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Optimal fiscal barriers to international economic integration in the presence of tax havens☆

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ABSTRACT

This paper develops a model where firms can shift profits to tax havens by means of intra-firm loans and countries can protect themselves against profit shifting by taxing cross-border interest flows. The model considers two countries with a scope for welfare improving economic integration. The first-best tax system has two important characteristics: (i) the tax rate on interest flows to the other country is zero to ensure the optimal level of economic integration; (ii) the tax rate on interest flows to tax havens is high enough to deter profit shifting to tax havens. In second-best environments, countries face a trade-off between economic integration and protection against tax havens, which causes protection to be suboptimally low. The key to the result is that economic integration makes it easier for multinational firms to circumvent taxes on interest payments to tax havens with conduit loans. The paper thus provides an explanation for the empirical puzzle that many countries do not tax interest payments to tax havens despite the scope for profit shifting.

1. Introduction

Multinational firms face strong incentives to shift profits from countries with high corporate taxes to tax havens. A common profit shifting technique uses intra-firm loans from finance subsidiaries in tax havens to operating subsidiaries in high-tax countries. Such loans generate a tax saving because the interest payments shift taxable profits from operating subsidiaries facing a high tax rate to finance subsidiaries facing a zero tax rate.

Recently, an interesting controversy has emerged about the welfare implications of profit shifting facilitated by tax havens. The conventional view that tax havens are harmful is formalized by Slemrod and Wilson (2009) in a model where tax havens provide tax evasion services to firms. In this setting, tax evasion reduces welfare due to unproductive use of resources by tax havens facilitating evasion and by tax administrations combating evasion. The alternative view that tax havens are beneficial is developed by Hong and Smart (2010) in a model where the corporate tax falls on both perfectly mobile capital employed by multinational firms and immobile capital employed by domestic firms. In this framework, profit shifting allows multinational firms to reduce their effective tax rate and thus improves efficiency by establishing a *de facto* differentiated capital tax with a lower effective rate on mobile capital than on immobile capital.[1]

Interestingly, Mintz (2004) notes that governments have access to a tax instrument capable of eliminating the scope for this type of profit shifting: Withholding taxes on interest payments to foreign entities effectively reduce the tax savings from intra-firm loans and thus constitute a fiscal barrier to profit shifting. Arguably, a general withholding tax on cross-border interest payments would place multinational firms at a disadvantage relative to other firms and therefore also constitute a fiscal barrier to economic integration. Under the view that tax havens are harmful, this suggests that optimal withholding taxes should be differentiated with a high rate applying to interest payments to tax havens and a zero rate applying to interest payments to other countries. Intuitively, such a tax system offers protection against profit shifting without impeding economic integration between countries.

Table 1 reports withholding tax schedules applying to intra-firm interest payments in 28 OECD countries. The first column lists the withholding tax rate stipulated by domestic law, which is the rate

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[1] Johannesen (2010a) points to a positive general equilibrium effect of tax havens. When tax competition for profits is imperfect in the sense that not all profits are shifted to the jurisdiction with the lowest tax rate, the tax game between *ex ante* identical countries may result in an asymmetric equilibrium with an endogenous fraction of high-tax and low-tax countries. In this setting, tax havens can potentially improve the welfare of countries by strengthening tax competition for profits, which induces low-tax countries to become high-tax countries.

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Table 1
Withholding tax rates on interest flows between related corporations (source country in rows, residence country in columns).
Source: PriceWaterhouseCoopers, Global Tax Summaries, Data extract on 2 March 2009.

	Domestic law	AT	BE	CZ	DK	FI	FR	GE	GR	HU	IE	IT	LU	NL	PL	PT	SP	SW	UK	AU	CA	JP	KO	MX	NZ	NO	CH	TR	US
Austria	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Belgium[a]	15	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	10	10	10	10	15	0	15	15
Czech Republic	15	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	10	10	10	10	0	0	20	0
Denmark	30	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Finland	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
France	0	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Germany	0	0	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Greece[b]	25	10	10	10	8	10	10	10	X	10	5	10	8	10	10	15	8	10	0	25	25	25	8	10	25	10	10	12	25
Hungary	0	0	0	0	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ireland	0	0	0	0	0	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Italy	0	0	0	0	0	0	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Luxembourg	0	0	0	0	0	0	0	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poland[b]	20	10	10	10	5	0	0	5	10	10	10	10	10	5	X	10	0	0	5	10	15	10	10	15	10	0	10	10	0
Portugal[b]	20	10	10	10	10	10	10	10	10	10	10	10	10	10	10	X	10	10	10	20	10	20	15	10	20	15	10	15	10
Spain	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	X	0	0	10	15	10	10	15	10	10	0	15	10
Sweden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0
United Kingdom	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	X	10	10	10	10	15	10	0	0	15	0
Australia	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	X	10	10	10	10	10	10	10	10	10
Canada	25	10	10	10	10	10	10	10	25	10	10	10	10	10	15	10	15	10	10	10	X	10	10	10	15	10	10	25	0
Japan	20	10	10	10	10	10	10	10	20	10	10	10	10	10	10	20	10	10	10	10	10	X	10	10	20	10	10	15	10
South Korea	25	10	10	10	15	10	10	10	8	0	0	10	10	10	10	15	10	15	10	15	10	10	X	15	10	15	10	10	12
Mexico	28	10	15	10	15	15	10	15	10	28	10	10	10	15	15	10	15	15	15	15	10	15	15	X	10	15	15	28	15
New Zealand	15	10	10	10	10	10	10	10	15	15	10	10	15	10	10	15	10	10	10	10	15	15	10	10	X	10	10	15	10
Norway	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	X	0	0	0
Switzerland	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	10	10	15	10	0	X	35	0
Turkey	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	X	10
USA	30	15	15	15	15	15	15	15	30	15	15	15	15	15	15	15	15	15	15	15	15	10	15	10	15	15	15	20	X

Note: Rules are in some cases complex and the rates presented here are the rates that would – according to our judgment – apply to a finance structure as described in the paper. No data were available for Iceland and the Slovak Republic.

[a] Withholding tax exemption when the Belgium compamny acts as a conduit company for transactions between two non-Belgian companies.

[b] Temporary exemption from Council Directive 2003/49/EC abolishing taxes on intra-firm interest flows within the EU. Rates to EU countries will fall to 5% on 1 July 2009 and 0% on 1 July 2013.

applying to interest flows to tax havens. Subsequent columns list withholding tax rates applying to interest flows to other OECD countries as specified by bilateral treaties and other international agreements. Generally, interest flows between OECD countries are subject to very low tax rates, most notably a zero rate applies to interest flows between EU countries.[2] This is consistent with the standard argument that countries benefit from a joint elimination of barriers to economic integration. Perhaps more surprisingly, a considerable number of countries, in particular EU countries, do not tax interest payments to tax haven entities. Evidently, a zero tax rate on interest payments to tax havens maximizes the benefits associated with tax planning by allowing firms to shift profits to tax havens at no tax cost.[3]

The absence of fiscal barriers to profit shifting is clearly consistent with the Hong–Smart view of tax havens. If profit shifting improves efficiency, there is no reason to expect that countries would tax intra-firm interest payments. Moreover, the absence of fiscal barriers to profit shifting is, seemingly, incompatible with the Slemrod–Wilson view of tax havens. If profit shifting to tax havens leads to wasteful use of resources, it is puzzling that a large number of countries do not set sufficiently high fiscal barriers to eliminate the scope for this type of tax planning. An important contribution of the present paper is to expose a mechanism that causes fiscal protection against tax havens to be suboptimal (or entirely absent) even when tax havens are harmful. This reconciles the Slemrod–Wilson view of tax havens with observed features of real-world tax systems.

This paper analyzes taxation of cross-border interest flows in a model of international economic integration. The model considers two countries, Home and Foreign, with a scope for welfare improving economic integration. Each country has access to three tax instruments: a corporate tax, a tax on interest payments to entities in the other country, an *internal fiscal barrier*, and a tax on interest payments to entities in tax havens, an *external fiscal barrier*. Firms are heterogeneous with respect to productivity and optimally choose whether to produce only domestically or in both countries.[4] Firms also make optimal decisions on the following two interrelated dimensions of financial policies: Firstly, they choose the capital structure of their operating subsidiaries including the amount of financing with intra-firm loans. Secondly, they decide whether to provide the intra-firm loans through a subsidiary in a tax haven and whether these loans should be direct loans or conduit loans. For instance, if Home sets a high external barrier to deter profit shifting, it may be optimal for firms producing in both countries to let the tax haven subsidiary grant a loan to the operating subsidiary in Foreign, which passes on

[2] Council Directive 2003/49/EC known as the *Interest and Royalty Directive* abolished withholding taxes on interest flows between related EU companies as from 1 January 2004, however, Portugal, Greece and Poland were conceded transitory arrangements allowing for withholding taxes until 1 July 2013.

[3] Admittedly, many countries have rules applying to controlled foreign companies (hereinafter "CFC rules") under which income earned by a finance subsidiary established in a tax haven could be subject to domestic corporate tax. Such CFC-rules may, however, be circumvented in a number of relatively simple ways: (i) "De-controlling": the finance company issues preferred shares to a third party whereby the ownership share of the parent company is diluted making the finance company fall outside the scope of the CFC-rules whereas effective control is retained; (ii) "Swamping": profits from the real activities of the firm are channeled through the finance company whereby the fraction of passive income in the finance company is reduced so it does not fall under the CFC-rules; (iii) "Migration": the ultimate parent company of the firm is established in a tax haven and this parent directly owns the finance company in which case the CFC-rules of the countries where the firm operates do not apply.

[4] This feature of the model bears some resemblance to Helpman et al. (2004) except that firms can only enter foreign markets by way of direct investment and not by way of exporting.

the loan to the operating subsidiary in Home. In that case, interest payments are subject to the internal barrier of Home and the external barrier of Foreign instead of the high external barrier of Home.

