Profit Shifting and Equilibrium Principles of International Taxation

Manon Francois

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Abstract

We study the choice between source-based and destination-based corporate taxes in a two-country model, allowing multinational firms to use transfer pricing to allocate profits across tax jurisdictions. We show that source-based taxation is a Nash equilibrium for tax revenue maximizing jurisdictions if domestic and foreign firms generate large revenues. We also show that destination-based taxes are a Nash equilibrium when firms generate low revenues, which implies the presence of multiple equilibria. Both the source and the destination principle coexist in equilibrium when domestic and foreign corporate revenues are intermediate. However, the source principle always tax-dominates the destination principle.

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The past decade is characterized by an increasing attention to multinational firms (MNF) behavior not paying their fair share of taxes, which led to a pressing demand to reform international corporate taxation. Multinational Firms (MNF) indeed locate their profits in the different tax jurisdictions in which they operate in order to reduce their tax liability.[1] The choice of a tax policy in a country will therefore trigger a reaction from those firms.[2] The tax policy, in our framework, is composed of a statutory tax rate, a tax base and a tax enforcement level.[3] Zooming in on the tax base, countries can decide to implement either a source-based or a destination-based tax system. The source system allows a government to tax profits if production occurs on its territory while the destination system allows to tax profits if production is sold on the territory, irrespective of the location of the production.

In the main strand of the literature studying the choice between the source and the destination principle, the tax rate is often exogenous and the tax base is not necessarily determined in equilibrium. In both the tax competition literature and the recent literature on destination-based taxes, statutory tax rates are rarely tax instruments governments choose endogenously (Georgakopoulos and Hitiris [1992], Grossman [1980], Auberbach and Devereux [2018]). We also observe that, in the corporate tax competition literature, tax bases are also often exogenous (Devereux et al. [2008]).

This paper contributes to the literature by endogenizing the tax rate, tax base and tax enforcement responses of governments to study the uncooperative equilibrium choice between the source and the destination principle.[4] It aims to shed light on a puzzle in which all countries, in practice, currently use the source principle while this tax system is considered suboptimal (Keen and Wildasin [2004], Lockwood [2001]). This choice between source-based and destination-based taxes gained some strength in 2016 when the US Congress proposed to shift the US source-based corporate

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[1] For example, "*Apple Sales International (ASI), [is] an entity that has acquired certain economic rights to Apple's intellectual property. Apple Inc. has used those rights of ASI to shift billions in profits away from the United States to Ireland, where it pays a corporate tax rate of 2% or less.*" Memo of the Permanent Subcommittee on investigations, 2013 (https://www.hsgac.senate.gov/subcommittees/investigations/hearings/offshore-profit-shifting-and-the-us-tax-code_-part-2).

[2] Apple has, for example, moved part of its paper profits from Ireland to Jersey, another tax haven, after the US Subcommittee on Investigations raised the alarm on Apple's profit shifting behavior in Ireland (https://www.hsgac.senate.gov/subcommittees/investigations/media/subcommittee-to-examine-offshore-profit-shifting-and-tax-avoidance-by-apple-inc).

[3] We abstract here from the role of deductions for capital expenses and therefore only focus on the statutory tax rate, not on the effective tax rate.

[4] The focus of this paper is on the choice between source and destination bases. We let aside all considerations regarding the choice between income taxation and cash-flow taxation.

tax system to a Destination-Based Cash-Flow Tax (DBCFT),[5] which is considered optimal.

To rationalize this puzzle, we build a tax competition model with the presence of multinational firms. We model two countries that maximize their tax revenue using three levels of decision: they choose the tax base, the tax rate and the tax enforcement level. Each country faces multinational firms that can engage in profit shifting by manipulating the transfer price of their intra-firm trade. This is the first paper, to the best of our knowledge, that gathers all three tax instruments endogenously.

We find that the source principle is the best-response to source-based taxes when domestic and foreign corporate revenues are large. Large profits entail a high source-based tax rate, which allows a source-based country to generate higher tax revenues than if it unilaterally adopted destination-based taxes. This high tax rate is possible because under the source principle, countries introduce a strict enforcement, thereby increasing the cost for firms to shift profits and thus to react to a high tax rate. We also show that for small values of corporate revenues, the best-response to the source principle is the destination principle. When foreign corporate revenues are small, the Home country does not give up on too much tax revenues from the foreign affiliate located in Home but selling to Foreign by moving to destination. Therefore, the source principle is part of a subgame perfect Nash equilibrium for large values of corporate revenues.

Considering the best-response to destination-based taxes, we find that the destination principle is the best-response of Home to destination-based taxes if domestic corporate revenues are small. As a destination-based country has no incentive to monitor profit shifting, it sets a loose enforcement policy, which allows it to attract profits, irrespective of its tax rate. All firms have an incentive to shift profits out of the source-based country and into the destination-based country. As domestic corporate revenues increase, the tax rate under a unilateral use of source-based taxation increases and the tax base widens, which pushes toward the use of the source principle in Home. Therefore, when domestic corporate revenues are large, the Home best-response is the use of the source principle. As a result, the destination principle is part of a subgame perfect Nash equilibrium for small values of corporate revenues.

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[5]Tax Reform Task Force, 2017, A Better Way: Our Vision for a Confident America. (Initial version 2016) https://www.novoco.com/sites/default/files/atoms/files/ryan_a_better_way_policy_paper_062416.pdf.

This implies that when both domestic and foreign corporate revenues are large, source-based taxation is a Nash equilibrium. Destination-based taxation is a Nash equilibrium for small values of corporate revenues. We thus observe that there can be a multiplicity of equilibria. When domestic and foreign corporate revenues are intermediate, both principles coexist in equilibrium. However, the source principle tax-dominates the destination principle by yielding more tax revenues. The advantage of using source-based taxes, namely the possibility to tax foreign firms, compensates the drawback, namely the exposition to profit shifting, because the source-based country strictly monitors profit shifting. And thus, the advantage outweighs the absence of profit shifting under destination-based taxation.

Finally, we show that there does not exist any equilibrium with a unilateral adoption of the destination principle. The gravitational power of a destination-based country vis-a-vis profits is too important for the source-based country to levy enough tax revenues. We also show that how our results change when we introduce variations to the model's assumptions.

The results of this paper have strong implications for tax policy. We find that source-based taxation can be an equilibrium and the existence of this equilibrium relies on the strict enforcement implemented under the source principle. Currently, we observe in many countries very low levels of profit shifting monitoring, which implies that source-based taxation is more distortive, and hence not necessarily revenue-maximizing. The results of this paper also suggests that the current international tax system could be the outcome of a noncooperative game played by rich countries maximizing tax revenues. Finally, it suggests that if one country were to unilaterally move to destination-based taxes, it could incentivize other countries to also adopt destination-based taxes, resulting in a new equilibrium with the universal adoption of the destination principle.

This paper first contributes to the literature regarding the optimality of source-based taxes relative to destination-based taxes by showing that the source principle can dominate the destination principle. Destination-based taxes are often considered optimal (Keen and Wildasin [2004], Lockwood [2001], Georgakopoulos and Hitiris [1992], Grossman [1980]). One argument put forward regarding corporate taxation is that destination-based taxes eliminate profit shifting (Auerbach et al. [2017]). However, some works have also shown that source-based taxes can dominate when taxes are set non-cooperatively (Lockwood [1993] with commodity taxation), or in the presence of imperfect competition (Keen and Lahiri [1998]). Our results sharply contrast with most of the

existing literature. We show here that source-based taxation can be an equilibrium, which can dominate the destination principle in terms of tax revenues in a tax competition framework, with trade within multinational firms.

It then contributes to the literature formalizing the implementation of a destination-based corporate tax. We first depart by endogenizing the tax rate,[6] the tax base and the tax enforcement level, which are assumed exogenous in the literature. We also depart by focusing on the impact of destination-based taxation on tax revenues. The debate about destination-based taxes started in the 1990s but gained interest recently.[7] Auberbach and Devereux [2018] and Becker and Englisch [2019] offer a formal analysis of the unilateral adoption of destination-based taxes. Bond and Gresik [2021] use the Auberbach and Devereux [2018] framework to study whether countries have a unilateral incentive to deviate from a multilateral DBCFT system using three tax policy parameters: the corporate tax rate, the level of deduction for capital expenditures, and the degree of border adjustment. We extend the approach of the above papers by introducing endogenous transfer price manipulation and strategic tax competition. It is crucial to take profit shifting through the use of transfer prices into account to study the strategic choice of tax policy since it represents enormous losses of tax revenues for most developed countries.[8] Finally, Bond and Gresik [2020] study the economic effects of unilateral adoption of corporate tax policies in a heterogeneous firm model with transfer pricing. A notable difference with the literature is that we do not have endogenous capital accumulation which would naturally imply endogenous profitability. In this paper, the profitability of the input is exogenous.

This paper is also related to the literature on tax competition and extend the standard models by letting countries choose between source-based and destination-based taxes. Moreover, we not only analyze the complementarity of statutory tax rates but also pin down the expression of the best-response and equilibrium tax rates with respect to different tax systems, as well as equilibrium tax enforcement behaviors. Standard models focus on source-based taxation (Bucovetsky [1991],

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[6]Bond and Gresik [2021] also endogenize the statutory tax rate.

[7]It started with Avi-Yonah [1993] and Bond and Devereux [2002] that first provided insights on the location and investment decisions of an MNF under both a source-based and a destination-based tax system without profit shifting or heterogeneity.

[8]In a recent contribution, Clausing [2020] shows that profit shifting costs the United States about $100 billion a year (at 2017 tax rates). We also have evidence that profit shifting was responsible for a $8 billion reduction of the tax base in France in 2008 (Vicard [2015]).

Klemm and Liu [2019], Krautheim and Schmidt-Eisenlohr [2011]).[9] In tax competition models as Zodrow and Mieszkowski [1986], Wilson [1986], Devereux et al. [2008], governments use the tax rates (both statutory and effective) as the only tax instruments. Last, the literature does not necessarily account for the profit shifting behavior of firms (Davies and Eckel [2010]).

The rest of the paper is organized as follows. Section 1 sets out the model assumptions. Section 2 solves the tax competition model for the equilibrium tax rates and enforcement levels. Section 3 develops the uncooperative equilibrium choice of tax system. Section 4 offers two extensions to the model to test the robustness of our results. Section 5 concludes.

1 The model

1.1 Multinational firms

There are two countries, Home and Foreign and each one faces a multinational firm. Each MNF consists of one parent and its single affiliate. The parent of the Home MNF is located in Home and has its affiliate in Foreign. This affiliate produces one unit of an intermediate good at cost c, which is normalized to 0. The good is then sold to its parent at some internal price q. This price, which is endogenously chosen by the MNF, is referred to as a transfer price. The parent earns a revenue π, yielding a profit $\pi - q$ in Home. The parent profit is taxed at rate $\tau \geq 0$ by the Home government. The net profit of the parent is therefore $(1 - \tau)(\pi - q)$.

The tax applying to the affiliate profit q depends on the principle of international taxation in use in Foreign. If Foreign uses the destination principle, the profit of the affiliate q remains untaxed in this country. If, on the contrary, Foreign uses the source principle, it levies a tax $\tau^* q$, which implies a net profit of the affiliate equal to $(1 - \tau^*)q$.

Under the destination principle, imports are subject to a border adjustment tax. If Home uses this principle, it taxes the revenue q earned by the Home MNF from intra-firm trade at rate τ. As a result, the net profit of the parent $(1 - \tau)(\pi - q)$ is still reduced by τq. The Home MNF thus gets $(1 - \tau)(\pi - q) - \tau q$.

