Bayesian Persuasion in Tax Competition

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Abstract

Multinational enterprises form long value chains linking subsidiaries and affiliates in a large number of countries. Some governments may offer tax preferences or assistance in profit shifting. Such actions lead to distortions in the rightful distribution of the profit along the value chains. This profit shifting is elusive for other countries, because no government has a complete view of the multinationals' business activity. The tax base erosion can be stopped if all governments are identically informed. Therefore, intergovernmental communication becomes a chief concern for counteraction to harmful tax competition and aggressive tax planning. To investigate the issue we model intergovernmental information exchange for tax matters as a sequential Bayesian persuasion. We show how free choice of communication rules promotes tax avoidance in chain structures and how countries take roles in profit shifting schemes. The key outcome is that formal information exchange agreements do not prevent profit shifting but change its beneficiaries. We also argue that, in contrast to public perception, a low tax rate is not a distinct feature of the countries assisting tax avoidance.

Keywords: Tax competition; Bayesian persuasion; networks.
JEL classification: D82, H26, H77.

1 Introduction

Harmful international tax competition and aggressive tax planning are hot spots of the contemporary global agenda on tax policy. The actual Action plan on Base Erosion and Profit Shifting [1] developed by the OECD and G20 is heavily focused on cooperation in information exchange between countries and restrictions on tax preferences. The latter can be granted in the form of secret tax deals distilling the issue down to information exchange only. However, there is a lack of theoretical models of tax competition with information exchange between governments in strategic settings and, to the best of our knowledge, this is the first paper to introduce Bayesian persuasion into the tax competition framework. We investigate the effects of information exchange and cooperation between countries on their tax policy and tax base allocation. It defines tax burden that, subsequently, affects capital allocation choice of multinational enterprises (MNE).

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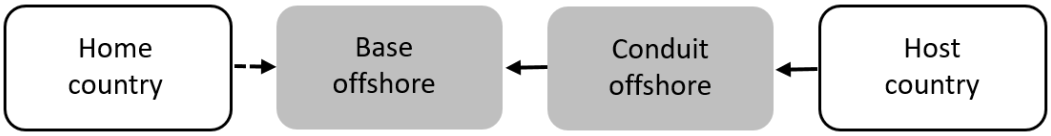
[1] The plan is available at https://www.oecd.org/tax/beps/beps-actions

In our approach we intentionally separate the capital and profit allocation problems. Previous models, by contrast, rationalise tax competition as the way of attracting mobile capital, but provide little justification for existence of tax hubs, such as Luxembourg and the Netherlands, and typical offshore jurisdictions. Accommodating the roles of tax hubs or offshores, countries do not compete for investments but happen to become usual companions of aggressive tax planning. We keep the capital allocation problem as an optimisation with respect to the after-tax return from investments. Meanwhile, we introduce the profit allocation problem as a minimisation of tax burden on the profit received by MNE at predefined capital allocation. Even if capital-recipient countries do not overtly provide tax preferences keeping high tax rates, tax base allocation is the covert playground for tax competition assisted by tax hubs and offshores.

The generally accepted difference between offshore jurisdictions and tax hubs is administrative cooperation. The latter provides information on MNE's activity of interest to other countries. In fact, most countries, including typical offshores, are committed to provide tax-related information on request or automatically according to the Convention on Mutual Administrative Assistance in Tax Matters [2]. However, the issue is whether such information exchange ends profit shifting. The main drawback of the cooperation is that countries usually do not have incentives to provide accurate and complete information regarding foreign business activity on their territory. Even if country reveals requested information truthfully, the information itself might be strategically biased. We model this drawback using Bayesian persuasion.

Let's consider a minimal functional offshore scheme termed "stepping-stone" revealed by the International Centre for Tax and Development in Picciotto (2020). The structure includes at least four countries depicted on Figure 1 below. A MNE being a tax resident in a home country receives income from a operating subsidiary in a host country. Initially, the profit after taxation in the host country should be transferred to the home country, but due to some business arrangements the profit center was moved to a base offshore. The profit being shifted from the host country passes a conduit offshore that removes taxation in the host country.

Figure 1: "Stepping-stone" offshore scheme



To avoid taxation in both home and host countries the MNE requires two offshores *at least*. One offshore reduces tax burden at the income-source country, while another minimise payable taxes at the country of residence. However, one offshore is sufficient in typical tax competition models, because the MNE can allocate capital there to enjoy benefits. In contrast, in our model we demonstrate that minimum two offshores are needed to make the whole value-chain structure opaque for both countries, if they do not observe the whole profit-shifting scheme.

[2] http://www.oecd.org/ctp/exchange-of-tax-information/convention-on-mutual-administrative-assistance-in-tax-matters.htm

The model we propose includes a firm and a finite number of countries, each of which plays one of three roles in a value chain. The firm owns production facilities in an exporting country and trades goods with an importing country. According to the income-source rule, the profit is taxable in the exporting country, but tax planning shifts the profit to other countries. The third role is a transit country that provides assistance in profit shifting. In addition, we assume any form of tax planing technique, either transfer pricing, excessive debt financing, or something else. Since the tax-planning toolbox is continuously changing, we only focus on resulting profit allocation. Possible transfer links between the countries form a communication network with the firm, which chooses an optimal path on it according to its overall tax burden.

The firm's objective is to minimise the tax burden on its global profit that can be achieved by formally shifting income source to another country. The exporting country has two instruments to assure tax compliance. The first is a tax audit, which is costly but effectively counteracts the profit shifting activity. One of the obtained results is that the less the efficacy of the tax administration, the large profit share is shifted. The second is an information exchange in the form of Bayesian persuasion developed by Gentzkow and Kamenica (2011), which is costless, but opens up possibilities for meddling with receiver's beliefs.

A distinctive feature of Bayesian persuasion is that there is no information hiding. Persuader truthfully reveals available information but can choose its source. By request of a foreign country, tax authorities collect documents on the deal that is the subject of the request. A choice of evidence defines whether the deal is a part of tax planning scheme, so truthful information may be initially biased. Only responding tax administration can decide to what extent challenge information source. For instance, Cyprus tends to "quote statements made by the information holder to the requesting jurisdiction" (OECD, 2020, p. 125), while Panama shows no efforts to "fully seek out all possible sources of information when requests are received" (OECD, 2019b, p. 66).

Since real business activity occurs in the exporting and importing countries, the transit country cannot acquire substantial information regarding the firm's profit. The purpose of subsidiaries in transit countries is to modify the nature of business operations reducing the firm's tax burden. In terms of Bayesian persuasion, the transit country plays the role of an information mediator between the exporting and importing countries. In terms of the persuasion, the transit country cannot make own trials but can reduce accuracy of the information provided by other countries.

Consider the case with an offshore between the exporting and importing countries. The manufacturing subsidiary is a subsidiary of a foreign holding. The tax authority in the exporting country is unaware whether the offshore company belongs to the holding. We demonstrated a non-cooperative nature of offshores. However, an attempt of getting information from the importing country would fail, being not *foreseeable relevant*. For example, Ireland provided information on direct Irish party of a business transaction, but refused requests on other residents that had the same directors and could be relevant to the initial request (OECD, 2017b, p. 76). Hence, transactions with residents of requesting country have higher chances of being considered as relevant.

A value or ownership chain can include several transit countries, so we employ and extend the approach of Kosenko (2018) in modelling sequential information intermediation in Bayesian persuasion. Each country in the chain is less cooperative. Since the firm has to report profit that is consistent with countries' beliefs, we demonstrate that sequential Bayesian persuasion results in a

profit allocation based on beliefs about the profit that the countries form during the communication process. As a result, our model reveals benefits that offshores and tax hubs have from tax planning.

Profit shifting is driven by information exchange between countries in the communication network, but the firm chooses its path. All countries on the path are at least indifferent in assisting the firm. Different paths lead to different communication outcomes and different profit allocations. In addition, the tax burden on the firm is defined by both the tax base and the tax rate. A choice of tax rates that countries make at the start may pin down a path choice of the firm. The more the country is important for profit shifting, the higher the tax rate it can impose. Thus, the importing country can impose high tax rates relative to transit countries. This result demonstrates that tax competition with information exchange does not necessary lead to zero tax rates. Moreover, high tax rates do not differentiate countries that benefit or suffer from profit shifting. Hence, it cannot be used to form a list of countries assisting profit shifting.

Extending the results, we show that farsightedness of the country has separate effect on the firm's tax burden. A perfectly farsighted importing country observes all countries on the path and executes full control over communication on this path attracting almost all benefits from tax avoidance. In this case, the firm does not receive the lowest possible tax burden. If the countries have restricted farsightedness, the firm can compose a path that reduces the negative effect of the farsightedness. However, the firm needs a sufficient number of different transit countries for such manipulations. Therefore, any international action that reduces a number of offshores or allows bilateral information exchange only increase the benefits some countries receive from profit shifting.

Consider our basic case assuming that the parent company of the holding is a resident of the importing country. The exporting country is unaware of the whole group structure. Meanwhile, the importing country can observe all members of the holding. The former is myopic, as the latter is farsighted. Even if the structure is revealed to the exporting country, it will have hard time of getting information bypassing the offshore. The reason was demonstrated on the examples with Ireland, that is foreseeable relevance.

We interpret farsightedness as political control that gives information advantage. In fact, the United Kingdom and the Netherlands still tightly control highly crowded offshore jurisdictions nowadays. For example, almost all of 75 billion US dollars investments that came to Caribbean offshores in 2015 were channelled through the British Virgin Islands and the Cayman Islands, which are under sovereignty of the United Kingdom (UNCTAD, 2016, p. 20). Our model reveals the benefits large offshore financial centres receive from collaboration with their captive offshores.

We do not model mobile capital allocation, but profit allocation affects it. Countries are different in the rate of return on capital they can provide. Some of those with high returns become exporting and importing countries. Others play the role of transit countries. Because the firm optimises the rate of return after taxation, countries might need to reduce the tax burden to win the competition for capital allocation, even with the assistance of transit countries.

