

Taxation of Unknown Beneficial Owners: Treaty Shopping with Incomplete Information*

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Abstract

This paper examines treaty shopping in a game-theoretic model with incomplete information. An investor has private information about her residence country and chooses a direct or indirect investment route to minimize tax. A tax agency has private information about its audit cost and decides whether to audit the investor. In this model there is an equilibrium where the tax agency of a low cost type audits the investor with positive probability and the investor of a country with tax-minimizing indirect routes chooses such routes with positive probability. The tax agency can earn a greater payoff by choosing the equilibrium random audit rule than by choosing the mandatory audit rule. Under foreign tax credit systems in residence countries with relatively high tax rates, there is an equilibrium where the investor chooses the direct route regardless of her type. This paper also examines the structure of tax-minimizing routes to distinguish country types and to assess treaty shopping arbitrage.

JEL classification: H250, H870, K340

Keywords: treaty shopping, incomplete information, tax-minimizing route, random audit, foreign tax credit

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1 Introduction

Multinational companies often organize indirect and complex business structures for tax motives.¹ Especially, multinational high-tech companies, whose business models rely on intangible assets (e.g., patents) and remote servers, may shift their profits more easily than conventional companies, away from the countries where they carry on business, and can avoid corporate income tax in the countries. Multinational companies can also avoid withholding tax by using conduit entities in countries with favorable tax treaties. The use of such indirect structures is called tax treaty shopping, and considered to be an improper use of tax treaties.²

A beneficial owner generally refers to a person entitled to the benefits of a tax treaty, such as the application of reduced withholding tax rates on dividends, interest, and royalties. This person must be a resident of a contracting state of the tax treaty. However, in cases of tax treaty shopping, it turns out that a beneficial owner is not a true resident of the contracting state. In such cases, an investor operates a conduit entity in a state with a favorable tax treaty to obtain those tax treaty benefits, even if she is not a resident of that state.³ When dealing with such cases, a tax agency may not know the true residency of the investor. In other words, the investor has

¹Mintz and Weichenrieder (2010) find that German multinational firms use indirect ownership structures through conduit countries and suggest that treaty shopping is a main reason for indirect structures. Lewellen and Robinson (2013) also discover that US multinational firms organize complex and indirect ownership structures for tax motives.

²OECD (2015) highlights the issues on treaty abuse in the Base Erosion and Profit Shifting (BEPS) project as follows: “Treaty abuse is one of the most important sources of BEPS concerns. The Commentary on Article 1 of the OECD Model Tax Convention already includes a number of examples of provisions that could be used to address treaty-shopping situations as well as other cases of treaty abuse, which may give rise to double non-taxation. Tight treaty anti-abuse clauses coupled with the exercise of taxing rights under domestic laws will contribute to restore source taxation in a number of cases.”

³For instance, a US multinational company, Corning, invested in a Korean manufacturer, Samsung Corning, through a Hungarian subsidiary, Corning Hungary Data Services Kft., where “Kft.” is a form of a Limited Liability Company (LLC) in Hungary. According to the Korea-US tax treaty, withholding tax rates on dividends are set at 10 or 15 percent depending on percentages of shares. However, the Korea-Hungary tax treaty sets the minimum withholding tax rate at 5 percent, and in Hungary, there is no withholding tax on dividends paid to non-residents.

private information about her country of residence.

The purpose of this paper is to examine tax treaty shopping in a game-theoretic model with incomplete information. I wish to address the following questions: How can investors organize tax-minimizing indirect structures for tax treaty shopping? How frequently do they use such structures? How should tax authorities counteract? How much does tax treaty shopping affect tax revenue in a source country? Can tax treaty shopping be prevented by tax relief rules, such as foreign tax credit systems?

Let us imagine the following situation. An investor, individual or corporate, lives in country h and plans to invest in country s . From this investment, the investor expects to earn income as dividends in country s and will repatriate her income to country h . The investor's type is determined by her residence (or home) country h . The investor of type h intends to minimize tax when she remits dividends to country h . The investor of type h can choose a direct route or an indirect route, which incorporates intermediary entities established in other countries.

Tax treaties, as well as national tax laws, determine withholding tax (WHT) rates on dividends paid across countries and corporate income tax (CIT) rates. These tax rates determine taxes paid along an investment route. The investor's net-of-tax income also depends on tax relief rules in her residence country. First it is assumed that residence countries have deduction or exemption systems. Foreign tax credit systems will be considered later.

In the source country s , a tax agency can audit the investor by incurring the audit cost c , which determines the tax agency's type. In other words, the tax agency of type c can choose whether to audit the investor without knowing the investor's type (residence country) and action (route choice). While an audit is costly, it can generate additional revenue for the tax agency. If the audit reveals that the investor chose an indirect route, the tax agency imposes a penalty tax on the investor. However, if the investor chose the direct route, the tax agency does not gain additional revenue from the audit but incurs the audit cost.

Both the tax agency and the investor have private information about their own types. The tax agency knows its own type c but the investor may not know the tax agency's type. Meanwhile, the investor knows her own type h but the tax agency may not know the investor's type. The tax agency and the investor have subjective beliefs about each other's type.

In a model with two residence country types and two audit cost types, there is no pure-strategy Bayesian Nash equilibrium. Thus, in equilibrium, it is necessary for the tax agency and the investor to play mixed strategies. I construct a Bayesian Nash equilibrium where the tax agency of the low audit cost type audits the investor with positive probability and the investor of the country with tax-minimizing indirect routes chooses such indirect routes with positive probability. In this equilibrium, the tax agency's audit probability is calculated as the ratio of net treaty shopping arbitrage (TSA) to expected penalty tax with respect to the investor's beliefs. The investor's indirect-routing probability is calculated as the ratio of audit cost to expected penalty tax with respect to the tax agency's beliefs. However, in the equilibrium, the tax agency of the high audit cost type chooses not to audit at all, and the investor of the country with a tax-minimizing direct route chooses the direct route for sure.

In the equilibrium, the tax agency earns the same expected payoff regardless of its type, while the investor earns different payoffs depending on her type. The investor's equilibrium payoffs are equal to the payoffs when the investor always chooses the direct route. However, the tax agency's equilibrium payoff is smaller than the payoff when the investor chooses the direct route and the tax agency chooses no audit. By taking the difference between these two payoffs, I calculate the decrease in the tax agency's expected payoff due to indirect routing, i.e., treaty shopping. This payoff loss can be calculated with the average WHT rate spread and the ratio of the audit cost to the penalty tax rate.

Interestingly, if the penalty tax rate is set sufficiently high, the tax agency earns a greater expected payoff by choosing the equilibrium random audit

strategy than by choosing the mandatory audit strategy. This is mainly because the tax agency incurs the audit cost but gains no additional revenue when always auditing the investor. However, in any case, the investor earns the same expected payoff.

Under foreign tax credit systems in the residence countries, if domestic CIT rates are higher than or equal to WHT rates, there is an equilibrium where the investor chooses the direct route regardless of her type. Otherwise, there is an equilibrium where the investor chooses tax-minimizing indirect routes with positive probability. This equilibrium is similar to the equilibrium under deduction or exemption systems.

Treaty shopping can be prevented by foreign tax credit systems in residence countries with relatively high CIT rates. The cost of this prevention is borne by residence countries, in terms of tax credits given to investors, whereas the benefit is enjoyed by source countries, in terms of increased tax revenue. Without overcoming such free-rider problems between countries, it may be difficult to sustain foreign tax credit systems in residence countries. Recently, France, Germany, Japan, and the United Kingdom moved away from tax credit systems to introduce exemption for foreign-source dividends.

I also examine the structure of tax-minimizing direct or indirect routes between 30 countries to distinguish home country types and to assess TSA rates. It turns out that investors can minimize tax on dividends by choosing indirect routes to 21 source countries. Specifically, when China is the source country, there are 15 home countries, such as the United Kingdom and the Netherlands, with tax-minimizing direct routes and 14 home countries, such as the United States and Japan, with tax-minimizing indirect routes. The average of TSA rates for China is calculated to be about 1.96 percentage points.

The contribution of this paper is threefold.

Broadly, this paper contributes to the economics of international taxation. In the literature, a central theme has been tax competition between countries, which can choose tax rates, as well as tax relief rules, such as foreign

tax credit, deduction, and exemption systems.⁴ Another important issue is to examine theoretical and empirical relations between tax treaties and Foreign Direct Investment (FDI). Chisik and Davies (2004) study the effects of FDI on tax treaty bargaining.⁵ Recently, increasing attention has been paid to international tax policies to deal with issues of Base Erosion and Profit Shifting (BEPS). Dharmapala (2014) provides a survey of empirical studies to assess the magnitude of BEPS.⁶ In contrast, this paper analyzes the effects of tax treaties, tax relief systems, and private information on strategic interactions between investors and tax authorities.