If the source principle is instead applied by Home, there is no border adjustment tax on the revenue q earned by the Home MNF from intra-firm trade, maintaining the parent net profit at

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[9]See Wilson [1999], Devereux and Loretz [2013] and Heimberger [2021] for a literature review.

$(1 - \tau)(\pi - q)$. The border adjustment tax thus implies a differentiated treatment of imports and exports: Home imports are taxed at rate τ while its exports are left out of its tax base.

In a nutshell the tax base of Home always includes the revenue of its parent MNF, regardless of the tax principle that it uses. The tax principle however influences the possibility of taxing the profits of the affiliates. If Home applies destination-based taxation, then the transaction between its parent MNF and its affiliate (located in Foreign) enters its tax base, while its tax base excludes the profit of the affiliate of the Foreign MNF. A symmetric argument applies in the case where Home applies source-based taxation: the profit of the affiliate of the Foreign MNF now enters its tax base, while its tax base excludes the transaction between its parent MNF and its affiliate.

International taxation refers to the arm's length principle to restrict the manipulation of the transfer price set by the MNF. Assuming that the marginal cost is publicly observed, it costs αq^2 to set a transfer price q that departs from $c = 0$. One can interpret this amount as a fine q^2 paid with probability α, with $\alpha \in [\underline{\alpha}, 1]$ and $0 < \underline{\alpha} \leq 1$. This probability α is the enforcement level of the arm's length principle. The amount αq^2 is called a concealment cost.[10]

We are now in a position to write down the expression of the Home MNF consolidated profits, i.e., the sum of the profits of the Home parent, its affiliate in Foreign and the concealment cost. To this aim, it is convenient to introduce a dummy variable D (resp., D^*) that takes value 1 if Home (resp., Foreign) applies the destination principle, and 0 otherwise. For simplicity, we denote $S = 1 - D$, and $S^* = 1 - D^*$ the dummies corresponding to the use of the source principle. The net profit of a MNF headquartered in Home can then be written as:

$$\Pi = (1 - \tau)(\pi - q) - D\tau q + (1 - S^*\tau^*)q - \alpha q^2. \tag{1}$$

The net profits of a MNF whose parent is located in Foreign obtains in a symmetric way,

$$\Pi^* = (1 - \tau^*)(\pi^* - q^*) - D^*\tau^* q^* + (1 - S\tau)q^* - \alpha^* q^{*2}, \tag{2}$$

with a star indicating a Foreign variable.

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[10]The main text focuses on inbound profit shifting monitoring: Home can control whether the Home MNF pricing policy accords with the arm's length principle, while it leaves the Foreign MNF outside the scope of its monitoring. We discuss the implications of outbound profit shifting monitoring in the conclusion.

Let $\mathcal{P} = \{D, \alpha, \tau\}$ represent the policy chosen by Home, and $\mathcal{P}^* = \{D^*, \alpha^*, \tau^*\}$ the Foreign policy. Given $\mathcal{P}$ and $\mathcal{P}^*$, the transfer price $q(\mathcal{P}, \mathcal{P}^*)$ set by the Home MNF maximizes its profits Π in (1). The profit is concave in q and its global maximum obtains from the first-order condition,

$$q(\mathcal{P}, \mathcal{P}^*) = \frac{(1-D)\tau - S^*\tau^*}{2\alpha}. \tag{3}$$

Similarly, the transfer price of the Foreign MNF is :

$$q^*(\mathcal{P}, \mathcal{P}^*) = \frac{(1-D^*)\tau^* - S\tau}{2\alpha^*}.$$

Our assumption $\underline{\alpha} > 0$ ensures that these prices are well defined for all enforcement levels α. The transfer price is negative if the MNF decides to set the transfer price below the marginal cost c (that is here set to 0). The MNF then tries to shift profits out of the affiliate and toward the parent firm. Otherwise, the transfer price is positive.

1.2 Governments

Governments are assumed to maximize the total amount of collected taxes by choosing between the source and destination principles, the tax rates τ and τ^* as well as the levels of enforcement α and α^*. The tax collected by the Home government is

$$T = \tau(\pi - q) + D\tau q + S\tau q^*. \tag{4}$$

In Foreign, it is

$$T^* = \tau^*(\pi^* - q^*) + D^*\tau^*q^* + S^*\tau^*q. \tag{5}$$

Kawano and Slemrod [2016] show that the 37 OECD countries in their sample made 171 tax rate changes over the period 1980-2004. All countries have changed their top statutory tax rates. On the contrary, we observe that they typically have stuck to the same tax enforcement policy over the past decades. This suggests to adopt the following timing: first governments choose the tax principle, then their enforcement policies, and last their tax rates. The model is solved backwards.

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2 Equilibrium tax rates and enforcement policies

In the last stage, we take as given the principles of international taxation and the enforcement policies α and α^*, both between $\underline{\alpha} > 0$ and 1. Assuming Nash behavior, the Home government takes the tax rate $\tau^* \geq 0$ chosen by Foreign as given and chooses $\tau \geq 0$ maximizing its tax revenue T,

$$T = \tau \left(\pi - q\left(\mathcal{P}, \mathcal{P}^*\right)\right) + D\tau q\left(\mathcal{P}, \mathcal{P}^*\right) + S\tau^*\left(\mathcal{P}^*, \mathcal{P}\right), \tag{6}$$

under the constraint that the after-tax profit of the domestic MNF, net of all profit taxed abroad,

$$(1 - \tau)\left(\pi - q\right) - D\tau q - \alpha q^2, \tag{7}$$

remains non-negative. Here we assume territorial taxation.[11] This program makes it clear that the choice of the tax rates influences the allocation of profits across countries. In our model, tax competition is induced by the MNF transfer pricing policy. Note that international mobility of profits does not transit through production location choices: the affiliate of the Home MNF always produces the input in Foreign, because of e.g., some location-specific intermediate good or input in Foreign.

If the Home country uses source-based taxes, its best-response tax rate is:[12]

$$\tau_S(\tau^*; \alpha, \alpha^*) = \left[\frac{\alpha\alpha^*}{\alpha^* + \alpha}\right]\left[\pi + \frac{\tau^*}{2}\left(\frac{(1 - D^*)}{\alpha^*} + \frac{S^*}{\alpha}\right)\right]. \tag{8a}$$

This tax rate is positively related to the Foreign country tax rate if the Foreign country uses source-based taxation as well. This fits the well-know pattern of tax competition arising with the source principle: countries compete over statutory tax rates, which can lead to a race to the bottom (Devereux et al. [2008]).

If the Foreign country uses the destination principle, $\tau_S(\tau^*; \alpha, \alpha^*)$ becomes independent of the tax rate of the Foreign country. Indeed, the input production of the Home affiliate is taxed in Home but not in Foreign, since it is not sold in Foreign (see eq. (4)). In addition, the Foreign affiliate is taxed in Home but the border adjustment cancels out with the input cost deduction (see eq. (5)).

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[11] Under worldwide taxation, the participation constraint would instead apply to the whole amount of profit Π.

[12] The detailed computations are postponed to appendix A.

The foreign input is therefore only taxed in Home. In each country, MNFs will thus decide on their transfer price depending on the tax rate in Home, irrespective of the tax rate in Foreign.

Suppose now that the Home country instead uses destination-based taxes. Its best-response tax rate is:

$$\tau_D(\tau^*; \alpha, \alpha^*) = 1 + \frac{S^* \tau^*}{2\alpha\pi}\left(1 - \frac{S^* \tau^*}{2}\right). \tag{8b}$$

When both countries use destination-based taxes, the tax rates become independent from each another. There is no profit shifting and so no tax competition between countries. All MNFs trade at arm's length. The universal use of the destination principle thus acts as a backstop to tax competition. However, when the Home country unilaterally uses the destination principle, its tax rate still depends on the source-based country tax rate. In this configuration, the transfer price enters the profit function of the Home MNF as a deduction and through the concealment cost. When the transfer price is sufficiently low, this increases the after-tax profit of the Home MNF, net of profits abroad (eq. (7), used to compute (8b)), and therefore, it increases $\tau_D(\tau^*; \alpha, \alpha^*)$. Otherwise, when the transfer price is larger, this decreases (7) and so it decreases $\tau_D(\tau^*; \alpha, \alpha^*)$.

Symmetrically, Foreign takes the tax rate τ as given and maximizes

$$T^* = \tau^*\left(\pi^* - q^*\left(\mathcal{P}^*, \mathcal{P}\right)\right) + D^* \tau^* q^*\left(\mathcal{P}^*, \mathcal{P}\right) + S^* \tau^* q\left(\mathcal{P}, \mathcal{P}^*\right). \tag{9}$$

Its best-response tax rate writes as in (8a) and (8b), after permuting Home and Foreign indices.

Lemma 2.1. *Consider a given principle of international taxation chosen by Home in $\{S, D\}$ and a given principle chose by Foreign in $\{S^*, D^*\}$. Given the enforcement policies α and α^*, both in $[\underline{\alpha}, 1]$, there exists a unique pure strategy Nash equilibrium in the (third-stage) tax rate subgame,*

$$\tau = \begin{cases} \dfrac{4}{3}\dfrac{\alpha\alpha^*}{\alpha + \alpha^*}\dfrac{2\pi + \pi^*}{2} & \text{if} \quad S = S^* = 1 & (10a) \\[2ex] 1 + \dfrac{\alpha^*}{\alpha + \alpha^*}\dfrac{\pi^*}{2\pi}\left(1 - \dfrac{\alpha\alpha^*}{\alpha + \alpha^*}\dfrac{\pi^*}{2}\right) & \text{if} \quad D = S^* = 1 & (10b) \\[2ex] \dfrac{\alpha\alpha^*}{\alpha + \alpha^*}\pi & \text{if} \quad S = D^* = 1 & (10c) \\[2ex] 1 & \text{if} \quad D = D^* = 1 & (10d) \end{cases}$$

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The equilibrium tax rate τ^* sets by the Foreign government obtains by symmetry, after permuting Home and Foreign indices in (10a) through (10d).

We can now characterize the equilibrium enforcement policies. Given α^* and after reintroducing the expressions of the equilibrium tax rates τ and τ^* defined in Lemma 1 into (6) and (9), the best-response enforcement policy α of Home maximizes (6).

The equilibrium tax rate of a source-based country increases with the enforcement levels α and α^*. When all countries use source-based taxation, profits are shifted to low-tax countries. If countries strictly monitor profit shifting, firms have less room for setting transfer prices that deviate from the arm's length price, which allows governments to set higher tax rates without loosing a significant amount of tax revenues. Since governments bear no cost for rising the enforcement level to 1, strict control is a dominant strategy in every country: we have $\alpha = \alpha^* = 1$ in equilibrium.

The situation is similar if one country unilaterally uses the source principle. This country then suffers from profit shifting towards the destination-based country, irrespective of its tax rate. Indeed, a destination-based country attracts profits, irrespective of its tax rate, as can be seen in eq. (3). Therefore this country still prefers to monitor profit shifting, and sets $\alpha = 1$ in equilibrium. The remaining country, applying the destination principle, benefits from profit shifting and thus has no incentive to monitor profit shifting. It sets the enforcement level α at its lower bound $\underline{\alpha}$. There is no profit shifting under a universal use of the destination principle. Hence the tax rates are independent of the enforcement, and so α and α^* can be set at any level.

