch and Becker (2021) and making projections about revenue effects (Clausing et al., 2021; Barake et al., 2021). The most closely related paper shows in a two-country model that the low-tax country may benefit from an exogenous increase in its own tax rate under plausible assumptions about strategic complementarity of tax policies (Hebous and Keen, 2021). While the focus in our paper is on the welfare consequences for non-havens, our results also suggest that havens benefit from the global minimum tax.[2]

The paper proceeds in the following way. Section 2 provides some institutional background. Section 3 presents the elements of the model. Section 4 determines the equilibrium behavior of firms, households and governments. Section 5 analyzes the welfare implications.

2. Background

Following up on efforts to address base erosion and profit shifting by multinational firms (OECD, 2013), an agreement on a two-pillar reform was concluded in October 2021 (OECD, 2021). Pillar One allocates some taxing rights to governments based on firm sales. Pillar Two introduces a global minimum tax at the rate of 15%. Both elements of the reform are scheduled to take effect as from 2023.

The global minimum tax implies that business profits are taxed at a minimum effective rate of 15% regardless of the jurisdiction where they are booked. If a firm books profits in a jurisdiction where they are taxed at a lower rate, the home country of the firm imposes an additional top-up tax up to the global minimum rate.

There are a several notable exceptions to these general principles. First, the global minimum tax only applies to multinational firms with a global revenue above €750 million. Second, a so-called carve-out rule reduces the profits used in the computation of the effective tax rate with reference to the firm's tangible assets and labor costs, reflecting that the global minimum tax does not aim to penalize real activities in low-tax countries. Third, a *de minimis* rule excludes jurisdictions where the scale of the firm's operations is low.

[1] This is reminiscent of the argument that foreign tax credits can make it optimal for capital-importing countries to tax foreign investment (Bond and Samuelson, 1989; Gordon, 1992).

[2] Our analysis builds on a broader theoretical literature on international tax competition in the presence of multinational firms with the ability to shift profits across borders (Slemrod and Wilson, 2009;Hong and Smart, 2010; Johannesen, 2010; Marceau et al., 2010; Johannesen, 2012;Bucovetsky, 2014).

3. Model

We consider a world with N countries, some of which are havens and others are non-havens. There are three types of agents. *Firms* conduct real economic activities in non-havens, but may engage in costly efforts to shift some of their profits to havens. *Households* own the firms and consume their net profits, which they receive as dividends. *Governments* tax profits and use the revenue to provide a public good that is valued by the households. We make more specific assumptions about the objectives and constraints of each type of agent below.

The sequence of events is the following. First, governments simultaneously choose their domestic policies while taking as given the global minimum tax rate and anticipating firms' responses to their policy choice. Second, firms choose the allocation of profits taking as given all dimensions of the tax environment. We are seeking to characterize the Nash equilibrium in the non-cooperative game played by governments. The ultimate question is how the equilibrium welfare of non-haven countries is shaped by the global minimum tax rate.

3.1. Firms

Each non-haven is home to a single multinational firm with headquarters in the home country and a subsidiary in each of the other countries in the world. The firms' objective is to maximize their payouts to the owners. To keep the model simple, we assume that firms' gross profits, and thus the underlying real economic activities, are fixed. The only choice facing firms is where to report profits for tax purposes. While profit shifting can generate tax savings, we assume that firms incur concealment costs in countries where they under-report profits.

We introduce the following notation and assumptions. First, we let $\overline{\pi}_{ij}$ denote the gross profits that the firm based in country i derives from its activities in country j. We ignore the possibility of losses and assume that $\overline{\pi}_{ij} \geqslant 0$ when j is a non-haven and, as there is no real activity in havens, that $\overline{\pi}_{ij} = 0$ when j is a haven.[3] We also assume, for any non-haven j, that $\overline{\pi}_{ij} > 0$ for at least one i so that some profits are generated in each non-haven. Second, we let π_{ij} denote the profits that the firm based in country i chooses to report for tax purposes in country j. We assume that every dollar of profits has to be reported somewhere so that a firm's total reported profits equal its total true profits.[4] Third, we let $\triangle_{ij} \equiv \max(0, \overline{\pi}_{ij} - \pi_{ij})$ denote under-reporting in country j by the firm based in country i and let $s(\triangle_{ij})$ denote the associated concealment costs, assuming that $s(\cdot)$ is a strictly convex function with $s(0) = 0$. These assumptions imply that it is increasingly costly for firms to under-report whereas no costly efforts are needed to conceal over-reporting. Finally, we let Π_i^* denote the maximized total profits of the firm in country i net of taxes and concealment costs, which is paid out to shareholders as dividends in proportion to their ownership shares.[5]