As a result, importing countries enjoy investments and profit shifted on its territory, while transit countries may receive their share of profit. In this framework, the exporting country receives foreign investments inducing it to enter into an implicit agreement on tax avoidance to reduce real tax burden and improve the business climate. Moreover, we show how a country with a moderate rate of return can enjoy larger tax revenues from being a transit country. As a result, severe

competition for mobile capital might make tax planning desirable for most countries.

Therefore, our model shows that information exchange is not enough to counteract aggressive tax planning. Countries can mislead one other even if information is truthfully revealed. To impede this activity, strict and comprehensive protocols on intergovernmental information exchange for any possible case must be developed, which appears to be a tough mission. The more realistic solution may be provision of technical assistance to improve efficacy of national tax authorities.

2 Related literature

The issue of tax competition has been research subject for long, but effects of information co-operation on tax policy was not investigated widely. The topic of information exchange in tax competition was mostly started by Bacchetta and Espinosa (1995). They consider a framework with two countries and a household endowed with capital partly invested abroad. The domestic government has no information on taxable foreign income and needs the information shared by the foreign country. At first, there is no incentive for communication, since the information provision removes tax benefits and deters foreign investors. However, the information received encourages the domestic government to raise its tax rate that, consequently, motivates domestic investors to invest the capital in the foreign country. If the first effect prevails, the government refrains from information exchange. Otherwise, it shares the taxpayer's information.

Makris (2003) reconsiders the model of Bacchetta and Espinosa (1995) amending some key mechanics. The first is that the cost of moving capital abroad is normalised some negative number instead of zero. As a result, there exists some default level of capital outflow that is beneficial to the domestic country. The second change is that the countries are free to impose any tax rates. The Makris revealed that no information exchange can be recommended to support export of capital, even in the case of cooperation between the countries. However, the both models have a shortcoming, they consider information exchange as an observable action. In fact, the information provided can have different informative value, from revealing the truth to being completely uninformative. Moreover, communication can be used to manipulate with receiver's decisions.

Another general way of developing such models was inclusion of either punishment for misinformation or positive incentives for full revelation. Specifically, Bacchetta and Espinosa (2002) enrich the mentioned model by posing information exchange as a repeated process. It makes possible to decrease creditability of the information source, which is considered as a penalty. They get a condition for information provision that is robust for short run deviations. In contrast to that approach, Keen and Ligthart (2006) develop a model with transfers to small countries in exchange for information. A common trait of the models is the assumption that information is truthful and accurate, which is not completely realistic. They have focus on mechanism design, but not on the modelling of information transformation in favour of the actors.

Assignment of the roles that countries play in tax planning is usually left out of scope of analytical models. Bucovetsky (1991) notices that a country with small population can impose a low tax rate and benefit from inflow of capital. It became a standard approach considering low-tax countries as a net capital importer. Later on, Slemrod and Wilson (2009) justified existence of tax havens introducing market of *concealment services*. Some countries might provide such services improving

own welfare in expense of tax base erosion in other countries. One can consider this market as a capital allocation externality. In fact, there is a lack of analytical models that demonstrate difference between low-tax countries, tax havens, and tax hubs, as well as reveal the roles they play in tax competition.

The seminal paper for Bayesian persuasion is Kamenica and Gentzkow (2011), where they develop a basic setup with discrete space of states of the nature and provide the general solution to the communication problem. We adapt the structure and extend it with sequential approach of Kosenko (2018), who models mediated Bayesian persuasion using the fundamental result of Blackwell (1953) on stochastic transformation of experiments. The approach of Kosenko (2018) to sequential communication sufficiently well replicates distribution of the information along value chains. Another approach to mediated persuasion was developed by Li and Norman (2018), where receiver observes the information from all mediators. However, this approach is not suitable for intergovernmental where information request must be foreseeable relevant.

We can also mention recent development on Bayesian persuasion on network by Egorov and Sonin (2019), where they consider a social network as an information propagator. However, networks in their paper are not formed by Bayesian persuasion itself, so networks do not affect the information in strategic way. Another approach in communication on networks was taken by Candogan (2019). In the paper he considers the case of public signal that can persuade most of agents connected into a random network to take a binary action. The agents benefit from like-minded neighbours, who took the same action.

More suitable for our application of Bayesian persuasion on networks was made by Das et al. (2017), where an agent is persuaded to choose a specific path on given network. However, in our model the choice of path is driven by outcomes of Bayesian persuasion on this path. One can see it as the traveler problem, where the traveler should visit restricted number of cities. The cities can change weights of adjacent edges to incentives the traveller to choose the path with them on it.

The rest of the paper is organised in the following way. Section 3 presents main primitives of the direct communication model. Then in section 1.4 we provide the solution for two-countries case, as in section 5 the solution is extended to mediated communication with assistance of transit countries. In section 6 we explain general features of the model with countries with restricted farsightedness, providing some policy considerations. Conclusion finalises the chapter. All formal proofs are given in the Appendix.

3 Direct communication

Let's consider a model, where a firm is incorporated and produces goods in an exporting country. Then, the goods are transported and distributed in an importing country. Main business activities are in the exporting country and it has priority in taxation the profit. However, the firm can establish a subsidiary in the importing country and formally move there activities like logistic or marketing. Thereon, a share of the profit should be allocated there. The reason for the arrangement is a lower tax rate in the importing country. The exporting country suspects that the structure has only tax objectives. However, to apply anti-avoidance rules and tax the profit it needs information from the importing country, because the foreign operations are unobservable to the exporting country.

Hence, the model includes a firm and a set of two countries $N = \{e, r\}$ that play the roles of exporting and importing countries, respectively. The firm has business activity in both countries making profit $\theta \in \Theta$, which is the firm's private information. The profit is a stochastic variable, which distribution over support $\Theta = \{\underline{\theta}, \bar{\theta}\}$ is common information. Because the firm can shift the whole or part of the profit to another country for taxation, there are two possible allocations for the profit $p_0 = \{e\}$ and $p_1 = \{e, r\}$ that constitute the set P. The firm establishes a subsidiary, if it chooses allocation p_1.

The model consists of four sequential stages. In the first stage both countries impose tax rates $\tau_i \in [0, 1]$ that is public information. In the next stage the firm chooses profit allocation $p \in P$. After that, the firm's profit state is realised and the countries engage in communication to deduce it. However, the exporting country does expect any information exchange, if the firm chooses allocation p_0. In the final stage both countries update their beliefs on the profit, while the exporting country decides whether to make tax audit $a \in \{0, 1\}$ cancelling out profit shifting and paying cost $c \geq 0$. It is worthwhile to mention, that audit is a unilateral enforcement and does not reveal the state.

The countries have common prior beliefs about profit $\mu_0 \in \Delta(\Theta)$ with mean m_0. After observing the same signals, both of them form posterior beliefs $\mu \in \Delta(\Theta)$ with mean m. We model intergovernmental communication as Bayesian persuasion with the importing country as a persuader and the exporting country as a receiver. The persuasion assumes formation of several posterior beliefs in response to observation of corresponding signal $s \in S$, where $|S| \geq 2$ and finite. The persuader chooses a *signalling rule* that is mapping $\pi \colon \Theta \to \Delta(S)$, in particular it is a set of likelihoods $\{\pi(\cdot \mid \theta)\}_\Theta$ for each signal $s \in S$. Bayesian persuasion assumes that both signalling rule and signals are truthfully revealed to the receiver and only choice of signalling rule gives the persuader control over receiver's posterior beliefs about the realised profit.

We investigate the information exchange for tax matters considering the fact that most of countries joined the Multilateral Convention on Mutual Administrative Assistance in Tax Matters. The importing country as a signatory should reply to foreseeable relevant requests for information. However, detailed accounting records are usually in hands of the taxpayer. Only responding tax authority can decide to what extent challenge information source. For example, Cyprus tends to "quote statements made by the information holder to the requesting jurisdiction" (OECD, 2020, p. 125). Moreover, taxpayer may statutorily be a primary information source. For example, to get banking information the Netherlands tax authority must "first approach the taxpayer" and only if "the taxpayer refuses to co-operate" it can send a request to the bank (OECD, 2019a, p. 80).

Moreover, it is a prerogative of the responding party to assure the information quality. For example, Panama shows no efforts to "fully seek out all possible sources of information when requests are received" (OECD, 2019b, p. 66), as the Cayman Islands has "no system of monitoring of compliance with accounting record-keeping requirements" (OECD, 2017a, p.65). In general, the information collection process is mostly based on sending requests to taxpayers. The responding tax authority should decide whether there are irregularities in the information received and information from other sources is needed. One can consider this decision as a choice of signalling rules, when negligence in information gathering more often produces signals of low value of the profit.

Signal updates prior beliefs according to the Bayes rule forming posterior belief $\mu_s(\theta)$ as a conditional probability $\mathbb{P}(\theta \mid s)$, that is the realised profit has state $\theta \in \Theta$ provided that reported

signal is s. We denote the whole distribution over the set of states after the signal was realised and revealed by μ_s.

$$\mu_s(\theta) = \frac{\pi(s \mid \theta)\mu_0(\theta)}{\sum_\Theta \pi(s \mid \theta')\mu_0(\theta')} \tag{1}$$

In Bayesian persuasion posterior beliefs induced by signals must be *Bayes plausible*. It means, that there exists a probability distribution Φ with density ϕ over the set of posterior beliefs $\{\mu_s\}_S$, which mean is equal to the common prior μ_0. This puts a restriction on the set of feasible signalling rules. It is worthwhile to mention that Gentzkow and Kamenica (2016) established that if a distribution of posteriors is Bayes plausible, the distribution of the posterior means is also Bayes plausible.

$$\sum_S \mu_s \, \phi(\mu_s) = \mu_0 \tag{2}$$

The interim payoff of the importing country ν_r is tax revenues and based on its choice of tax rate $\tau_r \in [0, 1]$ applied to the profit expectation based on its belief μ. However, it can have positive payoff only if the firm chooses to establish the subsidiary and the exporting country avoids tax audit. Otherwise, the importing country has zero tax revenues, because the firm finds it attractive to leave the profit at the source or the exporting country finds it beneficial to audit cancelling profit shifting.

$$\nu_r(\tau_r, a, \mu, p) = \begin{cases} \tau_r \mathbb{E}_\mu\Big[(1-a)\theta\Big] & , if \ p = p_1 \\ 0 & , otherwise \end{cases} \tag{3}$$

The exporting country has two actions to choose, tax rate $\tau_e \in [0, 1]$ and tax audit $a \in \{0, 1\}$ coming with cost c that is an idiosyncratic feature of the audited country. To keep the game non-trivial, we assume c to be in range $[0, m_0)$, so the prior mean is high enough to make tax audit profitable. Both actions and beliefs μ define the interim payoff ν_e, which is *net tax revenues*.