Lemma 2.2. *Given the principles of international taxation in $\{S, D\}$ for Home and in $\{S^*, D^*\}$ for Foreign, if both countries apply the destination principle, then any $\alpha \in [\underline{\alpha}, 1]$ and $\alpha^* \in [\underline{\alpha}^*, 1]$ is a Nash equilibrium. Otherwise, the equilibrium enforcement policy of a country using source-based taxation involves a strict control of transfer pricing (it sets an enforcement level of 1). The equilibrium enforcement policy of a country unilaterally using destination-based taxation involves a loose control of transfer pricing (it sets an enforcement level of $\underline{\alpha}$).*

Proof. See appendix B. □

The strict monitoring of transfer prices does not imply that there is no profit shifting by the MNF headquartered in a source-based country. Since MNFs differ in the revenue they make from

selling the output, equilibrium tax rates are different. Thus, there exists an incentive for MNFs to shift profits in equilibrium. Even when both source-based countries implement a strict monitoring of profit shifting, and hence firms pay a fine, the tax saving is larger than the concealment cost. [13]

3 Equilibrium principles of international taxation

All countries currently use source-based taxation and so decide to expose to fierce tax competition. In our setup, the race to the bottom of tax rates does not apply to the physical location of production activities, which is assumed to be given, but to the allocation of profits across tax jurisdictions that MNFs partially control through their transfer pricing policies. Instead, destination-based taxes, if used by all, would make countries immune to tax competition issues by rendering transfer prices a useless tool to reduce MNFs' tax liability. The main innovation of our paper is to discuss the outcome of a non-cooperative choice between destination and source-based taxation.

3.1 Best-response to the source principle

Suppose that Foreign uses source-based taxation S^*. The second and third stage equilibrium policies obtained in Lemma 2.1 and 2.2 yield the equilibrium level of the taxes T and T^* defined in (6) and (9) for every possible tax principle.

If Home uses the source principle, the collected tax revenue writes:

$$T_{SS^*} = \left(\frac{2\pi + \pi^*}{3} \right)^2. \tag{11}$$

Larger values of π and/or π^* favor the choice of source-based taxes in Home. If every country uses the source principle, they can tax both their domestic parent and the foreign affiliate. In the collected tax T_{SS^*} in (11), both the tax rate τ_{SS^*} in (10a) and the tax base $\pi - q(\mathcal{P}, \mathcal{P}^*) + q^*(\mathcal{P}, \mathcal{P}^*)$, here equal to $\frac{(2\pi + \pi^*)}{3}$ are increasing with π and π^*.

When Home uses the destination principle, its collected tax revenue is:

$$T_{DS^*} = \pi + \frac{\pi^*}{2(1 + \underline{\alpha})} - \frac{\pi^{*2}\underline{\alpha}}{4(1 + \underline{\alpha})^2}. \tag{12}$$

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[13]The expression of tax rates, tax bases and enforcement levels for each tax principle can be found in appendix C.

By (6), the collected tax T_{DS^*} equals $\tau_{DS^*}\pi$. Home now only taxes its domestic MNF, both through the parent firm and the border adjustment tax. Larger domestic corporate revenues π imply a smaller equilibrium tax rate τ_{DS^*} and a larger tax base. The expression of T_{DS^*} shows that, eventually, the collected tax increases with π. The impact of the revenue π^* of the Foreign MNF, not taxed in Home, therefore only transits through the tax rate τ_{DS^*}.

By (8b), we observe that τ_{DS^*} increases with $\tau^*_{DS^*}$ if $\tau^*_{DS^*} < 1$, which implies $\pi^* < \frac{1+\alpha}{\underline{\alpha}}$. As explained, this comes from the treatment of the transfer price of the Home MNF in the profit function, which only depends on $\tau^*_{DS^*}$. When the transfer price is sufficiently low, it increases the after-tax profit of the Home MNF, net of profits abroad (eq. (7)), used to compute (8b), and therefore, it increases τ_{DS^*}. Otherwise, when the transfer price is larger, this decreases (7) and so it decreases τ_{DS^*}.

We can now obtain the tax principle in Home that is best-response to source-based taxation in Foreign. Home is indifferent between source and destination-based taxation when Foreign uses the source principle if and only if:

$$T_{SS^*} - T_{DS^*} = 0. \tag{13}$$

Equation (13) defines an ellipse.[14] The pairs (π, π^*) such that Home prefers destination-based over source-based taxation satisfy $T_{SS^*} - T_{DS^*} < 0$. They are located in the blue area in figure (1a). For (π, π^*) located outside this area, the source principle is the best-response of Home to the source principle in Foreign.

For large values of corporate revenues, Home chooses to use the source principle when Foreign uses source-based taxes. The cost of not taxing the foreign affiliate under a unilateral adoption of the destination principle increases as the foreign affiliate generates large revenues. Therefore, Home chooses to use destination-based taxes only when corporate revenues are small.

Figure (1b) shows the Foreign tax principle that is best-response to source-based taxes in Home. Combining the two figures, we observe that there exist (π, π^*) such that $S = BR(S^*)$ and $S^* = BR^*(S)$, so we already know that the universal use of the source principle will be part of a perfect Nash equilibrium in pure strategies for (π, π^*) large. This is consistent with the empirical observation that rich countries tend currently to stick to source-based taxation.

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[14]The equation of the ellipse can be found in appendix D.1.

Figure 1: Best-response to source-based taxes

(a) Best-response of Home

(b) Best-response of Foreign
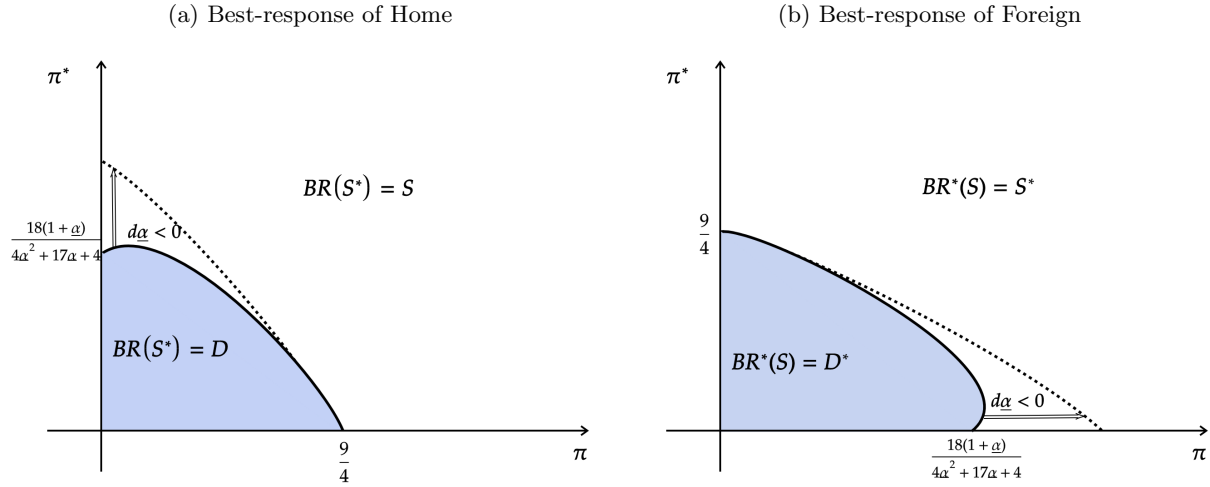
Note: Graphical representation of the tax revenue difference from equation (13) and the equivalent expression for the tax revenue difference for the Foreign country. π is represented on the horizontal axis and π^* is on the vertical axis. Inside the blue area, the best-response to source-based taxes is destination-based taxes. Outside the blue area, the best-response is source-based taxes. $BR(S^*)$ $(BR^*(S^*))$ is the Home (Foreign) best-response to the Foreign (Home) country using the source principle.

Proposition 3.1. *The source principle is the best-response to source-based taxes when both foreign corporate revenues and domestic corporate revenues are large. Otherwise, the best-response to the foreign country using source-based taxes is to use destination-based taxes.*

Furthermore, the best-response tax principle changes as the value of $\underline{\alpha}$ changes. we know that the equilibrium enforcement α_{DS^*} of Home in the configuration DS^* is $\underline{\alpha}$. A lower level $\underline{\alpha}$ allows the Home country to attract more profits from its domestic MNF, generating a greater amount of taxable profits if Home decides to use destination-based taxes. This thus reinforces the relative merit of the destination principle. This can be observed on figure (1a) as the blue area expands when $\underline{\alpha}$ decreases.

3.2 Best-response to the destination principle

In the literature, the common wisdom is that "*the unilateral adoption of a DBCFT would leave existing avoidance opportunities in place; however, they would operate to the detriment of the rest of the world, not that of the [destination-based tax] adopting country*".[15] This suggests that if,

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[15]See Auerbach et al. [2017], p.40.

for some reason, one country decides to adopt the destination principle, the remaining (source-based) countries would be incentivized to move to destination-based taxes. That is, the destination principle would be a best-response of Home to the destination principle chosen in Foreign.

Suppose that the Foreign country uses the destination principle. The tax collected by Home when it uses the source principle is:

$$T_{SD^*} = \frac{\pi^2 \underline{\alpha}}{2(1 + \underline{\alpha})}. \tag{14}$$

Instead, when both countries use the destination principle, the tax revenue collected by the Home country reduces to:

$$T_{DD^*} = \pi. \tag{15}$$

Suppose that $\pi > 0$. We find that Home is indifferent between source-based and destination-based taxes if and only if:

$$T_{SD^*} - T_{DD^*} = 0 \Leftrightarrow \pi = \frac{2(1 + \underline{\alpha})}{\underline{\alpha}}. \tag{16}$$

The choice of Home of the tax principle that is best-response to the use of the destination principle in Foreign only depends on the level of corporate revenues π generated by the Home MNF. Home can decide to expose to profit shifting by using the source principle, but this would allow it to tax the foreign affiliate. Or Home can choose not to tax the foreign affiliate and only tax its domestic MNF by moving to destination-based taxes, where there would be no tax competition and no profit shifting.

This choice of tax principle will also depends on the equilibrium tax rate under the configuration SD^*. The higher the tax rate τ_{SD^*} (in (10c)), the more profitable it can be for Home to use the source principle since this would allow it to tax both its domestic parent and the foreign affiliate at a high tax rate. This tax rate τ_{SD^*} increases with π. However, this also implies that there is less taxable profits from the Foreign MNF since Foreign reduces its transfer price to locate its profits in the destination-based country. The loss from Foreign affiliate capital flight eventually appears dominated: the tax base of the home country equals $\frac{\pi}{2}$ in the configuration SD^*. So, both the higher tax rate and the tax base widening push toward the source-based principle when π is

larger. This corroborates the intuition in Auerbach et al. [2017] that the destination principle is the best-response of Home to the adoption of the destination principle in Foreign as soon as π is small enough.

