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Ranking the Stars

Network Analysis of Bilateral Tax Treaties

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With a novel approach this paper sheds light on the international tax planning possibilities of multinationals. The international corporate tax system is considered a network, just like for transportation, and 'shortest' paths are computed, minimizing tax payments for the multinationals when repatriating profits. The network consists of 108 jurisdictions, and the 'shortest' paths are constructed from the rates of corporate income taxes, withholding taxes on dividends and the double taxation relief methods. Double taxation treaties typically lower bilateral withholding taxes. The possibility to funnel investments through a third country to take advantage of treaty provisions, treaty shopping, is found to lead to an average potential reduction of the combined effective tax rate of more than 6 percent. On average, multinationals need only pay taxes of 6 percent, after the corporate income tax in the host country. Moreover, the network approach identifies the countries which are most likely to perform the role of conduits. The United Kingdom heads the rankings of three out of four network centrality measures. The tax revenues on dividends for the conduit countries are less than a half percent of the worldwide flows. Finally, a crackdown on tax havens is simulated. The impact is found to be modest, both on the tax reduction and on network centrality. The result illustrates the strong dampening effect treaty shopping has on the remaining double tax rates.

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1. Introduction

There is growing international concern over the erosion of income tax bases, both personal and corporate. Actions to combat the evasion of the personal income tax seem to amount to a crackdown on bank secrecy laws and aggressive tax practices of international corporations are brought to the public eye, if not judgment.[1] With a novel approach this paper is able to shed light on part of the international taxation of multinationals.

Multinational enterprises (MNE's) can exploit the differences in the tax codes of different jurisdictions. This may take several forms, such as transfer pricing, thin capitalization, hybrid mismatches, and treaty shopping. The OECD (2013) is active in analyzing these practices and discussing policy options with the ongoing work on Base Erosion and Profit Shifting (BEPS).

Treaty shopping is the practice where MNE's, rather than investing directly in a host country, funnel the investment through a third country to take advantage of treaty provisions not found between the host and the home country of the investment (Davies, 2004). Countries sign treaties on a bilateral basis to avoid double taxation of corporate income to stimulate mutual foreign direct investment (FDI). These treaties are referred to as DTT's: double taxation treaties. The definition of treaty shopping we use is an economic one, emphasizing the indirect investment routing. This is opposed to a legal definition where treaty shopping is equated to treaty abuse. Treaty shopping used to receive relatively little attention, neither by international organizations nor in academic journals. However, recently the IMF (2014) has identified treaty shopping as a spillover in international corporate taxation and a concern for developing countries because of the loss of tax revenue. The OECD (2014) addresses it in its BEPS action plan.

We conclude that this attention is deserved as treaty shopping potentially leads to a significant reduction of the tax burden for MNE's. We find a world-average potential reduction of the compounded (combined effective) tax rate of 6 percent. This is on top of the reduction of the 9 percent which can already be realized through the DTT's themselves, i.e. without indirect routing of repatriated income. We consider the international tax system as a network, just like for transportation, and compute the 'shortest' paths, minimizing tax expenditure for the MNE's when repatriating profits. We are not aware of other work where this approach is taken and quantified. Our network consists of 108 jurisdictions, and the 'distances' are constructed from the statutory rates of corporate income taxes, withholding taxes on dividends and the double taxation relief methods. The bilateral DTT's typically lower, reciprocally, the withholding taxes and provide for more generous relief methods (Avi-Yonah and Panayi, 2011). We compute the subsequent potential tax reductions starting from full double taxation.

[1] Johannesen and Zucman (2014), EU Tax Information Exchange, since March 20, 2014, with Austria and Luxembourg committed, UK (Parliamentary) Public Accounts Committee, November 2012.

The network approach enables us to identify countries most likely to perform the role of conduits, countries often accused of being accessories to the tax avoidance by MNE's. Centrality in the tax network could well contribute to explaining the worldwide pattern of FDI stocks, see table 1. Countries with relatively small economies account for large shares in FDI. For example, total inward FDI stocks into the Netherlands in 2011 equaled USD 3327 billion, accounting for 14 percent of worldwide inward FDI stocks. In 2011 the Netherlands ranked 23rd in terms of GDP (between brackets in column 1), with a share of about 1 percent. For Luxembourg the discrepancy is even more pronounced. The worldwide FDI pattern suggests large-scale diversion for tax reasons.

Table 1: Top 10 of inward and outward FDI stocks in 2011

Country	Inward	FDI	Country	Outward	FDI
	bln US$	%		bln US$	%
World	23816	100.0	**World**	24287	100.0
Netherlands (23)	3327	14.0	**United States (1)**	4156	17.1
Luxembourg (99)	2653	11.1	**Netherlands (23)**	4118	17.0
United States (1)	2548	10.7	**Luxembourg (99)**	2731	11.2
China (2)	1907	8.0	**United Kingdom (8)**	1725	7.1
United Kingdom (8)	1064	4.5	**France (9)**	1597	6.6
Hong Kong (35)	1030	4.3	**Germany (5)**	1356	5.6
France (9)	973	4.1	**Switzerland (36)**	1028	4.2
Germany (5)	928	3.9	**Hong Kong (35)**	972	4.0
Brazil (7)	706	3.0	**Japan (4)**	963	4.0
Switzerland (36)	643	2.7	**Canada (13)**	670	2.8

Source: IMF Coordinated Direct Investment Survey data, 2011, reporting countries. The totals of inward and outward stocks are not equal due to incomplete reporting and differences in registering stocks by source and host countries. Between brackets: GDP ranking (ppp).

The top 4 in our measure of network centrality are the United Kingdom, Estonia, Singapore and the Netherlands. Luxembourg is ranked 9th. For individual countries a central position in the tax network can be seen as a necessary condition for the role as a conduit.[2] The role of a conduit country does however not lead to major tax revenues, if only because they perform that role because they are cheap in tax terms. Spain heads the list of conduit taxation revenues.

We implement an international tax system as in Barrios et al. (2012), also combining host and home country taxation, including tax treaties and also focusing on dividends. We, however, consider a profit repatriation decision, given a subsidiary in host country A and the parent company in home country B. In principle profits could be taxed with the corporate income tax in the host and home country and with the dividend withholding tax in the host

[2] The significant coefficients of a simple regression, see annex D1, suggests that the centrality measure and FDI stocks are heavily correlated.

country. Double tax relief methods and tax treaties limit the possible triple taxation of dividend flows substantially. The possibility to pass through countries is added and thus the taxes of all possible conduit countries matter as well, both as a home and a host country. After a few minor but crucial adaptations, a standard algorithm from graph theory is applied to compute the required minimizations, much like the one in the navigation tool in your car.

Our analysis takes the investment decisions as given, i.e. those from a mother company in country B to a daughter in country A, but we allow for indirect financing structures involving other countries so as to reduce, especially, the non-resident withholding taxes upon repatriation of dividends. Mintz and Weichenrieder (2010) refer to this as the treaty shopping motive for setting up conduit entities in third countries.

Our main contribution is the transition to a network approach, which offers a rich framework to further investigate the effective tax rates facing MNE's. As one example we perform a scenario analysis: what-if, on a worldwide scale, all dividends arriving from tax havens were to be excluded from double taxation relief? The impact is found to be surprisingly modest, both in terms of the tax rates and in the network centrality of countries. This policy simulation highlights the dampening effect treaty shopping has on the final remaining double tax rates.

The paper proceeds with a brief discussion of the literature in section 2. The network approach to the international corporate tax system is described in section 3. Section 4 presents the data of the tax system and, at an aggregate level, the first tax reductions. The subsequent potential reductions by indirect routing are the topic of section 5. Next, in section 6, the results of network centrality are presented in the form of country rankings. The consequences of treaty shopping for national tax revenues are discussed in section 7. Then the exercise simulating a crackdown on tax havens is presented in section 8. The concluding section summarizes and discusses directions for further research.

2. Literature

Our work is related to Barrios et al. (2012) by following a multilateral approach of international corporate taxation. They investigate the location decision of new foreign subsidiaries and find that taxation of the home country, additional to that of the host country, has a significant negative impact. This home country taxation was thought to matter less because of possibilities of deferral of tax payment. We also use the basic matrix structure of international corporate taxation for dividend flows, including bilateral tax treaties, albeit for a much larger set of countries. The multilateral approach is also found in the seminal tax competition paper of Devereux et al. (2008) who estimate N x (N-1) tax reaction functions.

Moreover, Egger et al. (2009) construct effective tax rates between country pairs, reflecting overall host and home country taxation, and find that this bilateral effective tax rate has a negative impact on bilateral FDI stocks. However, they only construct these rates for direct routes, not taking account of treaty shopping for a sample of OECD country pairs between 1991 and 2002. Because the focus on OECD countries for which marginal and average effective tax rates (EMTR and EATR) are available they are able to calculate effective tax rates for each country pair.

There is an important difference between the papers mentioned above in their use of the term 'effective tax rate'. Devereux et al. (2008) and Egger et al. (2009) use the term to denote the rate determined by the statutory rates and definitions of the tax base, for instance for deductibility of interest on debt. This use, and the concepts of EMTR and EATR, is most common in the literature. Barrios et al. (2012) also start with statutory rates and then use the term 'combined effective tax rate' to account for the reductions of the tax base in a sequence of combined, subsequent, taxations.[3] As we miss the data on effective tax rates, i.e. the national definitions of the tax base, for most of the non-OECD countries in our sample, we follow Barrios et al. (2012).

Different from the papers above we are not mainly interested in the effects of tax rates on FDI or mergers and acquisitions but on the combined effective tax rates themselves. In particular, we want to know the effects of treaty shopping on these tax rates.

The literature on treaty shopping so far considered only the FDI effects of treaty shopping. Direct evidence of treaty shopping on FDI is scarce. One reason for this may be that the concept of treaty shopping is not exactly defined (Avi-Yonah and Panayi, 2011). We use the economic, or neutral, definition of Davies (2004): 'the practice where MNE's, rather than investing directly in a host country, funnel the investment through a third country to take

[3] In separate regressions performed as robustness checks, Barrios et al. (2009) do however use the EATR.

advantage of treaty provisions not found between the host and the home country of the investment.' However, there is also a legalistic definition in which treaty shopping is equated with treaty abuse: a party from a third country gaining access to a treaty advantage not intended for this party.[4]

With the possibility of treaty shopping being illegal, direct data are not likely to be easily available. Weyzig (2013) however makes use of micro data of Dutch Special Purpose Entities (SPE's) from 2007. SPE's, in general, are entities with no or few employees, little or no physical presence in the host country and whose core business consists of group financing or holding activities (OECD, 2013a). By relating the FDI flows via SPE's to the direct FDI flows (from the balance of payment statistics) he concludes that the share of bilateral FDI that is passing the Netherlands is 6 percentage points higher with a tax treaty route. This is a large effect because on average 11 percentage points of bilateral FDI stocks has passed the Netherlands. Also the low withholding tax rates on dividends have a significant impact on treaty shopping.

Lejour (2014) includes the number of treaties a country has signed as an indicator for its attractiveness to establish a holding. This indicator significantly impacts FDI: twenty extra tax treaties increase bilateral FDI stocks by about 50%. Some recent papers (Blonigen et al. (2011), Davies et al. (2009)) using micro data find positive effects as well from treaties on FDI.

The data of table 1 are inclusive of FDI positions held through special purpose entities. The SPE's, or conduit entities, are instruments in the tax planning of MNE's. Weichenrieder and Mintz (2008) construct for German multinationals the chains of corporate structures across various countries and relate these structures in 2001 to the underlying fiscal motives. The level of withholding taxes is found to be important in determining which countries are used as a platform for investments.

Next to treaty shopping, Mintz and Weichenrieder (2010) identify two other motives for setting up a conduit entity. One motive is the *parking* function: a conduit company is used to 'park' income in order to avoid taxes on profit repatriation. This motive is especially relevant when the home country of the parent company applies the credit system as double tax relief but defers taxation upon actual repatriation of income. The second other motive is tax-efficiency which involves so-called 'double dip' structures. A conduit entity is set up in a third country to the deductibility of interest payments from taxable profits. With indirect financing structures the same interest costs can be made fiscally deductable in the host and in the home country. Such financing structures and deductions from taxable profits are beyond the scope of this analysis. In this analysis we take the corporate income tax of the host countries as given and consider the double taxation on top of it.

[4] Ministry of Finance of the Netherlands (2011) and Department of Finance Canada (2013), for example.

3. The network approach to international corporate taxation

The international corporate tax system can be considered a network of countries where distance is defined as the cost of channeling corporate income from one country to another in terms of the taxes to be paid. This section first describes how these distances are composed from different international taxes, following Barrios et al. (2012). Next, the costs of tax routes over the network are discussed, involving conduit countries and treaty shopping. It is shown how the distances can be made to fit efficient algorithms to compute shortest paths, fully maintaining their tax interpretation.[5] If there are N countries; we have $\mathrm{N(N\text{-}1)}$ pairwise distances; these are more than 10 thousand distances in our data sample. The tax data are presented in section 4.

The international tax system

Consider a multinational with a subsidiary in a host country S and a parent company in home country P. Both countries may tax the income of the subsidiary. First, there is the corporate income tax (CIT) to be paid in the host country, at a rate t_S.[6]

Next, the host country may levy a non-resident withholding tax on the income of the subsidiary, net of the corporate income tax, when it is repatriated to the parent.

We only consider the withholding tax on dividends, recognizing that interest and royalty income are important as well.[7] The income considered refers therefore to profit income. Let w_S be the general dividend withholding tax of host country S. However, the host and home country may have signed a tax treaty and a reduced rate $w_{SP} \leq w_S$ may apply. Finally, the parent country may tax the foreign-source income at its CIT rate of t_P.

The tax code of the parent country may contain provisions to avoid double taxation, for instance it may have a dividend participation exemption: under certain conditions all, or part, of the foreign-source dividend income is exempted from the corporate income tax. These conditions typically require a minimum share in the participation, and a minimum number of years that the stocks are held. With these provisions direct investment differs from portfolio investment. Some countries exclude profit income from low-tax countries from their double tax relief method. In general we assume that the conditions are satisfied. Apart from *exemption* two other methods of double tax relief are taken into account: *deduction* and *credits*.[8] Deduction is the most modest relief method where no taxes need to be paid over the taxes already paid. The latter are deducted from the tax base. With the credit system the base is the income of the subsidiary but the taxes paid in the host country

[5] A more detailed elaboration of the required adaptations can be found in annex C1.
[6] The notation of Barrios et al. (2012) is followed and extended with a bilateral country dimension.
[7] Interest and royalties in the context of treaty shopping will be discussed later.
[8] Thus no-relief-at-all, which does occur sparingly, is ignored. See also annex C1.

are credited against the home corporate income tax.[9] Excess credit is not restituted. The credit method is less generous in terms of tax relief than exemption is but more so than deduction.

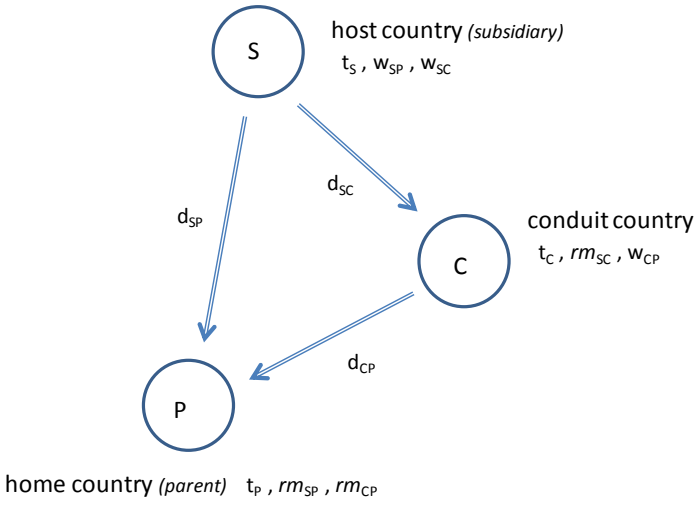
Let rm_P be the general double tax *r*elief *m*ethod applied by home country P. The tax treaties country P has signed may contain agreements to provide more generous double tax relief to treaty partner S. Thus also the relief methods have a double country dimension: rm_{SP}, the relief method applied by home country P on income from host country S. Observing that the tax paid in the host country is $1-(1-t_S)(1-w_{SP}) = t_S + w_{SP} - t_S w_{SP}$ the combined effective (compounded) tax rates $t^e_{SP}(rm_{SP})$ for the multinational can be determined depending on the relief method; all are fully in line with Barrios et al. (2012).

$$t^e_{SP}(deduction) = \quad 1-(1-t_S)(1-w_{SP})(1-t_P)$$
$$t^e_{SP}(credit) = \quad \max\{1-(1-t_S)(1-w_{SP}), t_P\}$$
$$t^e_{SP}(exemption) = \quad 1-(1-t_S)(1-w_{SP})$$

Conduit countries and treaty shopping

Now consider the possibility of indirect repatriation of dividends, i.e. through a third, or conduit, country C, see figure 1. It is rational for the MNE to choose the indirect route over the direct route, *ceteris paribus*, when its costs in terms of taxes are lower. For the total taxes on the indirect route care must be taken not to consider the CIT of the conduit twice.

Figure 1: Treaty shopping



Define the direct tax distance d_{SP} between host S and parent country P based only on the relevant withholding tax rate and the CIT of the parent, thus excluding the CIT of the host,

[9] With an indirect tax credit both the host corporate income tax and the withholding tax are credited. With a direct tax credit only the withholding tax can be credited. We ignore the latter here.

because this tax is always paid, irrespective of the relief method. Depending on the tax relief method again three possibilities are considered.

$$d_{SP}(deduction) = \quad 1-(1-w_{SP})(1-t_P)$$
$$d_{SP}(credit) = \quad \max\{ w_{SP}, (t_P - t_S)/(1-t_S)\}$$
$$d_{SP}(exemption) = \quad w_{SP}$$

By construction holds $t^e_{SP} = 1-(1-t_S)(1-d_{SP})$; the total taxation of the subsidiary's income in host S that is directly repatriated to parent country P can be composed of the CIT of host S and the tax distance between S and P.

Returning to the case of figure 1, the conduit country functions both as an intermediate host and as an intermediate parent. Treaty shopping will occur when total taxes over the indirect route are less than over the direct one, i.e. $1-(1-d_{SC})(1-d_{CP}) < d_{SP}$. As the CIT of host S is to be paid in both cases, it does not matter for the (absolute) comparison.

The CIT of an intermediate host does enter the equation when the next intermediate parent in a tax route applies the credit method. Then it may not be clear which taxes can be credited; all the taxes of the preceding part of the tax route, or just the taxes paid in the previous jurisdiction? In these conduit situations we take the rate of the world average corporate income tax to be credited. The withholding taxes of the previous country are always taken into account and are credited where required.

An alternative approach would be to assume that no taxes at all were paid so that no credits are applied. This would seriously underestimate the potential reduction of the tax burden for MNE's by treaty shopping. On the other hand, taking the nominal CIT of a conduit country as the basis for tax credit would overestimate the potential reduction as this CIT is not likely to be paid in full because of double tax relief.

As an example of an indirect route let the double tax relief of host P be the deduction method and let conduit country C exempt foreign-source dividend income.[10] The treaty shopping condition translates to $w_{SC} + w_{CP} - w_{SC}w_{CP} < w_{SP}$; the combined withholding taxes on the indirect route must be less than the one on the direct route. This is only possible when the withholding tax to the conduit country is less than the one to the parent, $w_{SC} < w_{SP}$.[11]

[10] Two numerical examples are provided in annex C2.