At allocation p_0 the taxation priority right of the exporting country is unchallenged. It can tax the whole profit without audit. At allocation p_1 the importing country claims its part of the profit and only audit can restore the priority right of the exporting country. However, the exporting country can levy only profit that is not reported in the importing country. This split is motivated by the *participation constraint* of the firm (6), that is countries should avoid overestimation of the profit.

$$\nu_e(\tau_e, a, \mu, p) = \begin{cases} \mathbb{E}_\mu\Big[a\big(\tau_e\theta - c\big)\Big] & , if \ p = p_1 \\ \tau_e \mathbb{E}_\mu\big[\theta\big] & , otherwise \end{cases} \tag{4}$$

Expected payoff of the firm u is defined by choices of tax rates $\boldsymbol{\tau} = \{\tau_i\}_N$, the beliefs on its profit that the countries have μ, and profit allocation choice p. The firm's utility can be interpreted as a global *tax burden* that it needs to be minimised.

$$u(\boldsymbol{\tau}, a, \mu, p) = \begin{cases} -\tau_e \mathbb{E}_\mu\big[a\theta\big] - \tau_r \mathbb{E}_\mu\big[(1-a)\theta\big] & , if\ p = p_1 \\ \\ -\tau_e \mathbb{E}_\mu\big[\theta\big] & , otherwise \end{cases} \tag{5}$$

To properly finalise the framework we should stipulate participation constraints for each agent. The payoff of both countries must not be negative, while the sum of taxable profit in both countries must not exceed the mean of the prior belief. Stated differently, they should avoid over-taxation of the firm.

$$\nu_r \geq 0\,; \qquad \nu_e \geq 0\,; \qquad \mathbb{E}_\mu\big[a\theta\big] + \mathbb{E}_\mu\big[(1-a)\theta\big] \leq m_0 \tag{6}$$

A solution for the problem is a perfect Bayesian equilibrium with any tie resolved in favor of persuader. In addition, the optimisation problem of the importing country is based on expected payoff $V_r(\phi) = \sum_S \nu_r(\mu_s)\phi(\mu_s)$, which is an expected utility with probability distribution ϕ over beliefs induced by corresponding signals. By contrast, the problem of the exporting country is considered regarding each induced posterior belief. It is worthwhile to remind, that tax rates and profit allocation are chosen before signal realisation, they are signal independent and fixed for all posterior beliefs.

4 Equilibrium

We start our analysis with the minimal model that puts together the firm, exporting, and importing countries. There are two profit allocations $\{p_0, p_1\}$. In the first allocation $p_0 = \{e\}$ the whole profit remains in the exporting country and no communication is expected. Otherwise, the firm can wholly or partly shift taxation priority to the importing country, that is $p_1 = \{e, r\}$, which assumes communication between the countries if they find it beneficial. According to the backward induction a choice of allocation is defined by optimum actions taken on the subsequent stage of the game, starting with the choice of the exporting country regarding audit that comes with cost c.

In the last stage the decision of the exporting country on whether to do tax audit against the importing country is based on net tax revenue (4) and varies regarding the firm's allocation choice. Audit never happens at p_0 due to absence of profit shifting. Audit would just decrease the utility without bringing any benefits to the exporting country. Hence, the optimisation problem that we need to consider assumes allocation p_1.

$$\max_{a \in \{0,1\}} \quad \mathbb{E}_\mu\Big[a\big(\tau_e\theta - c\big)\Big] \quad s.t.\ (6) \tag{7}$$

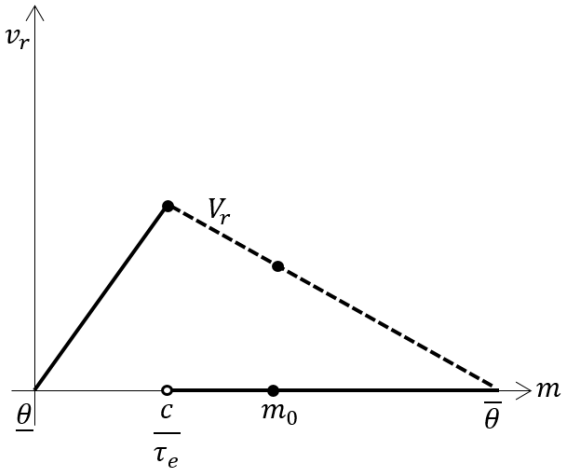
The optimal action of the exporting country a is a solution to the optimisation problem (7). Since the problem is linear in the means and audit is a binary action, it can be solved by comparison of payoffs in two cases $\nu_e(a = 1, \mu, p_1) > \nu_e(a = 0, \mu, p_1)$, with and without audit, respectively. We use strict inequality, because tie will be broken in favour of the importing country. Consequently, audit happens, if interim tax revenues received by the exporting country are enough to compensate the cost, that is $\tau_e m > c$.

$$a(\mu) = \begin{cases} 1 & , if\ \tau_e m > c\ and\ p = p_1 \\ 0 & , otherwise \end{cases} \tag{8}$$

By construction, we assumed that $m_0 > c$, so keeping the highest tax rate $\tau_e = 1$, the exporting country always chooses tax audit by default $a(\mu_0) = 1$. As a result, the importing country has zero payoff in this case. Moreover, according to the utility (3) the persuader gets zero utility for any mean in the interval $\left(c/\tau_e, \bar{\theta}\right]$, as it is depicted on Figure 2. However, the importing country can benefit positive utility if the mean of a posterior beliefs would be in the interval $\left[\underline{\theta}, c/\tau_e\right]$.

With prior mean $m_0 > c/\tau_e$ the importing country has zero payoff, but communication can change the result. The geometric analysis of the Figure 2 reveals that the piece-wise interim utility ν_r forms convex hull with the closure, which consists of two linear pieces. The first is payoff ν_r in domain $\left[\underline{\theta}, c/\tau_e\right]$ and the second piece is a convex combination of payoffs at points c/τ_e and $\bar{\theta}$. The latter is depicted as the dashed line. At point m_0 the convex combination of two beliefs provides higher payoff, then the interim payoff. In fact, the convex combination is expected utility $V_r(\phi)$ with the weights that are Bayes plausible density ϕ over the posterior beliefs. Consequently, the importing country initiate communication with the exporting country because $\mathbb{E}_\phi[\nu_r(\mu_s)] \geq \nu_r(\mu_0)$.

Figure 2: The persuader's utility.



Therefore, the geometric analysis revealed a room for information exchange between the countries. The importing country becomes better off, if it can induce two posterior beliefs with means at c/τ_e and $\overline{\theta}$ with density ϕ over them. This is the essence of Bayesian persuasion. Upon a request from the exporting country, the importing country chooses a document or procedure that can confirm that the firm's profit is high with Bayes plausible probability. Once the document is retrieved, both countries observe possible value of the profit. It is revealed with some bias, but it is enough to update the expectations.

In order to take advantage of the concavification, the importing country as a persuader should form signalling rule π that induces two posterior means with Bayes plausible distribution ϕ. One signal $\underline{s} \in S$ should induce *low posterior* belief $\underline{\mu}$ with mean $\underline{m}$, as another signal $\bar{s} \in S$ induces *high posterior* belief $\bar{\mu}$ with mean $\overline{m}$. Since there are two actions, it is sufficient to have $|S| = 2$ that

form two posterior means. Theoretically, there can be more signals and posteriors, but excessive posteriors μ' should have $\phi(\mu') = 0$ to maximise the persuader's expected payoff. It makes the persuader indifferent between the set of two signals and any other large set of signals.

Expected utility of the importing country is equal to the sum of two products $\phi(\underline{\mu})\nu_r(\underline{\mu}, a=0)$ and $\phi(\bar{\mu})\nu_r(\bar{\mu}, a=1)$. In fact, only the first term of the sum matters, because $\nu_r(\underline{\mu}, a=0)$ is equal to zero. Considering, the set to optimal posterior means $\{c/\tau_e, \bar{\theta}\}$, given audit cost, and tax rate imposed on the first stage, the probability of low posterior belief ϕ induced by signalling rule π is the following.

$$\phi(\underline{\mu}) = \frac{\tau_e(\bar{\theta} - m_0)}{\tau_e\bar{\theta} - c}\ , \quad for\ \tau_e\bar{\theta} > c \tag{9}$$

Hence, we can employ the Bayes rule (10) to derive signalling rule for given posterior beliefs and distribution ϕ. Because distribution over the binary set of states is discrete, density $\mu(\theta)$ is just a normalised mean $m/(\bar{\theta} - \underline{\theta})$. Given posterior conditional probability $\mu_s(\theta)$ after receiving corresponding signal defined in (1) and probability density over posterior beliefs $\phi(\mu_s)$ the optimal signalling rule is the set of conditional probabilities $\{\pi(\cdot\,|\,\theta)\}_\Theta$ over the set of signals.

$$\pi(s\,|\,\theta) = \frac{\mu_s(\theta)\,\phi(\mu_s)}{\mu_0(\theta)} \tag{10}$$

The result of communication stage is that the importing country might receive positive payoff, if low signal is realised. The expected utility over both outcomes of signalling rule is positive as well. In contrast, in the default case the exporting country always makes tax audit and any taxation in the importing country will increase tax burden of the firm violating its participation constraint. Meanwhile, the exporting country is indifferent, because it receives the same payoff regardless of communication.