Figure 2: Best-response to the destination principle

(a) Best-response of Home

(b) Best-responses of Home and Foreign
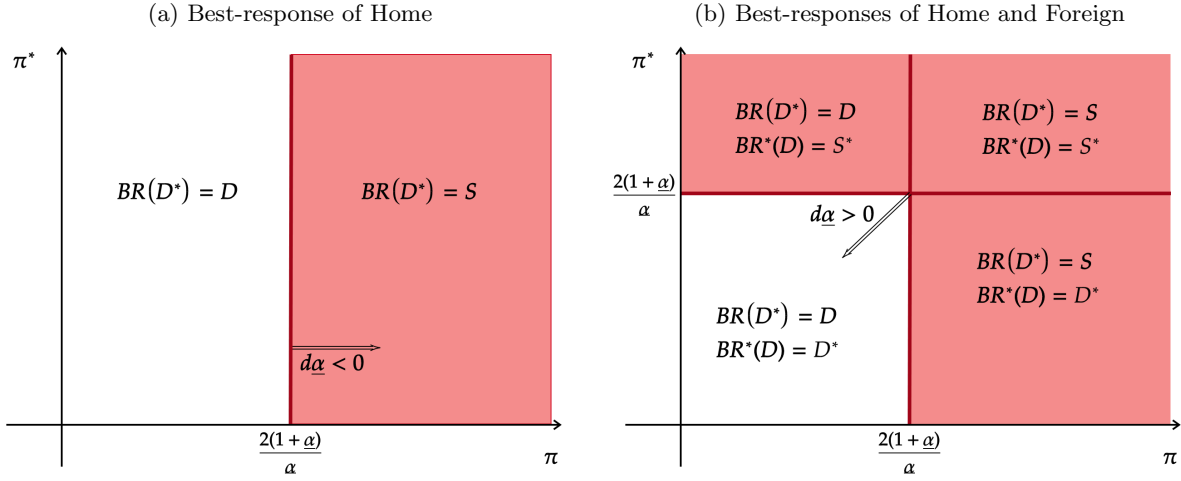
Note: Graphical representation of the tax revenue difference from equation (16) and the equivalent expression for the tax revenue difference for the Foreign country. π is represented on the horizontal axis and π^* is on the vertical axis. Inside the red area, the best-response to destination-based taxes is source-based taxes.

Proposition 3.2. *The destination principle is the best-response of Home to destination-based taxes if and only if domestic corporate revenues π are small enough.*

Destination will plausibly be the actual choice of Home if the lower bound $\underline{\alpha}$ for enforcement is small. In this case, Foreign attracts taxable profits of both MNFs by using destination-based taxes and thus provides Home with greater incentives to switch to the destination principle. In fact, if $\alpha^*_{SD^*} = \underline{\alpha}$ and/or $\alpha_{SD^*} = \underline{\alpha}$ tends to 0, there is no situation where one country would decide to unilaterally use the source principle, once the other country has adopted the destination principle.

3.3 Equilibrium tax principles

Propositions (3.1) and (3.2) provide us with preliminary characterizations of equilibrium tax principles: the source principle is part of a subgame perfect Nash equilibrium in pure strategies when π and π^* are large, while the destination principle is part of a subgame perfect Nash equilibrium in pure strategies when π and π^* are small.

We gather these two observations in the next proposition:

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Proposition 3.3. *1. In every equilibrium, both countries rely on the same tax principle.*

2. If π and π^* are large enough, source-based taxation is the only possible equilibrium choice.

3. If π and π^* are small enough, destination-based taxation is the only possible equilibrium choice.

4. For intermediate values of π and π^*, there exist multiple Nash equilibria: both SS^* and DD^* coexist in equilibrium.

Proof. The existence of equilibria where both countries rely on the same tax principle (in items 2 and 3) is a straightforward consequence of Propositions (3.1) and (3.2). We show below that, when the destination principle is the best-response of Home to the source principle, Foreign's best-response is always destination-based taxes, which implies that there can be no equilibrium where one country would unilaterally use the source principle. This can be proved by showing that the blue area representing $T_{SS^*} - T_{DS^*} = 0$ and $T^*_{SS^*} - T^*_{DS^*} = 0$ never intersects with the red area representing $T_{SD^*} - T_{DD^*} = 0$ and $T^*_{SD^*} - T^*_{DD^*} = 0$ on figure (3).

We consider the point of intersection between the ellipse and the horizontal axis, and the point of intersection between the vertical red line and the horizontal axis. The blue area crosses the horizontal axis at the farthest away from origin for either one of the two values below.

$$T_{SS^*} - T_{DS^*}|_{\pi^*=0} = 0 \Leftrightarrow \pi = \frac{9}{4}$$
$$T^*_{SS^*} - T^*_{DS^*}|_{\pi^*=0} = 0 \Leftrightarrow \pi = \frac{18(1+\underline{\alpha})}{4\underline{\alpha}^2 + 17\underline{\alpha} + 4}.$$

The red area crosses the horizontal axis when:

$$T_{SS^*} - T_{DD^*}|_{\pi^*=0} = 0 \Leftrightarrow \pi = \frac{2(1+\underline{\alpha})}{\underline{\alpha}}.$$

We have that

$$\frac{2(1+\underline{\alpha})}{\underline{\alpha}} > \frac{9}{4} \Leftrightarrow \underline{\alpha} < 8 \quad \text{always true.}$$

and

$$\frac{2(1+\underline{\alpha})}{\underline{\alpha}} > \frac{18(1+\underline{\alpha})}{4\underline{\alpha}^2 + 17\underline{\alpha} + 4} \Leftrightarrow 4\underline{\alpha}^2 + 8\underline{\alpha} + 4 > 0 \quad \text{always true.}$$

Therefore, the blue area and the red area never intersect. Countries always rely on the same tax principle. This proves items 1 and 4.[16]

$\square$

We already acknowledged that the choice between source-based and destination-based taxation reduces to the choice of taxing the foreign affiliate or taxing the internal transaction of the domestic MNF. In equilibrium, we find that countries either all use the source principle or they all use the destination principle. On the one hand, when corporate revenues are large, countries choose to use source-based taxes. The strict monitoring limits the negative impact of tax competition that is common under source-based taxation, which renders this principle more attractive. On the other hand, when corporate profits are small, countries choose to use destination-based taxes. In that case, there is no profit shifting and hence no tax competition, which compensates the fact that countries give up on taxing the foreign affiliate.

However, when countries can strictly monitor profit shifting, they do not have an incentive to be the sole user of the source principle. The intermediate case with one country unilaterally adopting the destination principle creates a large imbalance between both countries. The destination-based country behaves as a tax haven by keeping exports out of its tax base and attracts profits to an extent that depends on its enforcement level. The source-based country looses tax revenue, no matter how low its tax rate is. As the enforcement level in the destination-based country decreases, Home has an increasing incentive to also adopt destination-based taxes. On the contrary, when $\underline{\alpha}$ increases, both countries have an incentive to use the source principle.

Figure (3) illustrates the proposition. Overall, the destination principle is a Nash Equilibrium for low values of corporate revenues (π, π^*), when countries do not have to give up on too much foreign tax revenue. When corporate revenues are large, the source principle is a Nash Equilibrium. There thus exists an area with intermediate values of corporate revenues where both the source

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[16]We show graphically that the vertex of the ellipse (the point at which it is the longest) is always outside of $(\pi, \pi^*) \in \mathbb{R}_+$ in appendix D.2.

Figure 3: Equilibrium tax principle
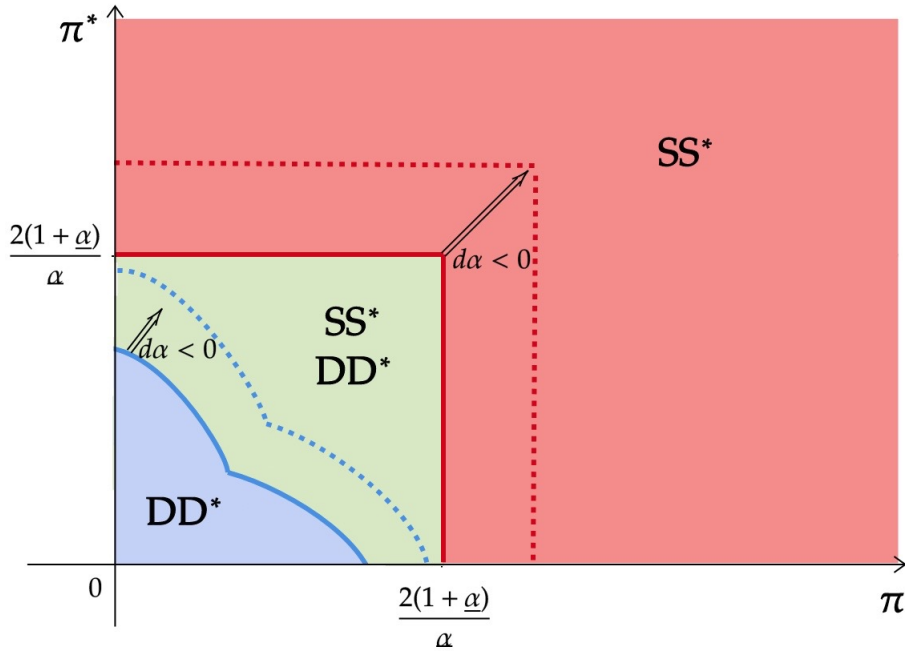
principle and the destination principle coexist as equilibria. In that case, MNFs do not generate
too much tax revenue, so it is not too costly for countries to use the destination principle, but both
countries also prefer to all use the source principle because they can tax both the domestic parent
and the foreign affiliate.

3.4 Tax-Ranking of equilibria

In the presence of multiple equilibria, we can rank the equilibria in terms of tax revenues for almost
all (π, π^*). The difference in the tax revenue collected in the two possible equilibria writes:

$$T_{SS^*} - T_{DD^*} = \left(\frac{2\pi + \pi^*}{3} \right)^2 - \pi \tag{17}$$

Figure (4) complements figure (3) by adding the black ellipse that represents the pairs (π, π^*)
such that the taxes T_{SS^*} and T_{DD^*} collected in equilibrium are equal (the difference given in (17) is
zero). Below this ellipse, the shaded region has T_{DD^*} greater than T_{SS^*}; above this ellipse, T_{SS^*} is

Figure 4: Tax-ranking of equilibria
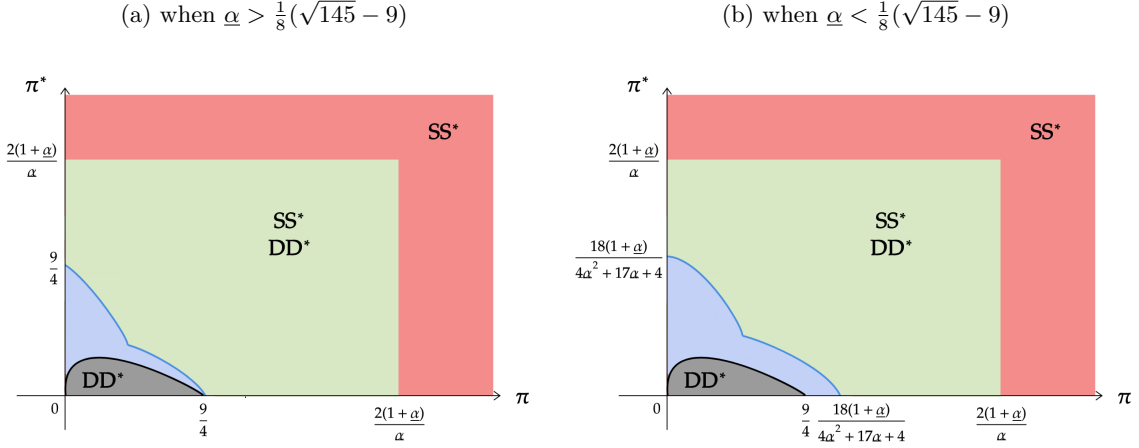
Note: Graphical representation of the tax revenue difference from equation (17). π is represented on the horizontal axis and π^* is on the vertical axis. The black ellipse represented is the solution to $T_{SS^*} - T_{DD^*} = 0$. Below the ellipse, $T_{SS^*} < T_{DD^*}$ and above the ellipse, $T_{SS^*} > T_{DD^*}$. The green area represents the area where there are multiple equilibria as can be seen on figure (3). For (π, π^*) in the blue area, DD^* is the unique equilibrium.

instead greater than T_{DD^*}. The configurations exported in figure (4) now indicate the equilibrium tax principle that generates the highest revenue.