More specifically, this paper contributes to the literature on tax treaty shopping and the ownership structures of multinational firms. This literature uses firm-level data or applies network optimization techniques to examine tax variables affecting ownership structures. Mintz and Weichenrieder (2010) show that there is a growing number of German firms organizing indirect ownership structures for foreign subsidiaries and suggest that treaty shopping is a main reason for indirect structures.⁷ Lewellen and Robinson (2013) show a similar finding for US firms. More recently, Hong (2014) and van't Riet and Lejour (2015) use network optimization techniques to examine the structure of tax-minimizing indirect investment routes. Hong (2014) also studies a game-theoretic model but does not consider private information between investors and tax authorities. To the best of my knowledge, this paper is the first attempt to consider strategic behavior and private information in the context of treaty shopping.

This paper also contributes to the theory of auditing. This literature

⁴For related studies, see Bond and Samuelson (1989), Janeba (1995), Konan (1997), Davies (2003), Stöwhase (2013), and Eggert and Itaya (2014).

⁵Conversely, Blonigen and Davies (2004) examine the effects of tax treaties on FDI stocks in the United States, and discover substantial heterogeneity in treaty effects across countries. Blonigen et al. (2014) find that US multinational firms using differentiated inputs show increased sales of foreign affiliates in countries with new tax treaties.

⁶Regarding specific BEPS actions, Johannesen (2014, 2016) studies tax avoidance with internal debt and hybrid financing. Behrens et al. (2014) examine the impact of transfer pricing regulation.

⁷Weyzig (2013) also confirms that reductions in withholding tax rates on dividends are significant determinants of FDI indirectly routed through the Netherlands.

has developed principal-agent models to examine optimal audit design. For instance, Mookherjee and Png (1989) analyze a model where a risk-averse agent has private information about her income and reports it to a risk-neutral principal who then chooses to audit the agent at a cost. In their model, random audits turn out to be optimal because random audits can reduce expected costs without significantly distorting the agent's incentive to report truthfully. Border and Sobel (1987) also show the efficiency of random auditing in a model with a risk-neutral agent.⁸ These studies only deal with auditing against underreported income in a single jurisdiction. In contrast, this paper examines random audits against tax planning techniques in a multi-jurisdictional setting.

The rest of this paper is organized as follows. Section 2 develops a game-theoretic model with incomplete information. Section 3 analyzes Bayesian Nash equilibria and the equilibrium random audit strategy, and examines the effects of tax relief systems on treaty shopping. Section 4 analyzes the structure of tax-minimizing routes between 30 countries, and assesses treaty shopping arbitrage rates. Section 5 concludes.

2 Model

An investor, individual or corporate, plans to invest in country $s \in N$ but lives in country $h \in H \subseteq N \setminus \{s\}$, where $N = \{1, 2, 3, \dots, n\}$ denotes the set of all countries. From this investment, the investor will earn income $m \in \mathbb{R}_{++}$ as dividends in country s and repatriate her income to country h . Country s is called the source country while country h is called the residence (or home) country. The investor's type is determined by the residence country $h \in H$. The investor of type h intends to minimize tax when she remits her income to country h , i.e., the investor intends to maximize her net-of-tax income in the residence country.

⁸Reinganum and Wilde (1988) show that a tax agency may gain in terms of revenue and compliance by increasing taxpayer uncertainty regarding its audit cost. In contrast, Reinganum and Wilde (1985) develop a model where random audit rules are weakly dominated by audit cutoff rules.

An investment route, or simply a route, is defined as a series of countries, h, i, \dots, j, s , from country h to country s . Given a route h, i, \dots, j, s , countries i through j are called pass-through countries. A route h, i, \dots, j, s is often written as $h \rightarrow i \rightarrow \dots \rightarrow j \rightarrow s$ when it is necessary to highlight the direction of the route.

A strategy of the investor, denoted by $b(\cdot)$, is a function mapping each type h to a route $b(h)$. If $b(h) = h, i, \dots, j, s$, the investor of type h chooses an indirect route to invest in country s by establishing entities in countries i through j and making her investment indirectly through these entities. If $b(h) = h, s$, she chooses the direct route to invest in country s . When the investor remits her income from country s to country h , the remittance route follows the reverse order of the countries in the investment route.

In the source country a tax agency is informed of the inbound investment. By incurring the audit cost $c \in C \subseteq \mathbb{R}_{++}$, the tax agency of the source country can audit the investor.⁹ The tax agency's type is determined by the audit cost $c \in C$. A strategy of the tax agency, denoted by $a(\cdot)$, is a function mapping each type c to an action $a(c) \in \{0, 1\}$. If $a(c) = 1$, the tax agency of type c audits the investor. Otherwise, the tax agency does not.

The investor has private information about her country of residence, i.e., the investor knows her own type $h \in H$ but the tax agency may not know the investor's type. The tax agency has subjective beliefs about the investor's type, described by a probability distribution π over H .

The tax agency has private information about its audit cost, i.e., the tax agency knows its own type $c \in C$ but the investor may not know the tax agency's type. The investor has subjective beliefs about the tax agency's type, described by a probability distribution ϕ over C .

⁹The tax agency chooses whether to audit the investor without knowing the investor's type (residence country) and action (route choice). Before making the audit choice, the tax agency may obtain some information about the investor's type and action, e.g., immediate shareholders of the company in the source country, from the investor's tax statement. However, the tax agency does not believe the information, i.e., the tax agency acts as if it does not know the information, due to the possibility of misreporting. The tax agency must conduct a costly investigation to collect evidence to impose a penalty tax.

Both the tax agency and the investor know a corporate income tax (CIT) rate t_i in country i and a withholding tax (WHT) rate t_{ij} on dividends paid from an entity in country i to another entity in country j . A tax rate matrix T summarizes WHT rates on dividends and CIT rates as follows:

$$T = \begin{bmatrix} t_1 & t_{12} & \cdots & t_{1n} \\ t_{21} & t_2 & \cdots & t_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ t_{n1} & t_{n2} & \cdots & t_n \end{bmatrix}$$

Let $w(b(h))$ denote the withholding tax rate of a route $b(h)$ at source such that $w(b(h)) = t_{sh}$ if $b(h) = h, s$ and $w(b(h)) = t_{sj}$ if $b(h) = h, i, \dots, j, s$. Let $f(b(h))$ denote the foreign tax rate of a route $b(h)$ such that $f(b(h)) = t_{sh}$ if $b(h) = h, s$ and $f(b(h)) = 1 - (1 - t_{sj})(1 - t_j) \cdots (1 - t_i)(1 - t_{ih})$ if $b(h) = h, i, \dots, j, s$.

When the investor of type h chooses a route $b(h)$, the net-of-tax income is $m(1 - f(b(h)))(1 - t_h)$ in country h , and the tax revenue is $mw(b(h))$ in country s . Here it is assumed that residence countries have either deduction or exemption systems. The CIT rate in country h is $t_h > 0$ under deduction systems and $t_h = 0$ under exemption systems. Foreign tax credit systems will be considered later.

Let $p^* \in \mathbb{R}_{++}$ and let $p(a(c), b(h))$ denote the penalty tax rate of an action $a(c)$ and a route $b(h)$ such that $p(a(c), b(h)) = p^*$ if $a(c) = 1$ and $b(h) = h, i, \dots, j, s$ and $p(a(c), b(h)) = 0$ otherwise. If the investor of type h chooses an indirect route $b(h) = h, i, \dots, j, s$ and the tax agency of type c audits the investor, i.e., $a(c) = 1$, the tax agency imposes the penalty tax mp^* , which the investor must pay to the tax agency. Otherwise, there is no penalty tax. The tax agency of type c incurs the audit cost $ca(c)$.

To summarize, given a probability distribution π and a type c , the payoff function of the tax agency (or player A) can be written as follows:

$$u_A(a(\cdot), b(\cdot); c) = E_\pi [mw(b(\cdot)) + mp(a(c), b(\cdot)) - ca(c)]$$

Given a probability distribution ϕ and a type h , the payoff function of the investor (or player B) can be written as follows:

$$u_B(a(\cdot), b(\cdot); h) = E_\phi [m(1 - f(b(h)))(1 - t_h) - mp(a(\cdot), b(h))]$$

When choosing whether to audit the investor, the tax agency of the source country does not know the investor's type (residence country) and action (route choice). The tax agency only knows its own type c , i.e., the audit cost. When choosing an investment route, the investor does not know the tax agency's type (audit cost) and action (audit choice). The investor only knows her own type h , i.e., the country of residence. The tax agency and the investor play a game with incomplete information.

Let $R(h, s)$ denote the set of all routes from country h to country s . A route $b^* \in R(h, s)$ is tax-minimizing if for each $b \in R(h, s)$, $f(b^*) \leq f(b)$.

For a pair (h, s) of home and source countries, if there is a tax-minimizing direct (TMD) route, $TMD_{hs} = 1$, and otherwise, $TMD_{hs} = 0$. Let $H^D = \{h \in H : TMD_{hs} = 1\}$ denote the set of home countries with tax-minimizing direct routes to country s . Let $H^I = \{h \in H : TMD_{hs} = 0\}$ denote the set of home countries with no tax-minimizing direct routes to country s . For each $h \in H^I$, there is a tax-minimizing indirect route $b^* = h, i, \dots, j, s$ with $f(b^*) < t_{sh}$.

For a pair (h, s) of home and source countries, the treaty shopping arbitrage (TSA) rate among routes from h to s is defined as $TSA_{hs} = t_{sh} - f(b^*)$, where b^* is a tax-minimizing route. In words, the TSA rate among routes between a pair of home and source countries is defined as the difference between the foreign tax rates of the direct route and a tax-minimizing route.