Before turning to the results, we briefly comment on certain important features of the model. Firstly, adding withholding taxes to the set of tax instruments has the obvious merit that the extent to which tax havens are integrated in the world economy is treated as a truly endogenous outcome. For instance, if both countries set high external barriers, there is no scope for profit shifting and tax havens are effectively cut off from the world economy. This contrasts the approach of related papers where the presence of tax havens is treated as an exogenous shock (e.g. Hong and Smart, 2010; Slemrod and Wilson, 2009; Johannesen, 2010a). Secondly, introducing conduit loans into the model of the firm highlights that the effective level of protection against profit shifting in a country depends not only on its own external barrier but also on the internal barrier and external barriers of other countries. Economic integration with other countries and economic integration with tax havens are therefore fundamentally intertwined. This point has not been made previously in the literature since existing models of optimal tax policy in the presence of tax havens are not embedded in models of economic integration. Finally, the model assumes symmetry in the production technologies of national and multinational firms and thus rules out that profit shifting to tax havens improves efficiency as in the Hong–Smart framework. This is to focus on the interesting case of harmful tax havens where there is a real tension between the two policy motives, economic integration and protection against tax havens, and not on the case of beneficial tax havens where there is no rationale for taxes on cross-border interest flows.

The first result relates to optimal tax policies under *perfect cooperation* where countries cooperate on all dimensions of tax policy. We show that the two countries optimally eliminate internal barriers and set external barriers so high that no firms shift profits to tax havens. This result is very intuitive given the premise that tax havens are harmful. The optimal policy achieves the optimal level of economic integration between the two countries while providing complete protection against tax havens.

The second result characterizes the equilibrium of a game where countries are committed not to use internal barriers and set other dimensions of tax policy non-cooperatively. The motivation for analyzing this game is that it mirrors the environment in which EU countries are currently setting capital taxes and we therefore label the game *EU-style cooperation*. We show that the game has a unique equilibrium where the external barrier in both countries is zero. The key to this result is that in the absence of internal barriers, firms use conduit loans to channel interest payments to tax haven entities through the country with the lowest external barrier. Countries therefore gain no additional protection against profit shifting by having external barriers higher than the other country. Moreover, countries gain from undercutting the other country since this attracts tax base in the form of conduit loans. In equilibrium, external barriers are competed down to zero and countries suffer from an absolute lack of protection against profit shifting. This result reconciles the empirical fact that a number of EU countries do not tax interest payments to tax havens with the Slemrod–Wilson view that tax havens are harmful.

The final result concerns optimal tax policies under *imperfect cooperation* where countries are unable to cooperate on all dimensions of tax policy. The analysis is motivated by the observation that cooperation on certain important policy dimensions, such as enforcement efforts and tax base definitions, is very difficult from a practical perspective. Formally, we assume that effective fiscal barriers are determined in two stages, a first stage where nominal barriers are set cooperatively and a second stage where another policy dimension, say enforcement efforts, is set non-cooperatively. We show that the optimal policy involves positive effective internal barriers. Intuitively, raising internal barriers hampers economic integration and reduces welfare, however, when raised from an initial level where economic integration is optimal, the welfare loss is second-order. On the other hand, raising internal barriers increases the tax cost of conduit loans, which is associated with a first-order welfare gain since it mitigates the race-to-the-bottom in external barriers.

Under the assumption of the model that tax havens are harmful, these results suggest that policies currently conducted by EU countries are suboptimal. Ideally, EU countries should extend policy cooperation and set a common external barrier high enough to deter tax planning involving tax havens. If this first-best policy is not implementable, the EU should allow member countries to raise internal barriers above zero. This would enhance welfare by making tax planning more costly and thus increase protection against profit shifting.

At a more general level, the integration of conduit finance into a model of capital taxation gives rise to two novel insights[5]: Firstly, countries face mixed incentives when choosing their policy position towards harmful tax havens: On one hand, countries wish to protect their domestic tax base and therefore have an incentive to use tax instruments to restrict transactions with tax havens. On the other hand, restrictive policies induce firms to carry out transactions with tax havens through affiliated entities in other countries. It follows that a fiscal environment with imperfect protection against harmful tax havens may be the endogenous outcome of tax competition. Secondly, there is an intrinsic tension between economic integration and protection against harmful tax havens. While international agreements eliminating taxes on cross-country capital flows have been successful in promoting economic integration, they also constitute powerful tax planning tools in the hands of multinational firms since they remove the tax cost of conduit structures. This provides an argument for taxes on international capital flows even at the cost of suboptimal economic integration.

The remainder of the paper is organized as follows: Section 2 develops the model. Section 3 characterizes the market equilibrium for given tax rates. Section 4 derives optimal tax policy under perfect cooperation. Section 5 analyzes the equilibrium under EU-style cooperation. Section 6 characterizes optimal tax policy under imperfect cooperation. Section 7 provides a few concluding remarks.

2. Model

The model considers two identical countries, Home and Foreign, which together constitute a small subset of the world economy. Both countries are populated by two types of individuals: *entrepreneurs* who own and operate a firm and *workers* who supply labor to the firms. Entrepreneurs are heterogeneous in two orthogonal dimensions. Firstly, entrepreneurs differ with respect to their ability as captured by the parameter α, which is uniformly distributed on the interval $[\alpha^L;\alpha^H]$. Secondly, a fixed fraction $\overline{\lambda}$ of the entrepreneurs are *avoiders* that exploit any profitable tax planning opportunities offered by the presence of tax havens whereas the remaining entrepreneurs are *compliers* that never exploit such opportunities due to unspecified informational, ethical or other constraints.[6] Workers are homogenous and inelastically supply one unit of labor. We normalize the mass of workers in each country to one. All individuals are

[5] Conduit finance has largely been neglected in the public finance literature. One exception is Mintz (2004) who computes the cost of capital with and without conduit entities but does not analyze optimal tax policy within this framework.

[6] The assumed heterogeneity in types is consistent with the empirically observable pattern that otherwise comparable firms differ widely in their use of tax haven subsidiaries (Desai et al., 2006).

endowed with s units of capital and we adopt the standard assumption that capital is perfectly mobile across countries whereas individuals are immobile. Finally, we assume that the world economy comprises at least one tax haven that levies no taxes.

2.1. Firms

Firms optimally choose one of the following production plans: (i) not produce at all; (ii) operate a single domestic production plant or (iii) operate a single domestic production plant and a single foreign production plant. Hence, active firms optimally choose whether to be national or multinational but are constrained to operate at most one plant in each country. In terms of organizational structure, each firm is headed by a *parent company* and comprises an *operating subsidiary* for each of its production plants. The parent company is managed by the entrepreneur whereas operating subsidiaries are managed by a representative worker.

The productivity of a production plant depends partly on the ability level of the entrepreneur, partly on the location of the plant and partly on the capital structure of the operating subsidiary. Specifically, operating a production plant requires a single unit of capital and h units of labor. The output of a production plant at these fixed input levels is given by the following production function:

$$F(\alpha,\theta)=\begin{cases}\alpha-c(\theta) & \text{if the plant is domestic}\\ \alpha-m-c(\theta) & \text{if the plant is foreign}\end{cases} \tag{1}$$

where θ is the debt–asset ratio of the subsidiary operating the plant. The first part of the production function gives the potential production level of the plant given the ability level of the entrepreneur. The potential production level is simply α for *domestic plants* located in the same country as the parent company and $\alpha-m$ for *foreign plants* located in the other country where m represents inefficiencies caused by the distance between the central management and the subsidiary. The second part of the production function $c(\theta)$ captures the impact of the capital structure on productivity. While we do not explicitly model this mechanism, the underlying idea is that firms are plagued by principal–agent problems and that capital structure is a corporate governance tool allowing entrepreneurs to mitigate inefficiencies associated with self-interested managers of the production plants. In our reduced-form formulation of the principal–agent problem, we simply assume that there exists a debt–asset ratio $\tilde{\theta}$, which maximizes the production of a plant, and that deviations from $\tilde{\theta}$ are associated with real costs in terms of lower output. We normalize the cost function so that $c\left(\tilde{\theta}\right)=0$ and assume that $c'(\theta)\left(\theta-\tilde{\theta}\right)>0$ and $c''(\theta)>0$, which implies that the output loss associated with a marginal change in θ away from $\tilde{\theta}$ is increasing in the distance $\left|\theta-\tilde{\theta}\right|$.

The notion that capital structure affects productivity draws on the argument of Jensen (1986) that when managers engage in empire building, debt increases efficiency by reducing the free cash flow available for unprofitable investment. While the original formulation of the theory is concerned with agency problems at the level of the central management, we follow Huizinga et al. (2008) in applying a similar reasoning to lower levels of management. Within multi-divisional firms local managers conduct business on behalf of the central management and presuming that the former are concerned with the growth of the specific division they are managing rather than the overall performance of the firm, debt financing of subsidiaries represents an instrument to discipline local managers producing a large cash flow. In the present model, we focus on agency problems at the subsidiary level and abstract from agency problems at the central level, hence the specification of the production function where the subsidiary-level debt–asset ratio rather than the firm-level debt–asset ratio determines plant productivity. This is consistent with a model property that will emerge below, namely that entrepreneurs, which constitute the central management of firms, are residual claimants of firm profits whereas the representative workers, which constitute the local management, receive a fixed salary.[7]

For expositional simplicity, we assume that firms do not have access to external loans. This implies that borrowing by operating subsidiaries must be in the form of *internal loans* from other firm entities.[8] While this assumption simplifies the analysis considerably, the qualitative results extend to a setting where subsidiaries can borrow from external investors provided that internal and external borrowing are imperfect substitutes from a non-tax perspective.

When the entrepreneur is a complier, the capital structure of the firm is particularly simple: The parent company raises equity in external capital markets and passes on the funds to operating subsidiaries in the form of debt and equity. Hence, the financial policy simply specifies the debt–asset ratio θ of each of the two operating subsidiaries. This is illustrated in Fig. 1 in the case of a firm that produces in both countries.

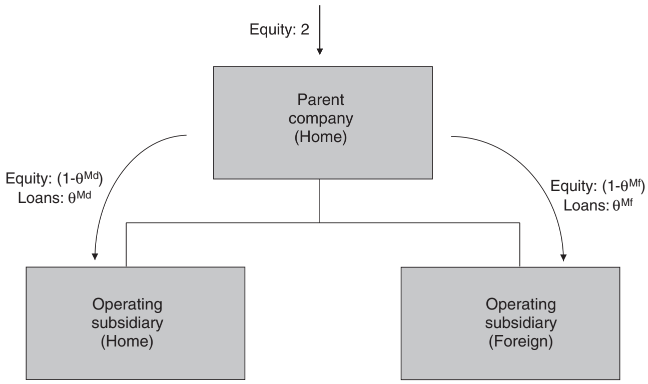
When the entrepreneur is an avoider, the firm may choose a more sophisticated financial policy that exploits the tax planning opportunities offered by tax havens. Under the simplest form of tax planning, the parent company injects equity into a *tax haven subsidiary*, which passes on the funds to the operating subsidiaries in the form of loans. This tax planning structure reduces the corporate tax bill by shifting taxable profits to the tax haven, however, there may be an offsetting effect on profits through exposure to the external barrier. The firm may choose to incorporate an additional element into the tax planning structure: If a country, say Home, attempts to deter profit shifting to tax havens by means of a high external barrier, the firm can resort to conduit loans that channel interest payments through Foreign. Specifically, the tax haven subsidiary grants a loan to the operating subsidiary in Foreign, which passes on the loan to the operating subsidiary in Home. The loan now faces the internal barrier of Home and the external barrier of Foreign instead of the external barrier of Home. The financial structure of a firm engaged in tax planning with conduit loans through Foreign is illustrated in Fig. 2.