Lemma 1. *Provided that $c/\tau_e > c$, at allocation other than p_0 the exporting country is indifferent between following Bayes plausible signalling rule π or choosing always $a=1$ without communication.*

Taking into account optimal strategies for tax audit and communication, on the second stage, the firm solves problem (11) and chooses allocation. Because the firm makes choice before the communication stage, it considers expected utility over realisation of any signals. As we mentioned before, in profit allocation problem the firm looks only on tax burden from investing into a pair of exporting and importing countries. Then the tax burden can be used to compare different capital allocations. Therefore, in the firm's problem only tax burden of the profit allocation makes any difference.

$$\max_{p\in P}\ \sum_{s\in S} u(\boldsymbol{\tau}, a, \mu_s, p)\phi(\mu_s) \quad s.t.\ (6) \tag{11}$$

In the direct communication the firm has only two allocations p_0 and p_1. In both allocations the tax burden is at most the prior mean m_0 due to the firm's participation constraint (6). The tax burden is defined by the countries' beliefs and the audit action. However, the latter does not

directly effect allocation choice. In order to see this, we should consider beliefs on profit in both allocations. At allocation p_0 for any audit action the firm is taxed according to prior belief of the exporting country, that is m_0. At another allocation, if the high signal is realised, profit is levied in the exporting country. Otherwise, the exporting country does not do audit and the profit is taxed in the importing country. Again the whole profit is taxed, but taxable sum in both countries is again m_0 due to the Bayes plausibility constraint.

The difference is in what share of the profit is taxed at lower tax rate. The firm is interested in decreasing overall tax burden, that is product of expectation of the profit and a tax rate. Hence, if both countries imposes equal tax rates, the firm is indifferent between two paths, because in both allocations the overall tax burden is identical. The firm does not care, which budget gets tax revenues. Otherwise, if the importing country imposes strictly lower tax rate, the firm benefits from increase of the profit share allocated to the importing country. As a result, allocation p_1 weakly dominates another allocation for any beliefs on path of the countries.

$$p = \begin{cases} \{e, r\} & , if\ \tau_r < \tau_e \\ \{e\} & , otherwise \end{cases} \tag{12}$$

The real difference between allocations is made only by the tax rates imposed in the first stage. At first glance, allocation p_0 is attractive for the exporting country, because it can levy the whole profit without making audit. To attract the firm, the country should keep $\tau_e \leq \tau_r$. However, tax rate is imposed before the firm's choice of allocation and the importing country has incentives to impose tax rate that $\tau_r < \tau_e$. It will attract the firm to p_1, because the reduced tax rate will be applied to some share of the profit. Whenever τ_e is imposed, the importing country will cut its tax rate, since on p_0 it has zero payoff. Such interaction leads to *the race to the bottom* that is similar to the Bertrand oligopoly. Hence, the best response of the exporting country is to stick to $\tau_e = 1$ enjoying positive net tax revenues when high signal is realised. Meanwhile, the importing country imposes $\tau_r < \tau_e$. In this case, the firm's optimal strategy is p_1.

Proposition 1. *In the direct communication between the exporting and the importing countries, the Subgame Perfect Equilibrium is the following:*

a) $\tau_e = 1$ *and* $\tau_r = 1 - \epsilon$, *where* $\epsilon > 0$ *and* $\epsilon \to 0$

b) $p = \{e, r\}$

c) signalling rule π *induces* $\underline{m} = c$ *and* $\overline{m} = \bar{\theta}$

d) $a(\bar{\mu}) = 1$ *and* $a(\underline{\mu}) = 0$

Summarising the above, in the first stage the countries impose tax rates $\tau_r < \tau_e = 1$ followed by the firm choosing allocation p_1. In the communication stage the importing country forms signalling rule π, as the exporting country participate in the persuasion due to indifference. The important feature of the persuasion is a decomposition of the prior belief into a set of posteriors. Receiver chooses action according to posteriors induced by realised signals, while persuader is aware of the posteriors, but evaluates performance according expected utility V_r. That is the reason, why in Proposition 1 optimal audit is function of posterior beliefs of the exporting country. In the direct

communication both countries have identical posterior beliefs, but in mediated communication they can be different. The fact we are going to exploit later.

EXAMPLE 1. Let's consider an example with cost $c = 0.35$, mean of prior belief $m_0 = 0.5$, and $\Theta = \{0, 1\}$. The right panel of Figure 1 shows, that at m_0 expected payoff of the importing country is a convex combination of payoffs at points $0.35/\tau_e$ and 1. The exporting country plays maximum tax rate $\tau_e = 1$, because it needs tax revenues to pay for tax audit at $\overline{m}$, while it is beneficial on p_0 as well. The importing country stipulates any $\tau_r < 1$ to exclude allocation p_0. The feasible posterior means are $\{0.35, 1\}$ with distribution over them $\phi = \{0.77, 0.23\}$. Expected payoffs are $V_e = 0.15$ and $V_r = 0.27\tau_r$. The exporting country gets from audit without communication $m_0 - c = 0.15$, so it is indifferent, while the importing country receives positive payoff due to the communication.

By employing Bayesian persuasion we managed to model three modes of intergovernmental interaction in tax matters. The classic tax competition when country with genuine priority in taxation tries to realise its right increasing economic attractiveness inducing *the race to the bottom*. Usually tax competition models mitigate this outcome by introducing of immobile tax base or public goods market. However, we demonstrated that all countries prefer to avoid this brute-force competition, keep positive tax rates, and switch to another modes, such as *unilateral enforcement*. In this mode country makes audit to enforce compliance with local tax law. It is an adequate strategy, if audit cost is reasonably low. However, another country will prefer to establish communication and manipulate with the profit estimation. This the *information cooperation* mode, when the country with the taxation priority is ready to cooperate, because it does not have better options, while another country can use cooperation for their own benefits.

The main policy outcome is that, while information cooperation might encourage profit shifting and tax planning, it supports positive tax rates, which we observe in practice. Therefore, aggressive tax planning does not always lead to zero tax rates.

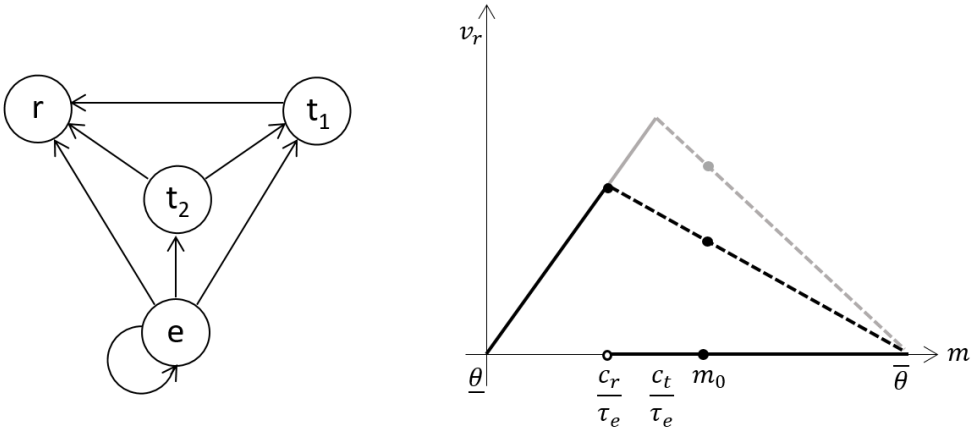
5 Mediated communication

We extend our analysis by introducing a set of transit countries $T \in N$ that are different in audit cost c_t, $\forall t \in T$. The firm does not conduct business activity on their territory, but it can use them to cut tax burden. Thus, transit countries expand the set of possible allocations $|P| > 2$ that consists of allocations $p_0 = \{e\}$ and $p_1 = \{e, r\}$ we discussed before, as well as of allocations that include at least one transit country $p = \{e, t, ..., r\}$ as depicted on Figure 3 for the case of two transit countries. Hence, the firm's profit can either stay in the exporting country or get shifted to the importing country directly or with assistance of transit countries. Since profit allocation is a path on directed communication network, hereinafter we term p as a *path* and P as a set of paths. The profit allocations p_0 and p_1 have been analysed, so the focus is on the role of transit countries.

Since the importing country with the firm can shift profit directly from the exporting country, a transit country should provide an advantage to the firm in order to stay in allocation. It does not have information on the firm's activity and cannot independently produce signals. However, transit country can play a role of information mediator in the sense of Kosenko (2019) garbling signalling

rule of the importing country. The posteriors that maximise the expected utility of the importing country are defined in (9). Transit country can make the firm better off inducing another set of posteriors that shifts more profit from the source. More specifically, signalling rule can be modified by application of *garbling rule*, which is mapping $\sigma\colon S \to \Delta(S')$. Set of garbled signals $|S'|$ has cardinality $|S'| \geq 2$ but finite and can differ from S. As a result, garbled signalling rule will produce modified posterior beliefs with Bayes plausible distribution over them.

Figure 3: Set of paths (left) and the persuader's utility (right).



The process of signal garbling is based on Theorem 5 stated in Blackwell (1953) regarding comparison of two experiments that are signalling rules in our model. That is, for any two conditional distributions $f_1 \succ f_2$, where the former is more informative than the latter, there always exists a mean-preserving stochastic transformation T that holds $Tf_1 = f_2$. Garbling rule is a transformation kernel $\{\sigma(s' \,|\, s)\}_S$ that converts original signalling rule into *a garbled signalling rule*, which is less informative in Blackwell order sense. It means that the posterior means induced by garbled signalling rule are closer to one another reducing the accuracy of separation of the states. For example, signalling rule that induces posterior means c_t/τ_e and $\bar{\theta}$ on the right panel of Figure 2 is less informative than one that leads to c_r/τ_e and $\bar{\theta}$. Several garbling rules are applied sequentially, so garbled signalling rule varies regarding composition of countries of a path.