3 Equilibrium Analysis

In this section I analyze the model with two home country types and two audit cost types. Let $H = \{1, 2\}$ with $H^I = \{1\}$ and $H^D = \{2\}$. Let $C = \{c_L, c_H\}$ with $c_L < c_H$. The tax agency's beliefs are described by a probability distribution π with $\pi(1) = \pi_1$ and $\pi(2) = \pi_2$. The investor's

beliefs are described by a probability distribution ϕ with $\phi(c_L) = \phi_L$ and $\phi(c_H) = \phi_H$.

It is assumed that the low audit cost is smaller than the expected penalty tax when indirect routes are chosen only by the investor of country 1, i.e., $c_L < \pi_1 mp^*$. Also, the treaty shopping arbitrage (TSA) rate net of tax in country 1 is smaller than the penalty tax rate discounted by the probability of the low audit cost, i.e., $(t_{s1} - f(b^*))(1 - t_1) < \phi_L p^*$, where $t_{s1} - f(b^*) = TSA_{1s}$ is the TSA rate and b^* is a tax-minimizing indirect route.

Remark 1. Under these assumptions, there is no pure-strategy Bayesian Nash equilibrium. The proof is presented in the Appendix.

Remark 2. If one of these assumptions is violated, the following Bayesian Nash equilibrium exists:

(i) If $\pi_1 mp^* < c_L$, there is an equilibrium where the tax agency of each type chooses not to audit, the investor of country 1 chooses a tax-minimizing indirect route, and the investor of country 2 chooses the direct route.

(ii) If $c_L < \pi_1 mp^* < c_H$ and $\phi_L p^* < (t_{s1} - f(b^*))(1 - t_1)$, there is an equilibrium where the tax agency of type c_L chooses to audit, the tax agency of type c_H chooses not to audit, the investor of country 1 chooses a tax-minimizing indirect route, and the investor of country 2 chooses the direct route.

(iii) If $c_H < \pi_1 mp^*$ and $\phi_L p^* < (t_{s1} - f(b^*))(1 - t_1) < p^*$, there is an equilibrium where the tax agency of type c_L audits for sure, the tax agency of type c_H audits with probability $((t_{s1} - f(b^*))(1 - t_1) - \phi_L p^*) / \phi_H p^*$, the investor of country 1 chooses tax-minimizing indirect routes with probability $c_H / \pi_1 mp^*$, and the investor of country 2 chooses the direct route for sure.

(iv) If $c_H < \pi_1 mp^*$ and $p^* < (t_{s1} - f(b^*))(1 - t_1)$, there is an equilibrium where the tax agency of each type chooses to audit, the investor of country 1 chooses a tax-minimizing indirect route, and the investor of country 2 chooses the direct route. The proof is presented in the Appendix.

From Remark 1, in this model, no pure-strategy equilibrium exists. Now I construct a mixed-strategy Bayesian Nash equilibrium where the tax agency

of the low cost type c_L audits the investor with positive probability and the investor of country 1 chooses tax-minimizing indirect routes with positive probability.

Theorem 1. *There is an equilibrium where (i) the tax agency of the low cost type c_L audits the investor with probability $(t_{s1} - f(b^*))(1 - t_1)/\phi_L p^*$, (ii) the tax agency of the high cost type c_H chooses no audit for sure, (iii) the investor of country 1 chooses tax-minimizing indirect routes with probability $c_L/\pi_1 m p^*$, and (iv) the investor of country 2 chooses the direct route for sure.*

The proof of Theorem 1 proceeds in five steps.

Step 1. For the investor of type $h = 2$, it is weakly dominant to choose the direct route. Let $b^*(2) = 2, s$ be the direct route. Because country 2 belongs to H^D , the direct route is tax-minimizing, i.e., for each $b \in R(2, s)$, $f(b^*(2)) \leq f(b)$. For each $b \in R(2, s)$ with $b \neq b^*(2)$, if $a(c) = 0$, then $p(a(c), b^*(2)) = p(a(c), b) = 0$ and $u_B(a(c), b; 2) \leq u_B(a(c), b^*(2); 2)$. If $a(c) = 1$, then $p(a(c), b^*(2)) = 0 < p^* = p(a(c), b)$ and $u_B(a(c), b; 2) < u_B(a(c), b^*(2); 2)$.

Step 2. Suppose that the investor of type $h = 2$ chooses the direct route for sure. Also, suppose that the investor of type $h = 1$ chooses tax-minimizing indirect routes with probability $c_L/\pi_1 m p^*$. Let $b^*(\cdot)$ denote such a strategy. Given $b^*(\cdot)$, the tax agency of type c_H chooses not to audit. Let $a^*(c_H) = 0$ and $a(c_H) = 1$. Given $b^*(\cdot)$, $u_A(a^*(c_H), b^*(\cdot); c_H) = E_\pi [mw(b^*(\cdot))]$. Also, $u_A(a(c_H), b^*(\cdot); c_H) = E_\pi [mw(b^*(\cdot))] + E_\pi [mp(a(c_H), b^*(\cdot))] - c_H$. Because $E_\pi [mp(a(c_H), b^*(\cdot))] = c_L$ and $c_L < c_H$, it holds that $u_A(a(c_H), b^*(\cdot); c_H) < u_A(a^*(c_H), b^*(\cdot); c_H)$.

Step 3. For the investor of type $h = 1$, it is dominated to choose an indirect route that is not tax-minimizing. Let $b(h) = b$ denote such a route. Because country 1 belongs to H^I , there is a tax-minimizing indirect route $b^* = 1, i, \dots, j, s$ with $f(b^*) < t_{s1}$. Let $b^*(h) = b^*$. Because b and b^* are indirect routes, for each $a(c) \in \{0, 1\}$, $p(a(c), b) = p(a(c), b^*)$. Because b^* is

tax-minimizing but b is not, $f(b^*) < f(b)$. Thus, for each $a(c) \in \{0, 1\}$ and for type $h = 1$, it holds that $u_B(a(c), b; h) < u_B(a(c), b^*; h)$.

Step 4. Suppose that there are $\ell \geq 1$ tax-minimizing indirect routes from country 1 to country s . Each of such routes is denoted by $b^k = 1, i_k, \dots, j_k, s$ with $k = 1, \dots, \ell$, and is played with probability q_k , where $\sum_{k=1}^{\ell} q_k = c_L/\pi_1 mp^*$. Let $(a^*(\cdot), b^*(\cdot))$ denote the strategy profile specified as follows:

$$a^*(c) = \begin{cases} 1 & \text{with probability } (t_{s1} - f(b^*))(1 - t_1)/\phi_L p^* \text{ for } c = c_L \\ 0 & \text{with probability } 1 - (t_{s1} - f(b^*))(1 - t_1)/\phi_L p^* \text{ for } c = c_L \\ 0 & \text{with probability 1 for } c = c_H \end{cases}$$

$$b^*(h) = \begin{cases} b^k & \text{with probability } q_k \text{ for } h = 1 \\ 1, s & \text{with probability } 1 - \sum_{k=1}^{\ell} q_k \text{ for } h = 1 \\ 2, s & \text{with probability 1 for } h = 2 \end{cases}$$

Given the investor's strategy $b^*(\cdot)$, for type c_L , $E_{\pi}[mp(1, b^*(\cdot))] = c_L$ and $u_A(1, b^*(\cdot); c_L) = E_{\pi}[mw(b^*(\cdot))]$. Also, $u_A(0, b^*(\cdot); c_L) = E_{\pi}[mw(b^*(\cdot))]$. Thus, the tax agency of type c_L is indifferent between $a^*(c_L) = 1$ and $a^*(c_L) = 0$. Given the tax agency's strategy $a^*(\cdot)$, for type $h = 1$, it holds that $u_B(a^*(\cdot), b^k; h) = m(1 - t_{s1})(1 - t_1) = u_B(a^*(\cdot), h, s; h)$. Hence, the investor of type $h = 1$ is indifferent between $b^*(h) = b^k$ and $b^*(h) = h, s$.

Step 5. From Step 1, it is weakly dominant for the investor of type $h = 2$ to choose the direct route. Thus, regardless of what the tax agency does, the investor of type $h = 2$ will choose the direct route, as specified in $b^*(\cdot)$. Given $b^*(\cdot)$, from Step 2, the tax agency of type c_H will choose no audit, as specified in $a^*(\cdot)$. Because it is dominated for the investor of type $h = 1$ to choose an indirect route that is not tax-minimizing, from Step 3, the investor of type $h = 1$ will only choose either the direct route or a tax-minimizing indirect route. By choosing the mixed strategy specified in Step 4, each player makes the other player indifferent between the actions played with positive probability. Therefore, $(a^*(\cdot), b^*(\cdot))$ is an equilibrium. \square

In Theorem 1, for the tax agency of the low cost type, the equilibrium audit probability is calculated as the ratio of net treaty shopping arbitrage

(TSA) to expected penalty tax with respect to the investor's beliefs. Hence, this audit probability is positively related to treaty shopping arbitrage, i.e., $TSA_{hs} = t_{sh} - f(b^*)$ for country $h = 1$. For the investor of the country with tax-minimizing indirect routes, the equilibrium indirect-routing probability is calculated as the ratio of audit cost to expected penalty tax with respect to the tax agency's beliefs.