[11] This implies, given that the undiverted investment also would have taken place without the treaty shopping, that the host country loses tax revenue. This is usually the case and has led the OECD to conclude that treaty shopping is a harmful tax practice (OECD, 1998).

Shortest path algorithm

The tax distance of an indirect tax route with a single conduit country is the usual combined effective rate of two tax rates. More in general, for any tax route, with an initial host $k=1$ and final destination $k=\mathrm{n}$, the total tax distance equals $1-\prod_{k=2}^{\mathrm{n}}(1-d_{k-1,k})$.

Clearly, the order of the bilateral tax distances in the computation does not matter. This characteristic allows the use of standard and efficient algorithms to determine the length of the shortest path between all pairs of nodes on the network; or rather the minimum tax costs of repatriating dividends over the network for all country pairs. We use the elegant Floyd-Warshall algorithm[12] for this task. It stepwise builds up the matrix of shortest distances by consecutively adding and evaluating a new node, in arbitrary order, as an intermediate node, or conduit country. Efficiency of the algorithm is important as the number of possible routes over a network is huge.[13]

Matrices of double tax rates

The algorithm generates the matrix of shortest distances, representing the lowest tax costs in repatriating profits from all source countries to all residence countries. The lowest costs for a particular pair may be incurred on the direct route or on an indirect one. The average over all pairs will be taken, double GDP weighted, and, as we consider the taxes following the CIT of the host countries, we will speak of the world average *double* tax rates.

To distinguish between the contributions of double tax relief and treaty shopping in the final remaining double tax rates we first define a reference double tax rate for each pair of countries based on two parameters: the general withholding tax rate of the host country and the CIT rate of the parent country, compounded into $d_{SP}^{CMPD}=1-(1-w_S)(1-t_P)$.[14]
A next matrix of double tax rates allows for application of the general relief method of the home country, $d_{SP}^{DTRM}=d(w_S,t_P,rm_P)$, reducing the rates. Further reduction follows when the parameters agreed in bilateral treaties are taken into account: $d_{SP}^{TRTY}=d(w_{SP},t_P,rm_{SP})$.[15]
Finally considering treaty shopping there is the matrix of the lowest remaining double tax rates as generated by the Floyd-Warshall algorithm. These rates are a function of all the parameters of the network: $d_{SP}^{SHOP}=d(network)$.

The world averages of these rates will be computed, as will be country averages, both as hosts (for outward directed profits) and as parents (for inward directed profits). Thus the consecutive reductions in the average tax rates emerge and these will be presented below.

[12] See for instance Minieka (1978).
[13] For a simple network, that has 10 countries and is complete, meaning that all direct pairwise connections exist, there are almost 10 million simple routes.
[14] We take deduction as a reference for relief, not 'no-relief-at-all'.
[15] We will include here the Parent-Subsidiary directive of the EU: a multilateral tax treaty.

4. Tax data and double tax relief

The selection of 108 jurisdictions for the international network contains all high and upper middle income economies[16] for which sufficient tax data are available. This is augmented with large economies from the lower middle income country category, such as India, Indonesia and the Philippines, thus covering almost 95 percent of worldwide GDP in 2011. The full list is found in annex A1.

The selection includes also many jurisdictions considered a tax haven, because the latter are usually small and affluent, see for instance Dharmapala and Hines (2009). The importance of including tax havens is evident: they are likely conduit countries if only for their characteristic of low or zero taxes (OECD, 1998). Avoiding precise definitions we refer to the list of Gravelle (2013) as benchmark for tax havens.[17] In the end, we classify 21 countries in our list of 108 countries as tax havens.

The tax data are mainly obtained from the Worldwide Corporate Tax Guide 2013 from EY (formerly Ernst & Young). For each country, we have data on the corporate income tax rate, the general rate of the withholding tax on dividends, the general double tax relief method, possibly the more lenient tax relief method for treaty partners and the treaty dividend withholding tax rates. For the dividend tax rates, we choose normally the lowest rate which is often conditional on a substantial participation in the daughter company.[18] Quite often this is 10 to 25 percent of the stocks, but sometimes the lowest tax rate applies only if the firm owns the majority of the daughter company.

Although the data have been cross-checked with other information from public sources,[19] still errors and omissions are expected to remain. In addition, choices and interpretations are unavoidable as tax codes contain different rates and provisions that apply under different conditions, which may involve the level of corporate income, the industry, ownership shares, etc. Our choices and best knowledge are found in annex A1 (except for the treaty withholding tax rates).

Statutory rates of corporate income taxation have been used, where applicable including local taxes.[20] We ignore the possibilities to reduce the tax base in the host countries. Therefore the tax rates we calculate are an upper bound. As we are mainly interested in the routing decision of repatriating income given the ultimate host and home

[16] World Bank Atlas method, based on 2012 GNI per capita data.
http://data.worldbank.org/about/country-classifications

[17] However we exclude Ireland, Jordan, Luxembourg, Switzerland and Singapore. The Gravelle list is based on an overview of other papers classifying tax havens. The first four appear only in the list of Dharmapala and Hines (2009) and Hines and Rice (1994) and Singapore is often considered as another financial centre, different from tax havens.

[18] We have ignored lowest tax rates which only apply to non-profit organizations, such as pension funds and government institutions.

[19] For instance, Deloitte (2013) and Loyens & Loeff (2013).

[20] OECD Tax Database and KPMG Tax Tools and Resources.

country, the deduction possibilities of these two countries apply whatever the route chosen. Still that leaves the intermediate jurisdictions on the route. When these apply dividend exemption, neither effective (as in EATR) nor statutory rates are relevant. A final reason for not using effective tax rates is that they are simply not available for most of the countries in our data.[21]

The CIT rates are listed in annex A1 and in the first column of table 2 for a selected number of countries.[22] When foreign-source income is exempted from corporate taxation (xmp), the tax rate is inconsequential, for the other double tax relief methods it is not. The general tax relief method is indicated in the second column. Countries may provide more generous relief for foreign-source dividends coming from tax treaty partners. Where we have found evidence for this the relief method is applied to all treaty partners, although it should be treaty specific (see column (3)).

Table 2: Tax data 2013 - selected countries

Country	CIT	DTRM	THR	CFC	WHT-div	no. trts	tax haven	GDP weight
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bermuda	0.0	xmp		0	0.0	0	1	0.01
Brazil	34.0	crd		1	15.0	35	0	2.97
Canada	26.3	crd		0	25.0	75	0	1.88
China	25.0	crd		1	10.0	64	0	15.66
France	34.3	ded	crd	1	30.0	80	0	2.84
Germany	30.2	crd	xmp	1	25.0	71	0	4.04
Hong Kong	16.5	xmp		0	0.0	14	1	0.47
Japan	37.0	crd		0	20.0	48	0	5.84
Luxembourg	29.2	xmp		0	15.0	56	0	0.05
Malta	35.0	xmp		0	0.0	40	1	0.01
Netherlands	25.0	xmp		0	15.0	72	0	0.89
Switzerland	21.1	xmp		0	35.0	70	0	0.46
United Arab Emirates	0.0	xmp		0	0.0	23	0	0.34
United Kingdom	23.0	xmp		1	0.0	55	0	2.95
United States	39.1	crd		1	30.0	54	0	19.79

Note: crd= credit system, xmp = exemption, ded= deduction system.

Deviations from the general relief method may also be less generous. This is the case when a country applies anti-abuse provisions, or CFC (controlled foreign corporation)-rules to counter tax deferral and avoidance through artificial foreign entities. The CFC-column indicates countries with such provisions and for them the tax relief method is set to deduction for dividends coming from tax havens, listed in column (7).

[21] More in general, a broader fiscal and juridical environment will affect the holding decisions of multinationals and the size of taxable profit incomes. These activities may involve intra-company financing, and the location of intellectual property rights, so that deductibility of interest, and royalty payments matter, and the withholding taxes for these categories. Our analysis is, however, confined to dividend payments.

[22] These are the 12 countries from table 1 plus three other countries.

Tax havens are often low-tax countries, as is the case for Bermuda and possibly Hong Kong. Malta, listed as a tax haven, has a high corporate income tax of 35 percent, see column (7).[23] For holding companies however, this is irrelevant as Malta applies a participation exemption, as does Hong Kong. Tax havens tend to have in common zero withholding taxes. The general rates of this tax are found in the fifth column of table 2 and annex A1.

The sixth column indicates the number of bilateral tax treaties a country has with partners within the selection of 108 jurisdictions. The treaty withholding tax rates are bilateral by nature. This gives the tax data an inherent matrix structure, see table 3. Quite often a pair of countries agrees on the same withholding tax rates, but this is not always the case. In particular for host countries which levy high withholding tax rates, such as United States and Germany, it is important to negotiate a tax treaty, with substantially lower rates. For a country like Nigeria this is less important.

Table 3: Dividend withholding tax matrix 2013 - selected countries

From \ To	**Bermuda**	**China**	**Germany**	**Malta**	**NLD**	**Nigeria**	**USA**	**General**
Bermuda	-	0	0	0	0	0	0	0
China	10	-	10	5	10	7.5	10	10
Germany	25	10	-	0	0	25	5	25
Malta	0	0	0	-	0	0	0	0
Netherlands	15	10	0	0	-	12.5	0	15
Nigeria	10	7.5	10	10	7.5	-	10	10
United States	30	10	0	5	0	30	-	30

One important multilateral tax treaty is the Parent-Subsidiary directive of the EU.[24] This stipulates intra-EU withholding tax rates of zero and dividend participation exemption.

Double tax relief

With these tax data, the combined effective tax rates can be computed, on a bilateral basis and succeedingly world averages. A multinational could face triple taxation when repatriating profits of a foreign subsidiary; first the host country could levy a corporate income tax, next it could levy the dividend withholding tax and finally the home country could levy a corporate income tax. With an average, GDP-weighted, CIT rate of 29 percent and an average dividend withholding tax rate of 17 percent this amounts to a compounded rate of about 58 percent in the hypothetical case if all three taxation options are effectuated.

The average tax rates presented here are double GDP-weighted over country pairs. The GDP weights are presented in the last columns of table 2 and annex A1. Imagine a given country facing incoming dividends from all over the world, where the shares of the partner countries

[23] However, the larger part of the tax bill can be reclaimed, see Loyens and Loeff (2013).
[24] Next to the 27 EU member countries, *de facto* also Iceland, Norway and Switzerland are included.

in the total correspond to their GDP's. Then the share of the country in world-wide incoming dividends is also assumed to correspond to its GDP share.[25]

Taking the CIT of the host country as given, there remains in theory about 41 percent additional taxation due to double and triple taxation.[26] In practice there are double tax relief methods and tax treaties to reduce or even eliminate double taxation. As a result, countries often do not levy the second or third tax or reduce the tax burden.

First, we analyze the effectiveness of double tax relief methods countries apply without considering special arrangements in tax treaties. This reduces the average additional tax rate from more than 41 percent to 21.5 percent, a reduction of 20 percent. This reduction takes into account that dividends stemming from tax havens are excluded from more generous relief methods (exemption and credit method) by those countries applying CFC-rules. The effect of these rules on the world average tax rate is small because of the low GDP weight of the tax havens.

Second, the effectiveness of tax treaties is considered; all bilateral ones and the Parent-Subsidiary directive of the EU (EU, 1990). The treaties combine two reductions: lower withholding tax rates and more lenient tax relief methods for treaty partners. The combined effect is another reduction of about 9.5 percent. This leaves an average 'double' taxation, on top of the CIT of the host country, of 12 percent. Thus one can safely conclude that the double tax relief methods and the tax treaties do what they are supposed to do: they reduce double taxation substantially, but not completely.

To give one example: consider repatriating dividends from a subsidiary in the USA to a mother company in China. Full triple taxation would involve, see table 2, the CIT in the USA of 39.1%, the general non-resident withholding tax of the USA on dividends of another 30% and the CIT of China of 25%. This amounts to a staggering combined rate of 68%. The double taxation, i.e. on top of the CIT of the USA, would be 47.5%. But China applies the credit method as double tax relief: the full credit leaves a double taxation of 30%.[27] Then, finally, the tax treaty of the USA and China stipulates a withholding tax of 10%, see table 3, replacing the general rate of 30%. Quite often the treaty withholding tax is what finally remains as double taxation instead of the full double tax. More country specific reductions, and their apparent pattern, are discussed in section 5.

[25] In section 6 we will also present unweighted results.
[26] World average taxation on top of the CIT of the host equals $1 - (1 - .17)(1 - .29) \cong 0.4107$.
[27] Double taxes are those on top of the CIT of the host, such as the withholding tax, also payable to the host.

5. Treaty shopping potential

Section 4 only considered direct routes between the host and home countries, but we know that firms use indirect routes for dividend repatriation (Mintz and Weichenrieder, 2010). While double tax relief results from government behaviour, the final tax reduction illustrates the possibilities multinationals have to exploit the favourable tax arrangements in tax treaties by establishing holdings in conduit countries as pass-through for profit incomes. By using these conduit countries multinationals can lower their tax bill compared to a direct route. The cheapest tax routes over the network, for all country pairs, follow from applying the shortest path algorithm discussed in section 3. We find that for 67 percent of all country pairs there is a tax route cheaper than the direct one.

Whereas the reductions stemming from the general tax relief methods and the tax treaty provisions are straightforward, the reductions from treaty shopping must involve deliberate diversion of investment, which will not always take place. Moreover the exploitation of tax treaties could be bounded to rules as by the limitation of benefits articles in the treaties. Therefore we label this as potential reductions. We find that the potential reduction by treaty shopping is 6 percent. This lowers the world-wide average additional taxation, i.e. given the corporate taxation of host countries, from nearly 12 to 6 percent. Recognizing that these double tax rates are based on statutory rates, indeed little 'double' taxation remains. The findings also establish that treaty shopping is a relevant mechanism for lowering the remaining double taxation after the application of double relief methods and tax treaties.

Treaty shopping lowers the combined effective tax rates for two reasons. The first is that firms benefit from lower withholding taxes which explains about three quarter of the tax rate reduction. The second is that firms benefit from more beneficial double tax relief methods agreed upon in treaties. This explains another fifth of the tax rate reduction.

Figure 2: Double tax relief and treaty shopping prevent double taxation

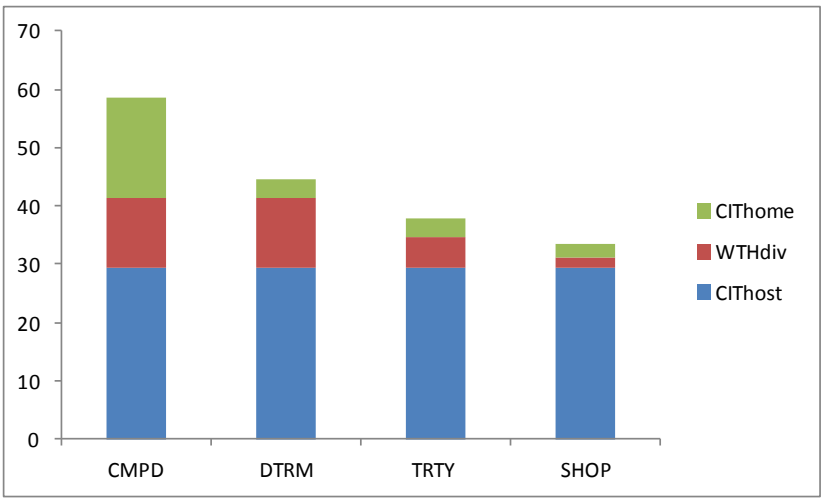


Figure 2 summarizes the consecutive tax reductions, from the compounded double taxation (CMPD), to the double tax relief methods (DTRM) and the reductions directly stipulated in the tax treaties (TRTY) and finally the reductions possible by treaty shopping (SHOP). The CIT of the host country, the blue base of the colons, remains unaffected in our analysis where treaty shopping is restricted to the benefits of indirect repatriation of dividend flows. The precise numbers are found in table 4.[28] Taxation in the conduit countries will be discussed in section 7.

Table 4: World average remaining combined effective tax rates (percentages)

	CMPD	DTRM	TRTY	SHOP
CIT host	29.23	29.23	29.23	29.23
WTH div	17.10	17.10	7.80	2.54
CIT home	29.23	5.36	4.63	3.58
Double	41.39	21.54	12.07	6.03
Triple	58.48	44.47	37.77	33.49

Even after the possibility of treaty shopping there remains an additional combined effective tax rate of about 6 percent because firms cannot always escape non-resident withholding taxation in the host country and the CIT in the home country. Some host countries always levy a withholding tax on outgoing dividends irrespective of the home country and some home countries always levy a CIT because they allow no tax relief at all or only deduction.

Country specific tax reductions

The world average tax reductions presented above are based on bilateral tax relations, which, for each country pair, have two directions. In one direction a country is the host for the investment and source of the repatriated profits while the other country is the home country of the investment and destination of the dividends. In the other direction the roles of both countries are reversed. The country specific results are therefore given in two tables, see annexes B1 and B2.[29] Observe that these country results are the rates multinationals face using the countries as hosts for their subsidiaries or as residence of the mother companies. The results do not directly relate to tax revenues. The weighted average double tax rates by country, discussed below for their outward and inward dividend flows, may help in understanding the workings of the international corporate tax system.

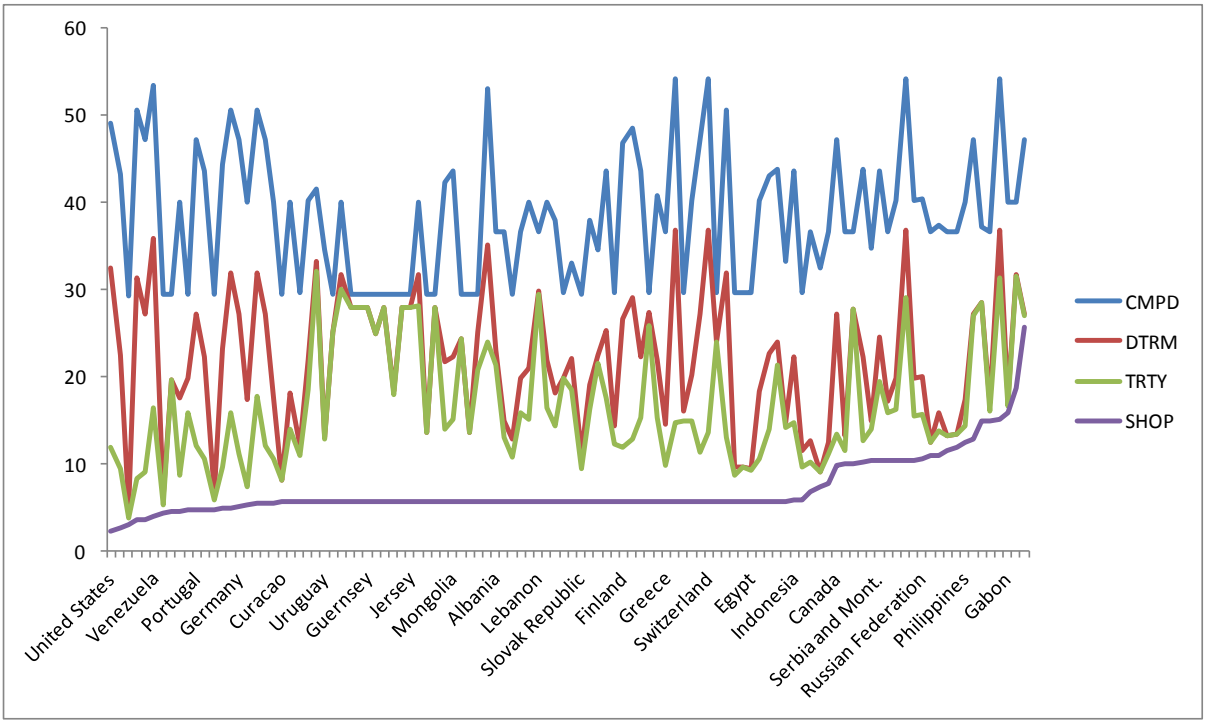
For host countries their own non-resident withholding tax rates matter, their general rates as well as the lowered rates agreed in treaties, if any. The own CIT is important in the first reduction: the double tax relief methods (DTRM) applied by the home countries have a huge impact on the remaining double tax rate of hosts with a high CIT. The reason for this large reduction is that high CIT rates of host countries lead to high credits in the two largest

[28] The rates for WHT div and CIT home in figure 2 are the effective rates, on top of CIT host.
[29] The country specific results are weighted row and column averages of the matrices of bilateral double tax rates introduced at the end of section 3.

economies, the USA and China, who apply the credit method. This also works the opposite way: low-tax havens[30] are not in the absolute top of lowest remaining double tax rates as the USA and China do not grant credits on flows coming from tax havens. Treaty arrangements (TRTY) account for large reductions in the remaining rates for countries with substantially lower average withholding tax rates in their treaties combined with a high number of treaties. Allowing for indirect routes via conduit countries gives the final reduction (SHOP). For some countries this is minimal, they often have few treaties and MNE's cannot escape their minimum withholding tax. These host countries are not well connected with a large integrated cluster of countries with low remaining tax rates.