3.2. Households

Household preferences are represented by the standard utility function $u(c, G)$ where c denotes private consumption and G denotes public consumption. Households own shares in firms. Specifically, we let σ_{ij} denote the share of the firm based in country j owned by households in country i so that $\sum_j \sigma_{ij} \Pi_j^*$ captures national dividend income in country i. Moreover, we let α denote a given household's share of the national stock portfolio where α is distributed with density $f(\alpha)$. The private consumption of a given household in country i is thus $c = \alpha \sum_j \sigma_{ij} \Pi_j^* + z$, which is the sum of dividend income and other income. Households make no choices but simply consume all of their income.

3.3. Governments

We assume that governments choose public policies with the objective of maximizing national welfare:

$$W = \int \Psi(u(c, G)) f(\alpha) d\alpha \tag{1}$$

where $\Psi(\cdot)$ has standard properties, $\Psi'(\cdot) > 0$ and $\Psi''(\cdot) < 0$.

Initially, each government has a single policy instrument: the tax rate t applying to reported profits. The revenue raised with this tax in country j is the sum of the profits reported there by firms based in all countries of the world multiplied by the country's tax rate: $t_j \sum_i \pi_{ij}$. Absent a global minimum tax, this is also the value of the public good, as there are no other sources of revenue.

When a global minimum tax is introduced, governments in non-havens raise additional revenue with top-up taxes. Specifically, if the firm based in country i reports profits in a country j where the tax rate is below the global minimum tax rate t_M, such profits are taxed in country i at a rate equal to the tax differential, $t_M - t_j$. The revenue raised with top-up taxes in country i thus equals $\sum_j \max(t_M - t_j, 0) \pi_{ij}$.

4. Equilibrium

In this section, we analyze the model described above. We first determine the allocation of profits chosen by multinational firms given the international tax environment (Section 4.1). We then identify the Nash equilibrium in the non-cooperative game played by governments when they set tax rates anticipating how they shape firm behavior (Section 4.2).[6]

4.1. Firms

Absent a global minimum tax, the net profits of the multinational firm based in country i can be stated as:

$$\Pi_i(\pi_{i1}, \pi_{i2}, \ldots, \pi_{iN}) = \sum_j \overline{\pi}_{ij} - \sum_j t_j \pi_{ij} - \sum_j s(\triangle_{ij}) \tag{2}$$

where the first term is the firm's total gross profits, the second term is the firm's total tax payments and the last term is the firm's total concealment costs associated with under-reporting. While the first term is exogenous, the second and third terms depend on the allocation of reported profits $(\pi_{i1}, \pi_{i2}, \ldots, \pi_{iN})$. In the presence of a global minimum tax, net profits have an additional negative term capturing top-up taxes paid in the firm's home country on profits reported in foreign countries with a tax rate below the global min-

[3] While it is common to ignore losses in both theoretical and empirical work on profit shifting, a couple of recent papers highlight the implications of losses for taxation of multinational firms (Koethenbuerger et al., 2019; Becker et al., 2020).

[4] This assumption rules out that part of the firm's profits is not taxable in any jurisdiction. Such stateless income (Kleinbart, 2011) can arise through the use of hybrid financial instruments for tax planning (Johannesen, 2014; Hardeck and Wittenstein, 2018).

[5] With heterogeneity in $s(\cdot)$, e.g. due to differences in enforcement, non-havens face different elasticities of reported profits and therefore choose different tax rates, but the analysis of the global minimum tax is qualitatively unchanged.