We observe that when both the source principle and the destination principle coexist as equilibria (in the green area on figure (4)), the source principle dominates the destination principle by generating more tax revenues. This again comes from the possibility of taxing the foreign affiliate under the source principle, that generates quite an amount of revenue.

Proposition 3.4. *Suppose that both DD^* and SS^* are equilibrium tax principles. Then the source principle always generates more tax revenues than the destination principle.*

Proof. We show here that the black ellipse is always contained in the blue area on figure (4). The black ellipse crosses the horizontal axis at $\pi = \frac{9}{4}$. The blue ellipses cross the horizontal axis at $\pi \geq \frac{9}{4}$. Therefore, either the black ellipse intersects the blue ellipse on the horizontal axis or it is contained in the blue area. Since the destination principle dominates the source principle in terms of tax revenue if (π, π^*) are below the black ellipse, we can conclude that the destination principle always yields less tax revenue than the source principle.[17] $\qquad \square$

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[17]We show in appendix D.3 how to compute the ellipse and we provide graphical proof that it is always contained in the blue area.

This result stands in sharp contrast with the well-known property establishing the superiority of the destination principle. This property is completely reversed in the presence of MNF that can use transfer pricing to allocate profits across countries. Here, governments are better off being exposed to tax competition while controlling MNF transfer pricing behavior. The reason is the following. The issue with the source principle is the tax competition countries are exposed to which lowers their tax rate and the profit shifting that harms their tax base. The advantage of the source principle is however that countries can tax both the domestic parent and the foreign affiliate, while with destination-based taxes, they can only tax the domestic MNF. With an endogenous choice of enforcement level, tax competition due to profit shifting is reduced since countries strictly monitor profit shifting. Therefore, the source principle dominates in terms of collected taxes.

4   Robustness checks - variations to the model

This section aims to give intuitions on how the results change if we relax some of the assumptions of the main model to make it more realistic.

4.1   Heterogeneous countries

So far, we have assumed that each country hosts only one multinational firm. This is obviously not realistic and we now relax this assumption. Assume that there is a number N of MNFs headquartered in Home, and N^* in Foreign. The details of the analysis of this general case are relegated in appendix E. Here, we only illustrate the impact of such an asymmetry across countries on the equilibrium tax principles.

When the number N of MNFs in Home increases, the total profits generated by all Home MNFs increase. The Home parents profits can be taxed in Home, irrespective of the tax principle it uses. If Home uses the source principle, it will only benefit from the impact of the large number of Home MNFs through the profits of the parents. However, if it uses the destination principle, it can also benefit by taxing the transactions equal to Nq in total between the Home parent MNFs and their affiliates. This provides Home with an incentive to adopt the destination principle. This property holds whatever the principle used in Foreign.

Considering the decision of the Foreign country, the high total profits of Home affiliates (pro-

ducing in Foreign) can be taxed by Foreign only if it uses source-based taxes. This suggests that equilibria where the two countries use different principles are possible.

However, the larger Home, the larger π^* such that Home chooses to use the destination principle as a best-response to source-based taxation. The large number of domestic MNFs compensates for not taxing the foreign affiliates. For Foreign, using destination-based taxes is costly and it therefore responds to source-based taxes by using source-based taxes. But if Home decides to use destination-based taxes, Foreign prefers to also use destination-based taxes. As N increases, the area where Foreign responds to destination-based taxes by using destination-based taxes expands. It is too costly for Foreign to suffer from profit shifting from the domestic MNFs. The equilibrium will eventually result in either all countries using destination-based taxes if corporate revenues are small or in all countries using source-based taxes if corporate revenues are large. Figure (5) shows the equilibria and how they rank. There thus does not appear to exist any situation where one country would unilaterally adopt the destination principle.

Proposition 4.1. *When considering countries asymmetric in terms of the number of parent firms they host, the larger the asymmetry, the more likely source-based taxation will be the only equilibrium.*

4.2 Fixed enforcement

In the main model, the equilibrium level of tax enforcement depends on the principle of taxation chosen by countries. This results in a large heterogeneity in terms of enforcement chosen. Since there is no cost of profit shifting monitoring, the model implies that countries choose corner solutions in terms of tax enforcement: they strictly monitor profit shifting when they use source-based taxation and set a loose control when they use destination-based taxation. In practice, enforcement levels are not that extreme. We now study the equilibrium principles of taxation chosen for given enforcement policies α and α^*, regardless of the tax principle in place. We assume here that countries do not adjust their enforcement level if they decide to use one tax principle or the other. We again focus here only on the equilibria and tax ranking of equilibria. The detailed analysis can be found in appendix F.

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Figure 5: Equilibria and tax-ranking

(a) Equilibria   (b) Tax-ranking
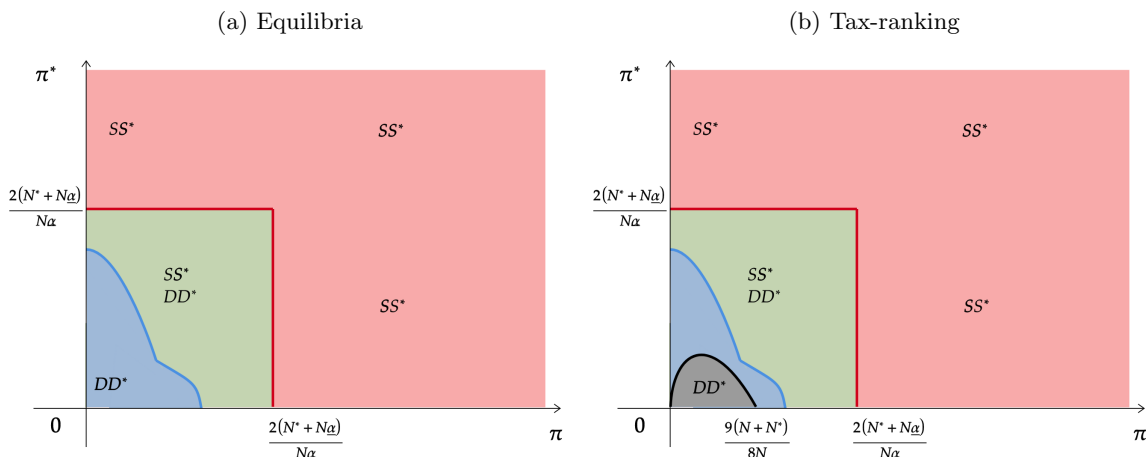
Note: Equilibria and tax-ranking of equilibria. π is on the horizontal axis and π^* is on the vertical axis. The blue areas correspond to the values of π, π^* where destination-based taxes are a best-response to the source principle (and there is a unique equilibrium in destination). The red area represents the area where source-based taxes are the only equilibrium. The green area represents the area where there are multiple equilibria. The black ellipse on figure (5b) represents the equation $TR_{SS^*} - TR_{DD^*} = 0$ to determine the tax-ranking of equilibrium. Below the black ellipse, the difference is negative, above, it is positive.

Consider that $\alpha = \alpha^*$. If $\alpha = \alpha^* = 1$, then countries have an incentive to adopt source-based taxation because the strict monitoring limits the impact of profit shifting. If $\alpha = \alpha^* = \underline{\alpha}$, countries have an incentive to use destination-based taxation. If however, $\alpha \neq \alpha^*$, then the choice of tax principle will depend on $\frac{\alpha}{\alpha^*}$.

Start from the equilibria where $\alpha = \alpha^* = 1$. For large values of (π, π^*), source-based taxation is an equilibrium and destination-based taxation is an equilibrium only for very small values of (π, π^*). We observe the existence of unilateral equilibria with one country using the source principle and the other using the destination principle. The Home country decides to unilaterally use the destination principle for values of π close to π^*, or when π is much larger than π^*, which means that it uses destination-based taxes when the foreign affiliate does not generate much revenues that Home cannot tax compared to the amount generated by the Home MNF. Conversely, the Foreign country unilaterally uses the destination principle when the revenues generated by the Home MNF are either not too large, relative to those of the foreign MNF or when π^* is much larger than π. We also observe multiple equilibria for an intermediate range of values of π and π^*: both unilateral equilibria coexist.

Now assume that α decreases while $\alpha^* = 1$. The shape of the equilibria is still similar but both ellipses representing the best-responses to source-based taxation expand and the area where the destination principle is an equilibrium also expands. The lower level of monitoring from the Home country makes the destination principle more attractive for both countries. A similar change occurs if we consider instead that α^* decreases.

When multiple equilibria coexist, we show that Home almost always raises more revenue by unilaterally using the destination principle than if it unilaterally adopts the source principle when the levels of enforcement are high in both countries. If at least either one of the two countries does not strictly enforce profit shifting monitoring, Home raises more tax revenues by unilaterally adopting the destination principle if $\pi < \pi^*$. In that case, Home can benefit from profit shifting if it uses destination-based taxes.

Figure 6: Equilibria and tax-ranking
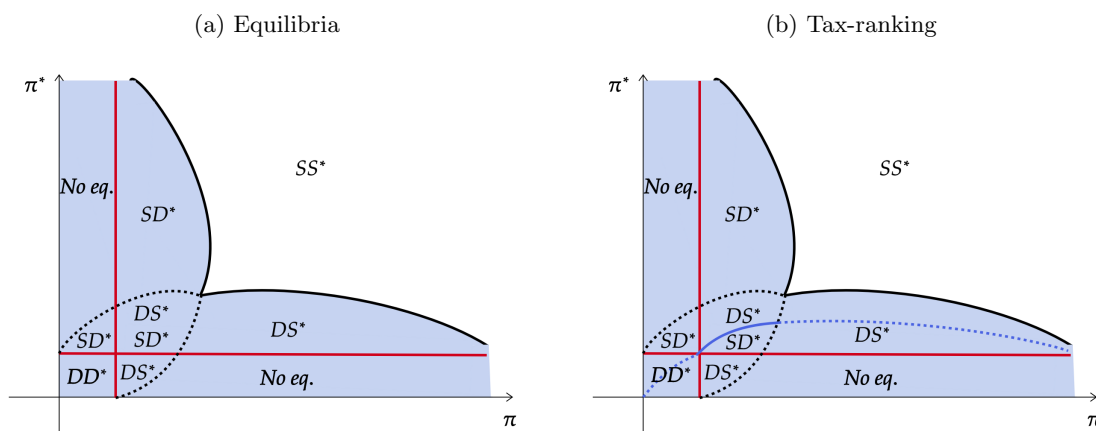
(a) Equilibria   (b) Tax-ranking

Note: π is represented on the horizontal axis and π^* is on the vertical axis. To the left of the lines, destination-based taxes are the best-response to destination-based taxes. To the right, source-based taxes are the best-response. In the blue areas, destination-based taxes are the best-response to source-based taxes.

Finally, we observe that there is no equilibrium for either low π or low π^*. Consider the area where there exists no equilibrium and π^* is small. In that area, Home has an incentive to adopt the destination principle when Foreign uses the source principle because its domestic MNF generates much more revenue than the foreign MNF. But the Foreign country also has incentives to adopt the destination principle if Home uses the destination principle because it faces profit shifted towards Home and looses tax revenues. But in that case, Home has incentives to then unilaterally use the source principle because it would be able to tax both the Home parent and the foreign affiliate,

while under a universal use of the destination principle, it can only tax the Home MNF, but without any profit shifting, contrarily to the case where it unilaterally uses the destination principle.