The full list of host country averages rates can be found in annex B1. They are ranked from the lowest final remaining double tax rate (SHOP) to the largest. This is graphically shown in Figure 3. A group of 82 countries has a rate of 5.8 percent or lower. The top jagged line (blue) is the high full double combined effective tax rates (CMPD). These are lowered by unilateral double tax relief, bilateral tax treaties and treaty shopping, but the impact of each of these elements is host country specific as discussed above. More importantly, the figure emphasizes the role of treaty shopping in practically equalizing the final combined effective tax rates for a large group of countries.

Figure 3: Average double tax rates for outward dividend flows by host country: treaty shopping practically equalizes the remaining double tax rates



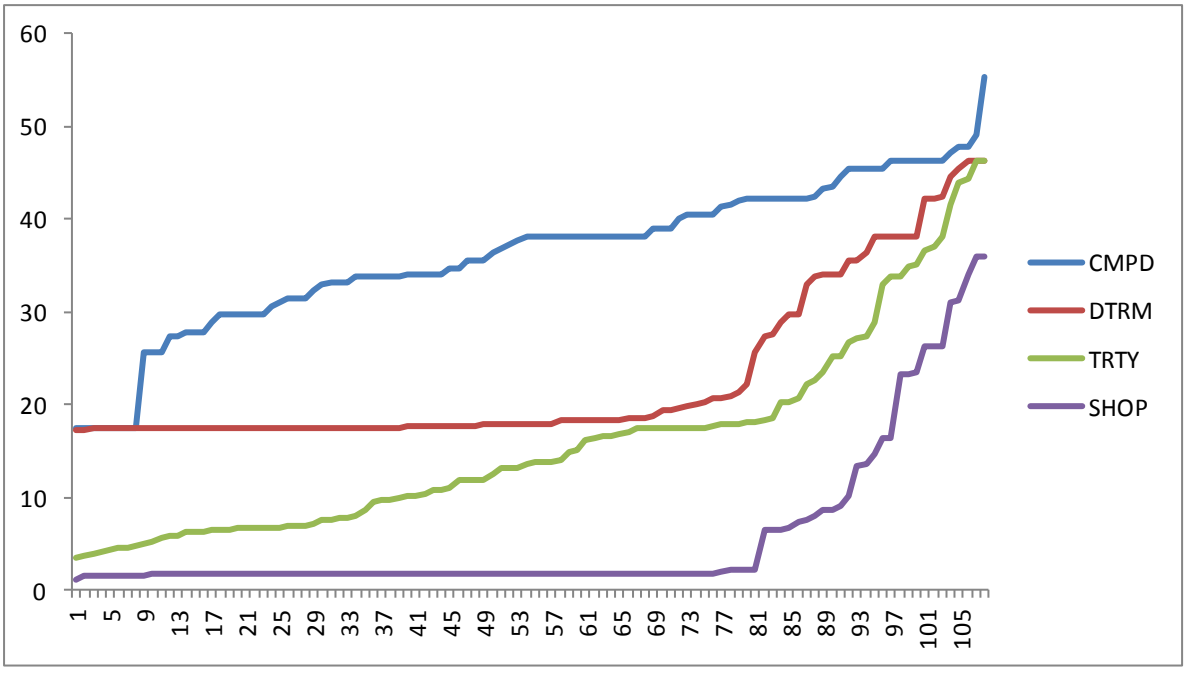
[30] Low-tax havens are jurisdictions on the Gravelle (2013) list with a CIT of 12.5% or less: Bahamas, Bermuda, Cayman Islands, Guernsey, Jersey, Isle of Man, British Virgin Islands, Cyprus, Macao and Liechtenstein.

Turning to the tax rates for inward profit flows, we consider the home countries of the investments. When the countries apply credit or exemption as relief method, the double tax rates are about halved (DTRM, see annex B2). With deduction as relief method there is no reduction effect from the perspective of incoming net profits.[31] For many countries with a credit or exemption method the remaining double tax rate equals the general withholding tax rate on dividends. The lower tax rates after accounting for the treaties (TRTY compared to DTRM) are due to the lower withholding tax rates. As before, treaty shopping does not completely eliminate the remaining tax rate. Since a number of host countries always levy a withholding tax on dividends, the flows are always taxed on average. At a global level this rate is 1.6 percent apart for some large countries with high withholding tax rates.

For host countries with a credit or exemption system and many treaties with relatively low withholding tax rates, the remaining tax rate is low: there is a distinct group of 76 jurisdictions with remaining double tax rates of 1.7 percent or even lower. The USA, for instance, is not part of this group: they apply the credit method, instead of exemption and levy a high CIT rate, and there are no detours to avoid this, given that we require repatriation of the foreign-source income, i.e. no deferral of taxation. In general, more stringent relief systems and a lack of treaties hamper the reduction of the tax rates.

The pattern for country average double tax rates on inwards profit flows is similar to that of outward flows. We illustrate this pattern however with a figure different from figure 3.

Figure 4: **Average double tax rates for incoming dividend flows (home countries re-ordered): treaty shopping lowers the floor in the remaining double tax rates**



[31] Deduction is the most strict double tax relief method that has been implemented.

Figure 3 shows the different rates vertically by country, with the countries ordered by the final remaining double tax rate (SHOP), lowest to highest. Figure 4 has all 4 types of tax rates ordered by country. Thus, read vertically, the rates do not correspond to the same country.

Figure 3 and 4 have in common that they show a floor in the final remaining double tax rates, i.e. after taking into account treaty shopping. For the inward flows, figure 4 also displays a floor in the rates after applying unilateral double tax relief (DTRM). This floor, which applies to about 70 jurisdictions, is the world average withholding tax rate of about 17 percent levied by the host countries, which cannot be avoided by the relief method of the home country. The treaties lower the withholding tax rates, but this varies by the individual agreements with the treaty partners. For a few countries the withholding tax rates are hardly lowered, but for others the decrease is 5 to 10 percentage points. These differences can be exploited by treaty shopping. What treaty shopping does is lowering the floor in the double tax rates. This can also be seen for the outward rates, see annex B3.

Parent firms in countries with relatively high FDI stocks, like the Netherlands, Luxembourg and Switzerland, hardly benefit from treaty shopping as home countries, because these countries have many favourable treaties and a generous tax relief system. This could be an indication that these countries are attractive as conduits. Section 6 will discuss this.

We started this section with world average remaining double tax rates and then presented averages by countries where we identified a floor in the rates. This floor is best understood when the bilateral rates are considered. At bilateral level this floor is rock bottom: final remaining double tax rates of zero. Even before treaty shopping costless repatriation of profits exists, i.e. non-taxed. The initial tax distance matrix contains 2376 cells with value zero, this is almost 21 percent of all country pairs.[32] Treaty shopping, potentially, increases the number of zero cells to 54 percent of all country pairs.

The effects of treaty shopping on the remaining tax rates are large because firms can benefit from more generous relief systems, e.g. CFC rules are not applied, or lower withholding tax rates. The firms will shop for treaty arrangements more beneficial to their interests. If a country pair would raise taxes on their bilateral dividend flows, firms could, for the greater part, circumvent the increased tax burden by using conduit countries. This is the working of international tax system. Countries could, unilaterally, combat this mechanism with high withholding taxes for all partner countries and stringent relief methods towards all countries. This however is likely to have repercussions for the country as it reduces its attractiveness for foreign capital and it reduces the incentive for its home companies to invest abroad. The combined workings of international tax competition and the tax network imply that strong international coordination will be required to combat corporate tax avoidance in its form of diverted dividend repatriation.

[32] The EU's Parent-Subsidiary directive alone is responsible for (27+3)*(27+3-1) = 870 tax distances of zero.

6. Identifying conduit countries

For 67 percent of the country pairs there is a cheaper tax route than the direct one. This leads to the question which countries are, potentially, the most used as locations for passing FDI. We identify these conduit countries using a centrality measure from the network theory: *betweenness*. Given all shortest paths between all pairs of jurisdictions in the network, betweenness centrality is determined as follows. For a given jurisdiction count the number of times it is on a shortest path from S to P. Divide this number by the total number of shortest paths between S and P. Then sum these fractions over all pairs S and P, excluding those pairs where the given jurisdiction is the initial host or final parent country.

An alternative centrality measure, still based on betweenness, takes whether a jurisdiction is at all on a shortest path of a pair (occurrence), a binary indicator instead of a fraction. By country the indicators are summed over the pairs. When there would be a unique shortest path for each pair the two measures would coincide; this is however not the case. Both centrality measures can be double weighted with GDP.

The centrality measures are calculated using all shortest paths. The total number of shortest paths can be quite larger than the number of country pairs. The combined effective tax rates of different tax routes between a host and parent country can be identical and this applies to the cheapest routes as well. In fact, multiplicity of shortest paths in the international corporate tax network is abundant. The first reason is that host countries apply a general rate for their non-resident withholding tax and when these are combined with CIT rates of home countries which are the same, identical combined rates may follow, depending on the relief methods. CIT rates are clustered around certain values, like 25 percent (16 countries), 30 percent (11), 20 percent (11) and 15 percent (8).

A second, potential source for huge multiplicity are direct connections with a zero tax rate; no double taxation at all on repatriation of dividends. The matrix with tax distances contains 2376 zero-cells, which is about one-fifth of all pairs. A consequence of these zeros is that, given a shortest route, there can be costless detours which are also shortest routes. However, in practice firms face costs setting up a holding, even if it is a shell company. The zero-cost detours have been countered by introducing a small penalty for each additional intermediate country on a route. The penalty could represent the cost of setting up a conduit entity in a new country. This reduces the average multiplicity, but it is still about 6 paths per country pair.

A third reason for multiplicity is that multinationals may prefer tax routes with slightly higher costs than the strictly cheapest routes because of non-tax characteristics of the conduit countries. These may include the quality of the financial sector and stability of the government. We allow for a half percent on top of the combined effective range of the

strictly shortest paths. Thus paths within this additive range will be considered relevant and included in the computation of the centrality measures. The average multiplicity per pair increases fifteen fold.

Table 5: Distribution of lengths of shortest paths and within range

	Total paths	Mult.	Length = no. of conduit countries				
			0	1	2	3	4
strict	64805	5.6	3844	52417	8281	263	
			5.9%	80.9%	12.8%	0.4%	
range	973611	84.2	3873	52441	749976	163305	4016
			0.4%	5.4%	77.0%	16.8%	0.4%

The distribution of lengths of the shortest paths and those within a range of a half percent is given in table 5. Length is denoted in number of intermediate jurisdictions. For 3844 country pairs, about 33 percent of all pairs, the direct connection is among the relevant paths. These 3844 paths are 5.9 percent of all strictly shortest paths. In nearly 81 percent of the paths there is exactly one conduit country in the shortest path. With a range of shortest paths, this is different. The extra shortest paths on top of the strictly shortest paths are not the paths with one conduit jurisdiction, but those with two or three jurisdictions. The maximum number is 4 conduit countries.

Centrality rankings

It is not obvious which measure of network centrality corresponds best with the conduit function of countries. The main variant which we present is betweenness, for relevant paths within range and double GDP weighted (BTWNS). Besides we use three extra measures to test whether the assumptions of BTWNS affect the outcomes. The first alternative measure is betweenness based on occurrence instead of fractions (OCCUR). The second variant is betweenness for strictly shortest paths, again weighted (STRCT). For estimation purposes unweighted betweenness may be a preferred measure (UNWTD). For all variants except STRCT holds that they are based on the paths within range, and all variants except UNWTD involve double GDP weighting of the country pairs.

Table 6 presents the top 10 of jurisdictions ranked in terms of betweenness centrality in the network of international corporate taxation. The full list is found in annex B4. The value of the betweenness measure is a weighted fraction: the United Kingdom would be on 8.35 percent of the cheapest tax routes of the world average country pair. For the variants the rank numbers are given.

The United Kingdom heads three of the four variants of the centrality measures. The reasons for this seem clear. It is a member of the EU and it levies no non-resident withholding tax on dividends. These two characteristics it has in common with Cyprus,

Estonia, Hungary and the Slovak Republic, all in the top 10. But the UK has more treaties, and a faces a lower average incoming withholding tax on dividends.[33]

Table 6: Top 10 of betweenness centrality

	Country	DIV	no. trts	BTWNS	rank OCCUR	rank STRCT	rank UNWTD
1	**United Kingdom**	0	51	0.0835	4	1	1
2	**Estonia**	0	36	0.0594	1	2	5
3	**Singapore**	0	40	0.0559	6	4	3
4	**Netherlands**	15	74	0.0463	14	5	2
5	**Hungary**	0	47	0.0455	2	7	6
6	**Slovak Republic**	0	42	0.0451	5	9	9
7	**Malaysia**	0	34	0.0420	8	14	7
8	**Cyprus**	0	35	0.0379	16	10	4
9	**Luxembourg**	15	57	0.0373	3	3	15
10	**Ireland**	20	53	0.0330	10	6	18

The impact on this ranking of a general rate of zero for the withholding tax is evident. The Netherlands is the first country without a general rate of zero to appear on the list,[34] and Luxembourg[35] and Ireland are second and third.

Singapore and Malaysia are the only non-EU countries in the top 10. If Hong Kong is a more significant gateway to China, as the FDI statistics suggest, this is not captured by our tax parameters.[36]

Most of the island low-tax havens, such as the Bahamas, Bermuda and the British Virgin and Channel Islands, also do not levy a non-resident withholding tax on dividends. But they do not rank high on any of the measures as they are relatively expensive to transfer dividends because they have no bilateral tax treaties. They do not significantly contribute to the conduit function because the other countries apply high withholding taxes on profit flows towards the low-tax havens.

Estonia ranks first in the alternative measure of occurrence. This ranking however, is not very different from the reference ranking of betweenness. Also the ranking with the strict shortest paths does not differ too much from that with a range.[37] In this respect the results are stable. Stability of the outcomes following changes in the tax parameters are discussed in section 9.

[33] Found as DIV2 in annex B1.
[34] The Netherlands do have a general rate of zero on royalties and interest, which is not taken into account.
[35] However, liquidation of a company in Luxembourg is treated as a capital transaction and is not subject to a dividend withholding tax. This is not taken into account.
[36] We have refrained from incorporating all sorts of country specifics, see previous footnotes, to keep the analysis strictly based on bare tax parameters.
[37] Kendall's (tau) rank correlation coefficients are 0.87 for OCCUR and 0.83 for STRCT.

Hypothetical dividend flows

The double GDP weighting we apply gives relative sizes of dividend flows between pairs of countries. This hypothetical construct assumes that FDI between two countries is proportional to the size of the economies and, next, that repatriated profits are proportional to the FDI. The centrality measure *betweenness* thus concerns hypothetical dividend flows through conduit countries, excluding, by definition, the origin and final destinations of the flows. But the inward and outward bound flows for countries as end points are known by the construction we started out with. These initial flows can then be added to the conduit flows to create a new measure (FLOWS). Just as with re-exports, the totals of the inward and outward flows summed over all countries will exceed the totals of the initial flows. We find a factor of 2.1.

This double counting is also reflected in the international data on FDI stocks, such as table 1. The OECD data on FDI stocks represent in theory only the stocks from the ultimate home countries and the stocks in the ultimate host countries. There are only 34 OECD countries. Comparing the aggregated FDI stocks, the outward stocks according to the IMF data including SPE's are about 30% higher than those of the OECD data. The inward stocks of IMF are nearly 40% higher. In any case this is a lower bound because these numbers still contain a degree of underreporting. Besides, many multinationals also pass FDI via conduit countries using holdings that also conduct productive activities.

The larger economies, such as the USA, China, Japan and India, rise to the top in table 7. This table begins to resemble table 1 with the FDI stocks, although the Netherlands is ranked 8th, and Luxembourg even 16th as can be seen in annex B5.

Table 7: Top 10 hypothetical dividend flows

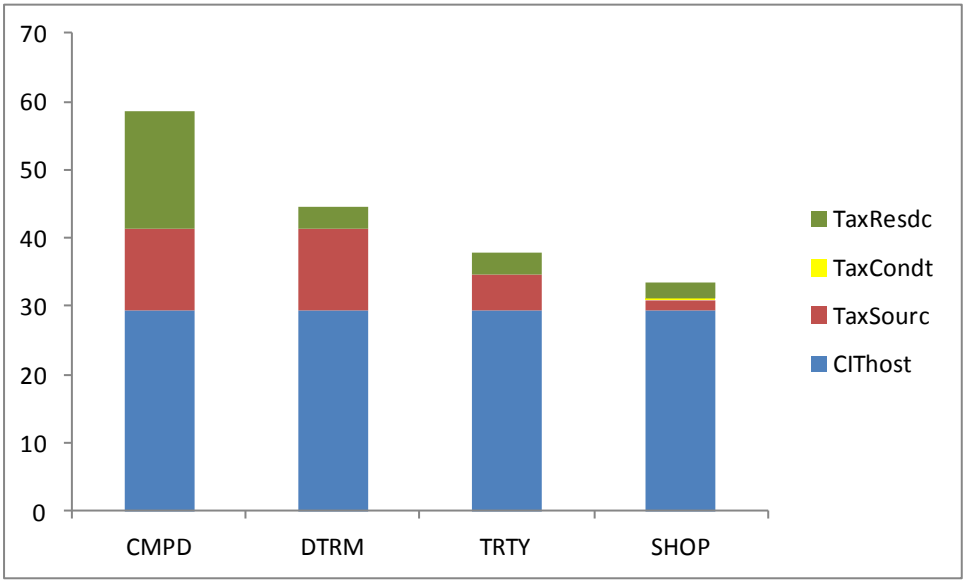
	Country	FLOWS	rnk BTWNS	GDP wght
1	**United States**	17.251	106	19.79
2	**China**	14.484	65	15.66
3	**United Kingdom**	11.457	1	2.95
4	**India**	6.125	71	5.91
5	**Japan**	6.047	73	5.84
6	**Singapore**	6.041	3	0.41
7	**Estonia**	5.983	2	0.04
8	**Netherlands**	5.587	4	0.89
9	**Germany**	5.572	26	4.04
10	**France**	5.328	16	2.84

The ranking in table 7 suggests that the betweenness indicator and the size of the economy (GDP) affect the size of the FDI stocks in a country. This relation is analyzed in a simple econometric specification, discussed in annex D1.