[6] In our model with multiple havens, the Stackelberg equilibrium where non-havens choose tax rates before havens is identical to the Nash equilibrium (see Wang, 1999).

imum: $-\sum_j \max[(t_M - t_j, 0)]\pi_{ij}$. The firm chooses the vector of reported profits so as to maximize net profits.

Lemma 1. Assume there is no global minimum tax and let t_L denote the lowest tax rate in the world. The firm based in country i reports profits in the following way:

(a) In each country j where $t_j > t_L$, optimal under-reporting is given by the value $\triangle_{ij}^* \leqslant \overline{\pi}_{ij}$ satisfying:

$$s\prime\left(\triangle_{ij}^*\right) = t_j - t_L \tag{3}$$

or, if such a value does not exist, the value $\triangle_{ij}^* = \overline{\pi}_{ij}$.

(b) In each country j where $t_j \leqslant t_L$, the firm optimally over-reports:

$$\frac{\sum_j \triangle_{ij}^*}{H} \tag{4}$$

where H is the number of countries with $t \leqslant t_L$.

Proof. The multinational firm based in i chooses $(\pi_{i1}, \pi_{i2}, \ldots, \pi_{iN})$ to maximize Eq. (2) subject to the constraints: $(\#A)$ $\sum_j \overline{\pi}_{ij} = \sum_j \pi_{ij}$ and $(\#B)$ $\pi_{ij} \geqslant 0$ for all j. Letting μ_i and λ_{ij} denote the Langrangian multipliers, we obtain the first-order conditions:

$$\mu_i + \lambda_{ij} = t_j - s\prime\left(\triangle_{ij}^*\right) \text{for all j} \tag{5}$$

Consider a country k where the firm over-reports, $\pi_{ik} > \overline{\pi}_{ik}$. This implies that $s\prime(\triangle_{ik}^*) = 0$ and $\lambda_{ik} = 0$. Inserting these expressions into Eq. (5) for k yields $\mu_i = t_k$. Inserting the latter expression into Eq. (5) for another country j, we obtain $\lambda_{ij} + s\prime(\triangle_{ij}) = t_j - t_k$. As the left-hand-side of this equation is (weakly positive), we have that $t_j \geqslant t_k$ and, as this must hold for any choice of j, that $t_k = t_L$. Hence, in any country j with $t_j > t_L$, there are two possible solutions, both with under-reporting. Either, an interior solution described by Eq. (3) where $\pi_{ij} > 0$ and $\lambda_{ik} = 0$. Or, a corner solution where $\pi_{ij} = 0$ and $\lambda_{ij} = t_j - t_L - s\prime(\triangle_{ik})$. By $(\#A)$, total under-reporting over countries with $t > t_L$ gives total over-reporting in countries with $t = t_L$. Assuming that the firm splits over-reporting equally across countries with $t = t_L$ yields (4).

These findings imply that multinational firms under-report profits in all countries where the tax rate is not the lowest in the world. Intuitively, they under-report up to the point where the marginal concealment cost, $s_{ij}\prime(\cdot)$, equals the marginal tax saving associated with profit shifting to the most favorable tax environment, $t_j - t_L$, or where reported profits are zero.[7] The under-reporting is mirrored by over-reporting where the tax rate is lowest. If two or more countries share the lowest tax rate, the Lemma states that they benefit equally from the over-reporting. Strictly speaking, multinational firms are indifferent between over-reporting profits in two or more countries with the same low tax rate and we break the tie by assuming that over-reporting is split equally between such countries.

Lemma 2. Assume there is a global minimum tax at the rate of t_M and that top-up taxes therefore apply to profits reported in countries with a tax rate below that rate. If $t_L > t_M$, Lemma (1) applies directly. If $t_L \leqslant t_M$, Lemma (1) applies with t_M replacing t_L.

[7] Several recent papers investigate this corner solution empirically by estimating how the propensity to report zero profits varies with tax incentives for profit shifting (Bilicka, 2019; Johannesen et al., 2020).