For analytical simplicity, we impose that only firms with operating subsidiaries in both countries can implement a tax planning structure. This assumption is consistent with the empirical pattern documented by Desai et al. (2006) that large and internationally oriented firms are much more likely to operate tax haven subsidiaries than small and domestically oriented firms. The assumption is also in line with the legal argument by Kleinbard (2011) that purely domestic firms are effectively precluded from engaging in most types of international tax planning.

Summing up, all entrepreneurs face a binary choice of firm scale (national *vs* multinational) and avoiders furthermore face a binary choice related to tax avoidance (tax planning *vs* no tax planning). There are at most three types of active firms, which we label in the following way for future reference: *national firms* operating a

[7] Other theories of corporate finance conjecture that a pre-commitment to future dividend payments may mitigate the free cash-flow problem in much the same way as the interest payments associated with debt. To model the choice between interest and dividend payments in a meaningful way, we would need to introduce two additional tax instruments into the model, namely a tax on dividend payments to the foreign country and a tax on dividend payments to the tax haven, which would greatly complicate the model. It is therefore assumed that debt is the only tool available to firms to mitigate agency problems.

[8] Recent empirical research shows that internal loans constitute an important component of the capital structure of multinational firms. The Midi dataset collected by the German Central Bank contains very detailed financial information on virtually all German inbound and outbound foreign direct investment and thus represent the most complete source of data on the capital structure of multinational firms. Two recent papers provide summary statistics from this dataset. Buettner and Wamser (2009) report an average internal debt–asset ratio of foreign affiliates of German multinational firms of around 24% whereas Ramb and Weichenreider (2005) report an average internal debt–asset ratio of German affiliates of non-German firms of around 30%. These figures are largely consistent with less complete data available for US multinational firms (Desai et al., 2004). See Johannesen (2010b) for a more comprehensive discussion of the available evidence on internal loans.



Note: θ^{Md} and θ^{Mf} denote the optimal level of debt in the domestic and foreign operating subsidiary of a multinational firm respectively.

Fig. 1. The financial structure of multinational firms.

domestic plant and not engaging in tax planning; *multinational firms* operating a plant in each of the two countries and not engaging in tax planning; *planning firms* operating a plant in each of the two countries and engaging in tax planning. Firms operating a domestic plant and engaging in tax planning are ruled out by assumption.

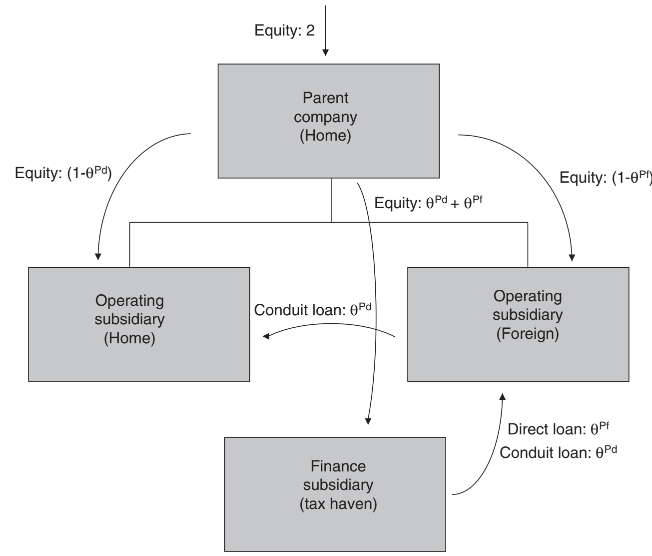
2.2. Government

The two countries levy taxes to finance a public good of a fixed size $\overline{G}$. The government objective is to maximize aggregate private disposable income X subject to the constraint that government revenue G satisfies the constraint $G=\overline{G}$.[9] Revenue is raised with a corporate tax t^C and withholding taxes on interest payments to foreign entities. The withholding taxes may be differentiated so that the applicable rate depends on the country where the foreign entity resides. In particular, the tax rate t^I applying to interest payments to entities in the other country need not coincide with the tax rate t^E applying to interest payments to tax haven entities. Since we are concerned with optimal tax policy from the perspective of the two countries, we refer to t^I as the *internal fiscal barrier* and t^E as the *external fiscal barrier*.

We assume that taxes fall directly on capital and not on capital income. Hence, the corporate tax base is capital reduced by net borrowing. Assuming that non-capital inputs of the entrepreneur are correctly classified as labor for tax purposes, this is equivalent to a tax on firm income net of interest expenses and labor costs, i.e. the conventional corporate tax. The withholding tax base is simply the amount of outstanding debt to foreign entities, which is equivalent to a tax on interest payments to foreign entities. It is assumed that both countries apply the exemption principle, which implies that profits generated by foreign subsidiaries are tax exempt at the level of the parent company.

2.3. Notation

In order to distinguish between the two countries, we let variables associated with Foreign have asterisks. In the case of policy parameters (e.g. tax rates) and factor prices (e.g. wage rates) this is straightforward. In the case of firm-specific and subsidiary-specific variables (e.g. profits and debt–asset ratios), we adopt the convention that variables have asterisks when the parent company resides in Foreign and



Note: θ^{Pd} and θ^{Pf} denote the optimal level of intra-firm debt in the domestic and foreign operating subsidiary of the planning firm respectively.

Fig. 2. The financial structure of planning firms.

let superscript d and f refer to a subsidiary in the same country as the parent company ($d=$domestic) and the opposite country of the parent company ($f=$foreign) respectively. Hence, θ^f denotes the debt–asset ratio of a subsidiary in Foreign owned by a parent company in Home whereas θ^{f^*} denotes the debt–asset ratio of a subsidiary in Home owned by a parent company in Foreign. Moreover, we let superscript N denote a national firm, M a multinational firm and P a planning firm. Finally, we introduce the short-hand notation $\mathbf{t}$ for a vector that fully describes the tax environment in the two countries, i.e. $\mathbf{t}\equiv(t^C,t^I,t^E,t^C,t^I,t^E)$.

3. Market equilibrium

This section derives the market equilibrium for given tax policies. The first subsection computes the maximum profits that can be obtained from each of the three firm types by a given entrepreneur in a given tax environment. The second subsection uses these expressions to show how entrepreneurs choose firm type as a function of their individual characteristics and derives the allocation of resources between the three firm types for given tax policies and factor prices. The third subsection sets up the clearing condition for the labor market and shows that the wage rate adjusts to determine the equilibrium number of firms of each type. Throughout the section, we analyze Home, however, everything is perfectly symmetric for Foreign.

3.1. Optimal financial policies

This subsection in turn derives optimal financial policies for each of the three firm types, national firms, multinational firms and planning firms, and uses the results to compute maximized profits for each of the firm types for a given entrepreneur.

The profit function of a *national firm* operated by entrepreneur i can be stated as:

$$\Pi_i(\theta)=\alpha_i-c(\theta)-hw-r-t^C \tag{2}$$

where r is the required net-of-tax return to capital exogenously determined on the world capital market. The expression merely states that profits equal production net of labor costs, capital costs and taxes. Since debt shifts the tax burden from the domestic subsidiary

[9] By assuming that governments maximize aggregate private consumption X, we sidestep redistributional issues.

to the parent company, which are both facing the tax rate t^C, the tax burden is simply t^C regardless of the debt–asset ratio θ. The profit-maximizing debt–asset ratio of the sole subsidiary of a national firm θ^N is implicitly defined by the first-order condition:

$$c'\left(\theta^N\right) = 0. \tag{3}$$

It follows directly from the assumptions about the agency cost function that $\theta^N = \tilde{\theta}$. Intuitively, a national firm has no tax incentive to deviate from the debt–asset ratio that is optimal for non-tax purposes.

The profit function of a *multinational firm* operated by entrepreneur i can be stated as:

$$\Pi_i(\theta) = \begin{cases} \alpha_i - c\left(\theta^d\right) - hw - r - t^C + \\ \alpha_i - m - c\left(\theta^f\right) - hw^* - r - \left(1-\theta^f\right)t^{C*} - \theta^f\left(t^C + t^{I*}\right) \end{cases} \tag{4}$$

where θ^d and θ^f are the debt–asset ratios of the domestic and the foreign subsidiary respectively. The first line reflects the profits of the domestic subsidiary whereas the second line reflects the profits of the foreign subsidiary. As for the domestic subsidiary, debt financing shifts profits to the parent company in Home, hence the tax burden is simply t^C regardless of the debt–asset ratio θ^d. As for the foreign subsidiary, equity is subject to the foreign corporate tax whereas debt is subject to the foreign internal barrier and the corporate tax at the level of the parent. The profit-maximizing debt–asset ratios of the domestic and foreign subsidiaries of a multinational firm, θ^{Md} and θ^{Mf} respectively, are implicitly defined by the first-order conditions:

$$c'\left(\theta^{Md}\right) = 0 \tag{5}$$

$$c'\left(\theta^{Mf}\right) = t^{C*} - t^C - t^{I*}. \tag{6}$$

The former first-order condition implies that $\theta^{Md} = \tilde{\theta}$. Just like the national firm, the multinational firm has no tax incentive to distort the capital structure of its domestic subsidiary because debt merely shifts taxable income from the domestic subsidiary to the parent. The latter first-order condition implies that $\theta^{Mf} \le \tilde{\theta}$ when tax policies in the two countries are symmetric (with equality when $t^I = 0$). Intuitively, while at symmetric tax policies shifting profits from the foreign subsidiary to the parent has no effect on the global corporate tax bill, the internal barrier introduces a tax disadvantage of debt over equity that induces the multinational to reduce the debt–asset ratio below the level that maximizes production.