7. Tax revenue perspective

In this section we shift perspective from the tax burden of multinational companies to the tax revenues of national governments. Clearly, when treaty shopping reduces the tax burden of MNE's, the tax revenues of governments must decrease, on average, too. In particular the source taxation in the form of non-resident withholding taxes is expected to fall, and this is the general pattern that is observed. Besides, also residence taxation falls on average. Two mechanisms are at play here. First, a consequence of reduced source taxation is that the taxable base for residence taxation increases. Thus, when the home country of the investment applies the same double tax relief method on the indirect and direct routes of repatriated dividends, the residence tax revenue increases. Second, a number of countries have preferential tax relief treatment for their treaty partners and tax minimizing MNE's will reroute dividends through these partners, thus reducing residence taxation. On a world scale the latter mechanism dominates, while for some individual countries the former does. Next to source and residence taxation, treaty shopping implies taxation in conduit countries. This component of the final remaining double taxation is, however, minimal, see figure 5.

Figure 5: World average distribution of tax revenue - conduit taxation is minimal



The world average taxation of the repatriated dividends, i.e. after corporate income taxation by the host, is 6.03 percent, see also table 4 in section 5. It is composed of 2.11 percent source, 0.43 percent conduit and 3.49 percent residence taxation. The source taxation here is the non-resident dividend withholding tax, the CIT of the hosts being excluded from the analysis. Also the conduit taxation only consists of withholding taxes, meaning that optimal routes avoid conduits where corporate income taxation would be due.

Country specific tax revenue results

For individual countries the consequences of indirect routing on tax revenues are widely diverging. These results are found in annex B6, where the ordering is from highest relative tax revenue loss to highest relative gain. Table 8 gives the outcomes for a number of selected countries.

Chile heads the list of countries that lose from treaty shopping. Tax revenue is expressed as a percentage of the dividend flows, after corporate income tax of the host, that leave or enter a country.[38] Without indirect routing Chile receives 27.3 percent in withholding taxes on outgoing and 11.9 percent in corporate income tax of incoming dividend flows. Treaty shopping completely erodes its residence taxation and brings the source taxation back to 5 percent, the minimum rate of withholding tax for Chile with Spain as treaty partner. Its total loss is 34.2 percent points.

Table 8: Tax revenue results (percentages)* - selected countries

	TRTY			SHOP				LOSS	CON#
	SRC	**RES**	***TOT***	**SRC**	**RES**	**CON**	***TOT***		
Chile	27.3	11.9	*39.2*	5.0			*5.0*	34.2	
Costa Rica	14.8	24.4	*39.2*	15.0			*15.0*	24.2	
Mongolia	13.7	10.3	*24.0*			0.5	*0.5*	23.5	0.0001
United States	10.3	10.4	*20.7*		8.9		*9.0*	11.7	
Bahamas									
India		3.0	*3.0*		5.4		*5.4*	-2.4	
Angola	10.0	28.9	*38.9*	10.0	34.4		*44.4*	-5.5	
Aruba	10.0		*10.0*	5.7		35.6	*41.3*	-31.4	0.0012
United Kingdom									
Spain	7.7	0.3	*8.0*	2.7		3.4	*6.1*	1.9	0.0647

* SRC: source, RES: residence, CON: conduit and TOT: total taxation.

Conduit taxation as percent points of worldwide dividend flows in stead of national.

A particular case is Costa Rica which ranks fourth in relative tax revenue loss. As with Chile all its residence taxation disappears, but it is the one case where a country experiences an increase in its withholding tax revenue following treaty shopping. Costa Rica has a general rate of 15 percent, and only for dividends to Spain a reduced rate of 5 percent. When the option of indirect routing becomes available this reduced rate is apparently scorned (see the average of 14.8 change to 15 percent). The reason is the following. Spain applies credits as its general double tax relief method and exemption for its treaty partners. Costa Rica is a double tax treaty partner of Spain but is also considered a tax haven. As Spain applies CFC-rules dividends coming from Costa Rica will not be granted exemption. Thus investors from Spain in Costa Rica will use an indirect route, for instance over an EU country, incurring

[38] With double GDP-weighting the outward and inward directed flows are identical.

higher withholding taxes but compensating this with avoiding the CIT in Spain. Hence the small increase in source tax revenue for Costa Rica.

A striking case is Mongolia, fifth on the list, which sees all its source and residence tax revenue on international dividends vanish. Its residence taxation disappears because of the tax credits Mongolia grants to treaty partners. Its source taxation disappears since it has four tax treaties in which withholding taxes of zero percent are stipulated. These treaties are with Luxembourg, the Netherlands, Singapore and the United Arab Emirates, and all outgoing dividend flows are diverted through these countries. Mongolia seems to take note of this effect and is in the process of cancelling these treaties 'as a result of perceived tax abuse'.[39] The analysis also shows that Mongolia could pick up some conduit taxation.

The United States are among the high relative losers in terms of tax revenue. Other countries neither lose nor gain from treaty shopping. They are those countries who do not levy non-resident withholding taxes and apply exemption as their unilateral tax relief method, thus they never extract tax revenue from the international dividend flows. This applies to tax havens such as the Bahamas but also to the United Kingdom.

India and Angola are examples of countries with an increased tax base for residence taxation. As their source taxation remains constant they are net gainers of treaty shopping. Also other developing countries exhibit increased residence taxation. The question is whether this materializes in practice. In our analysis we treat countries symmetrically as capital exporter (home) and importer (host country). In reality most developing countries are net capital importers. Thus the symmetric treatment of FDI flows and repatriated profits may not be the most suitable assumption in this case. Alternatively, the reduction in only source taxation can be inspected. As we only have a few developing countries in our data set nothing definitive can be concluded.

Conduit taxation

Aruba is the country that, in terms of relative tax revenues, benefits most of treaty shopping. It picks up 12/10000th of a percent on taxes of worldwide dividend flows as a conduit country, amounting to 35.6 percent of its own flows.

In real terms Spain has the most conduit tax earnings. It clearly benefits from the tax treaties it has with South American countries, not by means of the CIT, but with its withholding taxes on the next link. But also Spain does, however, still lose tax revenue on dividends flows following treaty shopping.

Total conduit taxation is less than a half percent of the worldwide dividend flows.

[39] See EY, Worldwide Corporate Tax Guide 2013, page 872. Expiry dates for the treaties haven been set on Jan 1, 2014, for Luxembourg and the Netherlands, on Jan 1, 2015, for the United Arab Emirates and on April 1, 2015 for Kuwait. We have no information on cancellation of the treaty with Singapore.

8. A crackdown on tax havens?

The network approach is very suitable for policy simulations: a change in one or more tax parameters can be evaluated in terms of the resulting changes of the world average remaining double tax rates or centrality rankings. More evolved interventions can also be accommodated. Such simulations could highlight the role of tax treaties, tax rates, double tax relief methods in the network, or tax havens. This last topic is covered in this section. What, however, the simulation illustrates most of all is the dampening effect of treaty shopping on the remaining double tax rates.

Assume all OECD countries decide to combat treaty shopping by excluding tax havens from any double tax relief other than deduction of taxes already paid. OECD members participate, as well as the countries already earmarked as applying anti-abuse rules, such as China. Tax havens are assumed to be all jurisdictions on the Gravelle list[40] as well as low-tax countries,[41] those with a corporate income tax below 15 percent, in total 31 jurisdictions.[42]

The impact of the crackdown on tax havens implemented this way is very modest: the world average remaining double tax rate is raised only 14/100th of a percent, from 6.03 to 6.17, see table 9. Noteworthy is that the effect does not change when the crackdown supersedes the EU's PS- directive: the five European countries among the tax havens (Cyprus, Ireland, Luxembourg, Malta and Switzerland[43]) then can no longer transfer dividends within the EU without taxes.

Table 9: World remaining double tax rates (percent)

	TRTY	Δ	SHOP	Δ
Reference	12.07		6.03	
Crackdown	12.44	0.37	6.17	0.14
Crackdown - incl. EU	12.48	0.41	6.17	0.14

The direct impact of the simulated crackdown is on the tax rates taking into account double tax relief, including tax treaties (TRTY). The difference with the reference world average rate is about 4/10th of a percent, the higher rate for the crackdown, of course, meaning the MNE's face a higher tax burden. Then the possibility of treaty shopping is considered, lowering the rates (SHOP). Treaty shopping allows the multinationals to compensate their loss compared to the direct impact. In fact, they recuperate more than half, reducing the

[40] That is including Jordan, Singapore, Luxembourg, Ireland and Switzerland. Some hypocrisy emerges in our scenario as the latter three are also members of the OECD.
[41] Added are the United Arab Emirates, Albania, Bulgaria, Qatar and Oman.
[42] The extended set of tax havens should not be confused with the set of 10 low-tax havens, defined earlier. Low-tax countries are included because some others countries do not grant a dividend participation exemption to dividend income coming from them. Belgium, for instance, has no CFC-rules as such, but has these subject-to-tax rules.
[43] Switzerland, Iceland and Norway are *de facto* part of the EU's Parent-Subsidiary directive.

increase in the average tax burden to only 14/100th of a percent. This strong effect of treaty shopping remains when the crackdown is taken to supersede the EU's PS-directive.

Thus the world-wide impact on remaining average tax rates is small. One reason is that the 31 tax havens are small sized economies; Hong Kong, Switzerland and Singapore are the largest of them. A second reason is that most of the island low-tax havens, such as the Bahamas, Bermuda and the British Virgin and Channel Islands, do not rank high on centrality as observed in section 6.

Other tax havens, subject to the simulated crackdown, do however rank high on centrality. These are Singapore, Luxembourg, Malta and Cyprus, see table 6. One expects these countries to lose position in the centrality ranking. This is the case, as can be seen in table 10 and annex B7. These four countries, together with Ireland and the United Arab Emirates, are the six countries whose score on the betweenness measure goes most down. Singapore drops from the third place in the betweenness ranking to 24th, and Ireland from 10th place to 44th. And when some countries drop in the rankings others must rise. Table 10 also lists the countries whose score on betweenness increases most because of the crackdown. These are countries that were already high on the centrality ranking.[44]

Table 10: Centrality results of the crackdown

	Δ BTWNS	rank CRCK	rank REF	Δ SHOP-out	Δ SHOP-in
Singapore	-0.043	24	3	0.0119	0.1562
Ireland	-0.027	44	10	0.0119	0.1560
Luxembourg	-0.024	22	9	0.4942	0.1557
Malta	-0.020	26	11	0.4850	0.1556
Cyprus	-0.020	15	8	0.0119	0.1556
Untd Arab Emirates	-0.020	36	13	0.0119	0.1561
Malaysia	0.025	5	7	0.0119	0.1566
Slovak Republic	0.026	3	6	0.0119	0.1558
United Kingdom	0.027	1	1	0.0122	0.1603
Estonia	0.029	2	2	0.0119	0.1557

The changes in centrality should however not divert attention from the modest impact on the combined effective tax rates, even on the affected countries themselves. The increases in their remaining outward and inward double tax rates, also shown in table 10 (ΔSHOP-out/in), are comparable to those of the world average. The United Kingdom, which ranks first in centrality, with and without the crackdown, faces even higher increases in its remaining double tax rates, albeit marginal.

The mechanism discussed in section 5 is at work here. Treaty shopping equalizes the remaining averages rates and lays a floor in these rates by country. The crackdown on tax

[44] Kendall's (tau) rank correlation coefficient is 0.85.

havens only slightly raises this floor. This is best understood at the bilateral level where the floor consists of zero rates. The simulation only reduces the number of bilateral zero's from about 6200 to 6000; the floor remains largely intact as does the same group of countries well connected through cheap tax routes. Increasing the cost of a few routes will lead to the use of alternative routes of which there are more than plenty.

A first conclusion is that treaty shopping has a strong dampening effect on the double tax rates. Another conclusion is that the tax havens are not crucial conduit countries for the treaty shopping motive.

9. Conclusions

We embark on a novel perspective by applying a network analysis to international corporate taxation. This yields the contribution of the indirect routing of FDI, and the corresponding profit flows, to the reduction of the tax burden of multinational enterprises as well as the insight in the central position of particular countries in the international tax network.

We have modeled corporate taxation in host and home countries, double tax relief methods, CFC rules and the withholding tax on dividends for all pairs in a sample of 108 countries. The first result concerns the direct effect of double tax relief: the relief has a substantial impact. Given statutory corporate income taxation in host countries, the double taxation multinationals may face without relief when repatriating dividends has a world average rate of 41 percent. The unilateral tax relief of home countries and the relief contained in bilateral tax treaties reduce the world average double tax rate to 12 percent. Then the possibility of treaty shopping allows for a further reduction of nearly 6 percent, hardly leaving, on average, any effective double taxation at all. For about two thirds of the country pairs examined there exists an indirect tax route that is more attractive in terms of lower taxes than the direct route.

A large cluster of some 70 countries exists that are well interconnected through cheap tax routes. Their remaining outward and inward double tax rates differ little and are about 6 percent and below 2 percent, respectively. The 27 EU members, Iceland, Norway and Switzerland are all in this group as they can transfer dividends among them without any tax cost because of the Parent-Subsidiary directive. Also tax havens are within the cluster as they often have low corporate income taxes and levy no withholding taxes. Countries like Canada, China, Japan, and the Russian Federation have higher remaining outward double tax rates, because they always levy at least a 5 percent withholding tax rate, even to their most favoured treaty partners. The United States is not in the group because it has a high remaining inward double tax rate, of almost 15 percent, caused by its method of double tax relief and its high CIT rate of 39 percent.

Centrality in the network is used to identify candidates for the role of conduit country. The United Kingdom heads the ranking of network centrality, followed by Estonia and Singapore. The top 10 has five EU countries, including Cyprus, who have in common that they do not levy a dividend withholding tax. The Netherlands is the first in the centrality ranking, on position 4, who does not have a zero rate for its general withholding tax, Luxembourg and Ireland, ranked 9th and 10th, are the second and third.

The traditional island low-tax havens do not rank in the absolute top of network centrality. The reason is that they have no, or hardly any, bilateral tax treaties which implies that the

other jurisdictions will apply their general non-resident withholding tax rates. This makes it relatively expensive to reach these low-tax havens.

As treaty shopping reduces the tax burden for multinationals, national governments face a decrease of tax revenue on international dividend flows. For individual countries, the consequences are widely diverging. Some countries, such as Mongolia, see their entire tax revenue on international dividend flows vanish. For other countries, nothing happens since they receive no tax revenue on international dividend flows anyway. This is, for instance, the case for the UK. Other countries even have a modest tax gain from treaty shopping. This is because as a residence country they face an increased tax base as multinationals have reduced taxes on the way.

Indirect tax routing over conduit countries does not lead to major tax revenues, if only because they perform that role because they are cheap in tax terms. Spain heads the list of conduit taxation revenues. It does however, overall, still lose tax revenue following treaty shopping. Total conduit taxation is less than a half percent of the worldwide dividend flows.

An OECD crackdown on tax havens is simulated showing a remarkable modest impact, both on the remaining double tax rates and on network centrality. The modest impact results from the strong dampening effect of treaty shopping on the double tax rates. This suggests that any attempt to combat corporate tax avoidance, in diverted dividend repatriation, would require major international coordination.

Another conclusion from the simulation is that the tax havens are not crucial conduit countries for the treaty shopping motive. There must be other reasons for choosing tax havens as an intermediate station, or temporary end point of a tax route.

This brings us to the limitations of the study. We take the profits in the host country as given and focus on dividend flows. More in general, a broader fiscal and juridical environment will affect the holding decisions of multinationals and the size of taxable profit incomes. These activities may involve intra-company financing and the location of intellectual property rights, so that deductibility of interest and royalty payments matter, and the withholding taxes for these categories. We ignore the possibilities to reduce the tax base with interest and/or royalty payments that determines net profits.

Next, our analysis lacks dynamics and we require profits to be repatriated to the home country. Thus deferral is no option and we miss out on the parking function associated with traditional low-tax havens, as discussed by Mintz and Weichenrieder (2010).

With these limitations also the directions for further research are identified. Bringing in royalty and interest payments into the network approach would seriously enhance the

analysis. This seems a real challenge. Next a dynamic component is required to accommodate deferral of taxation, where the benefits of deferral would need to be specified within an optimization framework.

Finally, the analysis yearns for an econometric analysis. The impact of the centrality measure on FDI stocks could be analyzed in an econometric setting for determining a causal impact. Then also time series data on the tax system, FDI stocks and flows, should be exploited.

Notwithstanding the limitations we show that already now with only few, bare, tax parameters we can sketch an entirely plausible and relevant world of international corporate taxation with treaty shopping for about the hundred largest and richest economies in the world including many tax havens and financial centers.