We provide a general view of the equilibria in figure (6). The detail of how the equilibria change can be found in appendix F.

Proposition 4.2. *When the enforcement level is fixed, there exists a greater incentive to adopt the destination principle when the enforcement levels are low. Countries are more likely to use the source principle when the enforcement levels are high. An asymmetric equilibrium is also possible when MNFs slightly differ in the amount of revenue they can generate.*

This shows that the level of tax enforcement plays a major role in this model. A strict enforcement favors source-based taxation. With low tax enforcement, being a high-tax source-based country makes it hard to raise tax revenues from multinational firms that try to escape taxation. There is evidence that auditing of multinational firms has decreased in several major countries. For the fiscal year 2017, the Internal Revenue Service (IRS), the governmental auditing institution in the US, audited only 331 of 616 corporate giants down from 431 audits in 2010.[18] This extension helps provide further intuition regarding the choice between source-based and destination-based taxation.

5 Conclusion

This paper focuses on the equilibrium choice of a tax policy in a context of tax competition with transfer price manipulation by multinational firms. This aims to shed light on the following puzzle: the source principle is considered suboptimal in the literature but all countries use source-based corporate taxes. To solve this puzzle, we develop a model of tax competition in which countries endogenously choose their tax policy.

Our findings show that the equilibrium response of countries that use the source principle is to implement a strict monitoring of profit shifting. This strict monitoring lowers the distortions that are well known under source-based taxation, and hence the race to the bottom. Destination-based

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[18]The number of agents working for that agency has also been reduced by a third in the last decade.

countries instead have an incentive to set a loose enforcement policy since they attract profits, regardless of their tax rate.

We find that with endogenous levels of tax enforcement and endogenous tax rates, source-based taxation is the best-response of the Home country to the source principle if domestic revenues are large, which entails a high source-based tax rate. We also find that source-based taxes are the best-response to the destination principle also if domestic revenues are large, because of a high tax rate under source-based taxes which compensates the fact that a source-based country is penalized by the profit shifting behavior of firms. Overall, the universal use of the source principle is a Nash equilibrium if both domestic and foreign corporate revenues are large. The universal adoption of the destination principle is a Nash equilibrium for small values of corporate revenues. We find that when both domestic and foreign corporate revenues are intermediate, both source-based and destination-based taxation coexist in equilibrium. However, the source principle tax-dominates the destination principle. Finally, we show that there does not exist any unilateral equilibrium where one country uses the destination principle and the other uses the source principle. We also show that how our results are affected to variations in the model's assumptions.

This has strong tax policy implications. Source-based taxation can be an equilibrium because of the strict tax enforcement. Currently, we observe a decreasing and now low level of tax enforcement in many developed countries. This paper shows that governments should increase the level of monitoring of profit shifting when using source-based taxes. It also suggests that the current international tax system could be the outcome of a noncooperative game played by rich countries maximizing tax revenues. Finally, it shows that a country deciding to move to destination-based taxation could incentivize other countries to implement such a reform, implying a new worldwide equilibrium tax system immune to profit optimization.

This paper only considers the monitoring of inbound profit shifting. Assuming that countries control the profit shifting behavior of the foreign MNFs (as in Peralta et al. [2006]) instead of that of the domestic MNFs would not really impact the results. Countries would still have incentives to monitor profit shifting under the source principle and not to monitor under the destination principle. In equilibrium, we can expect the destination principle to be the equilibrium for small values of corporate revenues while the source principle would be the equilibrium (and dominating the destination principle in the case of multiple equilibria) for large values of corporate revenues.

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Appendices

A   Derivation of equations (8a) and (8b)

We maximize (6) under the constraint that $\tau \geq 0$ and that the after tax profit of the domestic MNF, net of all profit taxed abroad is positive, i.e.:

$$(1 - \tau)(\pi - q) - D\tau q - \alpha q^2 \geq 0$$

To derive eq. (8a), we set $S = 1$.

$$\frac{\partial T}{\partial \tau} = 0 \quad \Leftrightarrow \quad \tau_S(\tau^*; \alpha, \alpha^*) = \left[\frac{\alpha \alpha^*}{\alpha^* + \alpha} \right] \left[\pi + \frac{\tau^*}{2} \left(\frac{(1 - D^*)}{\alpha^*} + \frac{S^*}{\alpha} \right) \right].$$

Similarly, to derive eq. (8b), we set $D = 1$.

$$\frac{\partial T}{\partial \tau} = 0 \quad \Leftrightarrow \quad \tau_D(\tau^*; \alpha, \alpha^*) = 1 + \frac{S^* \tau^*}{2\alpha\pi} \left(1 - \frac{S^* \tau^*}{2} \right).$$

B   Proof of lemma 2.2

B.1   When both countries use source-based taxation

The tax revenues of the Home country when both countries use source-based taxation write:

$$T_{SS^*} = \frac{2}{9} \frac{\alpha^* \alpha}{\alpha + \alpha^*} (2\pi + \pi^*)^2$$

$$\frac{\partial T_{SS^*}}{\partial \alpha} = \frac{2}{9} (2\pi + \pi^*)^2 \frac{\alpha^{*2}}{(\alpha + \alpha^*)^2} > 0$$

This implies $\alpha_{SS^*} = 1$. By symmetry, we find that $\alpha^*_{SS^*} = 1$.

B.2   When the Home country unilaterally uses the destination principle

The tax revenues of the Home country when it unilaterally uses destination-based taxation write:

$$T_{DS^*} = \pi + \frac{\pi^*\alpha^*}{2(\alpha + \alpha^*)} - \frac{(\pi^*\alpha^*)^2\alpha}{4(\alpha + \alpha^*)^2}$$

$$\frac{\partial T_{DS^*}}{\partial \alpha} = -\frac{\pi^*\alpha^*}{4(\alpha + \alpha^*)^3} \left[2\alpha + 2\alpha^* - \alpha\pi^*\alpha^* + \pi^*\alpha^{*2} \right]$$

$$\frac{\partial^2 T_{DS^*}}{\partial \alpha^2} = \frac{\pi^*\alpha^*}{2(\alpha + \alpha^*)^4} \left[2\alpha + 2\alpha^* - \alpha\pi^*\alpha^* + 2\pi^*\alpha^{*2} \right]$$

We look for local extrema:

$$\frac{\partial T_{DS^*}}{\partial \alpha} = 0 \Leftrightarrow -2\alpha - 2\alpha^* + \alpha\pi^*\alpha^* - \pi^*\alpha^*\alpha^* = 0 \Leftrightarrow \alpha = \alpha^* \frac{2 + \pi^*\alpha^*}{\pi^*\alpha^* - 2}$$

This extremum is unique. We study whether it is a maximum or a minimum. We evaluate the second partial derivative $\frac{\partial^2 \tau}{\partial \alpha^2}$ at $\alpha = \alpha^* \frac{2+\pi^*\alpha^*}{\pi^*\alpha^*-2}$.

$$\frac{\partial^2 T_{DS^*}}{\partial \alpha^2} > 0 \Leftrightarrow \pi^*\alpha^{*2} > 0 \tag{18}$$

The objective is convex. This local extremum is thus a global minimum.

The destination-based country best-response is found by comparing $T_{DS^*}|_{\alpha=\underline{\alpha}}$ and $T_{DS^*}|_{\alpha=1}$.

At $\alpha = \underline{\alpha}$, $T_{DS^*} = \pi + \frac{\pi^*}{2(1+\underline{\alpha})} - \frac{\pi^{*2}\underline{\alpha}}{4(1+\underline{\alpha})^2}$

At $\alpha = 1$, $T_{DS^*} = \pi + \frac{\pi^*\alpha^*}{2(1+\alpha^*)} - \frac{(\pi^*\alpha^*)^2}{4(1+\alpha^*)^2}$

We find that $T_{DS^*}|_{\alpha=\underline{\alpha}}$ is larger than $T_{DS^*}|_{\alpha=1}$ if $\pi^* > \frac{2\underline{\alpha}+\alpha^*(2\underline{\alpha}+2+2(\alpha^*))}{\alpha^*(\underline{\alpha}-\alpha^*)}$. We know that $\frac{2\underline{\alpha}+\alpha^*(2\underline{\alpha}+2+2\underline{\alpha}^*)}{\alpha^*(\underline{\alpha}-\alpha^*)} < 0$ since in equilibrium, $\alpha^* = 1$, therefore, if $\pi^* > 0$, $\alpha_{DS^*} = \underline{\alpha}$.

The source-based country tax revenues write:

$$T_{DS^*}^* = \frac{\pi^{*2}\alpha\alpha^*}{2(\alpha + \alpha^*)}$$

$$\frac{\partial T^*_{DS^*}}{\partial \alpha^*} = \frac{\pi^{*2}\alpha^2}{2(\alpha + \alpha^*)^2} > 0$$

Therefore $\alpha^*_{DS^*} = 1$. The equilibrium is thus $(\alpha_{DS^*}, \alpha^*_{DS^*}) = (\underline{\alpha}, 1)$.

C   Details of tax rates, tax bases and enforcement levels

Principles	Tax rates	Tax bases	Enforcement levels
SS^*	$\tau_{SS^*} = \frac{2}{3}(2\pi + \pi^*)\frac{\alpha\alpha^*}{\alpha+\alpha^*}$ $\tau^*_{SS^*} = \frac{2}{3}(\pi + 2\pi^*)\frac{\alpha\alpha^*}{\alpha+\alpha^*}$	$(\pi - q) + q^* = \pi - \frac{\tau_{SS^*}-\tau^*_{SS^*}}{2}\frac{\alpha+\alpha^*}{\alpha\alpha^*}$	$\alpha_{SS^*} = \alpha^*_{SS^*} = 1$
DS^*	$\tau_{DS^*} = 1 + \frac{\pi^*\alpha^*}{2\pi(\alpha+\alpha^*)} - \frac{\pi^{*2}\alpha^{*2}\alpha}{4\pi(\alpha+\alpha^*)^2}$ $\tau^*_{DS^*} = \frac{\pi^*\alpha\alpha^*}{\alpha+\alpha^*}$	π	$\alpha_{DS^*} = \underline{\alpha}; \alpha^*_{DS^*} = 1$
SD^*	$\tau_{SD^*} = \frac{\pi\alpha\alpha^*}{\alpha+\alpha^*}$ $\tau^*_{SD^*} = 1 + \frac{\pi\alpha}{2\pi^*(\alpha+\alpha^*)} - \frac{\pi^2\alpha^2\alpha^*}{4\pi^*(\alpha+\alpha^*)^2}$	$(\pi - q) + q^* = \pi - \frac{\tau_{SD^*}}{2}\frac{\alpha+\alpha^*}{\alpha\alpha^*}$	$\alpha_{SD^*} = 1; \alpha^*_{SD^*} = \underline{\alpha}$
DD^*	1	π	$(\alpha_{SD^*}; \alpha^*_{SD^*}) \in [\underline{\alpha}, 1]$

Table 1: Expressions of tax rates, tax bases and enforcement levels

D   Equilibrium tax principles - Details

D.1   Best-response to source-based taxes

We show here the computation of the ellipse that represents the best-response to source-based taxes. We start from eq. (20). We set for simplicity $x = \pi \geq 0$ and $y = \pi^* \geq 0$. We have

$$F(x, y) = \left(\frac{2x + y}{3}\right)^2 - x - \frac{y}{2(1 + \underline{\alpha})} + \frac{y^2\underline{\alpha}}{4(1 + \underline{\alpha})^2}$$

This is the equation of a conic section. We know that this conic section is an ellipse since the term in front of x^2 and the one in front of y^2 are non zero, have the same sign and are not equal to each other.