Proof. The proof follows that of Lemma (1) with minor adjustments. The first-order conditions read:

$$\mu_i + \lambda_{ij} = max(t_M, t_j) - s\prime\left(\triangle_{ij}^*\right) \text{for all } j \tag{6}$$

Assuming there is over-reporting in k implies that $\mu_i = max(t_M, t_k)$. Combining with Eq. (5) in another country j yields $\lambda_{ij} + s\prime(\triangle_{ij}) = t_j - max(t_M, t_k)$. If $t_L > t_M$, it holds that $max(t_M, t_k) = t_k$ and the solution is identical to Lemma (1). If $t_L \leqslant t_M$, it holds that $max(t_M, t_k) = t_M$. In that case, the solution for countries with $t > t_M$ is the same as before except that t_M replaces t_L. As before, total over-reporting equals total under-reporting and the firm splits over-reporting equally across countries with $t \leqslant t_M$.

This result shows that the global minimum tax puts a floor under the effective tax rate that multinational firms can obtain through cross-border profit shifting. If $t_L > t_M$, the global minimum tax is not binding and t_L remains the lowest obtainable tax rate. If $t_L < t_M$, the existence of top-up taxes implies that t_M, and not t_L, is effectively the lowest obtainable tax rate. This has implications on both sides of the profit shifting decision. One the one hand, t_M, rather than t_L, is governing the amount of under-reporting chosen by the multinational firms in countries with high tax rates (part (a) of the Lemma). On the other hand, all countries with tax rates at t_M, and not just those with the tax rate t_L, benefit from over-reporting (part (b) of the Lemma).

4.2. Governments

We are searching for a Nash equilibrium in which all governments set the tax rate that maximizes national welfare given the tax rates set by all other governments. Following most of the tax competition literature, we derive the first-order conditions that characterize the equilibrium, assuming that it exists, but do not formally prove existence (e.g. Keen and Konrad, 2013). We consider environments with and without a global minimum tax in turn.

Proposition 1. In the absence of a global minimum tax, the following policy choices constitute a Nash equilibrium:

(a) all havens set the tax rate equal to zero
(b) non-havens set the tax rate that satisfies

$$\frac{W\prime_G}{W\prime_C} = \frac{\Omega}{1+\epsilon} \tag{7}$$

where $\epsilon \equiv \frac{d\left(\sum_j \pi_{ji}\right)/\sum_j \pi_{ji}}{dt_i/t_i}$ is the tax elasticity of reported profits; $\Omega \equiv \sigma_{ii}\pi_{ii}/\sum_j \pi_{ji}$ is the share of profits reported in a country that is owned by local households; $W\prime_G$ is the marginal social value of the public good (i.e. the average of $\Psi\prime(\cdot)u\prime_G$ taken over all households) and $W\prime_C$ is the marginal social value of dividend payouts (i.e. the average of $\Psi\prime(\cdot)u\prime_c$ taken over all households weighted by ownership shares in the firm).

Because firms only shift profits to places with the lowest tax rate in the world and havens have no tax base other than the shifted foreign profits they can attract, havens compete their tax rate down to zero and earn no revenue in the equilibrium.[8] As required in a Nash equilibrium, no individual haven can increase its revenue, and thus improve welfare for its residents, by changing its tax rate given the zero tax rates set by other havens.

[8] This is akin to Bertrand competition.

The governments in non-havens set their tax rate while taking it for given that firms have the opportunity to shift profits to a zero-tax environment. We derive the first-order condition for the optimal tax rate in a non-haven by differentiating its welfare function with respect to its own tax rate (country indexes omitted for simplicity):

$$\int \Psi'(\cdot)\left(u\prime_c \frac{dc}{dt} + u'_G \frac{dG}{dt}\right) f(\alpha)d\alpha = 0 \tag{8}$$

A small change in the tax rate affects the private consumption of all households who own shares as well as the size of public good. In the optimum, the net welfare effect must be zero. We restate the first-order condition in the following way:

$$W'_C \underbrace{(-\sigma_{ii}\pi_{ii})}_{dC/dt} + W'_G \underbrace{\left(\sum_j \pi_{ji} + \frac{d\pi_{ji}}{dt_i} t_i\right)}_{dG/dt} = 0 \tag{9}$$

where W'_C is the marginal social value of dividend payouts (i.e. the average of $\Psi'(\cdot)u'_c$ over all households weighted by their ownership shares in the firm) and W'_G is the marginal social value of public consumption (i.e. the average of $\Psi'(\cdot)u'_G$ over all households). Dividing by $\sum_j \pi_{ji}$ and applying the definitions of Ω and ϵ yields Eq. (7).