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Annex A1: Collected tax data 2013 - 108 jurisdictions

Country	CIT	DTRM	THR	CFC	WHT_div	no. trts	tax haven	GDP wght
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Albania	10.0	3	3	0	10.0	26	0	0.03
Algeria	25.0	0	0	0	15.0	23	0	0.34
Angola	35.0	0	0	0	10.0	0	0	0.16
Argentina	35.0	3	3	0	35.0	14	0	0.94
Aruba	28.0	4	4	0	10.0	1	1	0.00
Australia	30.0	3	3	1	30.0	40	0	1.23
Austria	25.0	4	4	0	25.0	66	0	0.45
Azerbaijan	20.0	3	3	0	10.0	29	0	0.12
Bahamas	0.0	4	4	0	0.0	0	1	0.01
Bahrain	46.0	3	3	0	0.0	10	1	0.04
Barbados	25.0	3	3	0	15.0	23	1	0.01
Belarus	18.0	3	3	0	12.0	44	0	0.19
Belgium	34.0	4	4	0	25.0	70	0	0.53
Bermuda	0.0	4	4	0	0.0	0	1	0.01
Botswana	22.0	2	2	0	7.5	8	0	0.04
Brazil	34.0	3	3	1	15.0	35	0	2.97
Brunei Darussalam	20.0	4	4	0	0.0	1	0	0.03
Bulgaria	10.0	3	3	0	5.0	50	0	0.13
Canada	26.3	3	3	0	25.0	75	0	1.88
Cayman Islands	0.0	4	4	0	0.0	0	1	0.00
Chile	20.0	2	3	0	35.0	24	0	0.40
China	25.0	3	3	1	10.0	61	0	15.66
Colombia	25.0	3	3	0	0.0	4	0	0.63
Costa Rica	30.0	2	3	0	15.0	1	1	0.07
Croatia	20.0	3	3	0	12.0	44	0	0.10
Curacao	27.5	4	4	0	0.0	0	0	0.00
Cyprus	12.5	4	4	0	0.0	35	1	0.03
Czech Republic	19.0	2	3	0	35.0	66	0	0.36
Denmark	25.0	3	4	1	27.0	61	0	0.27
Dominican Rep.	29.0	3	3	0	10.0	1	0	0.12
Ecuador	22.0	0	0	0	0.0	10	0	0.19
Egypt	25.0	2	3	0	0.0	23	0	0.68
Equatorial Guinea	35.0	0	0	0	25.0	1	0	0.02
Estonia	21.0	3	4	0	0.0	36	0	0.04
Finland	24.5	3	4	1	24.5	59	0	0.25
France	34.3	2	3	1	30.0	80	0	2.84
Gabon	35.0	2	3	0	15.0	4	0	0.03
Germany	30.2	3	4	1	25.0	71	0	4.04
Greece	26.0	3	3	0	10.0	42	0	0.35
Guernsey	0.0	4	4	0	0.0	0	1	0.00
HongKong	16.5	4	4	0	0.0	14	1	0.47

Hungary	19.0	4	4	1	0.0	47	0	0.25
Iceland	20.0	3	3	0	18.0	38	0	0.02
India	34.0	3	3	0	0.0	40	0	5.91
Indonesia	25.0	3	3	0	20.0	52	0	1.54
Ireland	12.5	3	3	0	20.0	53	0	0.24
Isle of Man	0.0	4	4	0	0.0	0	1	0.01
Israel	25.0	3	3	1	20.0	43	0	0.31
Italy	31.4	3	3	1	20.0	69	0	2.31
Jamaica	25.0	2	3	0	33.3	15	0	0.03
Japan	37.0	3	3	0	20.0	47	0	5.84
Jersey	0.0	4	4	0	0.0	0	1	0.01
Jordan	14.0	2	3	0	0.0	13	0	0.05
Kazakhstan	20.0	3	3	0	15.0	35	0	0.29
Korea Republic	24.2	3	3	0	20.0	67	0	2.04
Kuwait	15.0	2	2	0	15.0	40	0	0.19
Latvia	15.0	3	3	0	10.0	45	0	0.05
Lebanon	15.0	2	3	0	10.0	13	1	0.08
Libya	20.0	0	3	0	0.0	1	0	0.10
Liechtenstein	12.5	4	4	0	0.0	3	1	0.00
Lithuania	15.0	3	4	0	15.0	44	0	0.08
Luxembourg	29.2	4	4	0	15.0	57	0	0.05
Macao	12.0	0	0	0	0.0	0	1	0.06
Malaysia	25.0	4	4	0	0.0	34	0	0.63
Malta	35.0	4	4	0	0.0	38	1	0.01
Mauritius	15.0	3	3	0	0.0	15	1	0.03
Mexico	30.0	2	2	0	0.0	36	0	2.22
Mongolia	25.0	2	3	0	20.0	27	0	0.02
Namibia	34.0	3	3	0	10.0	9	0	0.02
Netherlands	25.0	4	4	0	15.0	74	0	0.89
New Zealand	28.0	3	3	1	30.0	36	0	0.17
Nigeria	30.0	3	3	0	10.0	11	0	0.57
Norway	28.0	3	3	1	25.0	64	0	0.35
Oman	12.0	3	3	0	0.0	8	0	0.11
Pakistan	35.0	3	3	0	10.0	31	0	0.65
Panama	25.0	0	0	0	17.0	14	1	0.07
Peru	30.0	3	3	1	4.1	3	0	0.41
Philippines	30.0	3	3	0	15.0	29	0	0.54
Poland	19.0	3	4	0	19.0	64	0	1.01
Portugal	31.5	3	3	0	25.0	53	0	0.31
Puerto Rico	30.0	3	3	0	10.0	0	0	0.08
Qatar	10.0	2	3	0	7.0	36	0	0.24
Romania	16.0	3	3	0	16.0	66	0	0.35
Russian Federation	20.0	3	3	0	15.0	59	0	3.17
Saudi Arabia	20.0	0	3	0	5.0	18	0	1.14
Serbia and Mont.	15.0	3	3	0	20.0	42	0	0.10
Seychelles	33.0	0	0	0	15.0	12	1	0.00

Singapore	17.0	4	4	0	0.0	40	0	0.41
Slovak Republic	23.0	2	3	0	0.0	42	0	0.17
Slovenia	17.0	3	3	0	15.0	46	0	0.07
South Africa	28.0	3	3	1	15.0	55	0	0.74
Spain	30.0	4	4	1	21.0	71	0	1.78
Suriname	36.0	3	3	0	25.0	1	0	0.01
Sweden	22.0	3	3	1	30.0	67	0	0.50
Switzerland	21.1	4	4	0	35.0	71	0	0.46
Taiwan Province	17.0	3	3	1	20.0	19	0	1.14
Thailand	20.0	2	3	0	10.0	34	0	0.82
Trinidad and Tob.	25.0	3	3	0	10.0	16	0	0.03
Tunisia	30.0	0	0	0	0.0	26	0	0.13
Turkey	20.0	3	3	1	15.0	59	0	1.42
Ukraine	19.0	3	3	0	15.0	56	0	0.42
Untd Arab Emirates	0.0	4	4	0	0.0	21	0	0.34
United Kingdom	23.0	4	4	0	0.0	51	0	2.95
United States	39.1	3	3	1	30.0	54	0	19.79
Uruguay	25.0	2	2	0	7.0	6	0	0.07
Venezuela	34.0	3	3	0	34.0	28	0	0.51
Virgin Islands U.S.	38.5	3	3	0	11.0	0	1	0.00
Virgin Islands U.K.	0.0	4	4	0	0.0	0	1	0.00

Columns (2) and (3): 2 = deduction, 3 = credit, 4 = exemption

Annex B1: Remaining double tax rates for host countries

Out	Country	DIV	DiV2	minDIV	CIT	no. trts	CMPD	DTRM	TRTY	SHOP
1	United States	30	10.3	0	27.2	54	49.0	32.5	11.8	2.2
2	Japan	20	7.5	0	29.1	47	43.3	22.4	9.4	2.6
3	India	0	0.0	0	29.3	40	29.3	4.9	3.8	3.0
4	France	30	5.4	0	29.4	80	50.6	31.3	8.2	3.5
5	Belgium	25	6.4	0	29.5	70	47.1	27.1	9.0	3.6
6	Venezuela	34	14.7	0	29.5	28	53.5	35.9	16.4	3.9
7	Mexico	0	0.0	0	29.5	36	29.5	6.2	5.2	4.2
8	Bahrain	0	0.0	0	29.5	10	29.5	19.6	19.6	4.4
9	Brazil	15	6.9	0	29.4	35	40.0	17.5	8.7	4.4
10	Malta	0	0.0	0	29.5	38	29.5	19.8	15.9	4.6
11	Portugal	25	9.4	0	29.5	53	47.1	27.1	12.0	4.6
12	Italy	20	8.1	0	29.5	69	43.6	22.3	10.5	4.7
13	Tunisia	0	0.0	0	29.5	26	29.5	6.7	5.8	4.8
14	Spain	21	7.7	0	29.5	71	44.3	23.3	9.7	5.0
15	Australia	30	11.2	0	29.5	40	50.7	32.0	15.8	5.0
16	Germany	25	8.2	0	29.5	71	47.1	27.2	11.0	5.2
17	Luxembourg	15	1.9	0	29.5	57	40.1	17.4	7.4	5.2
18	New Zealand	30	13.4	0	29.5	36	50.7	32.0	17.8	5.5
19	Norway	25	10.4	0	29.5	64	47.2	27.1	12.1	5.5
20	South Africa	15	6.8	0	29.5	55	40.1	17.5	10.7	5.5
21	Curacao	0	0.0	0	29.5	0	29.5	8.2	8.2	5.6
22	Algeria	15	11.7	0	29.6	23	40.1	18.1	14.1	5.6
23	Ecuador	0	0.0	0	29.6	10	29.6	12.0	11.0	5.6
24	Kuwait	15	10.0	0	29.6	40	40.1	21.8	18.4	5.6
25	Panama	17	15.5	0	29.5	14	41.5	33.3	32.1	5.7
26	Uruguay	7	6.7	0	29.5	6	34.5	13.1	12.8	5.7
27	Macao	0	0.0	0	29.5	0	29.5	25.2	25.2	5.7
28	Seychelles	15	13.1	0	29.5	12	40.1	31.7	30.0	5.7
29	Virgin Islands U.K.	0	0.0	0	29.5	0	29.5	27.9	27.9	5.7
30	Cayman Islands	0	0.0	0	29.5	0	29.5	27.9	27.9	5.7
31	Guernsey	0	0.0	0	29.5	0	29.5	27.9	27.9	5.7
32	Liechtenstein	0	0.0	0	29.5	3	29.5	25.0	25.0	5.7
33	Isle of Man	0	0.0	0	29.5	0	29.5	27.9	27.9	5.7
34	Jordan	0	0.0	0	29.5	13	29.5	18.3	17.9	5.7
35	Bermuda	0	0.0	0	29.5	0	29.5	27.9	27.9	5.7
36	Jersey	0	0.0	0	29.5	0	29.5	27.9	27.9	5.7
37	Barbados	15	10.1	0	29.5	23	40.1	31.8	28.2	5.7
38	Libya	0	0.0	0	29.5	1	29.5	13.6	13.6	5.7
39	Bahamas	0	0.0	0	29.5	0	29.5	27.9	27.9	5.7
40	Iceland	18	7.8	0	29.5	38	42.2	21.7	14.0	5.7
41	Mongolia	20	13.7	0	29.5	27	43.6	22.3	15.2	5.7
42	Mauritius	0	0.0	0	29.5	15	29.5	24.4	24.3	5.7
43	Brunei Darussalam	0	0.0	0	29.5	1	29.5	13.6	13.6	5.7

44	Cyprus	0	0.0	0	29.5	35	29.5	25.0	20.8	5.7
45	Jamaica	33.33	20.9	0	29.5	15	53.0	35.2	23.9	5.7
46	Albania	10	8.9	0	29.5	26	36.6	23.0	21.3	5.7
47	Trinidad and Tob.	10	9.0	0	29.5	16	36.6	14.9	13.1	5.7
48	Estonia	0	0.0	0	29.5	36	29.5	12.8	10.8	5.7
49	Latvia	10	5.7	0	29.5	45	36.6	19.8	15.9	5.7
50	Slovenia	15	6.9	0	29.5	46	40.1	21.0	15.2	5.7
51	Lebanon	10	9.4	0	29.5	13	36.6	29.9	29.4	5.7
52	Lithuania	15	6.7	0	29.5	44	40.1	21.8	16.4	5.7
53	Croatia	12	8.6	0	29.5	44	38.0	18.1	14.4	5.7
54	Oman	0	0.0	0	29.6	8	29.6	19.8	19.8	5.7
55	Bulgaria	5	3.9	0	29.6	50	33.1	22.0	18.4	5.7
56	Slovak Republic	0	0.0	0	29.5	42	29.5	11.2	9.5	5.7
57	Belarus	12	10.0	0	29.6	44	38.0	19.0	16.2	5.7
58	Qatar	7	6.1	0	29.6	36	34.5	22.4	21.6	5.7
59	Ireland	20	2.9	0	29.6	53	43.7	25.4	17.5	5.7
60	Hungary	0	0.0	0	29.6	47	29.6	14.4	12.2	5.7
61	Finland	24.5	6.2	0	29.5	59	46.8	26.6	11.8	5.7
62	Denmark	27	7.5	0	29.5	61	48.6	29.1	12.8	5.7
63	Israel	20	12.2	0	29.6	43	43.6	22.3	15.4	5.7
64	Untd Arab Emirates	0	0.0	0	29.6	21	29.6	27.4	25.9	5.7
65	Romania	16	8.6	0	29.6	66	40.9	21.9	15.3	5.7
66	Greece	10	6.6	0	29.5	42	36.6	14.5	9.9	5.7
67	Czech Republic	35	7.7	0	29.6	66	54.2	36.8	14.8	5.7
68	Singapore	0	0.0	0	29.6	40	29.6	16.1	14.9	5.7
69	Ukraine	15	7.3	0	29.6	56	40.1	20.2	15.0	5.7
70	Austria	25	6.9	0	29.6	66	47.2	27.1	11.3	5.7
71	Switzerland	35	7.3	0	29.6	71	54.2	36.8	13.6	5.7
72	HongKong	0	0.0	0	29.6	14	29.6	24.0	24.0	5.7
73	Sweden	30	6.3	0	29.6	67	50.7	32.0	13.0	5.7
74	Malaysia	0	0.0	0	29.6	34	29.6	9.7	8.6	5.7
75	Colombia	0	0.0	0	29.6	4	29.6	9.7	9.6	5.7
76	Egypt	0	0.0	0	29.6	23	29.6	9.5	9.2	5.7
77	Netherlands	15	4.5	0	29.6	74	40.1	18.2	10.5	5.7
78	Poland	19	7.9	0	29.6	64	43.0	22.7	14.0	5.7
79	Taiwan Province	20	17.6	0	29.7	19	43.7	23.9	21.4	5.7
80	Saudi Arabia	5	4.8	0	29.6	18	33.2	14.8	14.1	5.7
81	Indonesia	20	11.1	0	29.6	52	43.7	22.3	14.7	5.8
82	United Kingdom	0	0.0	0	29.7	51	29.7	11.6	9.6	5.8
83	Pakistan	10	8.3	3.75	29.5	31	36.6	12.6	10.2	6.8
84	Peru	4.1	4.1	4.1	29.5	3	32.4	9.1	9.1	7.4
85	Namibia	10	9.5	5	29.5	9	36.6	12.5	11.1	7.8
86	Canada	25	8.9	5	29.6	75	47.2	27.2	13.4	9.8
87	Nigeria	10	9.3	7.5	29.5	11	36.6	13.2	11.5	9.9
88	Aruba	10	10.0	5	29.5	1	36.6	27.8	27.8	10.1
89	Korea Republic	20	8.9	0	29.6	67	43.7	22.3	12.6	10.2

90	Botswana	7.5	7.3	5	29.5	8	34.8	14.9	14.0	10.4
91	Serbia and Mont.	20	12.9	5	29.6	42	43.6	24.5	19.5	10.4
92	Azerbaijan	10	9.5	5	29.5	29	36.6	17.1	15.8	10.4
93	Kazakhstan	15	8.7	5	29.6	35	40.1	19.8	16.2	10.4
94	Chile	35	27.3	0	29.6	24	54.2	36.8	29.1	10.4
95	Turkey	15	10.3	0	29.7	59	40.2	19.9	15.4	10.5
96	Russian Federation	15	8.7	5	29.8	59	40.4	20.0	15.7	10.6
97	Angola	10	10.0	10	29.5	0	36.6	12.5	12.5	10.8
98	China	10	9.4	5	30.4	61	37.3	15.8	13.7	11.0
99	Puerto Rico	10	10.0	10	29.5	0	36.6	13.1	13.1	11.5
100	Dominican Rep.	10	10.0	10	29.5	1	36.6	13.5	13.5	11.8
101	Philippines	15	13.0	10	29.5	29	40.1	17.4	14.4	12.5
102	Suriname	25	24.8	7.5	29.5	1	47.2	27.1	27.0	12.7
103	Virgin Islands U.S.	11	11.0	11	29.5	0	37.3	28.5	28.5	15.0
104	Thailand	10	10.0	10	29.6	34	36.7	17.0	16.1	15.0
105	Argentina	35	30.1	10	29.5	14	54.2	36.8	31.3	15.1
106	Gabon	15	15.0	15	29.5	4	40.1	17.4	16.6	15.8
107	Costa Rica	15	14.8	5	29.5	1	40.1	31.7	31.6	18.8
108	Equatorial Guinea	25	25.0	15	29.5	1	47.2	27.1	27.1	25.7

Annex B2: Remaining double tax rates for home countries

In	Country	DIV	HR	CIT	no. trts	CMPD	DTRM	TRTY	SHOP
1	China	18.8	3	25	61	39.1	19.4	8.6	1.0
2	Russian Federation	17.5	3	20	59	34.0	17.6	6.7	1.5
3	Korea Republic	17.3	3	24.2	67	37.3	17.7	7.1	1.6
4	Thailand	17.4	2	20	34	34.0	34.0	18.5	1.6
5	Canada	17.2	3	26.3	75	39.0	17.8	7.0	1.6
6	Turkey	17.4	3	20	59	33.9	17.7	10.9	1.6
7	Chile	17.3	2	20	24	33.8	33.8	26.6	1.6
8	Dominican Rep.	17.4	3	29	1	41.3	18.3	18.1	1.6
9	Kazakhstan	17.4	3	20	35	33.9	17.5	7.7	1.6
10	Azerbaijan	17.4	3	20	29	33.9	17.5	14.1	1.6
11	Serbia and Mont.	17.4	3	15	42	29.8	17.4	13.1	1.6
12	Aruba	17.4	4	28	1	40.5	17.4	17.4	1.6
13	Virgin Islands U.K.	17.4	4	0	0	17.4	17.4	17.4	1.6
14	Bermuda	17.4	4	0	0	17.4	17.4	17.4	1.6
15	Cayman Islands	17.4	4	0	0	17.4	17.4	17.4	1.6
16	Curacao	17.4	4	27.5	0	40.1	17.4	17.4	1.6
17	Guernsey	17.4	4	0	0	17.4	17.4	17.4	1.6
18	Isle of Man	17.4	4	0	0	17.4	17.4	17.4	1.6
19	Jersey	17.4	4	0	0	17.4	17.4	17.4	1.6
20	Liechtenstein	17.4	4	12.5	3	27.7	17.4	16.3	1.6
21	Barbados	17.4	3	25	23	38.0	17.8	10.3	1.6
22	Bahamas	17.4	4	0	0	17.4	17.4	17.4	1.6
23	Iceland	17.4	3	20	38	33.9	17.5	6.6	1.6
24	Malta	17.4	4	35	38	46.3	17.4	6.6	1.6
25	Mongolia	17.4	2	25	27	38.0	38.0	23.6	1.6
26	Brunei Darussalam	17.4	4	20	1	33.9	17.4	16.6	1.6
27	Cyprus	17.4	4	12.5	35	27.7	17.4	7.5	1.6
28	Mauritius	17.4	3	15	15	29.8	17.5	14.9	1.6
29	Albania	17.4	3	10	26	25.6	17.4	13.8	1.6
30	Estonia	17.4	3	21	36	34.7	17.6	5.7	1.6
31	Jamaica	17.4	2	25	15	38.0	38.0	20.3	1.6
32	Trinidad and Tob.	17.4	3	25	16	38.0	17.8	10.0	1.6
33	Latvia	17.4	3	15	45	29.8	17.5	6.3	1.6
34	Luxembourg	17.4	4	29.2	57	41.5	17.4	4.0	1.6
35	Slovenia	17.4	3	17	46	31.4	17.5	6.5	1.6
36	Lebanon	17.4	2	15	13	29.8	29.8	28.8	1.6
37	Lithuania	17.4	3	15	44	29.8	17.5	6.3	1.6
38	Croatia	17.4	3	20	44	33.9	17.5	11.9	1.6
39	Oman	17.4	3	12	8	27.3	17.4	16.2	1.6
40	Bulgaria	17.4	3	10	50	25.7	17.4	6.7	1.6
41	New Zealand	17.4	3	28	36	40.5	18.2	9.5	1.6
42	Slovak Republic	17.4	2	23	42	36.4	36.4	13.1	1.6
43	Belarus	17.4	3	18	44	32.3	17.5	10.1	1.6