From Remark 2 and Theorem 1, we can see that the indirect-routing probability is minimized in the equilibrium of Theorem 1, which exists under the assumptions that $c_L < \pi_1 mp^*$ and $(t_{s1} - f(b^*))(1 - t_1) < \phi_L p^*$. Under (i), (ii), and (iv) of Remark 2, the investor of the country with tax-minimizing indirect routes uses such routes for sure in equilibrium. Under (iii), the investor uses such routes with probability $c_H / \pi_1 mp^*$, which is greater than the equilibrium probability $c_L / \pi_1 mp^*$ of Theorem 1. Therefore, to minimize the probability of using tax-minimizing indirect routes, the tax agency can set up a penalty tax rate p^* satisfying the assumptions of Theorem 1. This penalty tax rate can be thought of as an optimal rate for the tax agency of the source country because it minimizes the probability of treaty shopping.

Next I calculate equilibrium expected payoffs and the decrease in the tax agency's expected payoff due to the use of indirect routes for treaty shopping.

Remark 3. In equilibrium $(a^*(\cdot), b^*(\cdot))$, the tax agency of type c earns an expected payoff of $u_A(a^*(\cdot), b^*(\cdot); c) = E_\pi [mw(b^*(\cdot))]$. Thus, the tax agency earns the same expected payoff, regardless of its type. However, the investor of country h earns an expected payoff of $u_B(a^*(\cdot), b^*(\cdot); h) = m(1 - t_{sh})(1 - t_h)$, which depends on the investor's type.

In Remark 3, it is worthwhile to note that the investor's equilibrium payoffs are equal to the payoffs when the investor always chooses the direct route. In contrast, the tax agency's equilibrium payoff is smaller than the payoff when the investor chooses the direct route and the tax agency chooses no audit. By comparing these payoffs I calculate the payoff loss of the tax agency due to treaty shopping.

Remark 4. If the investor always chooses the direct route regardless of her type, the tax agency earns an expected payoff of $E_\pi [mt_{sh}]$ by choosing no audit. However, in equilibrium $(a^*(\cdot), b^*(\cdot))$, the tax agency's expected payoff is calculated as $E_\pi [mw(b^*(\cdot))] = E_\pi [mt_{sh}] - \pi_1 m \sum_{k=1}^{\ell} q_k (t_{s1} - t_{sj_k})$, where j_k is the last pass-through country in each tax-minimizing route $b^k = 1, i_k, \dots, j_k, s$ that is played with probability q_k . Therefore, the tax agency's expected payoff decreases by $\pi_1 m \sum_{k=1}^{\ell} q_k (t_{s1} - t_{sj_k})$, as the investor chooses tax-minimizing indirect routes for treaty shopping.

In Remark 4, the payoff loss of the tax agency is calculated with the weighted sum of withholding tax (WHT) rate spreads between the direct route and tax-minimizing indirect routes with weights given by the investor's equilibrium probability. Given $\ell \geq 1$ tax-minimizing indirect routes, if each of such routes is played with equal probability, i.e., if $q_k = c_L / \ell \pi_1 m p^*$ for $k = 1, \dots, \ell$, the payoff loss can be rewritten as $(c_L / p^*) (1 / \ell) \sum_{k=1}^{\ell} (t_{s1} - t_{sj_k})$, which is calculated with the average WHT rate spread and the ratio of the low audit cost to the penalty tax rate.

Now I examine whether the tax agency gains from the equilibrium random audit strategy.

Theorem 2. *If the penalty tax rate is greater than the maximum withholding tax rate spread, the tax agency earns a greater expected payoff by choosing the equilibrium random audit strategy than by choosing the mandatory audit strategy, while the investor earns the same expected payoff.*

Proof. Suppose that the penalty tax rate is greater than the maximum withholding tax rate spread, i.e., $p^* > \max_k (t_{s1} - t_{sj_k})$. If the tax agency chooses the mandatory audit strategy, i.e., if the tax agency must audit regardless of its type, the investor will always chooses the direct route to maximize her expected payoff. In this case, the tax agency of type c earns $E_\pi [mt_{sh}] - c$, and the investor of type h earns $m(1 - t_{sh})(1 - t_h)$. However, if the tax agency chooses the equilibrium random audit strategy, in the equilibrium, the tax agency of type c earns $E_\pi [mt_{sh}] - \pi_1 m \sum_{k=1}^{\ell} q_k (t_{s1} - t_{sj_k})$, and the

investor of type h earns $m(1 - t_{sh})(1 - t_h)$. Because $p^* > \max_k(t_{s1} - t_{sj_k})$ and $\sum_{k=1}^{\ell} q_k = c_L/\pi_1 m p^*$, it holds that $c_L > \pi_1 m (c_L/\pi_1 m p^*) \max_k(t_{s1} - t_{sj_k}) = \pi_1 m (\sum_{k=1}^{\ell} q_k) \max_k(t_{s1} - t_{sj_k}) \geq \pi_1 m \sum_{k=1}^{\ell} q_k (t_{s1} - t_{sj_k})$. Therefore, the tax agency earns a greater expected payoff by choosing the equilibrium random audit strategy than by always auditing the investor. However, in both cases, the investor earns the same expected payoff. \square

Contrary to classical studies on random audits, e.g., Border and Sobel (1987) and Mookherjee and Png (1989), in this model, the investor's tax avoidance technique is not based on underreporting but on indirect routing. Even if the investor reports her income truthfully, if she uses tax planning techniques, such as indirect routing, the tax agency can choose random audit strategies with sufficiently high penalty tax rates to earn greater revenue while maintaining the same expected payoff for the investor.

Next I consider foreign tax credit systems in residence countries and discuss the effects of tax relief systems on treaty shopping. There are three different tax relief systems that affect the net-of-tax income of investors in their home countries. Under deduction systems, foreign taxes are deducted as costs from taxable income before taxes are imposed by home countries. Under exemption systems, certain items of foreign-source income, such as dividends, are exempt from home country taxation. Under tax credit systems, foreign taxes are credited against tax liabilities in home countries. Thus, under tax credit systems in country h , the investor's net-of-tax income is determined by the greater of the foreign tax rate $f(b(h))$ and the domestic CIT rate t_h . The payoff function of the investor is given as follows:

$$u_B(a(\cdot), b(\cdot); h) = m(1 - \max\{f(b(h)), t_h\}) - E_{\phi}[mp(a(\cdot), b(h))]$$

If $f(b(h)) \leq t_h$, foreign taxes are no greater than domestic tax liabilities, and thus, the investor pays $m(t_h - f(b(h)))$ in country h and $mf(b(h))$ in countries along the investment route $b(h)$. The investor's net-of-tax income is $m(1 - t_h)$. However, if $t_h < f(b(h))$, foreign taxes are greater than domestic tax liabilities, and thus, the investor pays no tax in country h . The investor's

net-of-tax income is $m(1 - f(b(h)))$.

Let us consider the cases with two home country types and two audit cost types analyzed in Theorem 1. The following results show how domestic CIT rates affect equilibrium behavior. The proofs are presented in the Appendix.

Theorem 3. *Under tax credit systems in the residence countries, if $t_{s1} \leq t_1$, there is an equilibrium where the tax agency chooses no audit and the investor chooses the direct route regardless of their types.*

Theorem 4. *Under tax credit systems in the residence countries, if $t_1 < t_{s1}$, there is an equilibrium where (i) the tax agency of the low cost type c_L audits the investor with probability $(t_{s1} - t_f)/\phi_L p^*$ such that $t_f = \max\{f(b^*), t_1\}$, (ii) the tax agency of the high cost type c_H chooses no audit for sure, (iii) the investor of country 1 chooses tax-minimizing indirect routes with probability $c_L/\pi_1 m p^*$, and (iv) the investor of country 2 chooses the direct route for sure.*

Remark 5. When $t_{s1} \leq t_1$, in the equilibrium of Theorem 3, the tax agency of type c earns an expected payoff of $E_\pi [mt_{sh}]$, regardless of its type. The investor of country 1 earns $m(1 - t_1)$ while the investor of country 2 earns $m(1 - \max\{t_{s2}, t_2\})$. In this equilibrium, no treaty shopping occurs, and the tax agency of the source country earns the maximum possible tax revenue without incurring the audit cost. However, the residence countries earn tax revenues reduced by foreign tax credits given to the investor.

Remark 6. When $t_1 < t_{s1}$, in the equilibrium of Theorem 4, the tax agency of type c earns an expected payoff of $E_\pi [mw(b^*(\cdot))]$, regardless of its type. This is the same payoff as in the equilibrium of Theorem 1 and Remark 3. The investor of country 1 earns $m(1 - t_{s1})$ and the investor of country 2 earns $m(1 - \max\{t_{s2}, t_2\})$. In the source country the tax agency earns less tax revenue due to treaty shopping. Moreover, the residence countries earn zero tax revenue when foreign tax credits exceed domestic tax liabilities.