The profit function of a *planning firm* operated by entrepreneur i can be stated as:

$$\Pi_i(\theta) = \begin{cases} \alpha_i - c\left(\theta^d\right) - hw - r - \left(1-\theta^d\right)t^C - \theta^d t^{RE} \\ \alpha_i - m - c\left(\theta^f\right) - hw^* - r - \left(1-\theta^f\right)t^{C*} - \theta^f t^{RE*} \end{cases} \tag{7}$$

where t^{RE} is labeled the *real external barrier* and defined in the following way:

$$t^{RE} \equiv \min\left\{t^E; t^I + t^{E*}\right\}.$$

The real external barrier t^{RE} reflects that debt financing from a tax haven subsidiary to the domestic subsidiary may take the form of a direct loan, in which case the tax cost is t^E, or a conduit loan through the foreign operating subsidiary, in which case the tax cost is $t^I + t^{E*}$. The real external barrier t^{RE} thus expresses the lowest possible tax cost associated with a loan from the tax haven to the domestic subsidiary. Hence, the specification of the profit function takes into account that planning firms choose the most tax efficient path for loans granted by tax haven subsidiaries.[10] The profit-maximizing debt–asset ratios of the domestic and foreign subsidiaries of a planning firm, θ^{Pd} and θ^{Pf} respectively, are implicitly defined by the first-order conditions:

$$c'\left(\theta^{Pd}\right) = t^C - t^{RE} \tag{8}$$

$$c'\left(\theta^{Pf}\right) = t^{C*} - t^{RE*}. \tag{9}$$

The two first-order conditions imply that $\theta^{Pd} = \theta^{Pf} > \tilde{\theta}$ when tax policies are symmetric provided that $t^C > t^E$. Intuitively, when the tax treatment of loans from the tax haven subsidiary is more favorable than the tax treatment of equity, planning firms respond by distorting the capital structure of operating subsidiaries toward debt.

To summarize, we have derived optimal debt–asset ratios θ^k for each of the five plant types, i.e. the domestic plant of a national firm ($k = N$), the domestic plant of a multinational firm ($k = Md$), the foreign plant of a multinational firm ($k = Mf$), the domestic plant of a planning firm ($k = Pd$) and the foreign plant of a planning firm ($k = Pf$).

We simplify notation by letting $c^k \equiv c(\theta^k)$ denote agency costs at a plant of type k evaluated at the optimal debt–asset ratio θ^k. Moreover, we let T^j denote the tax bill associated with each firm type j evaluated at the optimal debt–asset ratios:

$$T^N = t^C \tag{10}$$

$$T^M = t^C + t^{C*} + \theta^{Mf}\left(t^C - t^{C*} + t^{I*}\right) \tag{11}$$

$$T^P = t^C + t^{C*} - \theta^{Pd}\left(t^C - t^{RE}\right) - \theta^{Pf}\left(t^{C*} - t^{RE*}\right) \tag{12}$$

where $j = N$ indicates a national firm, $j = M$ indicates a multinational firm and $j = P$ indicates a planning firm. With this notation we can express the maximized profits of each of the firm types in the following way:

$$\Pi_i^N = \alpha_i - hw - r - T^N \tag{13}$$

$$\Pi_i^M = \{\alpha_i - hw - r\} + \left\{\alpha_i - m - c^{Mf} - hw^* - r\right\} - T^M \tag{14}$$

$$\Pi_i^P = \left\{\alpha_i - c^{Pd} - hw - r\right\} + \left\{\alpha_i - m - c^{Pf} - hw^* - r\right\} - T^P. \tag{15}$$

3.2. Firm types

Entrepreneurs choose to operate the type of firm that yields the highest level of profits given their ability: Compliers choose between operating a national firm and a multinational firm. Avoiders choose between operating a national firm, a multinational firm and a planning firm. In addition, all entrepreneurs have the option not to produce, in which case profits are zero.

The equality $\Pi_i^N = 0$ defines a threshold ability level α^N at which entrepreneurs exactly break even if operating a national firm:

$$\alpha^N = hw + r + T^N. \tag{16}$$

[10] As a tie-breaker, we assume that firms prefer direct loans over conduit loans in cases where the two paths are equally tax efficient.

At this ability level, the production of the domestic plant is just sufficient to cover the costs of production inputs and taxes. Clearly, entrepreneurs with $\alpha_i < \alpha^N$ would make negative profits if operating a national firm and are therefore better off not producing at all whereas entrepreneurs with $\alpha_i > \alpha^N$ are able to derive positive profits from a national firm. We refer to a national firm operated by an entrepreneur with $\alpha_i = \alpha^N$ as a *marginal national firm*.

The equality $\Pi_i^M = \Pi_i^N$ defines a threshold ability level α^M at which entrepreneurs are exactly indifferent between operating a national firm and a multinational firm:

$$\alpha^M = m + hw^* + r + c^{Mf} + T^M - T^N. \tag{17}$$

Since the domestic subsidiary of a multinational firm is identical to the domestic subsidiary of a national firm in terms of financial policy and tax liability, $T^M - T^N$ is the tax bill associated with the foreign operating subsidiary of a multinational firm. It follows that α^M is the ability level at which the foreign operating subsidiary of a multinational firm exactly breaks even. Entrepreneurs with $\alpha_i < \alpha^M$ would derive negative profits from a foreign plant and are therefore better off only producing domestically whereas entrepreneurs with $\alpha_i > \alpha^M$ are able to derive positive profits from the foreign operating subsidiary. We refer to a multinational firm operated by an entrepreneur with $\alpha_i = \alpha^M$ as a *marginal multinational firm*.

In any symmetric equilibrium, it holds that $\alpha^M > \alpha^N$. Intuitively, domestic subsidiaries have advantages over foreign subsidiaries in terms of technology since the potential output of a foreign plant is lower than that of a domestic plant operated by the same entrepreneur and in terms of taxation since loans from the parent to the foreign subsidiary are subject to the internal barrier. Hence, it requires a higher ability level to break even with a foreign subsidiary than a domestic subsidiary. This implies the existence of an intermediate range of ability levels $\alpha_i \in [\alpha^N; \alpha^M]$ at which entrepreneurs prefer to operate a national firm over a multinational firm and a high range of ability levels $\alpha_i \in [\alpha^M; \alpha^H]$ at which entrepreneurs prefer to operate a multinational firm over a national firm. [11] Intuitively, the most productive entrepreneurs are able to derive positive profits from foreign subsidiaries despite the technological and fiscal disadvantage of foreign operations.[12]

For entrepreneurs that are compliers, α^N and α^M fully characterize choices over firm types. Compliers with ability level $\alpha_i < \alpha^N$ do not produce at all, compliers with $\alpha^N \leq \alpha_i < \alpha^M$ operate a national firm and compliers with $\alpha_i \geq \alpha^M$ operate a multinational firm.

For entrepreneurs that are avoiders and thus use tax havens whenever this is profitable, we also need to consider the possibility of a planning firm. We first define Γ as the difference in profits between a planning and a multinational firm $\Gamma \equiv \Pi_i^P - \Pi_i^M$ and rearrange to obtain:

$$\Gamma = \left\{T^M + c^{Mf}\right\} - \left\{T^P + c^{Pd} + c^{Pf}\right\}. \tag{18}$$

For a given avoider with ability level α_i, a multinational firm and a planning firm are identical in terms of inputs and potential output, hence $\Gamma > 0$ if and only if the minimized sum of tax payments and corporate governance related output losses is smaller for a planning firm (second bracket) than for the multinational firm (first bracket). Clearly, avoiders prefer a planning firm to a multinational firm if $\Gamma > 0$ and a multinational firm to a planning firm if $\Gamma \leq 0$. We shall later refer to Γ as the tax saving associated with tax planning although, strictly speaking, it includes differences in tax bills as well as corporate governance related output losses.

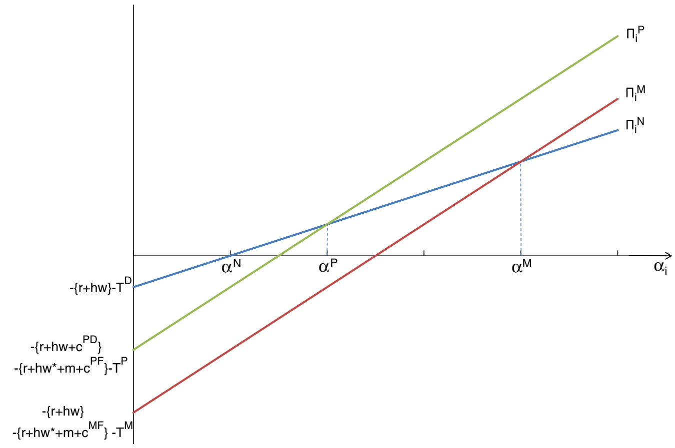


Fig. 3. The allocation of resources between firm types.

Finally, the equality $\Pi_i^P = \Pi_i^N$ implicitly defines a threshold ability level α^P at which avoiders are exactly indifferent between operating a national firm and a planning firm:

$$\alpha^P = m + hw^* + r + T^P + c^{Pd} + c^{Pf} - T^N. \tag{19}$$

Avoiders with $\alpha_i < \alpha^P$ are better off operating a national firm than a planning firm whereas the reverse is true for avoiders with $\alpha_i > \alpha^P$. We refer to a planning firm operated by an avoider with $\alpha_i = \alpha^P$ as a *marginal planning firm*.

It is easy to see that if $\Gamma > 0$, it holds that $\alpha^P < \alpha^M$, which implies a wedge between the abilities of entrepreneurs operating marginal planning firms and marginal multinational firms. As the tax saving approaches zero, the ability wedge closes and α^P approaches α^M.

For entrepreneurs that are avoiders, α^N, α^M, α^P and Γ jointly characterize choices over firm types. Avoiders with $\alpha_i < \alpha^N$ do not produce at all. When $\Gamma > 0$ avoiders with $\alpha^N \leq \alpha_i < \alpha^P$ operate a national firm whereas avoiders with $\alpha_i \geq \alpha^P$ operate a planning firm. When $\Gamma \leq 0$ avoiders with $\alpha^N \leq \alpha_i < \alpha^M$ operate a national firm whereas avoiders with $\alpha_i \geq \alpha^M$ operate a multinational firm.