44	Qatar	17.4	2	10	36	25.7	25.7	20.2	1.6
45	Ireland	17.4	3	12.5	53	27.7	17.4	5.6	1.6
46	Finland	17.4	3	24.5	59	37.6	17.9	4.6	1.6
47	Hungary	17.4	4	19	47	33.1	17.6	5.8	1.6
48	Denmark	17.4	3	25	61	38.0	17.9	4.6	1.6
49	Portugal	17.4	3	31.5	53	43.4	18.6	9.7	1.6
50	Israel	17.4	3	25	43	38.0	17.9	10.2	1.6
51	Romania	17.4	3	16	66	30.6	17.5	7.5	1.6
52	Untd Arab Emirates	17.4	4	0	21	17.4	17.4	13.2	1.6
53	Greece	17.4	3	26	42	38.9	17.9	11.8	1.6
54	Norway	17.4	3	28	64	40.5	18.2	7.8	1.6
55	Czech Republic	17.3	2	19	66	33.0	33.0	6.7	1.6
56	Singapore	17.5	4	17	40	31.5	17.5	10.8	1.6
57	Ukraine	17.4	3	19	56	33.1	17.5	6.4	1.6
58	Austria	17.3	4	25	66	38.0	17.3	4.8	1.6
59	Switzerland	17.3	4	21.1	71	34.8	17.3	4.9	1.6
60	HongKong	17.5	4	16.5	14	31.1	17.5	13.8	1.6
61	Sweden	17.3	3	22	67	35.5	17.7	3.8	1.6
62	Belgium	17.3	4	34	70	45.4	17.3	4.3	1.6
63	Malaysia	17.5	4	25	34	38.1	17.5	11.8	1.6
64	Colombia	17.5	3	25	4	38.1	17.9	16.9	1.6
65	Egypt	17.5	2	25	23	38.1	38.1	17.9	1.6
66	South Africa	17.4	3	28	55	40.5	18.3	6.6	1.7
67	Netherlands	17.4	4	25	74	38.1	17.4	3.4	1.7
68	Poland	17.4	3	19	64	33.1	17.5	6.3	1.7
69	Taiwan Province	17.4	3	17	19	31.4	17.6	15.2	1.7
70	Saudi Arabia	17.5	0	20	18	34.0	34.0	22.6	1.7
71	Indonesia	17.3	3	25	52	38.0	17.7	9.6	1.7
72	Spain	17.3	4	30	71	42.1	17.6	6.8	1.7
73	Italy	17.3	3	31.4	69	43.3	18.7	6.9	1.7
74	France	17.0	2	34.3	80	45.5	45.5	6.9	1.7
75	United Kingdom	17.9	4	23	51	36.8	17.9	3.8	1.7
76	Germany	17.1	3	30.2	71	42.1	18.3	5.2	1.7
77	Australia	17.2	3	30	40	42.1	18.4	8.0	2.0
78	Philippines	17.4	3	30	29	42.2	18.4	12.6	2.2
79	Nigeria	17.4	3	30	11	42.2	18.4	17.1	2.2
80	Peru	17.4	3	30	3	42.2	18.6	17.8	2.2
81	Puerto Rico	17.4	3	30	0	42.2	18.4	18.4	2.2
82	Costa Rica	17.4	2	30	1	42.2	42.2	41.5	6.5
83	Jordan	17.4	2	14	13	29.0	29.0	25.3	6.6
84	Libya	17.4	0	20	1	33.9	33.9	33.8	6.6
85	Venezuela	17.3	3	34	28	45.4	19.5	10.9	6.7
86	Namibia	17.4	3	34	9	45.5	19.5	18.1	7.4
87	Brazil	17.5	3	34	35	45.5	19.8	17.8	7.6
88	India	18.5	3	34	40	46.2	20.8	13.6	8.0
89	Argentina	17.2	3	35	14	46.2	20.0	17.8	8.6

90	Pakistan	17.4	3	35	31	46.3	20.2	13.9	8.6
91	Japan	17.2	3	37	47	47.8	21.4	11.9	9.1
92	Suriname	17.4	3	36	1	47.1	20.7	20.7	10.1
93	Macao	17.4	0	12	0	27.3	27.3	27.3	13.4
94	Virgin Islands U.S.	17.4	3	38.5	0	49.2	22.2	22.2	13.6
95	United States	14.3	3	39.1	54	47.8	20.9	16.7	14.6
96	Gabon	17.4	2	35	4	46.3	46.3	44.3	16.3
97	Kuwait	17.4	2	15	40	29.8	29.8	25.2	16.4
98	Botswana	17.4	2	22	8	35.6	35.6	34.9	23.3
99	Ecuador	17.4	0	22	10	35.6	35.6	33.9	23.3
100	Bahrain	17.4	3	46	10	55.4	27.5	27.1	23.5
101	Panama	17.4	0	25	14	38.0	38.0	36.7	26.2
102	Uruguay	17.4	2	25	6	38.0	38.0	37.0	26.2
103	Algeria	17.4	0	25	23	38.0	38.0	35.0	26.2
104	Mexico	17.8	2	30	36	42.4	42.4	32.9	31.1
105	Tunisia	17.4	0	30	26	42.2	42.2	38.0	31.1
106	Seychelles	17.4	0	33	12	44.6	44.6	44.0	34.1
107	Angola	17.4	0	35	0	46.3	46.3	46.3	36.1
108	Equatorial Guinea	17.4	0	35	1	46.3	46.3	46.3	36.1

Columns (2): 2 = deduction, 3 = credit, 4 = exemption

Annex B3: Corresponding figures form section 5

Figure 3BIS: Average double tax rates for outward dividend flows (re-ordered host countries): treaty shopping lowers the floor in the remaining double tax rates

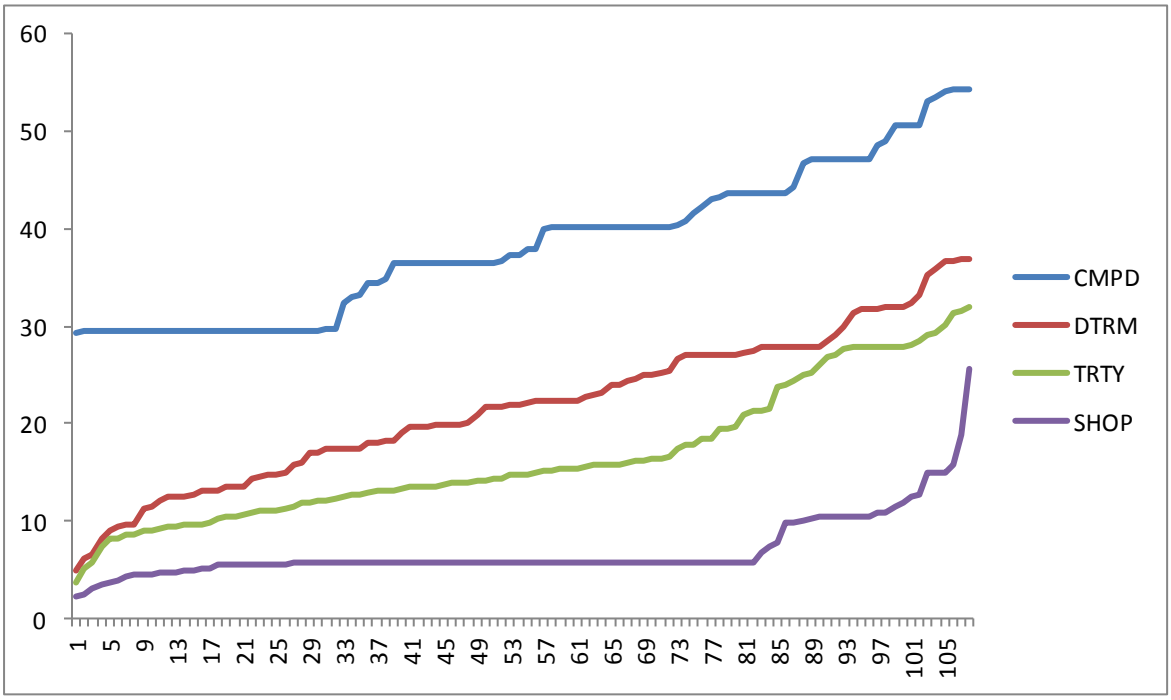
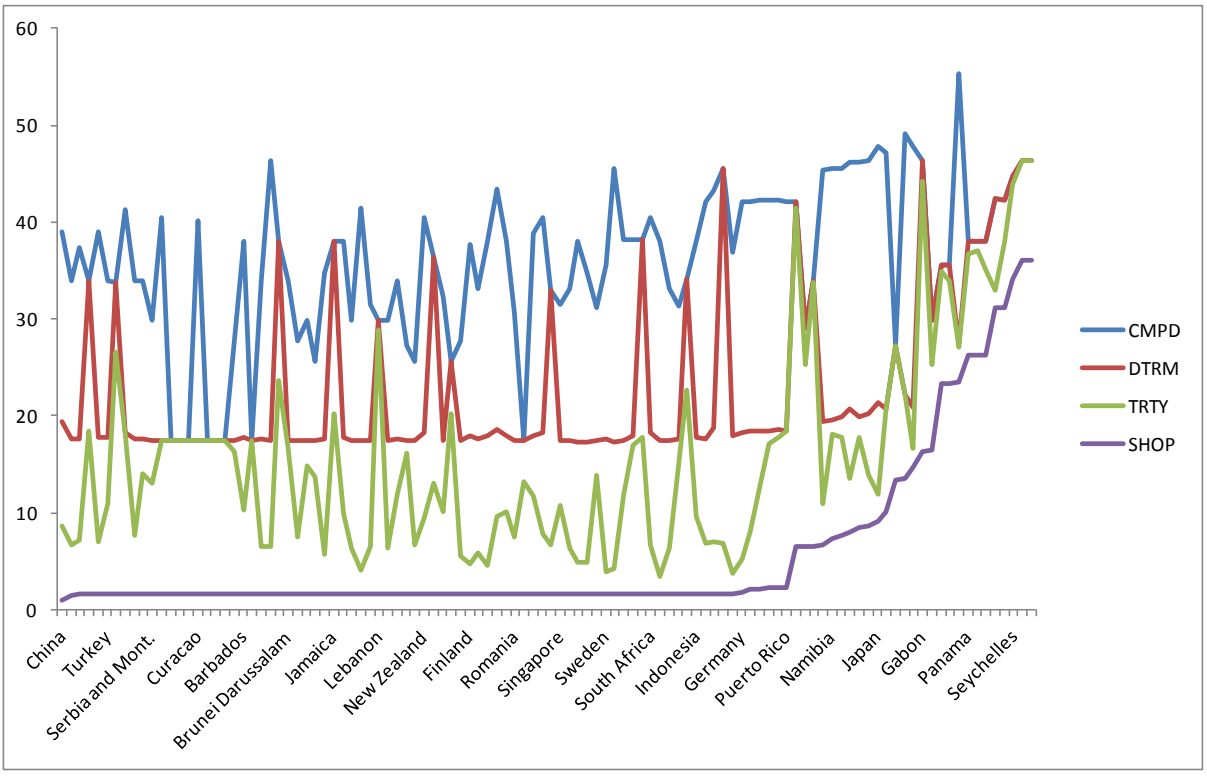


Figure 4BIS: Average double tax rates for incoming dividend flows (by home country): treaty shopping practically equalizes the remaining double tax rates



Annex B4: Centrality measures

	Country	DIV	no. trts	BTWNS	OCCUR	rO	STRCT	rS	UNWTD	rU
1	United Kingdom	0	51	0.0835	0.51	4	0.10	1	0.10	1
2	Estonia	0	36	0.0594	0.54	1	0.06	2	0.06	5
3	Singapore	0	40	0.0559	0.51	6	0.04	4	0.07	3
4	Netherlands	15	74	0.0463	0.47	14	0.02	5	0.08	2
5	Hungary	0	47	0.0455	0.53	2	0.02	7	0.06	6
6	Slovak Republic	0	42	0.0451	0.51	5	0.02	9	0.05	9
7	Malaysia	0	34	0.0420	0.49	8	0.01	14	0.05	7
8	Cyprus	0	35	0.0379	0.42	16	0.02	10	0.06	4
9	Luxembourg	15	57	0.0373	0.52	3	0.05	3	0.04	15
10	Ireland	20	53	0.0330	0.48	10	0.02	6	0.03	18
11	Malta	0	38	0.0318	0.42	15	0.01	11	0.05	8
12	Colombia	0	4	0.0303	0.48	13	0.00	37	0.04	11
13	Untd Arab Emirates	0	21	0.0271	0.49	9	0.01	16	0.04	13
14	Spain	21	71	0.0270	0.34	23	0.02	8	0.05	10
15	Brunei Darussalam	0	1	0.0233	0.49	7	0.01	13	0.02	20
16	France	30	80	0.0232	0.38	20	0.01	12	0.02	19
17	Oman	0	8	0.0222	0.48	11	0.00	28	0.03	16
18	Sweden	30	67	0.0221	0.40	17	0.01	19	0.01	37
19	Switzerland	35	71	0.0203	0.37	21	0.01	18	0.02	23
20	HongKong	0	14	0.0200	0.32	25	0.01	17	0.04	12
21	Denmark	27	61	0.0195	0.38	18	0.01	23	0.01	36
22	Curacao	0	0	0.0178	0.48	12	0.00	38	0.02	21
23	Belgium	25	70	0.0174	0.38	19	0.01	22	0.02	26
24	Norway	25	64	0.0149	0.28	30	0.01	27	0.01	34
25	Finland	24.5	59	0.0144	0.34	24	0.01	15	0.01	38
26	Germany	25	71	0.0136	0.31	27	0.00	31	0.01	43
27	Bulgaria	5	50	0.0128	0.28	32	0.00	30	0.01	39
28	Romania	16	66	0.0121	0.29	28	0.00	34	0.01	35
29	Mauritius	0	15	0.0120	0.28	31	0.00	39	0.04	14
30	Austria	25	66	0.0118	0.31	26	0.00	29	0.02	25
31	Lithuania	15	44	0.0109	0.27	41	0.01	21	0.01	47
32	Liechtenstein	0	3	0.0102	0.28	29	0.00	43	0.02	24
33	Qatar	7	36	0.0099	0.19	48	0.01	20	0.03	17
34	Slovenia	15	46	0.0098	0.25	43	0.01	26	0.01	50
35	Latvia	10	45	0.0097	0.25	44	0.01	24	0.01	46
36	Iceland	18	38	0.0093	0.23	45	0.00	33	0.01	51
37	Greece	10	42	0.0092	0.22	46	0.00	32	0.01	49
38	Poland	19	64	0.0087	0.27	33	0.00	41	0.01	40
39	Czech Republic	35	66	0.0072	0.27	42	0.00	40	0.01	48
40	Turkey	15	59	0.0071	0.16	51	0.00	53	0.00	64
41	Bahamas	0	0	0.0069	0.27	40	0.00	54	0.02	27
42	Bermuda	0	0	0.0069	0.27	35	0.00	55	0.02	28
43	Cayman Islands	0	0	0.0069	0.27	36	0.00	56	0.02	29

44	Guernsey	0	0	0.0069	0.27	37	0.00	57	0.02	30
45	Isle of Man	0	0	0.0069	0.27	38	0.00	58	0.02	31
46	Jersey	0	0	0.0069	0.27	39	0.00	59	0.02	32
47	Virgin Islands U.K.	0	0	0.0069	0.27	34	0.00	62	0.02	33
48	Italy	20	69	0.0067	0.15	52	0.00	35	0.01	45
49	Portugal	25	53	0.0053	0.14	54	0.00	52	0.00	54
50	Egypt	0	23	0.0044	0.37	22	0.00	66	0.01	52
51	Croatia	12	44	0.0036	0.20	47	0.00	42	0.01	42
52	Australia	30	40	0.0035	0.17	50	0.00	50	0.00	65
53	Ukraine	15	56	0.0028	0.15	53	0.00	36	0.01	41
54	Canada	25	75	0.0027	0.07	65	0.00	65	0.01	53
55	Trinidad and Tob.	10	16	0.0025	0.07	63	0.00	49	0.01	44
56	Korea Republic	20	67	0.0023	0.07	62	0.00	51	0.00	62
57	Dominican Rep.	10	1	0.0022	0.07	66	0.00	84	0.00	61
58	New Zealand	30	36	0.0021	0.12	56	0.00	71	0.00	63
60	Saudi Arabia	5	18	0.0020	0.18	49	0.01	25	0.00	59
59	Indonesia	20	52	0.0020	0.07	61	0.00	75	0.00	70
61	South Africa	15	55	0.0019	0.14	55	0.00	61	0.00	60
62	Barbados	15	23	0.0017	0.10	59	0.00	45	0.02	22
63	Albania	10	26	0.0015	0.10	58	0.00	48	0.00	56
64	Israel	20	43	0.0015	0.08	60	0.00	70	0.00	67
65	China	10	61	0.0013	0.06	69	0.00	69	0.00	71
67	Belarus	12	44	0.0012	0.07	64	0.00	64	0.00	55
66	Azerbaijan	10	29	0.0012	0.07	67	0.00	67	0.00	66
68	Kazakhstan	15	35	0.0011	0.07	68	0.00	63	0.00	73
69	Mongolia	20	27	0.0010	0.11	57	0.00	68	0.00	68
70	Serbia and Mont.	20	42	0.0010	0.05	71	0.00	44	0.00	75
71	India	0	40	0.0008	0.01	79	0.00	46	0.00	57
72	Russian Federation	15	59	0.0008	0.04	72	0.00	60	0.00	69
73	Japan	20	47	0.0007	0.03	74	0.00	47	0.00	58
74	Chile	35	24	0.0006	0.06	70	0.00	74	0.00	72
75	Aruba	10	1	0.0003	0.02	76	0.00	72	0.00	76
77	Taiwan Province	20	19	0.0002	0.01	78	0.00	103	0.00	78
76	Jamaica	33.3	15	0.0002	0.03	75	0.00	76	0.00	79
78	Thailand	10	34	0.0002	0.04	73	0.00	104	0.00	80
80	Lebanon	10	13	0.0001	0.02	77	0.00	90	0.00	74
79	Brazil	15	35	0.0001	0.00	81	0.00	73	0.00	77
81	Venezuela	34	28	0.0001	0.01	80	0.00	77	0.00	81
82	Algeria	15	23	0.0000	0.00	88	0.00	78	0.00	82
83	Angola	10	0	0.0000	0.00	89	0.00	79	0.00	83
84	Argentina	35	14	0.0000	0.00	90	0.00	80	0.00	84
85	Bahrain	0	10	0.0000	0.00	91	0.00	81	0.00	85
86	Botswana	7.5	8	0.0000	0.00	92	0.00	82	0.00	86
87	Costa Rica	15	1	0.0000	0.00	93	0.00	83	0.00	87
88	Ecuador	0	10	0.0000	0.00	94	0.00	85	0.00	88
89	Equatorial Guinea	25	1	0.0000	0.00	95	0.00	86	0.00	89

90	Gabon	15	4	0.0000	0.00	96	0.00	87	0.00	90
91	Jordan	0	13	0.0000	0.00	97	0.00	88	0.00	91
92	Kuwait	15	40	0.0000	0.00	98	0.00	89	0.00	92
93	Libya	0	1	0.0000	0.00	99	0.00	91	0.00	93
94	Macao	0	0	0.0000	0.00	100	0.00	92	0.00	94
95	Mexico	0	36	0.0000	0.00	101	0.00	93	0.00	95
96	Namibia	10	9	0.0000	0.00	82	0.00	94	0.00	96
97	Nigeria	10	11	0.0000	0.00	83	0.00	95	0.00	97
98	Pakistan	10	31	0.0000	0.00	84	0.00	96	0.00	98
99	Panama	17	14	0.0000	0.00	102	0.00	97	0.00	99
100	Peru	4.1	3	0.0000	0.00	87	0.00	98	0.00	100
101	Philippines	15	29	0.0000	0.00	85	0.00	99	0.00	101
102	Puerto Rico	10	0	0.0000	0.00	86	0.00	100	0.00	102
103	Seychelles	15	12	0.0000	0.00	103	0.00	101	0.00	103
104	Suriname	25	1	0.0000	0.00	104	0.00	102	0.00	104
105	Tunisia	0	26	0.0000	0.00	105	0.00	105	0.00	105
106	United States	30	54	0.0000	0.00	106	0.00	106	0.00	106
107	Uruguay	7	6	0.0000	0.00	107	0.00	107	0.00	107
108	Virgin Islands U.S.	11	0	0.0000	0.00	108	0.00	108	0.00	108