Under tax credit systems with $t_{s1} \leq t_1$, it is a weakly dominant strategy for the investor to choose the direct route regardless of her type. By using an

indirect route, the investor bears the risk of paying the penalty tax but does not earn greater net-of-tax income than by using the direct route. Under such tax credit systems, treaty shopping can be prevented in equilibrium, as suggested by Theorem 3.

However, foreign tax credit systems do not always help prevent treaty shopping. Under tax credit systems with $t_1 < t_{s1}$, there exists an equilibrium where the investor chooses indirect routes with positive probability, as shown by Theorem 4. This equilibrium is similar to the equilibrium of Theorem 1 that holds under deduction or exemption systems.

Treaty shopping can be prevented by foreign tax credit systems in residence countries with relatively high CIT rates. When no treaty shopping occurs, the source country earns the maximum possible tax revenue. However, this comes at the cost of tax credits given by the residence countries. The source country benefits from foreign tax credit systems in the residence countries that pay for the cost of the systems. Without overcoming such free-rider problems between countries, it may be difficult to sustain foreign tax credit systems in the residence countries. While China, Korea, and the United States maintain foreign tax credit systems, France, Germany, Japan, and the United Kingdom have moved away from these systems to introduce exemption for foreign-source dividends.

4 Network Analysis

In this section I analyze the structure of tax-minimizing routes to distinguish home country types and to assess treaty shopping arbitrage (TSA) rates. A tax rate matrix T shows withholding tax (WHT) rates on dividends and corporate income tax (CIT) rates. Each diagonal entry t_i denotes the CIT rate in country i . Each non-diagonal entry t_{ij} denotes the WHT rate on dividends paid from country i to country j . If an entity in country i remits dividends to an entity in country j , the tax agency in country i imposes a WHT on dividends at the rate t_{ij} , which is defined as the minimum of the rates specified by the tax treaty between countries i and j and by the

national tax law of country i .

Here I construct a tax rate matrix T between 30 countries by using the information on tax treaties and national tax laws from Deloitte International Tax Source and PwC Worldwide Tax Summaries.¹⁰ Table 1 shows notable WHT systems with minimum, median, and maximum WHT rates and CIT rates in the 30 countries.¹¹

Given the tax rate matrix, even without using a computation algorithm, we can find that the investor can minimize tax on dividends by investing directly to 9 countries. In particular, Bermuda, Brazil, Cayman Islands, Hong Kong, Singapore, and the United Kingdom impose no WHT on dividends. Australia has a dividend imputation system under which no WHT may be imposed. Argentina and India have a withholding tax system with a single rate for all countries. To these countries, direct routes are tax-minimizing.

However, the investor may be able to minimize tax on dividends by investing indirectly to the rest of the 21 countries. I develop a computation algorithm to find tax-minimizing investment routes. For each pair (h, s) of home and source countries, my algorithm first builds a list of all routes from country h to country s under the constraint that each route passes through at most two countries.¹² My algorithm then computes the net-of-tax income for each route and finds the routes that achieve the maximum net-of-tax income among all routes in the list.

Given 30 countries, there are 785 ($= 28 \times 27 + 28 + 1$) routes in the list of all routes from country h to country s with at most two pass-through countries. This list includes an indirect route h, i, j, s with pass-through countries i and

¹⁰Accessed at www.dits.deloitte.com and taxsummaries.pwc.com

¹¹This collection of countries includes the largest 24 countries in the world in terms of nominal gross domestic product (GDP) as of 2016, according to the IMF World Economic Outlook Database, accessed at www.imf.org/external/pubs/ft/weo/2016/02. Also included are 6 low-tax countries, such as Hong Kong, Ireland, Singapore, Luxembourg, Bermuda, and Cayman Islands. The total GDP of the 30 countries amounts to about 84.82 percent of the total GDP of the world in 2016.

¹²It may not be unrealistic to assume at most two pass-through countries. Mintz and Weichenrieder (2010, Table 4.4) discover that only 0.2 percent of German multinational firms use cross-border investment routes (ownership chains) with three or more pass-through countries.

Table 1. Selected countries and tax systems

Countries	Codes	WHT systems	Min	Med	Max	CIT
Argentina	AR	Single rate 10%	10	10	10	35
Australia	AU	Imputation	0	0	0	30
Belgium	BE		0	0	25	33
Bermuda	BM	No WHT	0	0	0	0
Brazil	BR	No WHT	0	0	0	34
Canada	CA		5	5	25	15
Cayman	KY	No WHT	0	0	0	0
China	CN		5	10	10	25
France	FR		0	0	30	33.3
Germany	DE		0	5	25	15
Hong Kong	HK	No WHT	0	0	0	16.5
India	IN	Single rate 15%	15	15	15	30
Indonesia	ID		5	12.5	20	25
Ireland	IE		0	0	20	12.5
Italy	IT		0	5	26	27.5
Japan	JP		0	10	20	23.9
Korea	KR		0	7	20	22
Luxembourg	LU		0	0	15	21
Mexico	MX		0	5	15	30
Netherlands	NL		0	0	15	25
Russia	RU		5	10	15	20
Saudi Arabia	SA		0	5	5	20
Singapore	SG	No WHT	0	0	0	17
Spain	ES		0	0	20	28
Sweden	SE		0	0	30	22
Switzerland	CH		0	0	35	8.5
Taiwan	TW		5	20	20	17
Turkey	TR		5	10	15	20
United Kingdom	GB	No WHT	0	0	0	20
United States	US		0	5	30	35

j , an indirect route h, j, s with pass-through country j , and the direct route h, s . For an indirect route, the net-of-tax income depends on CIT rates in pass-through countries. I assume that every pass-through country imposes CIT at a reduced rate of 1 percent.¹³

Table 2 summarizes the result of tax-minimizing routes to each source country. Column “Direct Home” shows the number of home countries with tax-minimizing direct routes to each source country, defined as $\sum_{h \neq s} TMD_{hs}$ for country s . Because there is only one direct route between a pair of home and source countries, this number coincides with the number of tax-minimizing direct routes to each source country. Column “Indirect Home” shows the number of home countries with no tax-minimizing direct routes to each source country. Column “Indirect Route” shows the number of tax-minimizing indirect routes to each source country. Column “TSA Mean” shows the average of TSA rates for each source country. For country s , TSA Mean is calculated as $\sum_{h \neq s} TSA_{hs}/(30 - 1)$.

Interestingly, I find no tax-minimizing route with two pass-through countries to all source countries except for Korea (KR) and Saudi Arabia (SA).¹⁴ To the other 28 countries, even if it is possible for a route to pass through two countries, every tax-minimizing route passes through at most one country.

As shown in Table 2, when China (CN) is the source country, there are 15 home countries with tax-minimizing direct routes. Precisely, these home countries are as follows:

$$H_{CN}^D = \{\text{BE, FR, DE, HK, IE, KR, LU, MX, NL, RU, SA, SG, SE, CH, GB}\}$$

Also, there are 14 home countries with 90 tax-minimizing indirect routes to

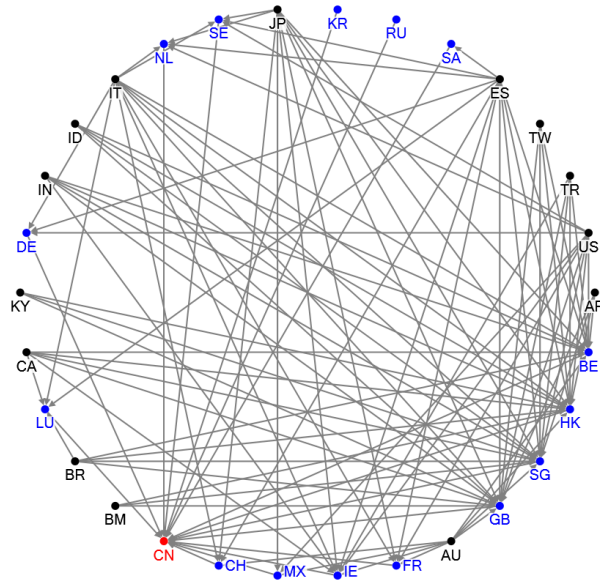
¹³In a pass-through country, CIT can be reduced by a favorable tax system for conduit entities, such as foreign equity holding companies. The structure of tax-minimizing routes presented in this section remains unchanged even if the reduced CIT rate is assumed to be slightly higher, say 3 percent.

¹⁴When Korea (KR) is the source country, there are 102 tax-minimizing indirect routes from 19 home countries with two pass-through countries and 9 tax-minimizing indirect routes from 9 home countries with one pass-through country. When Saudi Arabia (SA) is the source country, there are 69 tax-minimizing indirect routes from 6 home countries with two pass-through countries and 43 tax-minimizing indirect routes from 20 home countries with one pass-through country.