Setting $F(x, y) = 0$, we find that the solutions to this equation are of the form:

$$y = \frac{-8\underline{\alpha}^2 x - 16\underline{\alpha}x + 9\underline{\alpha} - 8x + 9}{4\underline{\alpha}^2 + 17\underline{\alpha} + 4}$$

$$\pm \frac{3}{4\underline{\alpha}^2 + 17\underline{\alpha} + 4} \sqrt{16\underline{\alpha}^4 x - 16\underline{\alpha}^3 x^2 + 84\underline{\alpha}^3 x - 32\underline{\alpha}^2 x^2 + 120\underline{\alpha}^2 x + 9\underline{\alpha}^2 - 16\underline{\alpha}x^2 + 52\underline{\alpha}x + 18\underline{\alpha} + 9}$$

$$(19)$$

We know that for any (x, y) inside the ellipse, $F(x, y) < 0$ which implies that $T_{SS} - T_{DS} < 0$. This corresponds to the case where the Home country chooses destination-based taxes as a response to source-based taxes.

The ellipse crosses the x-axis at $F(x, 0) = 0$, which is equivalent to $x = \frac{9}{4}$. It crosses the y-axis at $y = \frac{18(1+\underline{\alpha})}{4\underline{\alpha}^2 + 17\underline{\alpha} + 4}$, solution to (19) when $x = 0$.

By symmetry of the tax revenue equation of the Foreign country facing a choice between source-based and destination-based taxation when the Home country uses source-based taxes, we find that $F^*(x, y) = 0$ entails solutions of the form:

$$x = \frac{-8\underline{\alpha}^2 y - 16\underline{\alpha}y + 9\underline{\alpha} - 8y + 9}{4\underline{\alpha}^2 + 17\underline{\alpha} + 4}$$

$$\pm \frac{3}{4\underline{\alpha}^2 + 17\underline{\alpha} + 4} \sqrt{16\underline{\alpha}^4 y - 16\underline{\alpha}^3 y^2 + 84\underline{\alpha}^3 y - 32\underline{\alpha}^2 y^2 + 120\underline{\alpha}^2 y + 9\underline{\alpha}^2 - 16\underline{\alpha}y^2 + 52\underline{\alpha}y + 18\underline{\alpha} + 9}$$

D.2   Proof the proposition 3.3

We show below in figure (7) the shape of the equilibria discussed in section 3.3 for different values of $\underline{\alpha}$. This complements the proof of proposition 3.3 given in the main text. This shows that, even when the vertex of the ellipse goes further away than the point at which the ellipse crosses the axes, the blue area and the red area never intersect.

Figure 7: Shape of the equilibria

(a) $\underline{\alpha} = 1$ (b) $\underline{\alpha} = 0.8$ (c) $\underline{\alpha} = 0.6$ (d) $\underline{\alpha} = 0.3$
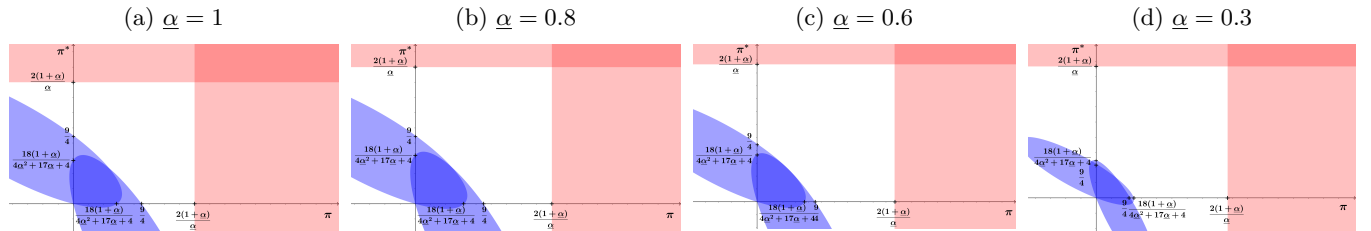
Note: Graphical representation of the equilibria discussed in section (3.3) for different values of $\underline{\alpha}$. π is represented on the horizontal axis and π^* is on the vertical axis.

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D.3 Proof of the tax-ranking

The black ellipse defines

$$T_{SS^*} - T_{DD^*} = 0 \Leftrightarrow \left(\frac{2\pi + \pi^*}{3}\right)^2 - \pi = 0$$
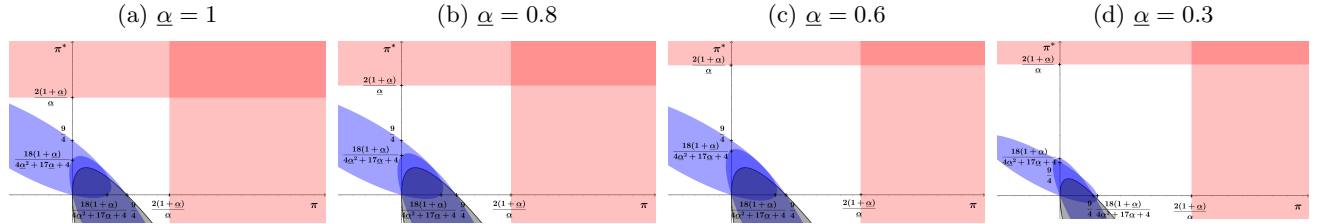
We set for simplicity $x = \pi \geq 0$ and $y = \pi^* \geq 0$. The solution to this equation is of the form:

$$y = -2x + 3\sqrt{x}$$

This ellipse crosses the horizontal axis at $(x, y) = (\frac{9}{4}, 0)$ and crosses the vertical axis at $(x, y) = (0, 0)$.

We show below on figure (8) that the black ellipse is always contained in the blue area for different values of $\underline{\alpha}$.

Figure 8: Tax-ranking of equilibria

(a) $\underline{\alpha} = 1$ (b) $\underline{\alpha} = 0.8$ (c) $\underline{\alpha} = 0.6$ (d) $\underline{\alpha} = 0.3$

Note: Graphical representation of the tax-ranking of equilibria discussed in section (3.4) for different values of $\underline{\alpha}$. π is represented on the horizontal axis and π^* is on the vertical axis.

E Heterogeneous countries - Detailed calculations

The tax revenue difference replacing (13) when the Foreign country uses source-based taxation is:

$$T_{SS^*} - T_{DS^*} = \frac{2}{9} \frac{(2N\pi + N^*\pi^*)^2}{N + N^*} - N\pi - \frac{NN^*\pi^*}{2(N^*\underline{\alpha} + N)} + \frac{NN^{*2}\pi^{*2}\underline{\alpha}}{4(N^*\underline{\alpha} + N)^2} \tag{20}$$

$T_{SS^*} - T_{DS^*} = 0$ is the equation of an ellipse whose shape depends on the ratio $\frac{N}{N^*}$ and the value of $\underline{\alpha}$. We show in figure (10) its shape for different values of $\frac{N}{N^*}$. As the ratio $\frac{N}{N^*}$ increases, Home is more willing to adopt the destination principle, even if π^* is large because it hosts a large number of parent firms it can tax under destination-based taxation. Moreover, even if destination-based

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taxation implies giving up on taxing the foreign affiliates, it can tax the transactions between the domestic parents and the affiliates producing in Foreign. As the ratio decreases, Home chooses to use destination-based taxes only if π^* is low, so that it does not give up on too much tax revenue from the foreign affiliates. Considering that the best-response of Foreign is symmetric, we observe that the source principle will be part of a subgame perfect Nash equilibria in pure strategies for large values of π and π^*.

Moreover, when the Home country becomes larger than the Foreign country, it risks becoming the high-tax country under source-based taxation. Indeed, when $N\pi > N^*\pi^* \Leftrightarrow \tau_{SS^*} > \tau^*_{SS^*}$. In that case, Home faces profit shifting. When its domestic firms generate low profits, Home cannot collect much revenue from its domestic parent firms and cannot fully tax foreign affiliates because they shift profits towards Foreign. Home therefore prefers to respond to source-based taxes by using destination-based taxes. However, when its domestic firms generate large revenues, Home can tax its numerous profitable firms at a high tax rate, which compensates the loss of tax revenue due to profit shifting. Finally, when $\tau_{SS^*} < \tau^*_{SS^*}$, Home chooses to use destination-based taxes because it can tax its domestic firms at a higher tax rate than under source-based taxation, which compensates for not taxing the foreign affiliates.

The level of $\underline{\alpha}$ also has an impact on the shape of the best-response. As $\underline{\alpha}$ decreases, the area where the destination principle is the best-response to the source principle increases, since lower monitoring by the destination-based country implies more profit shifting, which harms the source-based country.

When the Foreign country uses destination-based taxation, the difference writes:

$$T_{SD^*} - T_{DD^*} = 0 \Leftrightarrow \pi = \frac{2(N^* + N\underline{\alpha})}{N\underline{\alpha}} \tag{21}$$

This difference is decreasing in N and increasing in N^*. The pattern is similar to the symmetric case. Destination-based taxes are the best-response if domestic corporate revenues are small. The area where destination-based taxes are the best-response increases as the ratio $\frac{N}{N^*}$ decreases and as $\underline{\alpha}$ decreases. An decrease in the number of domestic MNF has the same impact as an decrease in the

Figure 9: Best-response of the Home country to source-based taxes
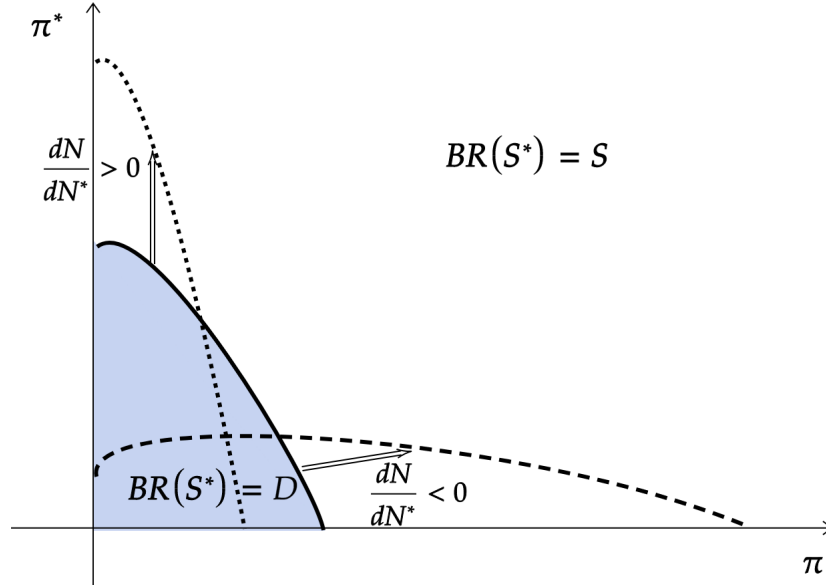
Note: Graphical representation of the tax revenue difference from equation (20).
π is represented on the horizontal axis and π^* is on the vertical axis. Below the
ellipse, the best-response to source-based taxes is destination-based taxes. Above
the ellipse, the best-response is source-based taxes. The ellipse itself represents
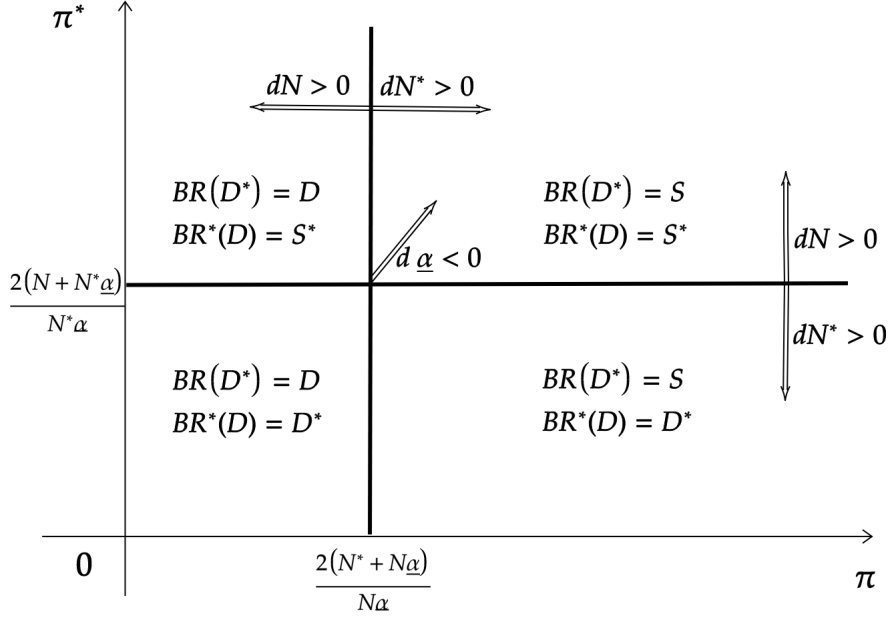the solutions to the equation $T_{SS^*} - T_{DS^*} = 0$.