Fig. 3 illustrates the profit functions of the three types of firms and the allocation of resources between them.[13] The line Π_i^N illustrates the maximized profits of a national firm as a function of the ability level of the entrepreneur. The intersection with the vertical axis gives the minimized costs of operating a national firm and the intersection with the horizontal axis gives the threshold ability level α^N at which a national firm breaks even. The slope of the line is 1 reflecting that a unit increase in ability yields a unit increase in profits. The line Π_i^M illustrates the maximized profits of a multinational firm. The minimized costs of operating a multinational firm are more than twice that of a national firm due to the technological and fiscal disadvantages of foreign plants relative to domestic plants. The slope of the line is 2 reflecting that a unit increase in ability yields a unit increase in profits at each of the two plants. The intersection between the lines Π_i^N and Π_i^M gives the threshold ability level α^M at which a multinational firm earns the same profits as a national firm. The line Π_i^P illustrates the maximized profits of a planning firm. The line is drawn under the assumption that the use of a tax haven subsidiary generates a tax saving, hence it is parallel to the line Π_i^M but shifted up by the amount of the tax saving Γ. The intersection between the lines Π_i^N

[11] Formally, this requires that α^H is sufficiently large.

[12] The property of the model that more productive firms become multinational through foreign direct investment whereas less productive firms remain national mirrors the finding by Helpman et al. (2004).

[13] Fig. 3 is based on a similar illustration in Helpman et al. (2004).

and Π_i^P gives the threshold ability level α^P at which a planning firm earns the same profits as a national firm.

Using the definitions of α^N, α^M, α^P and Γ, it is straightforward to compute the mass of national firms, E^N, multinational firms, E^M, and planning firms, E^P, respectively in a given tax environment:

$$E^N = \lambda\gamma\left[\alpha^P - \alpha^N\right] + (1-\lambda)\gamma\left[\alpha^M - \alpha^N\right] \quad (20)$$

$$E^M = (1-\lambda)\gamma\left[\alpha^H - \alpha^M\right] \quad (21)$$

$$E^P = \lambda\gamma\left[\alpha^H - \alpha^P\right] \quad (22)$$

where γ is the density of the ability distribution and λ is defined as follows:$\lambda \equiv \overline{\lambda}$ when $\Gamma > 0$ and $\lambda \equiv 0$ when $\Gamma \leq 0$ where we recall that $\overline{\lambda}$ is the exogenous fraction of entrepreneurs that are avoiders. Hence, in cases where $\Gamma > 0$, the mass of national firms E^N equals the mass of avoiders with ability between α^N and α^P and the mass of compliers with ability between α^N and α^M, the mass of multinational firms E^M equals the mass of compliers with ability above α^M and the mass of planning firms E^P equals the mass of avoiders with ability above α^P. In cases where $\Gamma \leq 0$, the mass of national firms equals the mass of entrepreneurs with ability between α^N and α^M, the mass of multinational firms equals the mass of entrepreneurs with ability above α^M and the mass of planning firms equals zero.

3.3. Labor market equilibrium

The fixed mass of workers together with the assumption that each production plant uses h workers restricts the number of production plants that may be operated in Home in equilibrium. Specifically, labor market clearance in Home requires:

$$1 = h\left(E^N + E^M + E^P + E^{M*} + E^{P*}\right). \quad (23)$$

The left-hand side of Eq. (23) is the fixed labor supply whereas the right-hand side is labor demand. All firms in Home ($E^N + E^M + E^P$) as well as multinational and planning firms in Foreign ($E^{M^*} + E^{P^*}$) operate a production plant in Home and hire h workers. Since the marginal ability levels vary positively with the wage rate w, the labor demand curve is downward sloping. Intuitively, at higher wage levels, it requires a higher ability to generate profits from production, hence fewer firms choose to produce and labor demand is lower. The combination of a downward sloping labor demand curve and a fixed labor supply ensures the existence of a unique equilibrium wage rate.

It should be noted that tax policies are transmitted through the labor market. Generally, tax increases cause profits to fall and induce marginal firms to close production plants and shed workers. Unemployment drives down wages, which, in turn, causes profits to rise and induce firms to open new production plants and hire workers until a new equilibrium is reached. Clearly, tax policy may change the allocation of resources between the three firm types. For instance, the initial impact of an increase in internal barriers is to reduce profits of multinational firms while leaving profits of other firms unaffected thus causing only multinational firms to close. The resulting wage pressure benefits all firms and causes firms of all types to open. The net effect is therefore a reallocation of resources from multinational firms to national firms and planning firms.

4. Perfect cooperation

This section analyzes tax policy under *perfect cooperation* where governments cooperate on all policy dimensions. We assume that governments cooperatively choose a vector of tax rates (t^C, t^I, t^E) that apply symmetrically in the two countries while anticipating that tax policies shape financial policies at the firm level and the equilibrium allocation of resources between the three firm types.[14] The optimal policy maximizes private disposable income subject to the revenue requirement. Private disposable income in each of the two countries is the sum of profits earned by domestic entrepreneurs, labor income earned by domestic workers and capital income:

$$X = \lambda\gamma\left\{\int_{\alpha^N}^{\alpha^P} \Pi_i^N d\alpha_i + \int_{\alpha^P}^{\alpha^H} \Pi_i^P d\alpha_i\right\} + (1-\lambda)\gamma\left\{\int_{\alpha^N}^{\alpha^M} \Pi_i^N d\alpha_i + \int_{\alpha^M}^{\alpha^H} \Pi_i^M d\alpha_i\right\} + w + Sr \quad (24)$$

where S is the total capital endowment of residents. Government revenue in each of the two countries may be written as the sum of the total tax payments of resident firms:

$$G = E^N T^N + E^M T^M + E^P T^P. \quad (25)$$

We are now prepared to present a proposition characterizing the optimal tax system under perfect cooperation:

Proposition 1. *The optimal tax system involves zero internal barriers, $t^I = 0$, and external barriers high enough to deter avoiders from engaging in tax planning, $t^E \geq t^C$. The corporate tax is at the lowest level that allows financing of the public good given that there is no revenue from internal and external barriers, $t^C = h\overline{G}$.*

Proof. See Appendix. ■

Intuitively, there are two possible sources of inefficiency in the model. Firstly, taxes may reduce the total output of the economy below its potential level by distorting the financial policies of firms. Specifically, positive internal barriers induce multinational firms to finance the foreign subsidiary with too little debt ($\theta^{Mf} < \tilde{\theta}$) because debt from the parent company is taxed more heavily than equity whereas a wedge between the corporate tax rate and the external barrier induces planning firms to finance subsidiaries with too much debt ($\theta^{Pf} = \theta^{Pd} > \tilde{\theta}$) because debt from the haven subsidiary is taxed less heavily than equity. Secondly, taxes may reduce the total output of the economy below its potential level by distorting the allocation of resources between firm types. Specifically, positive internal barriers raise the tax bill paid by two plants forming a multinational firm above the tax cost of two plants forming two individual national firms ($T^M > 2T^N$) causing too little economic integration among compliers whereas a wedge between the corporate tax rate and the external barrier lowers the tax bill of two plants forming a planning firm below the tax bill of two plants forming two individual national firms ($T^P < 2T^N$) causing too much economic integration among avoiders.

It is easy to see that a tax system with zero internal barriers and prohibitive external barriers raises the required revenue while realizing the full potential output of the economy. The fact that external barriers are prohibitive implies that only national and multinational firms exist in equilibrium. In the absence of internal barriers, firms face the same tax cost of financing subsidiaries with debt and equity, namely the corporate tax rate, hence financial policies of both firm types are undistorted ($\theta^N = \theta^{Md} = \theta^{Mf} = \tilde{\theta}$) and all production plants achieve their potential output. Moreover, in the absence of internal barriers, the total tax bill paid by two plants forming a multinational firm equals the total tax bill of two plants forming two individual national firms ($T^M = 2T^N$) so that the optimal tax system leaves the allocation of resources between national and multinational firms undistorted. In other words, the output of the foreign plant of a

[14] We focus on symmetric policy vectors since they give rise to symmetric outcomes in the two countries in terms of X and G. This allows us to abstract from the bargaining problem arising if we would allow for asymmetric policy vectors with asymmetric outcomes.

marginal multinational firm ($\alpha^M - m$) equals the output of the domestic plant of a marginal national firm (α^N), which implies that no increase in output can be achieved by reallocating entrepreneurial resources between the national and the multinational sectors.

The formal proof developed in the Appendix derives the marginal cost of funds (the 'MCF') associated with each of the three tax instruments. External barriers always improve efficiency and the MCF associated with this instrument is therefore below unity whereas the MCFs associated with internal barriers and the corporate tax are at least unity. This shows that external barriers should optimally be raised all the way to prohibitive levels where no planning firms exist. In the absence of planning firms, the corporate tax does not affect efficiency and is thus associated with a unit MCF whereas internal barriers reduce efficiency and are associated with a MCF exceeding unity. This shows that internal barriers should optimally be zero.

5. EU-style cooperation

This section analyzes a non-cooperative policy game where the two countries are not allowed to use internal barriers. This game resembles the current institutional framework for tax setting in the EU in the sense that the Interest and Royalty Directive has eliminated internal barriers within the EU whereas there is no binding cooperation on external barriers and corporate taxes. We therefore label this institutional setting *EU-style cooperation*.

Formally, we consider a game with the following two-stage structure: (i) governments set corporate tax rates and external barriers non-cooperatively under the constraint that $t^I = t^{I^*} = 0$ and (ii) entrepreneurs decide on financial policies and production plans. We immediately characterize the equilibrium properties in the following proposition:

Proposition 2. *Consider an environment where countries are committed not to use internal barriers, $t^I = t^{I^*} = 0$, and set other dimensions of tax policy non-cooperatively. In the unique Nash equilibrium, external barriers are competed down to zero, $t^E = t^{E^*} = 0$, and the public good is entirely financed with the corporate tax, $t^C = t^{C*} = \tau h\overline{G}$ where*

$$\tau \equiv \frac{E^N + 2E^M + 2E^P}{E^N + 2E^M + (2 - \theta^{Pd} - \theta^{Pf})E^P} > 1$$

for E^N, E^M, E^P, θ^{Pd} and θ^{Pf} evaluated at the equilibrium.