To gain intuition, we examine the two terms of Eq. (9) in turn. The first term is the negative welfare effect of a marginal tax increase working through lower private consumption of firm owners. The change in aggregate private consumption, dC/dt, equals the mechanical decrease in the after-tax profits of the local firm accruing to local households. While the firm responds to a higher tax by shifting more profits, this has no first-order effect on after-tax profits.[9] The welfare weight, W'_C, accounts for the unequal distribution of dividend income by weighing the household-level marginal welfare weights with ownership shares. The second term is the positive welfare effect working through higher government revenue. The change in the size of the public good, dG/dt, depends both on the mechanical effect and on firms' profit shifting responses. The revenue loss created by profit shifting responses represents a deadweight loss of taxation, which reflects that profit shifting requires socially wasteful concealment efforts.[10]

Eq. (7) characterizing the equilibrium policy choice in non-havens is familiar from standard models of tax competition (Keen and Konrad, 2013) although the interpretation is somewhat different. It is useful to compare to a closed economy where the government would tax profits up to the point where $W\prime_G = W\prime_C$, thus equalizing the marginal welfare gains associated with private and public consumption. In an open economy, the policy choice departs from this benchmark for two reasons. First, profit shifting responses ($\epsilon < 0$) introduce a cost of taxation, which induces governments to choose lower tax rates. This is similar to standard models of tax competition where governments tax productive capital and the elasticity of the capital supply with respect to taxation shapes the equilibrium policy choice in the same way as ϵ. Second, when profits partly accrue to foreign firms ($\Omega < 1$), because of cross-border portfolio investments by households or cross-border direct investment by firms, the incidence of the tax is partly on foreigners, which induces governments to choose higher tax rates (Huizinga and Nielsen, 1997).

We emphasize that there are many other equilibria than the one described in Proposition (1) with the same economic properties. In particular, any configuration where at least two havens set the tax rate equal to zero and non-havens set the tax rate that satisfies Eq. (7) constitutes an equilibrium. In each of these equilibria, profits are only shifted to havens with a zero rate, all havens earn zero revenue and no haven can increase revenue by changing their tax rate.

Proposition 2. In the presence of a global minimum tax at the rate of t_M that is not too high, the following policy choices constitute a Nash equilibrium:

(a) all havens set the tax rate equal to t_M
(b) non-havens set the tax rate that satisfies Eq. (7)

In the presence of a global minimum tax, a haven government cannot do better than setting a tax rate of t_M given that all other havens also set a tax rate of t_M. On the one hand, reducing the rate below t_M will not induce multinational firms to shift more profits to the haven, as the resulting tax savings in the haven are exactly offset by top-up taxes in the firms' home countries (see Lemma 2). On the other hand, raising the rate above t_M implies that multinational firms no longer shift any profits to the haven, as other havens offer effective taxation at t_M. From the perspective of an individual haven, t_M therefore strictly dominates all other tax rates by raising more government revenue for the same level of private consumption.

The policy choice also changes in non-havens; however, as long as the global minimum tax is not too high, the qualitative trade-off remains the same and the solution continues to be characterized by Eq. (7). In quantitative terms, it is unclear if the tax rates chosen by non-haven governments is higher or lower under a global minimum tax. To see this ambiguity, consider what happens to the incentives of a non-haven government when, starting from the equilibrium without the global minimum tax, the tax rate in havens increases to t_M. First, firms start paying tax in havens and, because they cut back on profit shifting, they also increase tax payments in non-havens. This implies a higher $W\prime_C$ and a lower $W\prime_G$, which creates an incentive to *lower* the tax rate. Second, the elasticity of profit shifting with respect to the tax rate ϵ may now be closer to zero, which creates an incentive to *raise* the tax rate.[11]

Proposition 3. In the presence of a global minimum tax at the rate of t_M that is sufficiently high, non-havens set the tax rate that satisfies

$$\frac{W\prime_G}{W\prime_C} = \Omega \tag{10}$$

These policy choices constitute a Nash equilibrium together with any choice of tax rates in havens.