EXAMPLE 2. Tax audit costs against the importing and the transit countries are $c_r = 0.35$ and $c_t = 0.4$, respectively. According to Example 1 the initial signalling rule has posteriors $\{0.35, 1\}$ with $\phi_\pi = \{0.77, 0.23\}$. If the importing country had audit cost c_t, the signalling rule π' would induce $\{0.4, 1\}$ with $\phi_{\pi'} = \{0.83, 0.17\}$. Because $\underline{m}_{\pi'} > \underline{m}_\pi$ and $\overline{m}_{\pi'} = \overline{m}_\pi$, $\pi \succ \pi'$ in sense of Theorem 5 in Blackwell (1953). Hence, there exists garbling rule σ that converts the original signalling rule π into the garbled signalling rule π'.

Therefore, for any pair of signalling rules with property $\pi \succ \pi'$ there is garbling rule σ, which converts more informative signalling rule π into less informative rule π'. Because the state and the signal spaces are discrete, both signalling and garbling rules can be specified as matrices Π and Σ with dimensions $|S| \times |\Theta|$ and $|S'| \times |S|$, respectively. In the previous section we found out that optimal signalling rule induces only two posterior means with positive marginal probability $\phi(\mu)$,

so two is sufficient number of signals. Since both state and signal spaces consist of two elements, both signalling and garbling rules are two by two square matrices.

The garbling rule that converts original signalling rule Π into less informative rule Π_t can be found out by applying simple algebraic operation (13). Garbling rule that leaves the signal unchanged is an identity matrix I. If transit country applies identity matrix, then garbled and original signals are identical $\pi'(s' \mid \theta) = \pi(s \mid \theta)$ for all $s \in S$ and $s' \in S$.

$$\Sigma = \Pi_t \Pi^{-1} \tag{13}$$

EXAMPLE 3. Extending Example 2 for the original signalling rule π that induces posteriors $\{0.35, 1\}$ with $\phi_\pi = \{0.77, 0.23\}$ and the garbled signalling rule π' that induces posteriors $\{0.4, 1\}$ with $\phi_{\pi'} = \{0.83, 0.17\}$ matrices Π and Σ are given below. It is important to notice, that neither π nor σ reveals high signal after receiving low state or low incoming signal.

$$\Sigma = \begin{bmatrix} 0.72 & 0 \\ 0.28 & 1 \end{bmatrix}; \qquad \Pi = \begin{bmatrix} 0.46 & 0 \\ 0.54 & 1 \end{bmatrix} \tag{14}$$

Communication is sequential, so the exporting country receives signals only from an adjacent country. Its decision on tax audit is driven by audit cost of the adjacent country on the path that can be the importing or a transit country. The reason for sequential nature of the intergovernmental communication is that any request must be *foreseeable relevant*. Even if a country has a guess on the structure of the value chain, it is usually not enough information to make a rightful request for tax assistance. For example, Ireland provided information on direct Irish party of a business transaction, but refused information provision about other Irish residents that have the same directors and could participate transactions related to the initial request (OECD, 2017b, p. 76). Hence, the transactions with residents of the requesting country have higher chanced to be considered as foreseeable relevant.

Optimal audit strategy is informed by posterior beliefs the exporting country formed after communication. The beliefs can be formed by signalling rule either produced by the importing country or garbled by transit countries. The property of sequential application of garbling rules, when garbled signalling rule becomes strictly less informative along the sequence, helps to redefine the minimal problem for any number of transit countries in concise manner using recurrent series in the utility functions. Hence, a country adjacent to the exporting country should produce the less informative signal. Otherwise, it does not provide any communication benefits on the path.

In the direct communication both countries had identical beliefs. The reason was in identical prior belief and in the fact that they observed the same signal. It does not hold in sequential communication. The countries on a path can observe different signals realised according to different signalling rules. Therefore, we introduce subscriptions for posterior beliefs μ_i and their means m_i to unambiguously attribute them.

In the next stage, the exporting country chooses audit strategy according to the garbled signalling rule produced by the adjacent country on the path. Since such country is unique for each path, we are going to use subscript p to denote the adjacent country. Similar to the direct communication the exporting country's tax base erodes wholly or partly, if the firm chooses allocation other than p_0. Also, since both the exporting and adjacent countries observe the same signal, they

have identical beliefs. Hence, the utility of the exporting country (15) is linked to allocation that has fixed adjacent country with corresponding audit cost and beliefs.

$$\nu_e(\tau_e, a, \mu_e, p) = \mathbb{E}_{\mu_e}\Big[\tau_e\Big(\theta - \mathbb{E}_{\mu_e}\big[\big(1 - a(\mu_e)\big)\theta\big]\Big) - a(\mu_e)c_p\Big] \tag{15}$$

Because the utility is linear in the action, optimisation of the utility of the exporting country can be done by comparison the payoffs in two cases. The first is when tax audit happened, as the second is when the exporting country refrained from the audit. That is $\nu(a = 1, \mu_p, \tau_e) > \nu(a = 0, \mu_p, \tau_e)$, respectively. As a result, we get the condition $\tau_e m_p > c_p$, which is conceptually close to the one for the case of the direct communication. The exporting country does audit, if its net tax revenues are non-negative. In case of path p_0 there is no adjacent country and the exporting country does not execute audit, because it strictly reduces its utility.

$$a(\mu) = \begin{cases} 1 & , if\ \tau_e m_p > c_p\ and\ p \neq p_0 \\ 0 & , otherwise \end{cases} \tag{16}$$

In our framework, the firm chooses a single allocation, that minimises its overall tax burden. However, it can be indifferent between several allocations that provides identical payoff. As a result, the countries in each allocation should provide the best signalling rule, that shifts the greatest possible part of the profit. Otherwise, the countries will lose the competition and get guaranteed zero payoff. Meanwhile, the garbled signalling rule that shifts the maximum profit is based on $c_p = max\{c_t\}_T$ and is based on the same principles as the signalling rule formation of the direct communication (9).

Lemma 2. *For given path p, prior μ_0, cost c_p, and tax rate $\tau_e > c_p$, the set of optimal posterior means $\{\underline{m}_\pi, \overline{m}_\pi\}$ and probability density of low posterior beliefs $\phi_\pi(\underline{\mu})$ induced by π are:*

$$\phi_\pi(\underline{\mu}) = \frac{\tau_e(\bar{\theta} - m_0)}{\tau_e\bar{\theta} - c_p}; \quad \underline{m}_\pi = \frac{c_p}{\tau_e}\ ; \quad \overline{m}_\pi = \bar{\theta} \tag{17}$$

The key consequence of signalling rule defined in Lemma 2 is that any original or garbled signalling rules induce mean of high posterior belief equal to $\bar{\theta}$. Since high posterior mean of any signalling rule is fixed, only mean of low posterior belief becomes larger for less informative signalling rules. As before, the reason is that persuaders and mediators need the highest probability on low signal to increase their utility. It can be achieved, if high posterior mean is at the upper boundary. As a result, neither signalling rule nor garbling rule does not report the high signal, if state or incoming signal is low, as it was demonstrated in Example 3. It increases the frequency of reporting of low signal.

Lemma 3. *In any path $p \in P$:*

a) two garbling rules σ and σ' applied sequentially form low garbled posterior means $\underline{m}$ and $\underline{m}'$, respectively, which are $\underline{m}' \geq \underline{m}$;

b) low signal $\underline{s}$ reported to mediator according to original or garbled signalling rule will be always revealed as a low signal $\underline{s}'$ by the mediator according to its garbling rule σ.

In mediated communication timing is similar to the direct case. In the first stage all countries impose their tax rates. After that, the firm chooses a path initiating sequential communication of the involved countries starting from the importing country and finishing with the exporting country. In mediated communication profit allocation defines not only a set of countries participating in profit shifting but also a sequence of communication. At the end, the exporting country makes decision on audit after receiving garbled signalling rule from the adjacent mediator.

The optimal action regarding audit stays as defined in (16), while means for the condition are formed by garbled signals. For sake of clarity, we restate the utility functions for the importing and transit countries. Because payable tax is a product of tax rate and tax base, we term the multiplier next to tax rate in (18) *tax base* b_r.

$$\nu_r(\tau_r, a, \mu_r) = \tau_r \mathbb{E}_{\mu_r}\Big[\big(1 - a(\mu_r)\big)\theta\Big] = \tau_r b_r \tag{18}$$

The communication is sequential and Lemma 3 stipulates that low posterior mean only increases along the path. For these reason we can define utility of transit countries in recursive form. The factor next to tax rate τ_t in (19) is *tax base* b_t of transit country. It is difference between own evaluation of the profit and the evaluation made by the adjacent country, b_p. For the first country after the importing country $b_p = b_r = \mathbb{E}_{\mu_r}\big[(1-a)\theta\big]$. For each further country the subtrahend represents all difference accumulated during previous communication stages in the path.

$$\nu_t(\tau_t, a, \mu_t, b_p) = \tau_t \mathbb{E}_{\mu_t}\Big[\big(1 - a(\mu_t)\big)\theta - b_p\Big] \tag{19}$$

Sequential communication and monotonic property of the signal garbling allows to present the problem in a recursive form. The importing country as an initiator of communication levies expectation of the profit based on audit action and its belief regarding state. Its expectation on audit is based on its beliefs and the optimal audit action $a(\mu_r)$ (16). To respect the firm's participation constraint (20), following countries have to deduct tax base, b_j, recognised by previous countries and tax only the difference.

$$\sum_{j \in p} b_j \leq m_0 \; ; \qquad \nu_j \geq 0 \; \forall j \in p \tag{20}$$

Due to the recursive formula, it is enough to deduct only adjacent country's tax base, that is fixed for a specific path and has subscript p. One can notice that if countries split the profit according to the prior, then without audit the whole profit is taxed in the importing country. However, application of garbling rules provides payoff opportunities to transit countries too.