Table 2. Tax-minimizing routes

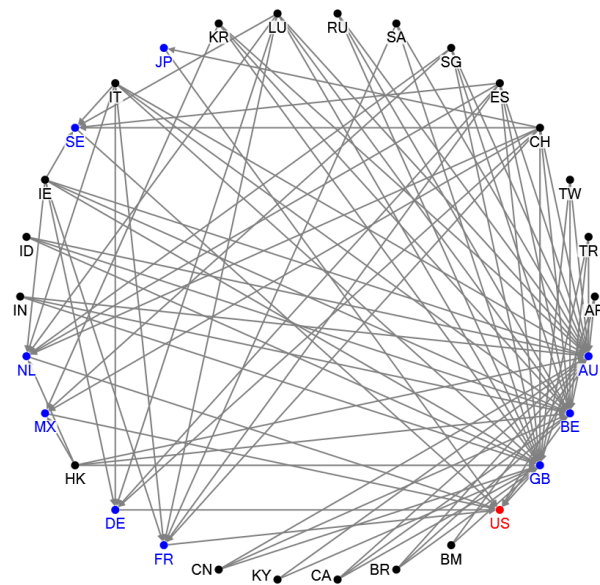
Source	Direct Home	Indirect Home	Indirect Route	TSA Mean
AR	29	0	0	0.00
AU	29	0	0	0.00
BE	26	3	18	2.48
BM	29	0	0	0.00
BR	29	0	0	0.00
CA	17	12	57	4.43
KY	29	0	0	0.00
CN	15	14	90	1.96
FR	15	14	60	5.55
DE	11	18	68	7.48
HK	29	0	0	0.00
IN	29	0	0	0.00
ID	1	28	28	6.32
IE	23	6	29	3.93
IT	11	18	68	7.76
JP	8	21	75	7.14
KR	1	28	111	8.73
LU	13	16	90	4.28
MX	10	19	102	4.79
NL	14	15	80	4.48
RU	14	15	74	3.13
SA	3	26	112	3.38
SG	29	0	0	0.00
ES	14	15	82	5.69
SE	13	16	58	7.72
CH	14	15	82	6.90
TW	10	19	90	5.72
TR	7	22	74	5.31
GB	29	0	0	0.00
US	9	20	85	10.69

Figure 1. Tax-minimizing routes to China



Note: source in red; countries with tax-minimizing direct routes in blue

Figure 2. Tax-minimizing routes to the United States



Note: source in red; countries with tax-minimizing direct routes in blue

China. These home countries are as follows:

$$H_{\text{CN}}^I = \{\text{AR, AU, BM, BR, CA, KY, IN, ID, IT, JP, ES, TW, TR, US}\}$$

Here the subscript (CN) is used to indicate the source country. For instance, there are tax-minimizing indirect routes from the United States (US) to China through the Netherlands or Hong Kong.¹⁵ The TSA rate among routes from US to CN is calculated to be about 4.05 percentage points while the TSA Mean for CN is about 1.96 percentage points. Figure 1 shows the structure of tax-minimizing routes to China. In Figure 1, the source country is marked in red. Home countries with tax-minimizing direct routes to the source country, as listed in H_{CN}^D , are marked in blue. Home countries with tax-minimizing indirect routes to the source country, as listed in H_{CN}^I , are marked in black. Each arrow shows the direction of a route.

Instead, when the United States (US) is the source country, there are 9 home countries with tax-minimizing direct routes. Also, there are 20 home countries with 85 tax-minimizing indirect routes to the United States. On average, the TSA rate is about 10.69 percentage points. Figure 2 shows the structure of tax-minimizing routes to the United States, marked in red. Countries marked in blue belong to H_{US}^D whereas countries marked in black belong to H_{US}^I .

5 Conclusion

In real-world cases of tax treaty shopping, investors own and operate conduit entities in countries with favorable treaties, and tax authorities may not know the true residency of the investors. To better understand the behavior of investors, or unknown beneficial owners, in this paper, I develop a game-theoretic model with incomplete information about the types of investors and

¹⁵This result is consistent with anecdotal evidence that IBM Corporation indirectly owned and operated IBM China Company Ltd., a Chinese subsidiary, through IBM Holdings B.V., a Dutch holding company. Starbucks Corporation also indirectly owned and operated Starbucks (China) Company Ltd., a Chinese subsidiary, through Starbucks Asia Pacific Investment Holding II Ltd., a holding company in Hong Kong.

tax authorities, and examine a Bayesian Nash equilibrium where an investor of a country with tax-minimizing indirect routes uses such indirect routes with positive probability. I also compute tax revenue loss due to the use of indirect routes for treaty shopping, and show the payoff dominance of a random audit strategy to the mandatory audit strategy. Under foreign tax credit systems in residence countries with relatively high corporate income tax rates, there is an equilibrium where an investor chooses a direct route regardless of her type. Thus, treaty shopping can be prevented in equilibrium. In addition I analyze the structure of tax-minimizing routes between selected countries to distinguish country types and to assess treaty shopping arbitrage.

For future studies it will be important to examine foreign tax credit systems from the perspectives of capital exporting or investors' residence countries. Foreign tax credit systems can help prevent treaty shopping but may also be vulnerable to other tax planning techniques, such as "foreign tax credit generators," unfairly reducing tax revenue in residence countries. In an extended model, residence countries may choose tax relief systems to maximize their own revenue, and then investors and source countries may play the game of treaty shopping and tax auditing, as examined in this paper.

It will also be interesting to study a model where an investor can choose a destination of investment. In this paper, given a pair of residence and source countries, an investor chooses an investment route, direct or indirect, from the residence to the source (destination) country. However, if the tax agency of the source country is expected to be aggressive, or to audit frequently, the investor may want to adjust her destination. Moreover, expecting this adjustment, the tax agency may have to be more accommodating toward the investor who uses a tax-minimizing indirect route.

I wish to address these issues in my future research.

Appendix

Proof of Remark 1. Because $a(c) \in \{0, 1\}$ for $c \in \{c_L, c_H\}$, there are four pure strategies for the tax agency. Let $a^1(\cdot)$ denote the strategy such

that $a^1(c_L) = 0$ and $a^1(c_H) = 0$. Let $a^2(\cdot)$ denote the strategy such that $a^2(c_L) = 0$ and $a^2(c_H) = 1$. Let $a^3(\cdot)$ denote the strategy such that $a^3(c_L) = 1$ and $a^3(c_H) = 0$. Let $a^4(\cdot)$ denote the strategy such that $a^4(c_L) = 1$ and $a^4(c_H) = 1$. This proof is divided into four cases.

Case 1. Suppose that the tax agency chooses $a^1(\cdot)$. Given $a^1(\cdot)$, to maximize her expected payoff, the investor chooses a tax-minimizing indirect route when she is of type $h = 1$ and chooses the direct route when she is of type $h = 2$. Let $b^0(\cdot)$ denote such a strategy. Because $b^0(\cdot)$ is the best response to $a^1(\cdot)$, $(a^1(\cdot), b^0(\cdot))$ is the only strategy profile that can be an equilibrium. Given $b^0(\cdot)$, if the tax agency chooses $a^1(\cdot)$, for type c_L , $u_A(a^1(\cdot), b^0(\cdot); c_L) = E_\pi [mw(b^0(\cdot))]$. If the tax agency chooses $a^3(\cdot)$, for type c_L , $u_A(a^3(\cdot), b^0(\cdot); c_L) = E_\pi [mw(b^0(\cdot))] + E_\pi [mp(1, b^0(\cdot))] - c_L$. Because $E_\pi [mp(1, b^0(\cdot))] = \pi_1 mp^*$ and $c_L < \pi_1 mp^*$, it holds that $u_A(a^1(\cdot), b^0(\cdot); c_L) < u_A(a^3(\cdot), b^0(\cdot); c_L)$. Thus, $a^1(\cdot)$ is not a best response to $b^0(\cdot)$, and $(a^1(\cdot), b^0(\cdot))$ is not an equilibrium.

Case 2. Suppose that the tax agency chooses $a^2(\cdot)$. By way of contradiction, suppose that for some $b(\cdot)$, $(a^2(\cdot), b(\cdot))$ is an equilibrium. For type c_H , $u_A(a^2(\cdot), b(\cdot); c_H) = E_\pi [mw(b(\cdot))] + E_\pi [mp(1, b(\cdot))] - c_H$ and $u_A(0, b(\cdot); c_H) = E_\pi [mw(b(\cdot))]$. Because $(a^2(\cdot), b(\cdot))$ is an equilibrium, $u_A(a^2(\cdot), b(\cdot); c_H) \geq u_A(0, b(\cdot); c_H)$, which implies $E_\pi [mp(1, b(\cdot))] \geq c_H$. Because $c_L < c_H$, $c_L < E_\pi [mp(1, b(\cdot))]$. However, for type c_L , $u_A(a^2(\cdot), b(\cdot); c_L) = E_\pi [mw(b(\cdot))]$ and $u_A(1, b(\cdot); c_L) = E_\pi [mw(b(\cdot))] + E_\pi [mp(1, b(\cdot))] - c_L$. Because $(a^2(\cdot), b(\cdot))$ is an equilibrium, it must be that $u_A(a^2(\cdot), b(\cdot); c_L) \geq u_A(1, b(\cdot); c_L)$, which implies that $E_\pi [mp(1, b(\cdot))] \leq c_L$. This is a contradiction. Thus, there is no $b(\cdot)$ for which $(a^2(\cdot), b(\cdot))$ is an equilibrium.