Annex B5: Hypothetical dividend flows ranking

	Country	FLOWS	rnk BTWNS	wght
1	United States	17.251	106	19.79
2	China	14.484	65	15.66
3	United Kingdom	11.457	1	2.95
4	India	6.125	71	5.91
5	Japan	6.047	73	5.84
6	Singapore	6.041	3	0.41
7	Estonia	5.983	2	0.04
8	Netherlands	5.587	4	0.89
9	Germany	5.572	26	4.04
10	France	5.328	16	2.84
11	Malaysia	4.884	7	0.63
12	Hungary	4.819	5	0.25
13	Slovak Republic	4.691	6	0.17
14	Spain	4.598	14	1.78
15	Cyprus	3.821	8	0.03
16	Luxembourg	3.791	9	0.05
17	Colombia	3.715	12	0.63
18	Ireland	3.563	10	0.24
19	Russian Federation	3.420	72	3.17
20	Malta	3.193	11	0.01
21	Brazil	3.140	79	2.97
22	Italy	3.130	48	2.31
23	Untd Arab Emirates	3.077	13	0.34
24	Sweden	2.748	18	0.50
25	Switzerland	2.525	19	0.46
26	HongKong	2.503	20	0.47
27	Korea Republic	2.399	56	2.04
28	Brunei Darussalam	2.364	15	0.03
29	Mexico	2.359	95	2.22
30	Oman	2.344	17	0.11
31	Belgium	2.314	23	0.53
32	Canada	2.278	54	1.88
33	Denmark	2.237	21	0.27
34	Turkey	2.226	40	1.42
35	Poland	1.957	38	1.01
36	Norway	1.869	24	0.35
37	Indonesia	1.843	59	1.54
38	Curacao	1.782	22	0.00
39	Finland	1.706	25	0.25
40	Austria	1.669	30	0.45
41	Australia	1.662	52	1.23
42	Romania	1.586	28	0.35
43	Saudi Arabia	1.430	60	1.14

44	Bulgaria	1.423	27	0.13
45	Greece	1.302	37	0.35
46	Qatar	1.250	33	0.24
47	Taiwan Province	1.241	77	1.14
48	Mauritius	1.228	29	0.03
49	Lithuania	1.180	31	0.08
50	Egypt	1.177	50	0.68
51	Czech Republic	1.112	39	0.36
52	Slovenia	1.059	34	0.07
53	Liechtenstein	1.027	32	0.00
54	Latvia	1.020	35	0.05
55	Argentina	1.010	84	0.94
56	South Africa	0.983	61	0.74
57	Iceland	0.946	36	0.02
58	Thailand	0.911	78	0.82
59	Portugal	0.865	49	0.31
60	Ukraine	0.743	53	0.42
61	Bahamas	0.709	41	0.01
62	Pakistan	0.702	98	0.65
63	Bermuda	0.702	42	0.01
64	Jersey	0.701	46	0.01
65	Isle of Man	0.700	45	0.01
66	Guernsey	0.698	44	0.00
67	Cayman Islands	0.698	43	0.00
68	Virgin Islands U.K.	0.696	47	0.00
69	Nigeria	0.611	97	0.57
70	Philippines	0.579	101	0.54
71	Venezuela	0.554	81	0.51
72	Chile	0.502	74	0.40
73	Israel	0.495	64	0.31
74	Croatia	0.470	51	0.10
75	Peru	0.446	100	0.41
76	Kazakhstan	0.427	68	0.29
77	New Zealand	0.394	58	0.17
78	Algeria	0.373	82	0.34
79	Dominican Rep.	0.359	57	0.12
80	Belarus	0.319	67	0.19
81	Trinidad and Tob.	0.286	55	0.03
82	Azerbaijan	0.248	66	0.12
83	Ecuador	0.210	88	0.19
84	Kuwait	0.207	92	0.19
85	Serbia and Mont.	0.207	70	0.10
86	Albania	0.187	63	0.03
87	Angola	0.176	83	0.16
88	Barbados	0.175	62	0.01
89	Tunisia	0.144	105	0.13

90	Mongolia	0.116	69	0.02
91	Libya	0.106	93	0.10
92	Lebanon	0.099	80	0.08
93	Puerto Rico	0.088	102	0.08
94	Costa Rica	0.081	87	0.07
95	Panama	0.078	99	0.07
96	Uruguay	0.074	107	0.07
97	Macao	0.064	94	0.06
98	Jordan	0.053	91	0.05
99	Jamaica	0.052	76	0.03
100	Bahrain	0.045	85	0.04
101	Botswana	0.043	86	0.04
102	Gabon	0.035	90	0.03
103	Aruba	0.030	75	0.00
104	Equatorial Guinea	0.026	89	0.02
105	Namibia	0.023	96	0.02
106	Suriname	0.009	104	0.01
107	Seychelles	0.003	103	0.00
108	Virgin Islands U.S.	0.002	108	0.00

Annex B6: Tax revenue results - percentages

	TRTY			SHOP				LOSS	CON[#]
	SRC	RES	*TOT*	SRC	RES	CON	*TOT*		
Chile	27.35	11.89	*39.24*	5.00			*5.00*	34.24	
Jamaica	20.86	10.07	*30.93*			2.03	*2.03*	28.90	0.0007
Gabon	15.00	27.58	*42.58*	15.00			*15.00*	27.58	
Costa Rica	14.82	24.36	*39.18*	15.00			*15.00*	24.18	
Mongolia	13.67	10.29	*23.96*			0.48	*0.48*	23.48	0.0001
Lebanon	9.43	11.43	*20.86*					20.86	
Taiwan Province	17.56	0.23	*17.79*					17.79	
Argentina	30.11	3.07	*33.19*	10.00	6.34		*16.34*	16.84	
Libya		16.45	*16.45*					16.45	
New Zealand	13.42	1.00	*14.42*					14.42	
Venezuela	14.72	2.92	*17.63*	0.99	2.68		*3.68*	13.96	
Suriname	24.84	3.30	*28.15*	7.51	7.93		*15.43*	12.71	
Australia	11.19	1.64	*12.82*		0.38		*0.38*	12.44	
Israel	12.20	0.63	*12.83*			0.68	*0.68*	12.15	0.0023
Saudi Arabia	4.77	9.66	*14.42*			2.34	*2.34*	12.08	0.0288
Panama	15.50	21.11	*36.61*		24.59		*24.59*	12.02	
United States	10.33	10.38	*20.71*	0.03	8.94		*8.97*	11.75	
Indonesia	11.14	0.40	*11.55*			0.09	*0.09*	11.46	0.0014
Jordan		9.88	*9.88*					9.88	
France	5.36	3.62	*8.98*	0.01		0.08	*0.09*	8.88	0.0025
Algeria	11.69	21.66	*33.35*		24.59		*24.59*	8.76	
Portugal	9.44	1.14	*10.58*	0.99		0.86	*1.85*	8.73	0.0029
Japan	7.53	5.91	*13.43*	0.04	4.71	0.04	*4.79*	8.64	0.0026
Thailand	10.00	8.47	*18.47*	10.00		0.01	*10.01*	8.46	0.0001
Kuwait	10.01	13.19	*23.20*	0.00	14.75		*14.76*	8.45	
Seychelles	13.10	27.60	*40.70*	0.01	32.46		*32.47*	8.24	
Egypt		8.14	*8.14*					8.14	
Belarus	9.97	0.13	*10.10*			2.24	*2.24*	7.86	0.0045
Italy	8.12	1.38	*9.51*	1.62		0.24	*1.86*	7.65	0.0058
Slovak Republic		7.46	*7.46*					7.46	
Germany	8.18	0.49	*8.68*	1.06		0.19	*1.24*	7.43	0.0078
Czech Republic	7.69	1.28	*8.98*			1.78	*1.78*	7.19	0.0070
Poland	7.86	0.04	*7.89*			0.77	*0.77*	7.12	0.0084
South Africa	6.80	1.19	*7.99*	1.00		0.42	*1.41*	6.58	0.0033
Denmark	7.48	0.38	*7.86*			1.84	*1.84*	6.02	0.0053
Sweden	6.28	0.35	*6.62*			0.76	*0.76*	5.86	0.0041
Romania	8.64	0.08	*8.72*			3.05	*3.05*	5.67	0.0114
Turkey	10.33	0.32	*10.66*	5.00		0.34	*5.34*	5.32	0.0051
Belgium	6.37		*6.37*	0.32		0.91	*1.23*	5.14	0.0052
Switzerland	7.35		*7.35*			2.38	*2.38*	4.97	0.0118
Norway	10.37	0.75	*11.12*	2.98		3.51	*6.49*	4.63	0.0133

Canada	8.91	0.73	*9.64*	5.09		0.12	*5.21*	4.43	0.0024
Netherlands	4.54		*4.54*	0.00		0.15	*0.15*	4.39	0.0014
Barbados	10.09	0.40	*10.50*			6.20	*6.20*	4.29	0.0006
China	9.37	0.85	*10.23*	6.17		0.01	*6.19*	4.04	0.0020
Russian Federation	8.74	0.19	*8.93*	5.00		0.10	*5.10*	3.83	0.0033
Austria	6.87		*6.87*			3.43	*3.43*	3.45	0.0168
Qatar	6.08	5.60	*11.68*			8.40	*8.40*	3.28	0.0216
Ukraine	7.29	0.13	*7.42*	0.00		4.17	*4.18*	3.25	0.0191
Uruguay	6.73	20.99	*27.72*		24.59		*24.59*	3.13	
Kazakhstan	8.70	0.16	*8.86*	5.00		0.79	*5.79*	3.07	0.0025
Greece	6.61	0.47	*7.08*			4.04	*4.04*	3.04	0.0153
Korea Republic	8.91	0.44	*9.35*	6.10		0.24	*6.33*	3.01	0.0051
Ireland	2.88	0.05	*2.93*			0.04	*0.04*	2.89	0.0001
Philippines	13.04	1.08	*14.12*	11.55	0.57	0.02	*12.14*	1.98	0.0001
Luxembourg	1.94		*1.94*					1.94	
Azerbaijan	9.55	0.16	*9.71*	5.00		2.79	*7.79*	1.91	0.0037
Spain	7.72	0.26	*7.98*	2.67		3.40	*6.08*	1.90	0.0647
Nigeria	9.32	1.02	*10.34*	8.41	0.59	0.02	*9.01*	1.33	0.0001
Finland	6.16	0.27	*6.43*			5.11	*5.11*	1.32	0.0138
Brazil	6.87	2.75	*9.63*	3.07	5.35		*8.41*	1.21	
Dominican Rep.	10.00	0.86	*10.86*	10.00		0.07	*10.07*	0.79	0.0001
Pakistan	8.28	3.21	*11.49*	5.27	5.46		*10.73*	0.76	
Serbia and Mont.	12.94	0.07	*13.02*	5.00		7.32	*12.32*	0.70	0.0079
Namibia	9.46	2.55	*12.01*	6.83	4.04	0.44	*11.31*	0.70	0.0001
Peru	4.10	1.16	*5.26*	4.10	0.57	0.04	*4.72*	0.54	0.0002
Colombia		0.45	*0.45*					0.45	
Puerto Rico	10.00	1.00	*11.00*	10.00	0.59	0.11	*10.70*	0.29	0.0001
Estonia		0.16	*0.16*					0.16	
Hungary		0.16	*0.16*					0.16	
Mauritius		0.08	*0.08*					0.08	
Oman		0.05	*0.05*					0.05	
Bahamas									
Bermuda									
Brunei Darussalam									
Cayman Islands									
Curacao									
Cyprus									
Guernsey									
HongKong									
Isle of Man									
Jersey									
Liechtenstein									
Malaysia									
Malta									
Singapore									
Untd Arab Emirates									

United Kingdom									
Virgin Islands U.K.									
Mexico		28.76	*28.76*		29.53		*29.53*	-0.77	
Botswana	7.27	18.36	25.63	5.00	21.64		*26.64*	-1.01	
Macao		9.91	9.91		11.80		*11.80*	-1.89	
Bahrain		11.76	11.76		13.70		*13.70*	-1.94	
Croatia	8.56	0.21	8.77	0.00		10.80	*10.81*	-2.04	0.0116
India		3.01	3.01		5.39		*5.39*	-2.38	
Tunisia		26.57	26.57		29.51		*29.51*	-2.94	
Ecuador		18.64	18.64		21.64		*21.64*	-3.00	
Virgin Islands U.S.	11.00	4.80	15.80	11.00	9.85		*20.85*	-5.05	
Equatorial Guinea	25.00	28.92	53.91	25.00	34.43		*59.43*	-5.51	
Angola	10.00	28.91	38.91	10.00	34.43		*44.43*	-5.52	
Slovenia	6.87	0.09	6.96			17.39	*17.39*	-10.43	0.0138
Bulgaria	3.92	0.04	3.96			14.63	*14.63*	-10.67	0.0208
Lithuania	6.75	0.06	6.81			20.55	*20.55*	-13.74	0.0183
Trinidad and Tob.	9.00	0.40	9.40			25.13	*25.13*	-15.73	0.0092
Albania	8.93	0.04	8.97			28.73	*28.73*	-19.76	0.0103
Iceland	7.84	0.14	7.98			32.95	*32.95*	-24.97	0.0058
Latvia	5.65	0.06	5.72			36.83	*36.83*	-31.11	0.0188
Aruba	9.96		9.96	5.70		35.62	*41.32*	-31.36	0.0012

[#] Conduit taxation as percent points of worldwide dividend flows instead of national.

Annex B7: Changes in betweenness centrality

	Δ BTWNS	rank CRCK	rank REF	Δ SHOP-out	Δ SHOP-in
Singapore	-0.043	24	3	0.0119	0.1562
Ireland	-0.027	44	10	0.0119	0.1560
Luxembourg	-0.024	22	9	0.4942	0.1557
Malta	-0.020	26	11	0.4850	0.1556
Cyprus	-0.020	15	8	0.0119	0.1556
Untd Arab Emirates	-0.020	36	13	0.0119	0.1561
Oman	-0.016	37	17	0.0118	0.1557
Switzerland	-0.014	52	19	0.0119	0.1563
HongKong	-0.014	50	20	0.0120	0.1563
Bulgaria	-0.007	51	27	0.0119	0.1557
Liechtenstein	-0.004	38	32	0.0119	0.1556
Mauritius	-0.004	32	29	0.0119	0.1556
Qatar	-0.002	35	33	0.0119	0.1560
Belgium	-0.002	20	23	0.0119	0.1564
Albania	-0.001	76	63	0.0119	0.1556
Canada	-0.001	63	54	0.0115	0.1585
Barbados	-0.001	73	62	0.0119	0.1556
Korea Republic	-0.001	65	56	0.0116	0.1588
Bahamas	-0.001	40	41	0.0119	0.1555
Bermuda	-0.001	41	42	0.0119	0.1556
Cayman Islands	-0.001	42	43	0.0118	0.1555
Guernsey	-0.001	43	44	0.0119	0.1556
Isle of Man	-0.001	45	45	0.0119	0.1556
Jersey	-0.001	46	46	0.0118	0.1556
Virgin Islands U.K.	-0.001	47	47	0.0119	0.1556
Netherlands	-0.001	6	4	0.0120	0.1569
South Africa	-0.001	67	61	3.5584	0.1197
New Zealand	0.000	61	58	2.1200	0.1512
France	0.000	12	16	0.0147	0.1601
Aruba	0.000	82	75	4.5266	0.1554
Taiwan Province	0.000	104	77	8.1145	0.0420
Lebanon	0.000	91	80	0.0119	0.1557
Algeria	0.000	79	82	0.0119	0.1171
Angola	0.000	80	83	0.0107	0.1013
Argentina	0.000	81	84	0.0108	0.1154
Bahrain	0.000	83	85	0.6649	0.2175
Botswana	0.000	84	86	0.0113	0.1213
Brazil	0.000	77	79	0.0123	0.1248
China	0.000	68	65	0.0134	0.1844
Costa Rica	0.000	85	87	0.5552	15.8624
Ecuador	0.000	86	88	0.0119	0.1216
Equatorial Guinea	0.000	87	89	0.0089	0.1012
Gabon	0.000	88	90	0.0101	0.1323

Germany	0.000	21	26	0.0124	0.1621
Japan	0.000	74	73	0.0126	0.0827
Jordan	0.000	89	91	0.0119	0.1478
Kuwait	0.000	90	92	0.0119	0.1012
Libya	0.000	92	93	0.0118	0.1480
Macao	0.000	93	94	0.0119	0.1370
Mexico	0.000	94	95	0.0121	0.1080
Namibia	0.000	95	96	0.0113	0.1122
Nigeria	0.000	96	97	0.0110	0.1554
Pakistan	0.000	97	98	0.0113	0.0974
Panama	0.000	98	99	0.0119	0.1168
Peru	0.000	99	100	0.0114	0.1551
Philippines	0.000	100	101	0.0108	0.1554
Puerto Rico	0.000	101	102	0.0107	0.1546
Seychelles	0.000	102	103	0.0119	0.1042
Suriname	0.000	103	104	0.0110	0.0984
Tunisia	0.000	105	105	0.0119	0.1090
United States	0.000	106	106	0.0148	0.0612
Uruguay	0.000	107	107	0.0119	0.1167
Venezuela	0.000	78	81	0.0120	0.1322
Virgin Islands U.S.	0.000	108	108	0.5915	0.0705
Russian Federation	0.000	72	72	0.0116	0.1607
Jamaica	0.000	75	76	0.0119	0.1556
Serbia and Mont.	0.000	70	70	0.0113	0.1557
Poland	0.000	31	38	0.0120	0.1571
Azerbaijan	0.000	66	66	0.0113	0.1558
Austria	0.000	25	30	0.0119	0.1563
Israel	0.000	60	64	0.0120	0.1560
Chile	0.000	71	74	0.0113	0.1562
Belarus	0.000	62	67	0.0119	0.1558
India	0.000	69	71	0.0127	0.1248
Kazakhstan	0.000	64	68	0.0113	0.1560
Indonesia	0.001	58	59	0.0121	0.1580
Dominican Rep.	0.001	56	57	0.0107	0.1558
Trinidad and Tob.	0.001	55	55	0.0119	0.1556
Portugal	0.001	39	49	0.0119	0.1561
Mongolia	0.001	59	69	0.0119	0.1556
Saudi Arabia	0.001	57	60	0.0120	0.1574
Ukraine	0.001	54	53	0.0119	0.1562
Italy	0.001	34	48	0.0122	0.1593
Finland	0.001	19	25	0.0119	0.1560
Norway	0.001	18	24	0.0119	0.1561
Denmark	0.002	13	21	0.0119	0.1560
Czech Republic	0.002	30	39	0.0119	0.1561
Spain	0.002	9	14	0.0121	0.1584
Iceland	0.002	28	36	0.0119	0.1556

Greece	0.002	27	37	0.0119	0.1561
Croatia	0.002	49	51	0.0119	0.1557
Australia	0.003	48	52	0.0120	0.1507
Turkey	0.003	29	40	0.0115	0.1578
Slovenia	0.003	23	34	0.0118	0.1557
Egypt	0.004	33	50	0.0119	0.1566
Sweden	0.004	11	18	0.0120	0.1563
Thailand	0.004	53	78	0.0108	0.0993
Romania	0.005	16	28	0.0119	0.1561
Latvia	0.007	17	35	0.0119	0.1556
Lithuania	0.007	14	31	0.0118	0.1557
Curacao	0.010	10	22	0.0118	0.1556
Colombia	0.013	7	12	0.0119	0.1566
Brunei Darussalam	0.018	8	15	0.0118	0.1556
Hungary	0.025	4	5	0.0119	0.1559
Malaysia	0.025	5	7	0.0119	0.1566
Slovak Republic	0.026	3	6	0.0119	0.1558
United Kingdom	0.027	1	1	0.0122	0.1603
Estonia	0.029	2	2	0.0119	0.1557

Annex C1: The adapted shortest path algorithm

This annex documents the three main adaptations required to make the world of international corporate taxation fit, *in abstracto*, the world of transportation. The mapping described covers the three most common options for double taxation relief; two more options are briefly considered.