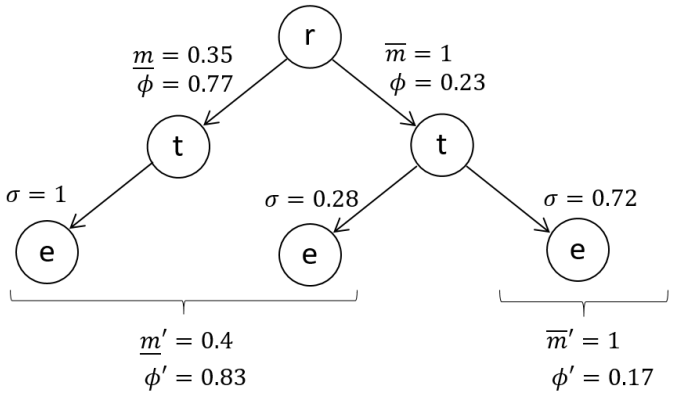
Allocation is the firm's choice, but countries at the allocation are free to choose the most beneficial communication protocol. In mediated communication each country on the allocation would prefer to produce signals according to Lemma 2. Upon receiving the garbled signalling rule, the exporting country does audit according to the optimal strategy (16) with the lowest frequency.

At the same time, the exporting country's strategy depends on the audit cost of the adjacent mediator, so Lemma 2 does not bind communication protocols between preceding mediators and the importing country. However, Theorem 5 of Blackwell (1953) must hold to all countries in allocation and garbling signalling rule can be only less informative. Altogether, it raises the issue of consistency of signalling and garbling rules at given path.

5.1 Optimal signalling and garbling rules

We demonstrated before that the utility of the importing country is difference between the prior and product of high posterior mean and corresponding density induced by signalling rule, $b_r(\pi) = m_0 - \phi(\bar{\mu})\overline{m}$. The second term is not arbitrary and governed by Lemma 2. Therefore, for given tax rate of the exporting country optimal signalling rule is driven by audit cost only. In addition, the tax base of a transit country can be rewritten as $b_t(\pi') = \phi(\bar{\mu}_\pi)\overline{m}_\pi - \phi(\bar{\mu}_{\pi'})\overline{m}_{\pi'}$. It is just a difference between high posteriors and corresponding densities for the initial and garbled signalling rules. Hence, before defining an equilibrium signalling rule, we should investigate the way signalling and garbling rules split the profit and affect utility of the countries involved.

Figure 4: Illustration of the communication in Example 3.



The mechanism of mediated communication is the following. The importing country forms signalling rule based on its audit cost c_r. According to the signalling rule π it produces high signal with probability $\phi(\bar{\mu}_\pi)$ and low signal with complement probability $\phi(\underline{\mu}_\pi)$. It expects the exporting country to avoid tax audit, if the low signal is revealed. Hence the importing country does not expect any tax revenues in case of the high signal is reported. This communication strategy is depicted as the top tier on Figure 3. At the next communication instance the transit country defines the possible garbled signalling rule based on its audit cost c_t. Because we assumed that $c_t > c_r$, the garbled signalling rule induces larger low posterior mean that benefits the transit country cutting out its share in the firm's profit.

The transit country forms a garbling rule. According to Lemma 3, the country never reports high garbled signal after receiving low incoming signal, that is $\sigma(\bar{s}' \mid \underline{s}) = 0$. At the same time, it corrupts the high initial signal by reporting it as low garbled signal. Because of sequential nature of the communication, the importing country cannot observe, which garbled signal is revealed. As a result, the difference in probability densities of the initial signalling rule and the garbling rule brings

the transit country its share in the profit, as it is depicted on Figure 3. In fact, this communication behaviour schematically reproduces the role of tax hubs and offshores in information corruption that disguises real profit of the firm attracting part of its profit on own territory for taxation.

The analysis of interim utilities demonstrates that they are never negative. Moreover, the sum of expected utilities is equal to prior holding the firm's participation constraint. If low signal is never garbled as high signal, then a sequence of signals can be all high, all low, or there is a pivoting signal that splits the sequence into two parts, with only high and only low signals. Let's define joint distribution of signals of all countries on the path $F(z)$ with support $\{S\}^{|p-1|}$. $F(z) > 0$ only if z is a feasible sequence of signals according to Lemma 3.

Keeping country p as a mediator that is adjacent to the exporting country, we have $\sum F(z \mid s_p = \underline{s}) + \sum F(z \mid s_p = \bar{s}) = 1$. The second term has unique sequence of signals, when all signals are high. In this case, each persuader expects tax audit and does not include profit into tax base. As a result, the profit is taxed only in the exporting country. The first term is a set of sequences with monotonically increasing low posterior means, that will be split between mediators and the importing country according to their beliefs. As a result, at any allocation the firm's profit is fully distributed between countries $\underline{m}_p \sum F(z \mid s_p = \underline{s}) + \overline{m}_p \sum F(z \mid s_p = \bar{s}) = m_0$. This feature gives us the corollary.

Corollary 1. *At any allocation the firm's participation constraint holds with equality.*

Since the firms profit is fully distributed between countries and taxed there, composition and order of countries in allocation matters. Value of audit cost defines the parameters of garbled signalling rule received by the exporting country. Communication between other allocation participants does not restricted by their audit costs. The only restriction is decreasing informativeness of garbled signalling rules. The first country in any allocation besides p_0 is the importing country. A share of the profit shifted from the exporting country is defined by audit cost of the last mediator. The larger cost, the larger share of profit is shifted.

Despite the fact that communication between the importing country and mediators has only restriction on informativeness, the communication still has a unique solution. Let's consider allocation with a transit country that has audit cost $c_t > c_r$. We did not introduce any restrictions on path observability, which assumes perfect farsightedness of all countries. The importing country is aware that the receiver is a mediator, so it can form posterior means for any cost in interval $[c_r, c_t]$. According to Lemma 2 we know that for any $c \geq c'$ there is $\underline{m}(c) \geq \underline{m}(c')$. Moreover, since the persuader expects no audit at low posterior mean, the larger $\underline{m}$, the larger expected utility. This monotonic property motivates the importing country as the persuader to form a signalling rule based on the upper bound of the range, that is c_t. If there are several transit countries on the path, the importing country will choose the largest cost $c_{\bar{t}} = max\{c_t\}_T$.

After receiving signalling rule base on c_t, all mediators with $c_t \leq c_{\bar{t}}$ have choice to apply the identity garbling rule I or garble signal even more. Garbling the signalling rule more than Lemma 2 allows initiates tax audit even at low posterior mean, because the exporting country will expect tax base $\underline{m}_e > c_t/\tau_e$. Hence, both mentioned communication strategies lead to zero utility for the mediator. In this case, following the concept of sender-preferred equilibrium, the

mediator being indifferent will choose the identity garbling rule. Taking into account the optimal strategy of the mediator, the initial signalling rule based on the audit cost of the transit country is dominating communication strategy for the importing country. The profit will be split between only the importing and exporting countries, the former gets larger share in comparison with the direct communication.

5.2 Equilibrium

Let's assume that any transit countries $t \in T$ has audit cost with the following property $\tau_e m_0 \geq c_t \geq c_r$. Being perfectly farsighted all countries can observe others on the path. In order to receive a positive share in the profit mediator should have larger audit cost than its up-stream adjacent country. However, as we found out before, the importing country chooses the less informative signalling rule making the mediators to follow truth-telling strategy. It just need the country with $c_{\bar{t}}$ to be adjacent to the exporting country.

Because the profit is shared between only two countries, the exporting and the importing countries, to create incentive for the firm to choose allocation with such property, the importing country has to impose tax rate that is lower than the tax rate of the exporting country. Since the larger share of profit is shifted from the source, the firm might find the indirect path more beneficial than the direct communication p_1.

This allocation does not need to be unique. The optimal audit action of the exporting country (16) is driven by audit cost of the adjacent country only. As far as, the transit country with the largest audit cost stays next to the exporting country, allocations might have any number of transit countries in any order. However, in all of these allocation the firm gets the same tax burden, because the profit is shared between the exporting and the importing countries only. The firm is indifferent between all of them, because it has identical overall tax burden on each of them.

Proposition 2. *In mediated communication with perfectly farsighted countries, the Subgame Perfect Equilibrium is:*

a) $\tau_e = 1$*;* $\tau_r = 1 - \epsilon$*, where* $\epsilon > 0$*,* $\epsilon \to 0$*;* $\tau_t \in [0, 1]$ $\forall t \in T$*;*

b) given country $\bar{t}$ *with* $c_{\bar{t}} = \max\{c_t\}_T$*, the optimal allocation* p *is any allocation in form* $\{e, \bar{t}, ..., r\}$*;*

c) π_r *has posterior means and density over them according to* (17) *with* $c_{\bar{t}}$*;*

d) σ_t $\forall t \in p$ *is* I*;*

e) $a(\underline{\mu}_{\pi_r}) = 1$ *and* $a(\bar{\mu}_{\pi_r}) = 0$*.*

The exporting country keeps the highest tax rate equal to 1, while the importing country should choose tax rate $\tau_e > \tau_r$. The former keeps the highest tax rate to compensate audit costs it bears if high signal is realised. The transit countries on the paths have no profit share, so they can impose any tax rates. It will not effect overall tax burden of the firm. As a result, in perfectly farsighted communication the importing country has large power over distribution of the profit across countries.

Consider our main motivation case with a parent company of the group in the importing country. Due to its unique advantage, the importing country gets exclusive information on the group

structure. It can form its communication strategy considering the offshores in the value chain. Such information advantage also can be received due to political control over offshore jurisdictions. A unique position allows to keep high tax rate and avoid *the race to the bottom*. The firm still prefer indirect paths, because larger share of its profit is taxed at lower tax rate. In the following section we will demonstrate that transit countries can have positive payoff from profit shifting, if some of the countries on the path are limitedly farsighted.