The intuition for this result is very simple. When t_M takes a sufficiently high value, multinational firms shift no profits. This implies that the corporate tax base is inelastic with respect to the tax rate ($\epsilon = 0$) so that Eq. (7) collapses to Eq. (10). The set of non-haven tax rates defined by this equation constitutes a policy equilibrium together with any set of tax rates in havens, as the latter are entirely irrelevant for the equilibrium allocation of profits.

Finally, at intermediate values of the global minimum rate, it is possible that a "mixed equilibrium" emerges where some non-havens choose the tax rate t_M and others choose the interior optimum characterized by Eq. (7). This occurs when, evaluated at the

[9] The effect on global after-tax profits, $\Pi(\cdot)$ of a small increase in profit shifting out of country i is $t_i - t_L - s\prime(\cdot)$, which is zero (see Lemma 1). This is an application of the envelope theorem.

[10] Firms generally shift profits out of country i up to the point where $t_i - t_L - s\prime(\cdot) = 0$. In the equilibrium where $t_L = 0$, this implies that $t_i = s\prime(\cdot)$ so that the marginal revenue loss due to profit shifting responses mirrors the marginal use of resources on concealment.

[11] The effect on ϵ generally depends on the functional form of $s(\cdot) = 0$. One case where ϵ gets closer to zero is $s\prime\prime\prime(\cdot) = 0$.

policy choices described in Proposition 2, at least one non-haven can increase its welfare by setting the tax rate t_M and receiving shifted profits from other non-havens rather than the interior optimum. This is not possible at low nor at high values of t_M where deviating from the interior optimum generates little or no additional revenue. However, at intermediate values of t_M, mimicking the tax rate choice of havens may be attractive for non-havens because the revenue gain can be significant. Importantly, it is not optimal for all non-havens to adopt t_M at the same time: Each additional non-haven choosing t_M makes this choice less attractive for others, as aggregate shifted profits decreases and the number of countries sharing this tax base between them increases. This suggests a "mixed equilibrium" where some non-havens choose the tax rate t_M, other non-havens choose the interior optimum, and the number of non-havens pursuing each of the two policies is such that welfare levels are equalized between the two groups.[12]

5. Welfare analysis

In the baseline model, the policy choice by non-haven governments is distorted by two countervailing forces: the mobility of profits (ϵ) tends to raise the cost of public funds *above* the true social cost whereas the scope for tax exporting created by cross-border ownership of profits (Ω) tends to lower the cost of public funds *below* the true social cost. This complicates the welfare analysis of the global minimum tax and before proceeding, we therefore make the following assumption, which effectively eliminates the distortion coming from tax exporting:

Assumption 1. All profits in country i accrue to households in country i, i.e. $\Omega = 1$.

The assumption allows us to focus on how the global minimum tax addresses the challenges associated with profit shifting while ignoring its interaction with cross-border ownership and other possible sources of policy imperfections. To justify this focus, we note that recent work on corporate taxation highlights the quantitative importance of profit shifting (e.g. Tørsløv et al., 2018; Damgaard et al., 2019). Moreover, most current policy debate about corporate taxation revolve around the distortions created by profit shifting and the global minimum tax is explicitly *designed* to address them. Nevertheless, we discuss below how the welfare analysis changes when we drop Assumption 1 and thus allow for cross-border ownership.

Proposition 4. Introducing a global minimum tax at a low rate has an ambiguous effect on welfare in non-havens: it lowers welfare by mechanically increasing firms' foreign tax costs and increases welfare by mitigating the erosion of the domestic tax base through profit shifting. On balance, the welfare effect is more likely to be positive when the private consumption of firm owners has a low marginal weight in the social welfare function, i.e. $W\prime_C(\cdot)$ is small relative to $W\prime_G(\cdot)$, and when profit shifting is highly sensitive to the tax differential between havens and non-havens.