The Floyd-Warshall algorithm and a basic method

The all-pairs shortest path problem (APSP) is solved with the Floyd-Warshall algorithm.[45] The core of this algorithm is the next comparison, where d_{ij}^{m} is the length of the shortest path from *i* to *j* allowing only the first *m* vertices (countries) as intermediate stations.

$$d_{ij}^{m} = \min\{d_{im}^{m-1} + d_{mj}^{m-1}, d_{ij}^{m-1}\}$$

The algorithm is initialized with the distance matrix, which contains all the relevant information ($D^0 = D$). By consecutively allowing an additional vertex as intermediate station, the length of the shortest path over the whole network is computed for all possible pairs ($S = D^{\mathrm{N}}$). The order in which the vertices are considered does not influence the final outcome. The elegance and efficiency of the algorithm is that with a fixed and limited number of additions and comparisons, each of the order N^3, it completes the job.

The core comparison of the algorithm reflects that in the world of transportation distances simply can be added. This is obviously not the case for tax rates, as the base for taxation with a second rate, are the profits after the first tax. The comparison is easily adapted to accommodate this; the adaptation corresponds with *deduction* as the method for double taxation relief.

$$d_{ij}^{m} = \min\{d_{im}^{m-1} + d_{mj}^{m-1} - d_{im}^{m-1} d_{mj}^{m-1}, d_{ij}^{m-1}\} \qquad \text{or} \quad d_{ij}^{m} = \min\{1-(1-d_{im}^{m-1})(1-d_{mj}^{m-1}), d_{ij}^{m-1}\}$$

The tax rates considered include the non-resident withholding taxes, which are given for a pair of jurisdictions, i.e. from *i* to *j*. The corporate income taxes (CITs) however are an attribute of a single jurisdiction, and care must be taken not to apply them both on inward flows and on outward flows. In the main text is described how the CITs are part of the compounded distances rates for inward income flows. This is the second adaption.

There is a convenient consequence of including the CIT of a home country in the tax distances applying to its inward flows. For countries with *exemption* as their double tax relief method it amounts to having a CIT of zero. Their actual CIT only matters when these

[45] See for instance Minieka (1978).

countries are the initial host on a repatriation path, then their CIT must be included in the full combined effective tax rate of the path.

More in general, for any tax route, with an initial host $k=1$ and final destination $k=\mathrm{n}$, the full combined effective tax rate equals $1-(1-t_1)\left(\prod_{k=2}^{\mathrm{n}}(1-d_{k-1,k})\right)$.

Here t_1 denotes the CIT of country 1 and $d_{1,2}=w_{1,2}$ is the bilateral withholding tax rate from 1 to 2. The other tax distances are either the bilateral withholding tax rates, $d_{k-1,k}=w_{k-1,k}$, when country *k* applies *exemption*, or they include the CIT of the intermediate home country *k*, $d_{k-1,k}=1-(1-w_{k-1,k})(1-t_k)$, when it applies *deduction* as double tax relief. The adapted Floyd-Warshall takes care of the product of the tax distances, in which the order is inconsequential,[46] as is desired.

Thus a basic method is defined, with a deduction 'metric'[47], covering both *deduction* and *exemption* as double tax relief methods. Incorporating the *credit* method introduces a complexity which requires a final adaptation.

Dealing with the credit method in conduit situations

The complexity with *credits* as a double tax relief method is the question which taxes can be credited against the corporate tax in the final, or intermediate, home country. Roughly three possibilities can be identified: i) all taxes paid on the preceding tax route are credited, ii) only the taxes actually paid in the last preceding jurisdiction are credited, and iii) the nominal CIT rate of the last preceding jurisdiction is credited as is its the withholding tax[48], whether this CIT is paid or not. The first option may be most in line with the philosophy of the credit method, i.e. capital export neutrality.

The option of crediting the nominal CIT of the last preceding country has the advantage that nothing needs to be known of the route before that last country visited. Moreover it fits into the method described above, with the definition of tax distance also given in the main text:

$$d_{k-1,k}(credit) = \max\{w_{k-1,k}, (t_k - t_{k-1})/(1-t_{k-1})\}$$

As a bit of a degenerate example, let's see how this pans out for repatriation of dividends from Malta to the USA. Both countries have a CIT rate of 35 percent[49], Malta levies no non-resident withholding tax on dividends and the USA applies an indirect credit method. Thus the tax distance is zero and no taxes are due in the USA. This may make sense when Malta is the initial host and actual business takes place in Malta. When Malta is used as a conduit

[46] This is the communicative property.
[47] Strictly speaking it is not a metric, since, for instance, the property of symmetry is not satisfied.
[48] This is the indirect tax credit system, see below.
[49] State taxes on top of the federal US rate of 35 percent ought to be considered too.

country its double tax relief method comes into the picture, which is exemption, and no taxes at all are paid in Malta. Then it is, to say the least, less evident that the USA would (want to) grant a full credit.

In practice it may be difficult, or undesirable, to account for all the accumulated taxes paid on a tax route. In terms of the algorithm of the basic method, when reaching a given jurisdiction, to be evaluated as an intermediate station (*m*), the total taxes paid on the route arriving there seem to be known (d_{im}^{m-1}). These total taxes include the treatment of the CIT of the evaluated jurisdiction. However, it must be realized that the treatment of the CIT in the jurisdiction under consideration is based on the initial distance matrix, so that the credit is based on the *nominal* tax rate of the previous jurisdiction on the path: the algorithm therefore does not contain the information on *actual* total taxes paid, or actual taxes paid at the last stop. This excludes implementing the first two options.

Acknowledging that the practice of the credit method is complex and that we have no structural information to determine which option best reflects the actual operation of the credit method we decided on the next implementation: we let the world average corporate income tax be credited, in combination with the actual withholding tax of the last conduit jurisdiction preceding the parent jurisdiction with the credit method.

A conservative implementation would be to assume that no corporate income tax at all can be credited in conduit situations. The total taxes paid would then severely be overestimated, because most often corporate taxes will be paid in the last preceding jurisdiction or on the route before that.[50]

It must be observed that the world average tax rate is only applied in those conduit situations where a jurisdiction with the credit method follows a conduit country. When the last preceding jurisdiction is the starting point of a tax route the corporate income tax is paid in the initial host and is credited in the next stop of a tax route. This gives rise to the final adaptation of the shortest path algorithm.

Let d_{ij} denote the usual tax distance between *i* and *j* when *i* is the first node of a path, and let p_{ij} denote the distance between *i* and *j* when *i* is an intermediate node on a path. This second distance incorporates the assumption dealing with the credit method.

$$p_{k-1,k}(credit) = \max\{ w_{k-1,k}, (t_k - \bar{t}) / (1-\bar{t}) \}, \qquad \text{with } \bar{t}: \text{ world average CIT}$$

[50] A third tack on this would be to credit the CIT of the initial host. This has not been examined yet.

Let p_{ij}^N be the output of the Floyd-Warshall algorithm with the deduction 'metric' applied to distances for intermediate stations. Thus all shortest distances are known for the inner work of tax routes, i.e. when the first vertex of the route eventually is the second. Then the outer work of initial vertices (jurisdictions) can be added as follows.

$$d_{ij}^N = \min\{d_{ij}, \min_m(d_{im} + p_{mj}^N)\}$$

How does all this work out for Malta and the USA? When Malta is the initial host, a corporate income tax of 35 percent is paid in Malta and is credited against the corporate tax in the USA, also 35 percent, so that no corporate taxes are paid there. When Malta is a conduit country just in front of the USA on a tax route the world average CIT rate is credited, reflecting both the taxes on the route before reaching Malta and those of Malta, which are zero, because of its exemption method and the fact that it levies no withholding tax on dividends.

Direct versus indirect credit and no-relief-at-all

Instead of allowing both the corporate tax of the host country and the withholding tax to be credited, some countries only allow the withholding tax to be credited against their corporate tax. The latter method is referred to as a direct foreign tax credit whereas the former is the indirect tax credit method. For conduit situations we use the direct credit method!

The direct credit method could also easily be implemented; it suffices to define the tax distance for *i* as a first node of a tax route, see below. We have however not collected information on countries applying direct rather than indirect credits.

$$d_{ij}(direct\ credit) = \max\{w_{ij}, t_j\}$$

Some countries provide no relief at all for double taxation; the combined effective tax rate for a direct route is as shown below.

$$t_{SP}^e(no\ relief) = t_S + w_{SP} - t_S w_{SP} + t_P$$

In conduit situations problems similar to those with indirect credits occur, although no-relief-at-all is not likely to occur in conduit situations. Nevertheless, we have not covered it.

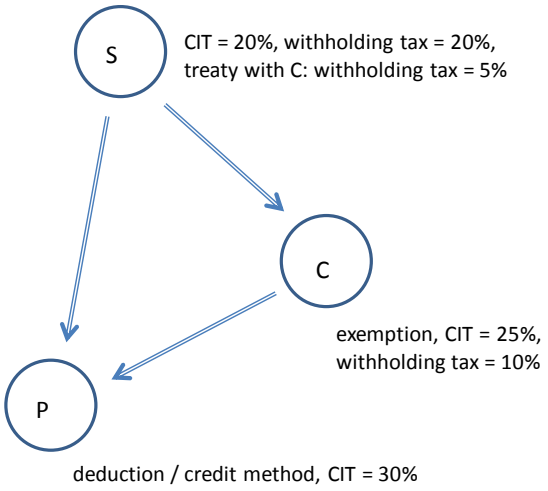
Annex C2: Numerical examples of compounded tax rates and treaty shopping

Host country S levies a corporate income tax (CIT) with a rate of 20%. It also applies this rate on the profits of subsidiaries of foreign companies. When dividends are repatriated to the parent company, host S levies a non-resident dividend withholding tax of again 20%.
Parent country P has a CIT of 30%. The world average CIT is 25%.

Deduction method

First assume that the home country P applies the deduction method for double tax relief. Now what is the combined effective tax rate the company faces when repatriating dividends directly from S to P? The compounded taxes due in host S are 36%.[51] And parent P applies another 30% on the after-tax foreign income to yield an overall combined effective tax rate of 55.2%.[52]

Figure C1: A numerical example



The parent company could have diverted the investment through an entity in conduit country C. When this is the case, repatriating profits from S involves other tax rates. First the 20% CIT of host S needs to be paid. And again there is a withholding tax. However, countries S and C have signed a bilateral tax treaty, stipulating a withholding tax on flows from S to C of only 5%, instead of the general rate of 20%.

Conduit country C has a CIT rate of 25%, but exempts foreign source dividend income to avoid double taxation. It does levy a withholding tax of 10% .This gives a sequence of four compounded taxes yielding a final rate of 52.1%.[53] As this is less than the final rate of the direct route, the rational choice is for the indirect route, i.e. treaty shopping.

[51] Computed as 1 - (1 - 0.20)(1 - 0.20) = 1 - 0.64 = 0.36.
[52] Computed as 1 - (1 - 0.20)(1 - 0.20)(1 - 0.30) = 1 - 0.448 = 0.552.
[53] Computed as 1 - (1 - 0.20)(1 - 0.05)(1 - 0.10)(1 - 0.30) = 1 - 0.684 = 0.5212.

Credit method

Now assume that the home country P applies the credit method for double tax relief. The combined taxes due in host S are again 36%. This exceeds the CIT rate of 30% of the parent country. As excess credits are not refunded, the overall effective or compounded tax rate is 36%.

Again the parent company could have diverted the investment through an entity in conduit country C. Then it would be able to make use of the lower withholding tax rate found in the treaty between S and C, and of the exemption in the conduit country. The three taxes already paid when arriving at P amount to a rate of 31.6%.[54] This rate exceeds the CIT rate of P. However, in conduit situations we allow the just world average CIT to be credited, and the relevant withholding tax. These two amount to 32.5%,[55] which also exceeds the CIT of P.

The conservative approach would be imposing the direct credit method, which means that only the withholding tax rate can be credited. This results in a combined effective tax rate of 46.8%.[56] In this case treaty shopping is not profitable.

[54] Computed as 1 - (1 - 0.20)(1 - 0.05)(1 - 0.10) = 1 - 0.684 = 0.316.
[55] Computed as 1 - (1 - 0.25)(1 - 0.10) = 1 - 0.675 = 0.325.
[56] Computed as 1 - (1 - 0.20)(1 - 0.05)(1 - 0.30) = 1 - 0.532 = 0.468.

Annex C3: Generating all shortest paths, and all those within range

The Floyd-Warshall algorithm is an efficient method to compute the value of the strict shortest paths for all pairs of nodes of a network. With a small addition to the algorithm the so-called Penultimate Vertex Matrix can be maintained. Upon completion of the Floyd-Warshall algorithm shortest paths for all pairs can be reconstructed from this matrix. The PVM-method generates only a single strict shortest path for a given pair. We however require all shortest paths of a given pair, to be able to compute centrality measures. We do expect multiplicity of strictly shortest paths. But in addition we are also interested in those paths for a given pair with a length that is within a prespecified admissible range on top of the value of the strictly shortest path. These paths within range are also considered relevant for the centrality measures. The PVM-method is not suitable for generating all those relevant paths.

What has been implemented in stead is a branch and bound method. The branching consists of a full, depth-first enumeration of all possible combinations. The bounding is accomplished with the values of the strict shortest paths which are computed with the Floyd-Warshall algorithm, executed beforehand.

The depth-first enumeration will provide a sequence of vertices (countries), say {1, 2, .. , *k*}. Let the value of the length (or tax cost) of this path be V(1,2, .. , *k*). This value must always be greater or equal to the value of the shortest path from 1 to *k*, S(1, *k*).
When V(1,2, .. , *k*) = S(1, *k*) : recognize sequence {1, 2, .. , *k*} as a shortest path from 1 to *k*.
When V(1,2, .. , *k*) > S(1, *k*) : backtrack because the upperbound is exceeded.

The backtracking will be to the sequence: {1, 2, .. , k-1, k+1), which then will be evaluated. With a full enumeration, depth-first, all strictly shortest paths will be found.

Generating all relevant paths within an additive range R is accomplished with the following rules. When V(*k, .. , m*) <= S(*k,m*) + R : recognize {*k, .. , m*} as a relevant path from *k* to *m*.
When V(*k, .. , m*) > S(*k, m*) + R : backtrack because the upperbound is exceeded.

This implementation is a brute-force approach. It is only possible because the relevant paths are not too long, with a sequence of six or seven countries as a maximum. And even then the performance is poor. The run generating almost 900,000 relevant paths took about 18 hours to execute. This means that the algorithm for the full enumeration is not very efficient and improvements are currently being examined.

Annex C4: The betweenness centrality measure and flows

Double GDP - weights on the dividend flows w_{ij} are : $w_{ij} = \frac{GDP_i.GDP_j}{\sum_k \sum_{l \neq k} GDP_k.GDP_l}$.

By construction $\sum_i \sum_{j \neq i} w_{ij} = 1$.

The weights are the shares of the flows when 1 euro or dollar is run through the system.

The measure of *betweenness centrality* for vertex *k*, B_k , is computed from the number of times vertex *k* is on a relevant path from *i* to *j*, excluding *k* as start and end point, n_{kij} , as a share in the total number of relevant paths from *i* to *j*, N_{ij} , and then these fractions are weighted over all pairs *i* and *j*.

$$B_k = \sum_{i \neq k} \sum_{j \neq i,k} w_{ij} \frac{n_{kij}}{N_{ij}}$$

The assumption here is that each of the relevant paths between *i* and *j* takes the same share, being $1/N_{ij}$, of the total flow of the pair *ij*, whose share is w_{ij} .

Betweenness centrality thus measures the share of total flows that run through a vertex. This excludes the flows that start or end at the given vertex *k*. When these are added the *flows* measure, F_k , is defined.

$$F_k = B_k + \sum_{i \neq k} w_{ik} = B_k + \sum_{j \neq k} w_{kj}$$

The sum of this measure over all vertices gives an aggregate statistic on the indirect routing.

$$Total\ \ flows = \sum_k F_k = 1 + \sum_k B_k$$

Annex D1: Centrality and FDI positions

Table 1 in the introduction gives an overview of the inward and outward FDI positions according to the IMF/CDIS data which include FDI stocks held by special purposes entities (SPE's). The question is whether these positions can be explained by the country's position in the international tax network. The centrality measure, presented in section 6, is used as a proxy for the attractiveness of a country as conduit for dividend flows and we investigate to what extent it can explain the size of the outward and inward FDI stocks. A simple cross sectional regression analysis illustrates the role of centrality in the international tax network. We certainly not claim that this superficial analysis gives the final proof of a casual relation. Because it is a cross section we cannot use country fixed effects to correct for unobserved country characteristics. In addition, we do not test the causality, which is problematic because the outcomes of the centrality measures are affected by tax rates and treaties, which could be influenced by the size of FDI stocks.

We use the IMF/CDIS FDI stocks data are for the year 2011. Because not all countries report to IMF we use for our sample of 108 countries the mirrored data.[57] Our tax data are for 2013. Because most of the withholding taxes on dividends and double tax relief systems do not frequently change over time, the mismatch in timing is not too problematic. The basic regression is as follows: $\log(FDI_{di}) = \alpha\, C_i + \beta_k X_{kdi} + \varepsilon_i$. C_i is the centrality measure of country *i* and X_{kdi} is the set of other covariates. ε_i is the error term, assumed to be independent and identically distributed according to a normal distribution. The subscript *d* refers to the inward or outward stock. Among the covariates are institutional quality and log(GDP) with a 3-year lag, which serves as a proxy for market size. We also control for tax related factors by including a dummy for tax havens based on Gravelle (2013) and the CIT rate. The CIT is only included in the inward FDI regression.

Table D1: Estimation results for inward and outward stocks

FDI Stock	inward	outward
Centrality/Flows	17.79**	18.68**
Standardized coefficients	0.30	0.31
log (GDP)	0.86***	0.90***
Institutional quality	0.76***	1.50***
CIT	-0.04**	
Tax haven dummy	1.36***	2.64***
Constant	0.53	-2.29
R^2 (adj)	0.65	0.72

Notes: 108 observations. ***,** and * denote 99, 95 and 90% statistical significance. OLS regression for 2011 with robust standard errors.

[57] The construction of the data and regression analysis are explained in more detail by Delgado (2014).

The results in table D1 show that the centrality measure has a significant impact on the inward and outward FDI stocks. An increase of a standard deviation in the betweenness centrality increases the inward FDI stock on average by 30 percent and the outward stock by 31 percent (see standardized coefficients). We interpret these significant effects of the centrality variable on FDI stocks as indirect evidence of treaty shopping.

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