6 Discussion

In the framework we developed in the previous sections intergovernmental communication steers competition between countries for global tax base. In fact, our model allows countries to participate in tax competition for the firm's profit keeping high tax rates. It might look like a paradoxical result, but it has unambiguous reasons. Tax revenues depend on tax rate along with evaluation of tax base the authority estimated. The latter is informed by evidences on the firm's business activity. In absence of information countries compete only in tax rates, but if they participate in information exchange, they can enjoy better outcome. However, there are factors that shift balance between countries and the firm.

6.1 Limited farsightedness

Before we considered perfectly farsighted countries, here we assume *myopic or limitedly farsighted* countries, which is closer to the real-world application. The easiest way to see difference between fully farsighted and myopic cases is to consider the fact whether information of group structure is available. The ownership structure does not perfectly reveal the way they are interconnected with business transactions. Although, it uncovers the set of countries participating in the tax competition. Myopic or limitedly farsighted countries have no or limited access to this information. In ultimate case of myopic country, it can see only adjacent country on a path.

Depending on degree of farsightedness country has a different number of other countries in its neighbourhood on specific profit-shifting path. In the sequential communication we modelled persuader or mediator has control only over own signalling or garbling rule and rules of the following countries on the path, so we term an observable number of countries following the persuader $i \in p$ in given allocation $p \in P$ including the persuader itself as *neighborhood* and denote it as N_i^p. In addition, we allow countries to have different farsightedness, so each country may observe different number of countries.

It is worthwhile to start with myopic case, when any country observe only countries that are adjacent to them in an allocation. For the same reason as describe in the case of perfect farsightedness the importing country will form its signalling rule based on audit cost of its adjacent country t, if $c_t \geq c_r$. Moreover, the following mediators will align with this strategy. Let's introduce another transit country t' with audit cost $c_{t'} \geq c_t$ between the transit and the exporting countries. Instead of producing garbled signalling rule for $\underline{m}(c_t)$ the first transit country can garble the incoming signal to form $\underline{m}(c_{t'})$. It increases its interim utility (19) from zero to positive difference $\phi(\bar{\mu}_\pi)\overline{m}_\pi - \phi(\bar{\mu}_{\pi'})\overline{m}_{\pi'}$. Transit country t' will follow previously described strategy and apply identity garbling rule I, if it is adjacent to the exporting country. Therefore, starting from the importing county persuaders all

the way to the adjacent mediator have similar preferences and form their communication strategy on the highest known audit cost in its neighbourhood.

As a result, in myopic communication each country on allocation receives its positive share of the profit, except the last mediator that is adjacent to the exporting country. However, the choice of allocation belongs to the firm. According to Corollary 1, the profit is always fully distributed between the countries on the path, so only tax rates can change tax burden. The countries on the allocation should impose tax rates in the first stage in such way, that provides the lowest tax burden to the firm. In order to see how the firm can order set of allocation according to tax burden, we should order the set of countries in ascending order regarding their audit costs. Because the importing country can always induce low posterior mean based on its audit cost, transit countries with $c_t < c_r$ are not considered for any allocations.

Hence, the importing country can increase profit share of any country on the path, except the exporting country and the country adjacent to it, by removing its adjacent mediator. For example, there are sequence $c_r < c_{t_1} < c_{t_2}$. If the firm choose path $\{e, t_2, r\}$ instead of $\{e, t_2, t_1, r\}$, then the importing country increases its share in profit forming signalling rule base on c_{t_2}. The firm cannot choose a path with inverted order $\{e, t_1, t_2, r\}$, because it assumes the second transit country producing more informative signalling rule. Therefore, the firm has only one reason to remove any country from the allocation that includes all of them. If a country provides lower tax rate than its adjacent country, the firm finds it profitable to remove the adjacent country and reallocate its share in the profit to the country with low tax rate. As a result, there is strict relationship between ordering of the countries on allocation regarding audit costs and ordering them regarding tax rates imposed in the first stage.

Proposition 3. *In mediated communication with myopic or limitedly farsighted countries, where $c_i = max\{c_t\}_{N_i^p}$, the optimal path p has the following relationship between costs and tax rates:*

$$\forall i, j \in p \backslash e : \quad c_r \geq c_i \geq c_j \quad \Leftrightarrow \quad \tau_r \geq \tau_i \geq \tau_j \tag{21}$$

The key outcome of the myopic case is that the firm can get lower tax burden than in the previous case with perfectly farsighted countries. The most of the control over profit allocation shifts from the importing country to the firm. Hence, the latter is strictly better off, if the countries in the allocation can observe smaller part of a communication path.

Let's consider the case of limited farsightedness and alternative strategies the firm has. We assume that the importing country has neighbourhood $|N_r^p|$ that is relatively small. The firm can extend optimal path from myopic case $\{e, t_2, t_1, r\}$ by including neighbourhood of the importing country instead of single transit country t_1, that is $\{e, t_2, N_r^p, r\}$. As a result, the less informative signal that the importing country can produce is based on maximum cost of the countries in its neighbourhood have, $c_N = \max\{c_t\}_{N_r^p}$. The firm can increase informativeness of signalling rule of the importing country by assembling the $|N_r^p|$ number of countries with the lowest audit costs into set N_p^r. Moreover, the last country in N_r^p has to be the country with cost c_N, but composition and order of other countries do not make any difference.

The effectiveness of this strategy depends on available of necessary number of transit countries.

If the number is large enough and audit cost varies among transit countries, then the firm can always compose set of neighbourhood of the importing country in such way to mitigate its limited farsightedness. In more realistic case with limited number of transit countries and regulatory restrictions, such as *black lists*, the importing country or any another farsighted country can more efficiently utilise its farsightedness. Anyway, existence of limitedly farsighted countries creates market for larger number of transit country relatively to myopic case.

Limited farsightedness has its effect on tax rates. The firm has option to substitute a transit country by set N_r^p, if the order of tax rates (21) holds for all other counties on the path. Due to Proposition 3 any agreements on minimal tax rate only moves up absolute values of tax rates, but do not change its order. Therefore, such agreement cannot make profit shifting less beneficial.

Corollary 2. *Given a floor tax rate that is $\underline{\tau} < 1$, intergovernmental agreements on information exchange that imposes the floor tax rate do not stop profit shifting.*

In this case the importing country or other farsighted countries have larger control over profit shifting. In case of perfectly farsighted importing country, it has the whole control over profit distribution and the game becomes equivalent to direct communication. However, according to Proposition 3 the importing country can stipulate larger tax rate, since it mimics own cost with the largest available cost. All transit countries do not have a share in the profit and their tax rates are irrelevant any more.

However, with myopic importing country fully farsighted transit country might attract most of benefits from profit shifting, but its tax rate will depend on how audit costs are distributed among all transit countries. The larger gaps in audit costs between transit countries the larger specific transit country can impose tax rate. The analysis demonstrate that limited information revelation just moves benefits from profit shifting from the firm and offshore countries to the importing country and offshore financial centres.

6.2 Capital allocation

Key roles that countries have in global tax system are specified in the model. For example, size of tax rate is not distinctive feature between countries that benefit from profit shifting activity and others that do not. Both exporting and importing countries can have high tax rates. Exporting country that observe adjacent country with high audit cost might suffer from intensive profit shifting, so it needs the highest tax rate. At a time, importing country can also have high tax, while facilitating and benefiting from profit shifted to its territory. Otherwise, in absence of tax planning it will not have tax base to levy.

In the model we assumed exogenously given appointment of countries for the exporting, importing, and transit roles. In fact, we can consider a pair of exporting and importing countries as winners in capital allocation problem. They benefit investments, because they provide the highest return to capital after taxation. Let's introduce a couple of component of the capital allocation model. The firm has capital stock $\overline{k}$ and there are set K of possible capital allocations that is a pair $\{e_k, r_k\}$. The allocations are different in prior distribution of the profit μ_0^k. The firm still chooses only a path, but the exporting and the importing countries on the path are defined by capital

allocation, that is $p = \{e_k, ..., r_k\}$. Finally, the maximisation problem of the firm regarding profit after taxation is the following.

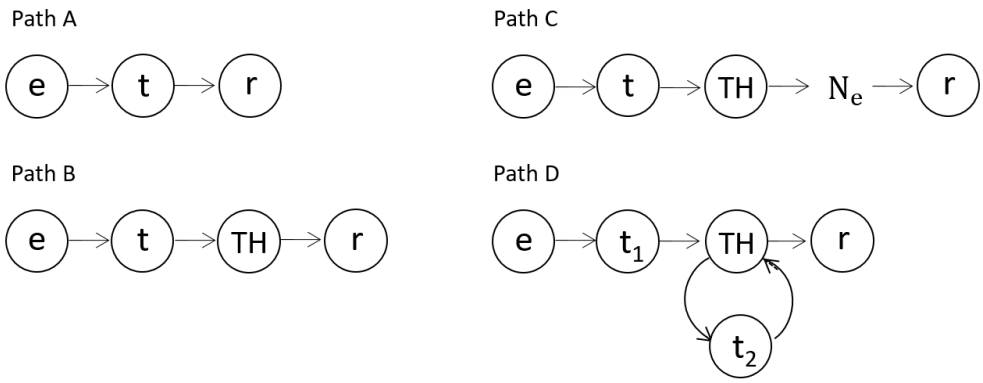
$$\max_{p \in P} \quad \mathbb{E}_{\mu_0^k}[\theta] + \sum_{j \in p} \sum_{s \in S} u(a, \mu_s, p, \boldsymbol{\tau}) \phi(\mu_s) \quad s.t.\ (6) \tag{22}$$

Our model demonstrates that countries can win competition for mobile capital keeping high tax rates but with assistance from transit countries. In the capital allocation problem transit countries can be considered as countries that lost competition for capital. However, it is not the only reason. A prospective recipient of investment can become a mediator, because it brings larger tax revenues avoiding tax competition for capital allocation. Defining all details and outcome of capital allocation problem is out of scope of the chapter. However, we can provide illustrative example to support the statement.