Proof. See Appendix. ■

The key to the result that external barriers are competed down to zero lies in the fact that in the absence of internal barriers the real external barrier faced by firms is simply given by the lowest of the external barriers in the two countries. Planning firms therefore channel all loans from the tax haven subsidiary through the country with the lowest external barrier. Starting from external barriers $t^E > t^{E^*}$ where planning firms channel all loans from the tax haven subsidiary through Foreign, Home can induce planning firms to instead channel loans through Home by setting t^E marginally below t^{E^*}. This gives rise to a discrete increase in government revenue because loans from tax haven subsidiaries now become subject to the external barrier in Home rather than in Foreign. It follows that the best response of any individual country is always to undercut the external barrier of the other country. Countries thus engage in a Bertrand style tax competition for the mobile tax base comprised by loans from tax havens, which drives external barriers to zero.[15]

It is instructive to inspect the efficiency properties of the equilibrium. By the arguments invoked in the previous section, the absence of internal barriers implies that financial policies of multinational firms are undistorted and that the foreign plant of a marginal multinational firm and the domestic plant of a marginal national firm are equally productive ($\alpha^M - m = \alpha^N$) so that the allocation of entrepreneurial resources between national and multinational firms is undistorted. However, the absence of external barriers introduces several inefficiencies. Firstly, planning firms face different tax costs of financing with debt and equity and the financial policies of planning firms are therefore distorted ($\theta^{Pd} = \theta^{Pf} > \tilde{\theta}$). This implies that planning firms do not achieve their potential output. Secondly, the tax saving generated by tax planning introduces a wedge between the productivity of a marginal planning firm and a marginal multinational firm ($\alpha^P < \alpha^M$). This implies that total output could be increased by reallocating entrepreneurial resources from planning firms to national and multinational firms.

The main lessons from this analysis are the following: When countries remove internal barriers in order to remove the obstacles to economic integration, it triggers a race-to-the-bottom in external barriers because governments endeavor to prevent conduit financing of plants located on its territory or to attract conduit loans financing plants located outside its territory. In the resulting equilibrium, external barriers are entirely absent and tax planning is profitable for avoiders. This is inefficient because planning firms use too much debt relative to the socially optimal level and because the *de facto* differential tax treatment of avoiders and compliers causes firms operated by more able compliers to be crowded out by firms operated by less able avoiders.

As noted earlier, the structure of the game analyzed in this section resembles the institutional framework for tax setting in the EU where internal barriers have been abolished and countries set corporate taxes and external barriers non-cooperatively. Interestingly, the equilibrium of the game reproduces the puzzling feature of observed tax structures in many EU countries, namely the absence of external barriers. The analysis thus takes us some way towards understanding why many EU countries have no external barriers. A limitation of the analysis, however, is the fact that it treats the institutional framework for tax setting as exogenously given. The question thus remains why this particular type of cooperation has prevailed in the EU rather than perfect cooperation.

A possible explanation revolves around political feasibility. Arguably, cooperation on internal barriers involves a smaller political cost than cooperation on external barriers since the former only affects transactions with specific partner countries whereas the latter affects transactions with all third countries. To explore the implications of the hypothesis that only cooperation on internal barriers is politically feasible, it would be useful to analyze a variant of EU-style cooperation where countries set a common internal barrier in a first stage whereas external barriers and corporate tax rates are set non-cooperatively in a second stage. To the extent that the optimal common internal barrier was found to be zero, EU style cooperation could be rationalized as a second-best policy under the constraint that cooperation on external barriers involves a prohibitive political cost. Unfortunately, this policy game has no policy equilibrium in pure strategies.[16] In principle, one could attempt to compute a

[15] The game may be interpreted along the lines of Janeba and Peters (1999): The two countries compete for a perfectly mobile tax base and may choose to give preferential treatment to the perfectly mobile base over less mobile bases by setting $t^E < t^C$. In the unique equilibrium, the tax rate applying to the perfectly mobile base (i.e. t^E) is competed down to zero.

[16] To see this, note that with a common internal barrier $t^I = t^{I^*} > 0$, Home can set t^E as high as $t^{E^*} + t^I > 0$ without inducing firms to use conduit finance through Foreign. Similarly, Foreign can set t^{E^*} as high as $t^E + t^{I^*}$ without inducing firms to use conduit finance through Home. Up to a certain point, this creates a race-to-the-top in external barriers since raising external barriers allows countries to increase protection against tax havens without triggering a loss of tax base through conduit financing. When t^{E^*} is high enough, however, it becomes optimal for Home to undercut the external barrier of Foreign by just enough to make firms undertake conduit finance through Home, that is $t^E < t^{E^*} - t^I$. Given this low value of t^E, it is no longer optimal for Foreign to set a high value of t^{E^*}. By the same argument, the fully non-cooperative policy game has no equilibrium in pure strategies either. The absence of a pure strategy equilibrium in tax policy games with a perfectly mobile tax base is fairly common in the literature (see for instance Marceau et al., 2010)

policy equilibrium in mixed strategies but given the complexity of the model we do not pursue this avenue.

Another possible explanation for the fact that the actual form of cooperation in the EU does not conform to the socially optimal policies derived in Proposition 1 emphasizes the role of commitment. If countries were to agree to implement a zero internal barrier and a prohibitive external barrier in the absence of a commitment mechanism, the reasoning underlying Proposition 2 tells us that the external barrier would be subject to the same race-to-the-bottom as under EU-style cooperation. If Foreign complies with the agreement, Home has an incentive to deviate by lowering the external barrier in order to induce avoiders to finance subsidiaries in Foreign with conduit loans through Home and given this deviation by Home, it is optimal for Foreign to deviate by setting the external barrier even lower. It is therefore *a priori* conceivable that EU-style cooperation is a second-best policy under the constraint that there is no mechanism by which governments can commit to implementing high external barriers. The next section provides a formal analysis of optimal policies in a setting where cooperation is limited by an imperfect commitment mechanism. The results, however, do not support the hypothesis that EU-style cooperation is a second-best policy but rather suggest that the EU countries could improve the outcome by raising internal barriers above zero.

6. Imperfect cooperation

Effective taxation is determined by a host of policy dimensions, for instance the nominal tax rate, the broadness of the tax base, the scope for avoidance and the enforcement efforts exerted by tax administrations. While it is relatively easy to specify a common nominal tax rate in an international agreement, coordination on other dimensions of tax policy is considerably more difficult. Most obviously, any attempt to specify enforcement efforts in an international agreement would face very significant measurement problems.[17] Arguably, international cooperation on the complex of legal details that defines a tax base faces similar difficulties since it almost inevitably leaves some scope for idiosyncratic administrative practices and legal interpretations that affect effective taxation. These considerations suggest that even if international agreements constrain individual governments in some policy dimensions, governments are likely to retain flexibility in other policy dimensions that have a bearing on effective taxation.

The empirical relevance of these considerations for the withholding taxes studied in this paper is confirmed by the following anecdotal evidence: Luxembourg is a leading player in the fierce international competition for holding companies. Like most other countries, Luxembourg levies a high withholding tax on dividend payments to tax havens, however, if enforced strictly the tax could make tax planning involving Luxembourg holding companies owned by offshore funds unattractive since repatriation of profits would not be tax efficient. While Luxembourg is not explicitly bound by an international agreement to levy the withholding tax, abolishing it would likely entail a political cost by exposing the role Luxembourg plays in harmful international tax planning. Instead of abolishing the tax, the Luxembourg tax administration thus allows multinational firms to circumvent it. Holding companies issue several classes of shares each linked to the profits of a specific fiscal year. When the holding company needs to pay a dividend to the offshore fund by which it is owned, it liquidates a class of shares and the repatriated profits are free of withholding tax since the tax administration considers them liquidation proceeds rather than dividends. This administrative practice does not rest on a firm legal basis and must be confirmed by the administration in confidential advance tax agreements in each separate case. The example illustrates the important role of obscure legal details and opaque administrative practices for effective taxation and thus the potential difficulties of defining all policy dimensions exhaustively in international agreements.

This section analyzes optimal tax policies in a setting where international cooperation is plagued by the imperfection described above and the main result is that optimal tax policy involves strictly positive internal barriers. Intuitively, raising internal barriers above zero is in itself undesirable since it places multinational firms at a disadvantage relative to other types of firms and thus distorts the allocation of resources. However, by raising the cost of conduit finance, internal barriers also serve as a tool to implement effective external barriers. Clearly, the race-to-the-bottom in external barriers explored in the previous section was caused by the absence of internal barriers, which induced planning firms to channel loans from tax haven subsidiaries through the country with the lowest external barrier. Raising internal barriers introduces an additional tax cost of conduit finance, which reduces the incentive to compete on external barriers. In particular, since the tax cost of financing production plants in Home with conduit loans through Foreign amounts to $t^I + t^{E^*}$, Home can raise its external barrier t^E at least up to t^I without inducing planning firms to resort to conduit finance regardless of t^{E^*}. By showing that positive external barriers can only be enforced at the cost of also enforcing positive internal barriers, the analysis highlights the interesting trade-off between economic integration and protection against profit shifting, which we conjecture is generally present in second-best environments.

In the formal analysis, we assume that tax policy has two dimensions. The first policy dimension is directly observable and can be interpreted as *nominal tax rates*. The second policy dimension is not directly observable and can be interpreted as either enforcement efforts or as the broadness of tax bases, however, for ease of reference we shall use the label *enforcement levels*. The relevant tax rates for firm behavior and revenue considerations are *effective tax rates*, which are affected by both policy dimensions. Specifically, we assume that the enforcement level associated with a given tax instrument is a continuous variable z scaled to the interval $[0,1]$ where 0 is no enforcement and 1 is full enforcement. Letting $\bar{t}$ denote the nominal rate of a given tax, we assume that the effective tax rate is given by $t = z\bar{t}$. This formulation implies that nominal tax rates place upper limits on effective tax rates while different degrees of imperfect enforcement can be used to achieve any level of effective taxation between zero and the nominal tax rate.

We consider an institutional setting, which we label *imperfect cooperation*, where the two governments cooperate on nominal internal and external barriers but are unable to commit to enforcement levels. We thus analyze the following sequence: (i) governments choose nominal internal barriers $\bar{t}^I$ and nominal external barriers $\bar{t}^E$ cooperatively; (ii) governments choose nominal corporate tax rates and enforcement levels non-cooperatively, that is Home chooses $\left\{\bar{t}^C, z^I, z^E, z^C\right\}$ and Foreign chooses $\left\{\bar{t}^{C*}, z^{I*}, z^{E*}, z^{C*}\right\}$; and (iii) entrepreneurs make optimal decisions given the effective tax rates $\{t^I, t^E, t^C, t^{I^*}, t^{E^*}, t^{C^*}\}$. This game structure implies that governments effectively choose effective tax rates non-cooperatively but subject to upper limits on internal and external barriers $\bar{t}^I$ and $\bar{t}^E$ decided cooperatively in the first stage.