To assess how the global minimum tax affects welfare in non-havens, we differentiate the welfare function for country i with respect to the rate t_M.

$$\frac{dW}{dt_M} = W'_C \underbrace{\left(-\triangle^*_{ii}\right)}_{\partial C/\partial t_M} + W'_G \underbrace{\left(\frac{d\pi_{ii}}{dt_M} t_i\right)}_{\partial G/\partial t_M} \tag{11}$$

The first term captures that a small increase in the global minimum tax *lowers* welfare by increasing firms' tax liabilities in havens. Increasing the global minimum tax rate induces a one-to-one increase in the equilibrium tax rate in havens, as shown in Proposition 2, and thus mechanically raises the tax cost incurred by the firm based in i. This represents a loss of private consumption for firm owners, which lowers welfare. The second term captures that a small increase in the global minimum tax *raises* welfare by curbing profit shifting. With a higher equilibrium tax rate in havens, firms reduce profit shifting, as shown in Lemma 1. While the reduced profit shifting has no first-order effect on after-tax profits (by application of the envelope theorem), it raises government revenue in non-havens. This represents a gain of public consumption, which raises welfare. Further, the government optimally adjusts its own tax rate, as discussed in the previous section, but this has no first-order effect on country's welfare (by application of the envelope theorem).

We illustrate this result with a quantitative example. A recent estimate sets the profits shifted to havens globally at around $600 billion. If the global minimum tax is introduced at a rate of 1%, the resulting increase in equilibrium tax rates in havens mechanically raises firm tax payments by $6 billion, which constitutes a welfare-reducing loss of private consumption in non-havens. In response, firms reduce profit shifting, which creates a revenue gain for governments in non-havens. Whether this gain is large enough to make the overall welfare effect positive generally depends on the tax sensitivity of profit shifting as well as the marginal social value of the private consumption of firm owners.[13] One benchmark is $W\prime_C \approx 0$, reflecting that firms are largely owned by high-income households with little weight in the social welfare function. In this case, the first term drops out and the reform improves welfare even if the reduction in profit shifting is small. Another benchmark is where $W\prime_C \approx W\prime_G$. In this case, the revenue gain associated with the reduction in profit shifting needs to be larger than the private loss of $6 billion for the reform to be welfare-improving. With a corporate tax rate of around 25%, profit shifting must fall by at least $24 billion.

In the Online Appendix, we investigate how the analytical results change when we allow for cross-border ownership of profits ($\Omega < 1$). In this case, the welfare effects may be highly heterogeneous as, loosely speaking, non-havens' gains from the global minimum tax decrease in the activity of their domestic firms on foreign territory (through $\partial C/\partial t_M$) and increase in the activity of foreign firms on their own territory (through $\partial G/\partial t_M$). The global minimum tax thus redistributes from non-havens with a positive net FDI position to non-havens with a negative net FDI position through this channel. Moreover, the global minimum tax changes welfare in an ambiguous way through its effect on national tax policies. If it induces non-havens to raise their tax rate, it exacerbates the negative tax exporting externality, which adds a negative welfare effect. If it induces non-havens to lower their tax rate, it alleviates this externality, which adds a positive welfare effect.

Proposition 5. Introducing a global minimum tax at a sufficiently high rate has an unambiguously positive effect on welfare in non-havens.

If the global minimum tax is levied at a sufficiently high rate, e.g. higher than the corporate tax rates set by the non-havens themselves, multinational firm abandon profit shifting altogether, as shown in Proposition (10). This raises welfare in non-havens

[12] A similar equilibrium emerges in Johannesen (2010) where imperfect mobility of profits, rather than a global minimum tax, creates a rent to be shared between low-tax jurisdictions.