Case 3. Suppose that the tax agency chooses $a^3(\cdot)$. Given $a^3(\cdot)$, to maximize her expected payoff, the investor always chooses the direct route regardless of her type. This is because $(t_{s1} - f(b^*))(1 - t_1) < \phi_L p^*$ implies that, for the investor of type $h = 1$, $u_B(a^3(\cdot), b^*; 1) = m(1 - f(b^*))(1 - t_1) - \phi_L p^* < m(1 - t_{s1})(1 - t_1) = u_B(a^3(\cdot), 1, s; 1)$. For the investor of type $h = 2$, the direct route is tax-minimizing with no risk of the penalty tax. Let $b^1(\cdot)$ denote the

strategy that the investor always chooses the direct route. Because $b^1(\cdot)$ is the best response to $a^3(\cdot)$, $(a^3(\cdot), b^1(\cdot))$ is the only strategy profile that can be an equilibrium. Given $b^1(\cdot)$, if the tax agency chooses $a^3(\cdot)$, for type c_L , the expected payoff is $u_A(a^3(\cdot), b^1(\cdot); c_L) = E_\pi [mt_{sh}] - c_L$. If the tax agency chooses $a^1(\cdot)$, for type c_L , the expected payoff is $u_A(a^1(\cdot), b^1(\cdot); c_L) = E_\pi [mt_{sh}]$. Thus, $a^3(\cdot)$ is not a best response to $b^1(\cdot)$, and $(a^3(\cdot), b^1(\cdot))$ is not an equilibrium.

Case 4. Suppose that the tax agency chooses $a^4(\cdot)$. Because the tax agency of each type audits the investor, as in Case 3, $b^1(\cdot)$ is the best response to $a^4(\cdot)$. However, $a^4(\cdot)$ is not a best response to $b^1(\cdot)$, and $(a^4(\cdot), b^1(\cdot))$ is not an equilibrium. \square

Proof of Remark 2. This proof is divided into four parts.

(i) Assume $\pi_1 mp^* < c_L$. Let $a^1(\cdot)$ be the strategy that the tax agency of each type chooses no audit. Let $b^0(\cdot)$ be the strategy that the investor of country 1 chooses a tax-minimizing indirect route and the investor of country 2 chooses the direct route. Show that $(a^1(\cdot), b^0(\cdot))$ is an equilibrium. Let $a^1(\cdot)$ be given. Because the tax agency of each type chooses not to audit at all, the investor of country 1 can maximize her payoff by choosing a tax-minimizing indirect route and the investor of country 2 can maximize her payoff by choosing the direct route. Thus, for the investor, $b^0(\cdot)$ is a best response to $a^1(\cdot)$. Let $b^0(\cdot)$ be given. Because $\pi_1 mp^* < c_L$ and $c_L < c_H$, when the investor of country 1 chooses an indirect route and the investor of country 2 chooses the direct route, the tax agency of each type can maximize its payoff by not auditing. Thus, for the tax agency, $a^1(\cdot)$ is a best response to $b^0(\cdot)$. Therefore, $(a^1(\cdot), b^0(\cdot))$ is an equilibrium.

(ii) Assume $c_L < \pi_1 mp^* < c_H$ and $\phi_L p^* < (t_{s1} - f(b^*))(1 - t_1)$. Let $a^3(\cdot)$ be the strategy that the tax agency of type c_L chooses to audit and the tax agency of type c_H chooses not to audit. Let $b^0(\cdot)$ be the strategy that the investor of country 1 chooses a tax-minimizing indirect route and the investor of country 2 chooses the direct route. Show that $(a^3(\cdot), b^0(\cdot))$ is

an equilibrium. Let $a^3(\cdot)$ be given. For the investor of country 1, it is dominated to choose an indirect route that is not tax-minimizing, as shown in the proof of Theorem 1. Also, because $\phi_L p^* < (t_{s1} - f(b^*))(1 - t_1)$, it holds that $u_B(a^3(\cdot), 1, s; 1) = m(1 - t_{s1})(1 - t_1) < m(1 - f(b^*))(1 - t_1) - \phi_L m p^* = u_B(a^3(\cdot), b^*; 1)$. Thus, the investor of country 1 earns a greater payoff by choosing a tax-minimizing indirect route b^* than by choosing the direct route. Moreover, for the investor of country 2, it is weakly dominant to choose the direct route, as in the proof of Theorem 1. Thus, for the investor, $b^0(\cdot)$ is a best response to $a^3(\cdot)$. Let $b^0(\cdot)$ be given. Because $c_L < \pi_1 m p^*$, $u_A(0, b^0(\cdot); c_L) = E_\pi [mw(b^0(\cdot))] < E_\pi [mw(b^0(\cdot))] + \pi_1 m p^* - c_L = u_A(1, b^0(\cdot); c_L)$. Thus, the tax agency of type c_L earns a greater payoff by auditing. However, because $\pi_1 m p^* < c_H$, the tax agency of type c_H earns a greater payoff by not auditing. Thus, for the tax agency, $a^3(\cdot)$ is a best response to $b^0(\cdot)$. Therefore, $(a^3(\cdot), b^0(\cdot))$ is an equilibrium.

(iii) Assume $c_H < \pi_1 m p^*$ and $\phi_L p^* < (t_{s1} - f(b^*))(1 - t_1) < p^*$. Let $a^*(\cdot)$ be the strategy that the tax agency of type c_L audits for sure and the tax agency of type c_H audits with probability $\alpha = ((t_{s1} - f(b^*))(1 - t_1) - \phi_L p^*) / \phi_H p^*$. Let $b^*(\cdot)$ be the strategy that the investor of country 1 chooses tax-minimizing indirect routes with probability $\beta = c_H / \pi_1 m p^*$ and the investor of country 2 chooses the direct route for sure. Show that $(a^*(\cdot), b^*(\cdot))$ is an equilibrium. Let $a^*(\cdot)$ be given. As in the proof of Theorem 1, the investor of country 1 chooses either the direct route $1, s$ or a tax-minimizing indirect route b^* . Because $E_\phi [mp(a^*(\cdot), b^*)] = \phi_L m p^* + \phi_H \alpha m p^* = m(t_{s1} - f(b^*))(1 - t_1)$, it holds that $u_B(a^*(\cdot), 1, s; 1) = m(1 - t_{s1})(1 - t_1) = u_B(a^*(\cdot), b^*; 1)$. Thus, the investor of country 1 is indifferent between $1, s$ and b^* . Moreover, for the investor of country 2, it is weakly dominant to choose the direct route. Thus, for the investor, $b^*(\cdot)$ is a best response to $a^*(\cdot)$. Let $b^*(\cdot)$ be given. For the tax agency of type c , because $E_\pi [mp(1, b^*(\cdot))] = \pi_1 \beta m p^* = c_H$, $u_A(1, b^*(\cdot); c) = E_\pi [mw(b^*(\cdot))] + c_H - c$. Because $u_A(0, b^*(\cdot); c) = E_\pi [mw(b^*(\cdot))]$, the tax agency of type c_L prefers audit, and the tax agency of type c_H is indifferent between audit and no audit. Thus, for the tax agency, $a^*(\cdot)$ is a best response

to $b^*(\cdot)$. Therefore, $(a^*(\cdot), b^*(\cdot))$ is an equilibrium.

(iv) Assume $c_H < \pi_1 mp^*$ and $p^* < (t_{s1} - f(b^*))(1 - t_1)$. Let $a^4(\cdot)$ be the strategy that the tax agency of each type chooses to audit. Let $b^0(\cdot)$ be the strategy that the investor of country 1 chooses a tax-minimizing indirect route and the investor of country 2 chooses the direct route. Show that $(a^4(\cdot), b^0(\cdot))$ is an equilibrium. Let $a^4(\cdot)$ be given. For the investor of country 1, it is dominated to choose an indirect route that is not tax-minimizing, as shown in the proof of Theorem 1. Also, because $p^* < (t_{s1} - f(b^*))(1 - t_1)$, it holds that $u_B(a^4(\cdot), 1, s; 1) = m(1 - t_{s1})(1 - t_1) < m(1 - f(b^*))(1 - t_1) - mp^* = u_B(a^4(\cdot), b^*; 1)$. Thus, the investor of country 1 earns a greater payoff by choosing a tax-minimizing indirect route b^* than by choosing the direct route. Moreover, for the investor of country 2, it is weakly dominant to choose the direct route, as in the proof of Theorem 1. Thus, for the investor, $b^0(\cdot)$ is a best response to $a^4(\cdot)$. Let $b^0(\cdot)$ be given. Because $c_L < c_H$ and $c_H < \pi_1 mp^*$, $u_A(0, b^0(\cdot); c_L) = E_\pi[mw(b^0(\cdot))] < E_\pi[mw(b^0(\cdot))] + \pi_1 mp^* - c_L = u_A(1, b^0(\cdot); c_L)$. Thus, the tax agency of type c_L earns a greater payoff by auditing. Similarly, because $c_H < \pi_1 mp^*$, the tax agency of type c_H earns a greater payoff by auditing. Thus, for the tax agency, $a^4(\cdot)$ is a best response to $b^0(\cdot)$. Therefore, $(a^4(\cdot), b^0(\cdot))$ is an equilibrium. \square

Proof of Theorem 3. This proof proceeds in three steps.