The following lemma confirms the intuition outlined in the previous section that under imperfect cooperation where countries can only agree on nominal tax rates due to the lack of a commitment mechanism, complementing a zero common internal barrier with a positive common external barrier leads to the same equilibrium outcome as EU style cooperation, namely zero effective internal and external barriers.

[17] Cremer and Gahvari (2000) emphasize the practical obstacles associated with coordination of enforcement efforts and show that international coordination of tax rates may lead governments to compete for mobile tax bases by reducing audit probabilities

Lemma 1. *Any first-stage policy vector with zero nominal internal barriers, $\bar{t}^I = 0$, and positive nominal external barriers, $\bar{t}^E \geq 0$, leads to a symmetric equilibrium policy vector in the non-cooperative second stage where effective internal and external barriers are zero, $t^I = t^E = 0$, and the public good is entirely financed with the corporate tax, $t^C = \tau h\bar{G}$.*

Proof. See Appendix. ■

As noted above, the role of nominal tax rates chosen in the cooperative first stage is to constrain the effective tax rates that can be chosen in the non-cooperative second stage. The zero nominal internal barrier $\bar{t}^I = 0$ effectively imposes a zero effective internal barrier $t^I = 0$ whereas the positive nominal external barrier $\bar{t}^E > 0$ allows countries to choose any effective external barrier $t^E \in \left[0; \bar{t}^E\right]$. Hence, the non-cooperative subgame is identical to EU-style cooperation except that t^E has an upper limit and clearly the same tax competition mechanism emerges: external barriers are competed down to zero through a race-to-the-bottom in enforcement levels.

While the equilibrium outcome of EU style cooperation is not changed simply by adding a positive external barrier to the zero internal barrier, this does not imply that the equilibrium cannot be changed at all. The following lemma shows that by raising nominal internal barriers above zero, an equilibrium can be obtained where both effective internal and effective external barriers are positive.

Lemma 2. *Provided that λ is not too large, a first-stage policy vector where nominal internal and external barriers are marginally positive, $\bar{t}^I = \bar{t}^E = \rho$ for $\rho \to 0$, leads to a symmetric equilibrium in the non-cooperative second stage where effective internal and external barriers are marginally positive, $t^I = t^E = \rho$, and the remainder of the public good is financed with the corporate tax, $t^C = \tau' h\left(\bar{G} - Q\right)$ where*

$$Q = \left\{E^M \theta^{Mf} + E^P\left(\theta^{Pd} + \theta^{Pf}\right)\right\}\rho$$

$$\tau' \equiv \frac{E^N + 2E^M + 2E^P}{E^N + 2E^M + \left(2 - \theta^{Pd} - \theta^{Pf}\right)E^P}$$

for E^N, E^M, E^P, θ^{Mf}, θ^{Pd} and θ^{Pf} evaluated at the equilibrium.

Proof. See Appendix. ■

When nominal internal and external barriers are set at $\rho > 0$ in the first stage, countries can choose any level of effective internal and external barriers up to ρ in the second stage by adjusting enforcement levels. In the proof, we derive the MCF associated with each of the three tax instruments t^C, t^I and t^E from the perspective of an individual government, which only takes into account the private disposable income of its own residents and its own tax revenue. We show that the MCF associated with both t^I and t^E is lower than the MCF associated with t^C when evaluated at $t^I = t^E = 0$. It follows that when nominal fiscal barriers are raised marginally above zero in the first stage, countries fully enforce these taxes in the second stage in order to fully exploit the opportunity to raise revenue with t^I and t^E at a low marginal cost while lowering t^C so as to reduce the revenue raised at a higher marginal cost. In the equilibrium, revenue Q is raised with internal and external barriers and revenue $\bar{G} - Q$ is raised with the corporate tax. Lemma 2 thus shows that starting from an initial situation with zero effective fiscal barriers, a socially desirable increase in effective external barriers can be achieved at the cost of a socially undesirable increase in effective internal barriers.

Lemma 3 compares the welfare levels in the equilibria characterized by Lemma 1 and Lemma 2 respectively and shows that the net welfare effect of raising both internal and external barriers marginally above zero is positive.

Lemma 3. *Welfare in a symmetric equilibrium with $t^I = t^E = \rho$ for $\rho \to 0$ and $t^C = \tau' h\left(\bar{G} - Q\right)$ is higher than welfare in a symmetric equilibrium with $t^I = t^E = 0$ and $t^C = \tau h\bar{G}$.*

Proof. See Appendix. ■

The proof of Lemma 3 shows that from a social perspective the marginal cost of public funds associated with the combined use of effective internal and external barriers is smaller than the marginal cost of public funds associated with the corporate tax rate when evaluated at $t^I = t^E = 0$. This implies that increasing effective internal and external barriers marginally while reducing the corporate tax rate to leave government revenue unchanged raises the level of private disposable income and thus welfare.

To see the intuition for this result, note that we analyze a neighborhood around a market equilibrium with the following properties: On one hand, the absence of internal barriers implies that the debt level of multinational firms is socially optimal ($\theta^{Mf} = \tilde{\theta}$) and that the allocation of entrepreneurial resources between national and multinational firms is undistorted in the sense that the foreign plant of a marginal multinational firm and the domestic plant of a marginal national firm are equally productive ($\alpha^M - m = \alpha^N$). On the other hand, the absence of effective external barriers implies that the debt level of planning firms is too high ($\theta^{Pd} = \theta^{Pf} > \tilde{\theta}$) and that there is a wedge between the productivity of a marginal planning firm and a marginal multinational firm ($\alpha^P < \alpha^M$) so that total output could be increased by reallocating entrepreneurial resources from planning firms to national and multinational firms.

Starting from this market equilibrium, a combined increase in effective internal and external barriers affects welfare through several channels. Firstly, increasing external barriers raises welfare by reducing the extent to which financial policies of planning firms are distorted whereas increasing internal barriers reduces welfare by introducing a distortion of the financial policies of multinational firms. The welfare gain is first-order but the welfare loss is only second-order because the financial policies of multinational firms are initially undistorted. Secondly, increasing external barriers raises welfare by reducing the after-tax profits of planning firms and causing a reallocation of resources from marginal planning firms to more productive marginal national and multinational firms whereas increasing internal barriers reduces welfare by eroding the after-tax profits of multinational firms and causing a reallocation of resources from marginal multinational firms to marginal national firms. Again, the welfare gain is first-order but the welfare loss is only second-order because marginal national firms and marginal multinational firms are initially equally productive.

Proposition 3 builds on Lemmas 1–3 to characterize the optimal tax policy in the cooperative first stage:

Proposition 3. *Provided that λ is not too large, the optimal tax policy in the cooperative first-stage must be one that gives rise to strictly positive effective internal barriers in the non-cooperative second stage.*

Proof. See Appendix. ■

The result implies that EU-style cooperation cannot be rationalized as a second-best policy in the institutional environment that we refer to as imperfect cooperation. Rather, the result suggests that if cooperation between EU countries is limited by commitment problems, starting from the current policy equilibrium welfare could be improved by sacrificing some measure of economic integration in order to obtain better protection against international tax planning.

An obvious limitation of the results presented in this section is the particular institutional assumptions under which they are derived. We believe, however, that the mechanisms are fairly general and that the result would extend to many other institutional settings where the first-best policy is not implementable. Generally, when a group of countries only imperfectly controls effective external barriers in a cooperative stage, there is a scope for harmful tax competition, which may be mitigated by internal barriers. Applying a standard second-best argument, no dimensions are undistorted in the optimum, hence internal barriers should be positive even at the cost of suboptimal economic integration.

7. Concluding remarks

This paper has analyzed optimal taxation of cross-border interest flows from the perspective of two countries. The main findings were the following: If governments cooperate on all policy dimensions, optimal tax policy is characterized by a zero internal barrier and a prohibitive external barrier. While the absence of internal barriers allows the two countries to achieve the optimal degree of economic integration, high external barriers provide protection against profit shifting to tax havens. Assuming that tax policy has dimensions on which governments are unable to cooperate, optimal tax policy involves effective internal barriers above zero. In the absence of internal barriers, firms may circumvent external barriers by means of conduit loans at no tax cost, which triggers a race-to-the-bottom in external barriers leaving countries without protection against profit shifting. While increasing internal barrier is in itself undesirable, it enhances welfare by raising the tax cost of conduit loans, which allows countries to implement effective external barriers.

The results relate to a recent controversy between Hong and Smart (2010) and Slemrod and Wilson (2009) about the welfare implications of profit shifting to tax havens. We documented that a considerable number of countries, in particular EU countries, do not tax interest payments to tax haven entities, which maximizes the scope for profit shifting. This is clearly consistent with the Hong–Smart view that tax havens are beneficial whereas it is, seemingly, at odds with the Slemrod–Wilson view that tax havens are harmful. By showing that fiscal barriers to profit shifting may be absent even when tax havens are harmful, our model reconciles the Slemrod–Wilson view of tax havens with the observed features of real-world tax systems.

Although our results are derived in a model where firms use a particular tax planning structure, we believe that the mechanism would carry over to other related settings, for instance optimal taxation of cross-border dividends and royalties. In the case of dividend taxes, note that some multinational firms have a tax haven entity as the ultimate parent company and eventually need to repatriate profits to this entity. Based on the intuition developed above, we conjecture that first-best dividend taxes are characterized by zero taxes on dividend payments between countries and prohibitive taxes on dividend payments to tax haven entities. However, firms may circumvent high external barriers of any individual country by means of holding structures. We thus conjecture that eliminating internal barriers would trigger a tax competition for intermediate holding companies driving external barriers to zero and that second-best dividend taxation involves positive internal barriers. A very similar argument applies to royalty taxes. International tax planning may consist of a contribution of patents to a tax haven entity, which subsequently licenses the right to use the patents back to operating subsidiaries against the payment of royalties. The royalty payments erode the corporate tax base of the operating subsidiaries while being taxed at a zero rate at the level of the tax haven entity. Obviously, firms may circumvent high external barriers of any individual by means of conduit structures whereby the right to use the patent is licensed to a conduit entity which subsequently sublicenses the patent to the plant. This triggers a tax competition dynamics, which is identical to the one we have analyzed in the context of interest taxes and we conjecture that second-best taxation of royalty payments involves positive internal barriers.