[13] In a richer model, the incidence of firm taxes would be shared beween owners and workers, consistent with recent empirical evidence (Arulampalam et al., 2012; Fuest et al., 2018). With a partial pass-through to workers, $W\prime_C$ should be formed as the average of $\Psi\prime(\cdot)u\prime_c$ weighted by each household's share of the tax costs through ownership and employment.

in two ways relative to a situation without a global minimum tax. First, the sum of private and government consumption is higher, as firms no longer waste resources on concealment. Second, the split between private and government consumption is fully efficient, as the tax instrument is not associated with a marginal deadweight loss.

Proposition 6. A global minimum tax that is not high enough to eliminate profit shifting has an unambiguously positive effect on welfare in havens.

Havens are only affected by the global minimum tax through its effect on government tax revenue. Absent the global minimum tax, havens compete tax rates down to zero and earn no revenue. When a global minimum tax is introduced, equilibrium tax rates in havens increase up to the global minimum. Unless that rate is so high that profit shifting ends, havens earn positive revenue, which implies that welfare has increased.

Finally, we derive parametric conditions under which a 15% global minimum tax improves welfare in non-havens with an initial tax rate of 25%. As Eq. (11) does not apply to non-marginal reforms, we simulate a series of marginal reforms that gradually raises the global minimum rate from 0% to 15%, in each step computing the mechanical loss to multinational firms, the decrease in profit shifting and the resulting revenue gain in non-havens. For different values of $W\prime_C/W\prime_G$ (assumed constant), we then use an iterative procedure to determine the semi-elasticity of profit shifting (assumed constant) required for the welfare effect to be positive. Table 1 shows the results. The central scenario assumes that the tax rate choice of non-havens is unaffected by policies in havens (Column 1). Here, the required semi-elasticity is 4 when $W\prime_C = W\prime_G$ and approaches zero as $W\prime_C$ becomes small relative to $W\prime_G$. Assuming tax rates in non-havens to be complements to tax rates in havens lowers the required semi-elasticities somewhat (Column 2). Intuitively, reductions in profit shifting raise welfare more when tax rates in non-havens are higher. Conversely, assuming tax rates are substitutes changes the results in the opposite direction (Column 3).

Table 1
Conditions for a 15% global minimum tax to improve welfare. The table reports the lowest semi-elasticity of profit shifting with respect to the marginal tax savings at which a global minimum tax at the rate of 15% improves welfare in non-havens with a national tax rate of 25% for different assumptions about (i) the marginal social value of the private consumption of firm owners ($W\prime_C/W\prime_G$) and about (ii) the change in the tax rate chosen by non-havens in response to a unit increase in the tax rate chosen by havens (dt^{NH}/dt^{H}). The conditions are determined by simulating a series of marginal reforms that gradually raises the global minimum tax from 0% to 15%, in each step computing the mechanical loss to multinational firms, the decrease in profit shifting and the resulting revenue gain in non-havens, and finally employing an iterative procedure to determine, for different (constant) values of $W\prime_C/W\prime_G$, the (constant) semi-elasticity of profit shifting required for the total welfare effect of the marginal reforms to be positive.

Marginal social value of private consumption	(1)	(2)	(3)
	Required semi-elasticity		
W'C/W'G	Fixed tax rate in non-haven (dt^{NH}/dt^{H}=0)	Tax rate complementarity (dt^{NH}/dt^{H}=0.5)	Tax rate substitutability (dt^{NH}/dt^{H}=-0.5)
1.0	4.00	3.55	4.56
0.5	2.00	1.76	2.30
0.2	0.80	0.70	0.93
0.1	0.40	0.35	0.46

6. Concluding remarks

In this paper, we have studied the global minimum tax in a model of international tax competition with heterogeneous countries. The key insight is that a global minimum tax at a low rate changes the incentives for tax havens radically: It induces them to raise their tax rate to the global minimum, which creates an additional tax cost for profit-shifting firms and may imply that the overall welfare effect is negative in non-havens. By contrast, the welfare effect is unambiguously positive when the global minimum tax rate is high enough to end profit shifting. The analysis thus highlights the risk of introducing a global minimum tax at a low rate where profit shifting continues and havens capture part of the global revenue gain associated with the policy.

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. Supplementary material

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.jpubeco.2022.104709.

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