level of monitoring of destination-based countries. Less monitoring by Foreign when it unilaterally
uses destination-based taxes triggers a choice for Home in favor of the destination principle and so
does a relative decrease of the number of domestic MNFs compared to the number of foreign MNFs.

If either N or N^* tends to infinity, then the universal use of the destination principle is never
an equilibrium. The smaller country always has an incentive to use the source principle in order to
tax the numerous affiliates of the large country's MNFs.

We show here how to obtain the ellipse that represents the solution to:

$$T_{SS^*} - T_{DS^*} = 0.$$

Figure 10: Best-responses to destination-based taxes

Note: Graphical representation of the tax revenue difference from equation (21). π is represented on the horizontal axis and π^* is on the vertical axis. The vertical line represents the solution to the equation $T_{SD^*} - T_{DD^*} = 0$. The horizontal line is the solution to $T^*_{SD^*} - T^*_{DD^*} = 0$ for Foreign.

We set $x = \pi \geq 0$ and $y = \pi^* \geq 0$. The solutions to this equation are of the form:

$$
\begin{aligned}
y = & \frac{-16\underline{\alpha}^2 N^{*2} N x + 9\underline{\alpha} N^{*2} N - 32\underline{\alpha} N^* n^2 x + 9\underline{\alpha} N^* N^2 + 9N^* n^2 - 16n^3 x + 9N^3}{N^*(8\underline{\alpha}^2 N^{*2} + 25\underline{\alpha} N^* N + 9\underline{\alpha} N^2 + 8N^2)} \\
& \pm \frac{3}{N^*(8\underline{\alpha}^2 N^{*2} + 25\underline{\alpha} N^* N + 9\underline{\alpha} N^2 + 8N^2)} \Big(32\underline{\alpha}^4 N^{*5} N x + 32\underline{\alpha}^4 N^{*4} N^2 x + 132\underline{\alpha}^3 N^4 N^2 x \\
& - 32\underline{\alpha}^3 N^{*3} N^3 x^2 + 168\underline{\alpha}^3 N^{*3} N^3 x - 32\underline{\alpha}^3 N^{*2} N^4 x^2 + 36a^3 N^{*2} N^4 x + 9\underline{\alpha}^2 N^{*4} N^2 + 168\underline{\alpha}^2 N^{*3} N^3 x \\
& + 18\underline{\alpha}^2 N^{*3} N^3 - 64\underline{\alpha}^2 N^{*2} N^4 x^2 + 240\underline{\alpha}^2 N^{*2} N^4 x + 9\underline{\alpha}^2 N^{*2} N^4 - 64\underline{\alpha}^2 N^* N^5 x^2 + 72\underline{\alpha}^2 N^* N^5 x \\
& + 18\underline{\alpha} N^{*3} N^3 + 68\underline{\alpha} N^{*2} N^4 x + 36\underline{\alpha} N^{*2} N^4 - 32\underline{\alpha} N^* N^5 x^2 + 104\underline{\alpha} N^* N^5 x \\
& + 18\underline{\alpha} N^* N^5 - 32\underline{\alpha} N^6 x^2 + 36\underline{\alpha} N^6 x + 9N^{*2} N^4 + 18N^* N^5 + 9N^6 \Big)^{\frac{1}{2}} \quad (22)
\end{aligned}
$$

F Fixed enforcement - detailed calculations

When the Foreign country uses source-based taxes, the collected tax of the Home country when it uses source-based taxes writes:

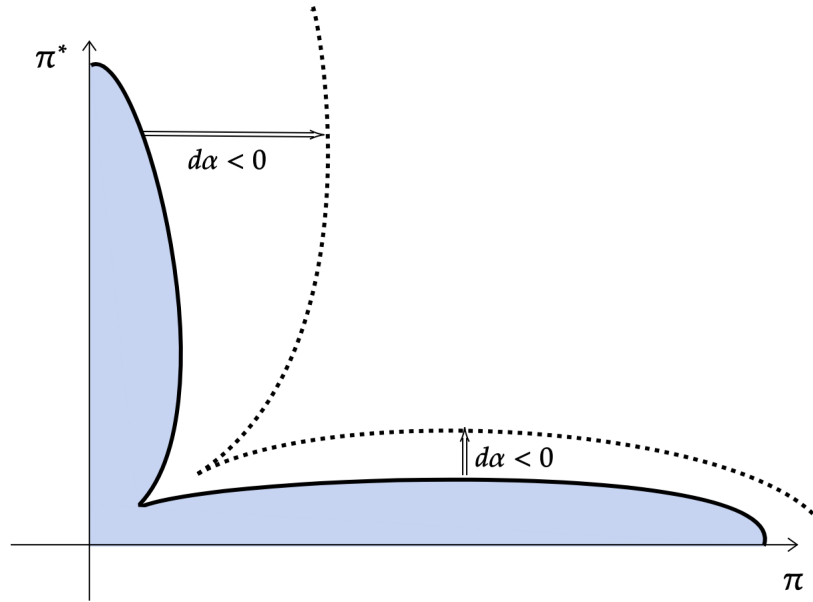$$T_{SS^*(\alpha,\alpha^*)} = \frac{2\alpha\alpha^*(2\pi + \pi^*)^2}{9(\alpha + \alpha^*)} \tag{23}$$

$T_{SS^*(\alpha,\alpha^*)}$ is increasing in both α and α^*. The stricter the enforcement in both countries, the higher the tax revenues under source-based taxation.

When it uses destination-based taxes, it writes:

$$T_{DS^*(\alpha,\alpha^*)} = \pi + \frac{\pi^*\alpha^*}{2(\alpha + \alpha^*)} - \frac{\alpha\alpha^{*2}\pi^{*2}}{4(\alpha + \alpha^*)^2} \tag{24}$$

$T_{DS^*(\alpha,\alpha^*)}$ is decreasing in α^* and decreasing and then increasing in α.

Figure 11: Best-response to source-based taxes

Note: Graphical representation of the tax revenue difference (23) - (24). π is represented on the horizontal axis and π^* is on the vertical axis. The black ellipse represents the solutions to the equation $T_{SS^*} - T_{DS^*} = 0$. Below the ellipse, destination-based taxes are the best-response to source-based taxes. Above the ellipse, source-based taxes are the best-response.

Overall, when both π, π^* are small, both countries respond to source-based taxation by using destination-based taxes. When π is large and π^* is small, Home choose destination-based taxes

and Foreign chooses source-based taxes. Contrarily, when π is small and π^* is large, Home chooses source-based taxes and Foreign chooses destination-based taxes. Finally, when both π, π^* are large, both countries respond to source-based taxation by using source-based taxes. What changes is the range of π, π^* such that countries prefer one system over the other when α, α^* change.

If $\alpha = \alpha^* = 1$, the range of values of π, π^* such that both countries choose to use destination-based taxes is very small. It is more likely that they all decide to use the source principle. As $\alpha = \alpha^*$ increase, the area where destination-based taxation is the best-response expands for both countries. Lower enforcement makes the destination principle more attractive. If for example, α is low and α^* is high, for small values of π^*, Home chooses to use destination-based taxes but prefers source-based taxation once π^* becomes large. Foreign behaves accordingly but tolerates larger values of π such that it chooses destination-based taxes. A larger π implies a higher τ_{SD^*}, which in turn implies that MNFs have more incentives to shift profits to the destination-based country. Therefore, even though Foreign strictly monitors profit shifting, it prefers to use destination-based taxation for low and intermediate values of π to benefit from profit shifting from the MNFs.

When the Foreign country uses the destination principle, the tax revenue difference writes:

$$T_{SD^*} - T_{DD^*} = \frac{\pi^2 \alpha \alpha^*}{2(\alpha + \alpha^*)} - \pi \tag{25}$$

The tax revenue difference depends positively on both α and α^* and is independent of π^*. To the left of the lines, destination-based taxes are the best-response to destination-based taxes. To the right, source-based taxes are the best-response. For any π^*, the more monitoring from both countries, the bigger the area where source-based taxes are a best-response to destination-based taxes.

Figure 12: Best-response of Home to destination-based taxes
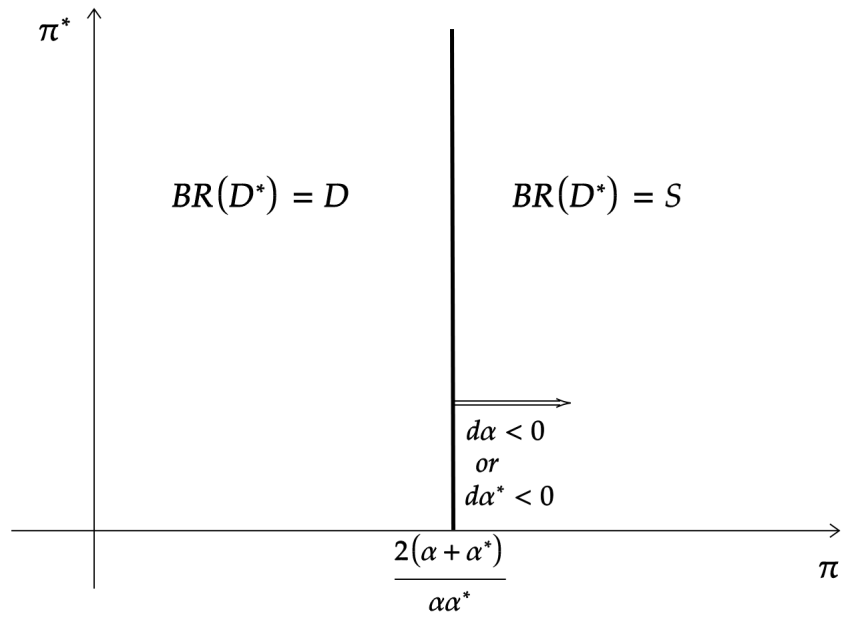
Note: Graphical representation of the tax revenue difference (25). π is represented on the horizontal axis and π^* is on the vertical axis. To the left of the line, destination-based taxes are the best-response to destination-based taxes. To the right, source-based taxes are the best-response.