Step 1. For the investor of type $h = 1$, it is weakly dominant to choose the direct route. Let $b^*(1) = 1, s$ be the direct route. For each $a(c) \in \{0, 1\}$, $p(a(c), b^*(1)) = 0$. Because $f(b^*(1)) = t_{s1}$ and $t_{s1} \leq t_1$, $u_B(a(c), b^*(1); 1) = m(1 - \max\{t_{s1}, t_1\}) = m(1 - t_1)$. For each $b \in R(1, s)$ with $b \neq b^*(1)$, if $a(c) = 0$, then $p(a(c), b) = 0$ and $u_B(a(c), b; 1) = m(1 - \max\{f(b), t_1\})$. Because $t_1 \leq \max\{f(b), t_1\}$, $u_B(a(c), b; 1) \leq u_B(a(c), b^*(1); 1)$. Also, if $a(c) = 1$, $p(a(c), b) = p^*$ and $u_B(a(c), b; 1) = m(1 - \max\{f(b), t_1\}) - mp^*$. Because $mp^* > 0$ and $t_1 \leq \max\{f(b), t_1\}$, $u_B(a(c), b; 1) < u_B(a(c), b^*(1); 1)$.

Step 2. For the investor of type $h = 2$, it is weakly dominant to choose the direct route. Let $b^*(2) = 2, s$ be the direct route. Because $H^D = \{2\}$,

the direct route is tax-minimizing, i.e., for each $b \in R(2, s)$, $f(b^*(2)) \leq f(b)$. For each $b \in R(2, s)$ with $b \neq b^*(2)$, if $a(c) = 0$, then $p(a(c), b^*(2)) = p(a(c), b) = 0$. Thus, $u_B(a(c), b; 2) = m(1 - \max\{f(b), t_2\})$, and since $f(b^*(2)) = t_{s2}$, $u_B(a(c), b^*(2); 2) = m(1 - \max\{t_{s2}, t_2\})$. Because $t_{s2} \leq f(b)$ implies $\max\{t_{s2}, t_2\} \leq \max\{f(b), t_2\}$, $u_B(a(c), b; 2) \leq u_B(a(c), b^*(2); 2)$. Also, for each $b \in R(2, s)$ with $b \neq b^*(2)$, if $a(c) = 1$, then $p(a(c), b^*(2)) = 0 < p^* = p(a(c), b)$. Thus, $u_B(a(c), b; 2) = m(1 - \max\{f(b), t_2\}) - mp^*$, and since $f(b^*(2)) = t_{s2}$, $u_B(a(c), b^*(2); 2) = m(1 - \max\{t_{s2}, t_2\})$. Because $mp^* > 0$, similarly as above, $u_B(a(c), b; 2) < u_B(a(c), b^*(2); 2)$.

Step 3. From the previous steps, for the investor of both types, it is weakly dominant to choose the direct route. If the investor chooses the direct route regardless of her type, there is no penalty tax even if the tax agency audits the investor. Thus, to maximize the payoff, the tax agency chooses no audit regardless of its type. Hence, there is an equilibrium where the tax agency chooses no audit and the investor chooses the direct route regardless of their types. \square

Proof of Theorem 4. This proof proceeds in five steps.

Step 1. For the investor of type $h = 2$, it is weakly dominant to choose the direct route. Let $b^*(2) = 2, s$ be the direct route. Because $H^D = \{2\}$, the direct route is tax-minimizing, i.e., for each $b \in R(2, s)$, $f(b^*(2)) \leq f(b)$. For each $b \in R(2, s)$ with $b \neq b^*(2)$, if $a(c) = 0$, then $p(a(c), b^*(2)) = p(a(c), b) = 0$. Thus, $u_B(a(c), b; 2) = m(1 - \max\{f(b), t_2\})$, and since $f(b^*(2)) = t_{s2}$, $u_B(a(c), b^*(2); 2) = m(1 - \max\{t_{s2}, t_2\})$. Because $t_{s2} \leq f(b)$ implies $\max\{t_{s2}, t_2\} \leq \max\{f(b), t_2\}$, $u_B(a(c), b; 2) \leq u_B(a(c), b^*(2); 2)$. Also, for each $b \in R(2, s)$ with $b \neq b^*(2)$, if $a(c) = 1$, then $p(a(c), b^*(2)) = 0 < p^* = p(a(c), b)$. Thus, $u_B(a(c), b; 2) = m(1 - \max\{f(b), t_2\}) - mp^*$, and since $f(b^*(2)) = t_{s2}$, $u_B(a(c), b^*(2); 2) = m(1 - \max\{t_{s2}, t_2\})$. Because $mp^* > 0$, similarly as above, $u_B(a(c), b; 2) < u_B(a(c), b^*(2); 2)$.

Step 2. Suppose that the investor of type $h = 2$ chooses the direct route for sure. Also, suppose that the investor of type $h = 1$ chooses tax-minimizing

indirect routes with probability $c_L/\pi_1 mp^*$. Let $b^*(\cdot)$ denote such a strategy. Given $b^*(\cdot)$, the tax agency of type c_H chooses not to audit. Let $a^*(c_H) = 0$ and $a(c_H) = 1$. Given $b^*(\cdot)$, $u_A(a^*(c_H), b^*(\cdot); c_H) = E_\pi [mw(b^*(\cdot))]$. Also, $u_A(a(c_H), b^*(\cdot); c_H) = E_\pi [mw(b^*(\cdot))] + E_\pi [mp(a(c_H), b^*(\cdot))] - c_H$. Because $E_\pi [mp(a(c_H), b^*(\cdot))] = c_L$ and $c_L < c_H$, it holds that $u_A(a(c_H), b^*(\cdot); c_H) < u_A(a^*(c_H), b^*(\cdot); c_H)$.

Step 3. For the investor of type $h = 1$, it is weakly dominated to choose an indirect route that is not tax-minimizing. Let $b(h) = b$ denote such a route. Since country 1 belongs to H^I , there is a tax-minimizing indirect route $b^* = 1, i, \dots, j, s$ such that $f(b^*) < t_{s1}$. Let $b^*(h) = b^*$. Because b and b^* are indirect routes, for each $a(c) \in \{0, 1\}$, $p(a(c), b) = p(a(c), b^*)$. Because b^* is tax-minimizing but b is not, $f(b^*) < f(b)$, which implies $\max\{f(b^*), t_1\} \leq \max\{f(b), t_1\}$. Thus, for each $a(c) \in \{0, 1\}$ and for type $h = 1$, it holds that $u_B(a(c), b; h) \leq u_B(a(c), b^*; h)$.

Step 4. Suppose that there are $\ell \geq 1$ tax-minimizing indirect routes from country 1 to country s . Each of such routes is denoted by $b^k = 1, i_k, \dots, j_k, s$ with $k = 1, \dots, \ell$, and is played with probability q_k , where $\sum_{k=1}^{\ell} q_k = c_L/\pi_1 mp^*$. Let $t_f = \max\{f(b^*), t_1\}$. Let $(a^*(\cdot), b^*(\cdot))$ denote the strategy profile specified as follows:

$$a^*(c) = \begin{cases} 1 & \text{with probability } (t_{s1} - t_f)/\phi_L p^* \text{ for } c = c_L \\ 0 & \text{with probability } 1 - (t_{s1} - t_f)/\phi_L p^* \text{ for } c = c_L \\ 0 & \text{with probability 1 for } c = c_H \end{cases}$$

$$b^*(h) = \begin{cases} b^k & \text{with probability } q_k \text{ for } h = 1 \\ 1, s & \text{with probability } 1 - \sum_{k=1}^{\ell} q_k \text{ for } h = 1 \\ 2, s & \text{with probability 1 for } h = 2 \end{cases}$$

Given the investor's strategy $b^*(\cdot)$, for type c_L , $E_\pi [mp(1, b^*(\cdot))] = c_L$ and $u_A(1, b^*(\cdot); c_L) = E_\pi [mw(b^*(\cdot))]$. Also, $u_A(0, b^*(\cdot); c_L) = E_\pi [mw(b^*(\cdot))]$. Thus, the tax agency of type c_L is indifferent between $a^*(c_L) = 1$ and $a^*(c_L) = 0$. Given the tax agency's strategy $a^*(\cdot)$, for type $h = 1$, it holds

that $u_B(a^*(\cdot), b^k; h) = m(1 - t_{s1}) = u_B(a^*(\cdot), h, s; h)$. Hence, the investor of type $h = 1$ is indifferent between $b^*(h) = b^k$ and $b^*(h) = h, s$.

Step 5. From Step 1, it is weakly dominant for the investor of type $h = 2$ to choose the direct route. Thus, regardless of what the tax agency does, the investor of type $h = 2$ will choose the direct route, as specified in $b^*(\cdot)$. Given $b^*(\cdot)$, from Step 2, the tax agency of type c_H will choose no audit, as specified in $a^*(\cdot)$. Because it is weakly dominated for the investor of type $h = 1$ to choose an indirect route that is not tax-minimizing, from Step 3, the investor of type $h = 1$ will only choose either the direct route or a tax-minimizing indirect route. By choosing the mixed strategy specified in Step 4, each player makes the other player indifferent between the actions played with positive probability. Therefore, $(a^*(\cdot), b^*(\cdot))$ is an equilibrium. \square

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