EXAMPLE 4. There are four myopic countries with audit costs $\{c_1 = 0.1, c_2 = 0.1, c_3 = 0.2, c_4 = 0.4\}$ and two capital allocations with positive return $k_1 = \{e_1 = 1, r_1 = 2\}$ and $k_2 = \{e_2 = 3, r_2 = 2\}$. Let's assume that expected return on capital $m_0^1 = m_0^2 = m_0$ is identical in both capital allocations. If country 1 participates in tax competition with country 3, then it will get zero payoff, because of *the race to the bottom*. Even if one country wins, it can get not more profit than 0.167. Meanwhile, if country 1 becomes a transit country for allocation k_2, then it gets 0.278 as tax base and benefits from this role for any tax rate $\tau_1 \geq 0.6$. Country 3 also could prefer to be a transit country on allocation k_1 and get 0.208 as tax base. However, if country 1 keeps tax rate in range $[0.6, 0.8)$, then country 3 better off staying exporting country in k_2.

Finally, we can make classification of countries with respect to the roles they play in tax competition. The Example 4 gives the intuition about transit countries. A typical offshore jurisdiction reduces quality of passing information. This makes it valuable in value and ownership chains. Such transit country creates an opaque obstacle for information flow along the chains, as it is illustrated on Path A on Figure 5. This type of transit countries usually have high audit cost and low rate return to investments (offshores).

Figure 5: Profit shifting paths.



Not all mediators are countries with high audit cost. Some countries with low audit cost but positive rate of return can also choose the role of transit country. The reason is avoidance of competition for capital allocation. Being a country with low audit cost, they can be placed next to the importing country as it is depicted on Path B on Figure 5. In contrast to offshores, they cannot reduce quality of information alone. However, in a pair with an offshore they increase magnitude of profit shifting, but they need myopic income-source country. Such type of countries can be called *offshore financial centres*. This path explains well, why some global financial centres cooperate with offshores. In fact, this Path B is "stepping stone" scheme from Picciotto (2020).

If countries are limitedly farsighted, it could be sufficient to introduce additional transit countries into the neighbourhood of the farsighted country. As it is illustrated on the Path C on Figure 5. Thus, any policy of restriction of interacting with specific countries is of low efficiency. The firm can find countries to create neighbourhood of *white list* countries as a buffer. However, offshore financial centres can be differently cooperative to different countries. For example, the Path D on Figure 5 illustrates a tax scheme known as *Double Irish* or *Holland sandwich*. In this case audit costs that tax hub exposes to the importing and transit country are different.

Remark. *Transit countries includes two types of countries:*

a) offshore financial centres are countries with low tax audit cost, but moderate rate of return on capital;

b) offshores are countries and jurisdictions with high tax audit cost, but low rate of return on capital.

Exporting country is a source of any type of income, including royalty, interests, and dividends. It is also a place of capital allocation and may compete for investments. The firm allocates capital to the countries with the highest profit after taxation. Therefore, the exporting country has two option, either it reduces own tax rate, or it participate in profit-shifting activity. In both cases it will improve its investment climate. As a result, not all legitimate income source countries are interested in ending up profit shifting.

7 Conclusion

We developed the model that simulates international tax competition with information exchange based on Bayesian persuasion. All agents in the model, except for the firm, are governments which defines the way the communication is modelled. Countries are sovereign actors and cannot be effectively enforced to meet tax agreements. Meanwhile, governments have monopolistic access to information originating on their territory. A conflict of interests can lead to meddling with the information revealed to other countries. This makes reports received in intergovernmental communication a questionable source of information. If accurate and complete communication is not incentive compatible, any information exchange agreement can be undermined to increase personal benefits.

In the model we demonstrate the effects of unverifiable communication on tax policy. Properties of the equilibrium depend on a single exogenous parameter - cost of tax audit. The higher cost,

the less is the result of communication favourable to the receiver. Moreover, countries can form communication network that efficiently exploit the highest cost of tax audit. In addition, our model justifies existence of several example from real life. For example, structures like the Holland sandwich, where a tax harbour is isolated on the path by a developed country provides tax avoidance opportunities when importing and exporting countries avoid any deals with the jurisdictions in *black list*. Another example is the widespread practice of keeping tax harbours under the political control of developed countries, such as the United Kingdom and the Cayman Islands.

The model demonstrates that tax agreements on the floor tax rate are not efficient. The key feature of profit-shifting paths is the relative value of tax rates that the countries involved in profit shifting impose, as well as their order. An increase in the minimum tax rate elevates absolute values of tax rates, but does not change the order. As a result, profit shifting can flourish even with such agreements in effect. Consequently, level of tax rates cannot be used to fence countries facilitating tax planning.

In addition, even not all exporting countries are interested in the absence of tax planning. If an exporting country deals with firms of high profit or has reasonably low audit costs, it can benefit from the existence of tax planning. Moreover, the country might receive more tax revenues from being tax hub than a place of capital allocation.

While the model identifies the most effective way in tackling harmful tax competition, just information exchange can even aggravate the matters. In particular, a technical assistance to the governments of the countries with inefficient tax authorities can reduce audit costs. Only an increase in efficiency of tax audit procedures and building of own source of correct tax information in each country can help. This will not only reduce negative effects of harmful tax competition, but also diminish the ability of multinational enterprises to evade taxation globally.

8 Appendix

A1. Proof of Lemma 1

If the exporting country does not follow signalling rule π, it takes mean of prior belief as an estimator of the profit. Otherwise, the exporting country follows the signals of the signalling rule and mean of posterior beliefs are an estimator of the profit. Hence, it is enough to compare *ex ante* utility of the exporting country in both cases.

$$\mathbb{E}_{\phi_\pi}\big[\nu_e(a = a(\mu_s), m_s)\big] \geq \nu_e(a = 1, m_0)$$

Applying Lemma 2 on optimal posterior beliefs and probability distribution ϕ over them in the signalling rule π, this equality always holds with equality for any tax rate.

■

A2. Proof of Lemma 2

The choice of optimal posterior means are based on the result of Kamenica and Gentzkow (2011). In particular, the posterior mean that induces action favourable to the persuader must be equal to

the mean that holds the receiver indifferent between actions. Another posterior mean must reveal the state of nature with certainty. The reason is the maximisation of probability of the posterior belief that is in favour of the persuader.

According to optimal action on audit (16) the exporting country are going to make audit, if its posterior belief $m_j > c_j/\tau_e$. Since there are two possible audit actions $a \in \{0, 1\}$ and the set of signals includes two signals $|S| = 2$, it is enough to solve the following equality based on Bayes plausibility constraint (2):

$$m_j(\underline{s})\phi(\underline{s}) + m_j(\overline{s})\big(1 - \phi(\underline{s})\big) = m_0$$

Taking into account the firm's participation constraint (20) and the interim payoff of the importing country (18), the sender expects no audit only for low signal with payoff $\tau_r m(\underline{s})\phi(\underline{s})$. However, the maximum low posterior mean is c_p/τ_e. In addition, probability $\phi(\underline{s})$ can be achieved, if high posterior mean at right-most position, that is $m(\overline{s}) = \bar{\theta}$. By putting known values of posterior means into the Bayesian plausibility constraint provides distribution Φ over posterior means.

■

A3. Proof of Proposition 1

Statement *a*) comes form the fact that the exporting country receives positive payoff only if it makes tax audit. In this case it does not to compete for profit share and can impose $\tau_e = 1$, which maximises its payoff. The importing country has to impose lower tax rate to reduce tax burden on path p_1.

Statement *b*) is corollary of choices of the tax rates.

Statements *c*) and *d*) are proved in Lemma 2.

■

A4. Proof of Lemma 3

Statement *a*) is corollary of optimal low posterior mean derived in Lemma 2 and the assumption that mediator can only reduce informativeness of signalling rule according to Blackwell (1953).

Regarding statement *b*) probability of signal realisation $\phi(s)$ for garbled signalling rule π' can be represented as a composition of conditional probabilities:

$$\phi_{\pi'}(s') = \sum_{s \in S} \phi_{\pi'}(s' \mid s)\phi_{\pi}(s)$$

Since $|S| = 2$ and communication is a sequence of pairs of countries, this decomposition is true for any pair of sender (mediator) and receiver. The goal of garbling is to increase probability of realisation of the low signal, so the low signal receive by mediator cannot be reported as the high garbled signal, that is $\mathbb{P}[\underline{s} \mid \underline{s}] = 1$. Hence, probability of the low signal can be increased by keeping $\mathbb{P}[\underline{s} \mid \overline{s}] > 0$.

■

A5. Proof of Proposition 2

Statement a) comes form the fact that the exporting country receives positive payoff only if it makes tax audit. In this case it does not to compete for profit share and can impose $\tau_e = 1$, which maximises its payoff. The importing country has to impose lower tax rate to reduce tax burden on path p_1. The profit is not allocated to transit countries, so their tax rates do not affect tax burden of the path.

Statement b) is corollary of choices of the tax rates.

Statements c) and e) is proved in Lemma 2.

Statement d) comes from the sequential nature of the communication and the assumption that mediator can only reduce informativeness of signalling rule according to Blackwell (1953). If a mediator received signalling rule is based on audit cost that is minimal in its neighbourhood, it can apply only I not violating Lemma 2.

■

A6. Proof of Proposition 3

According to Corollary 1 the firm's participation constraint (20) holds with equality, so the profit is fully distributed between the countries on the path. According to Lemma 3 low posterior mean that is taxed not in the exporting country increases in following garbling signalling rules. Hence, the firm keeps a country on the path only if it reduces its tax burden by imposing lower tax rate. If tax rate of the following transit country is higher than the tax rate of the previous transit country, the firm removes such transit country increasing profit share allocated to the previous transit country. As a result, all countries $t \in T$ with $b_t > 0$ must have tax rate that is lower than of the previous country on the path.

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