Appendix

Proof of Proposition 1. Governments maximize X subject to $G=\overline{G}$. Letting μ denote the Lagrange multiplier associated with the revenue constraint, the first-order conditions characterizing the optimal tax policy may be stated as:

$$-\frac{dX/dt^k}{dG/dt^k}=\mu \text{ for } k=C,I,E. \tag{26}$$

Optimality thus requires that the marginal cost of public funds is equalized across tax instruments.[18]

The proof proceeds in the following way. First, we derive the effect of small tax changes on private disposable income and government revenue respectively. Secondly, we use these expressions to compute the marginal cost of public funds associated with each of the three tax instruments on the basis of which we characterize the optimal tax system.

We differentiate Eq. (24) with respect to t^k using the definitions of Π_i^N, Π_i^M and Π_i^P to obtain:

$$-\frac{dX}{dt^k}=\left\{\begin{array}{c}\lambda\gamma\int_{\alpha^N}^{\alpha^P}\left\{\frac{\partial T^N}{\partial t^k}+h\frac{dw}{dt^k}\right\}d\alpha_i+(1-\lambda)\gamma\int_{\alpha^N}^{\alpha^M}\left\{\frac{\partial T^N}{\partial t^k}+h\frac{dw}{dt^k}\right\}d\alpha_i\\ +\lambda\gamma\int_{\alpha^P}^{\alpha^H}\left\{\frac{\partial T^P}{\partial t^k}+\left(\frac{\partial T^P}{\partial\theta^{Pd}}+\frac{\partial c^{Pd}}{\partial\theta^{Pd}}\right)\frac{\partial\theta^{Pd}}{dt^k}+\left(\frac{\partial T^P}{\partial\theta^{Pf}}+\frac{\partial c^{Pf}}{\partial\theta^{Pf}}\right)\frac{\partial\theta^{Pf}}{dt^k}+2h\frac{dw}{dt^k}\right\}d\alpha_i\\ +(1-\lambda)\gamma\int_{\alpha^M}^{\alpha^H}\left\{\frac{\partial T^M}{\partial t^k}+\left(\frac{\partial T^M}{\partial\theta^{Mf}}+\frac{\partial c^{Mf}}{\partial\theta^{Mf}}\right)\frac{\partial\theta^{Mf}}{dt^k}+2h\frac{dw}{dt^k}\right\}d\alpha_i\\ +\lambda\gamma\left\{\Pi^N\left(\alpha^N\right)\frac{d\alpha^N}{dt^k}-\Pi^N\left(\alpha^P\right)\frac{d\alpha^P}{dt^k}+\Pi^P\left(\alpha^P\right)\frac{d\alpha^P}{dt^k}\right\}\\ +(1-\lambda)\gamma\left\{\Pi^N\left(\alpha^N\right)\frac{d\alpha^N}{dt^k}-\Pi^N\left(\alpha^M\right)\frac{d\alpha^M}{dt^k}+\Pi^M\left(\alpha^M\right)\frac{d\alpha^M}{dt^k}\right\}\\ -\frac{dw}{dt^k}\end{array}\right. \tag{27}$$

where we have introduced the notation $\Pi^j(\alpha_i)$ for the profits of a firm of type j operated by an entrepreneur with ability α_i. It follows from the first-order conditions for optimal financial policies that indirect effects on firm profits through changes in financial policies are zero. Moreover, by the definitions of α^N, α^M and α^P, it holds that $\Pi^N(\alpha^N)=0$, that $\Pi^M(\alpha^M)=\Pi^N(\alpha^M)$ and that $\Pi^P(\alpha^P)=\Pi^N(\alpha^P)$. This implies that the effect of changes in the allocation of entrepreneurial resources between national, multinational and planning firms (fourth and fifth line) is zero. Finally, it follows from Eq. (23) that the effects working through changes in the wage rate sum to zero. We may thus rewrite Eq. (27) as the sum of the mechanical effects on firm profits:

$$-\frac{dX}{dt^k}=E^N\left\{\frac{\partial T^N}{\partial t^k}\right\}+E^M\left\{\frac{\partial T^M}{\partial t^k}\right\}+E^P\left\{\frac{\partial T^P}{\partial t^k}\right\}. \tag{28}$$

We differentiate Eq. (25) with respect to t^k to obtain:

$$\frac{dG}{dt^k}=\left\{\begin{array}{c}E^N\frac{\partial T^N}{\partial t^k}+E^M\frac{\partial T^M}{\partial t^k}+E^P\frac{\partial T^P}{\partial t^k}\\ E^N\left\{\frac{\partial T^N}{\partial\theta^N}\frac{\partial\theta^N}{\partial t^k}\right\}+E^M\left\{\frac{\partial T^M}{\partial\theta^{Md}}\frac{\partial\theta^{Md}}{\partial t^k}+\frac{\partial T^M}{\partial\theta^{Mf}}\frac{\partial\theta^{Mf}}{\partial t^k}\right\}+E^P\left\{\frac{\partial T^P}{\partial\theta^{Pd}}\frac{\partial\theta^{Pd}}{\partial t^k}+\frac{\partial T^P}{\partial\theta^{Pf}}\frac{\partial\theta^{Pf}}{\partial t^k}\right\}\\ \frac{dE^N}{dt^k}T^N+\frac{dE^M}{dt^k}T^M+\frac{dE^P}{dt^k}T^P\end{array}\right.. \tag{29}$$

[18] We note, however, that the marginal cost of public funds cannot be computed for tax instruments that do not apply to a tax base. This is the case, for instance, when t^E is prohibitively high so that no planning firms exist. Clearly, setting t^E at prohibitive levels is optimal if the marginal cost of public funds is lower than for alternative tax instruments at all non-prohibitive levels.

We then use definitions of E^N, E^M, E^P, α^N, α^M and α^P to restate the third line in the following way:

$$-\gamma\left\{\begin{array}{c}\left(\frac{\partial T^N}{\partial t^k}+h\frac{dw}{dt^k}\right)T^N+\lambda\left(\frac{\partial\left(T^P-T^N\right)}{\partial t^k}+h\frac{dw}{dt^k}\right)\left(T^P-T^N\right)\\+(1-\lambda)\left(\frac{\partial\left(T^M-T^N\right)}{\partial t^k}+h\frac{dw}{dt^k}\right)\left(T^M-T^N\right)\end{array}\right\}. \quad (30)$$

We differentiate Eq. (23) to derive the following equation relating changes in tax policies to changes in wages:

$$\begin{aligned}\frac{dw}{dt^k}&=-\frac{1}{2h}\left(\frac{\partial T^N}{\partial t^k}+\lambda\frac{\partial\left(T^{P*}-T^{N*}\right)}{\partial t^k}+(1-\lambda)\frac{\partial\left(T^{M*}-T^{N*}\right)}{\partial t^k}\right)\\&=-\frac{1}{2h}\left(\lambda\frac{\partial T^P}{\partial t^k}+(1-\lambda)\frac{\partial T^M}{\partial t^k}\right)\end{aligned} \quad (31)$$

where the second equality uses symmetry to eliminate asterisks. We insert the latter expression into Eq. (30), insert the resulting expression back into Eq. (29) and rearrange to obtain:

$$\frac{dG}{dt^k}=\left\{\begin{array}{c}E^N\frac{\partial T^N}{\partial t^k}+E^M\frac{\partial T^M}{\partial t^k}+E^P\frac{\partial T^P}{\partial t^k}+\\E^N\left\{\frac{\partial T^N}{\partial\theta^N}\frac{\partial\theta^N}{\partial t^k}\right\}+E^M\left\{\frac{\partial T^M}{\partial\theta^{Md}}\frac{\partial\theta^{Md}}{\partial t^k}+\frac{\partial T^M}{\partial\theta^{Mf}}\frac{\partial\theta^{Mf}}{\partial t^k}\right\}+E^P\left\{\frac{\partial T^P}{\partial\theta^{Pd}}\frac{\partial\theta^{Pd}}{\partial t^k}+\frac{\partial T^P}{\partial\theta^{Pf}}\frac{\partial\theta^{Pf}}{\partial t^k}\right\}\\-\frac{\gamma}{2}\left[\begin{array}{c}(1-\lambda)\left(T^M-2T^N\right)\left\{\frac{\partial T^M}{\partial t^k}-2\frac{\partial T^N}{\partial t^k}\right\}+\\\lambda\left(2T^N-T^P\right)\left\{2\frac{\partial T^N}{\partial t^k}-\frac{\partial T^P}{\partial t^k}\right\}+\\\lambda(1-\lambda)\left(T^M-T^P\right)\left\{\frac{\partial T^M}{\partial t^k}-\frac{\partial T^P}{\partial t^k}\right\}\end{array}\right]\end{array}\right. \quad (32)$$

Tax changes affect government revenue through three distinct channels: a *mechanical effect* represented by the first line; a *behavioral effect* working through changes in the debt–asset ratios represented by the second line; and a *general equilibrium effect* working through a reallocation of resources between firm types represented by the expression in square brackets. The general equilibrium effect should be interpreted in the following manner: If a policy change reduces the total profits of two plants forming a multinational firm more than the total profits of two plants forming two individual national firms, that is if $\partial T^M/\partial t^k > 2\partial T^N/\partial t^k$, there is a net reallocation of resources from multinational firms to national firms causing a loss of government revenue proportional to T^M-2T^N. Similarly, if a policy change reduces the total profits of two plants forming two individual national firms more than the total profits of two plants forming a planning firm, that is if $2\partial T^N/\partial t^k > \partial T^P/\partial t^k$, there is a net reallocation of resources from national firms to planning firms causing a loss in government revenue proportional to $2T^N-T^P$. Finally, if a policy change reduces the total profits of two plants forming a multinational firm more than the total profits of two plants forming a planning firm, that is if $\partial T^M/\partial t^k > \partial T^P/\partial t^k$, there is a net reallocation of resources from multinational firms to planning firms causing a loss of government revenue proportional to T^M-T^P.

We use Eqs. (28) and (32) to derive the marginal cost of public funds (the 'MCF') for each of the three tax instruments. For expositional convenience, we report the inverse MCFs, that is the government revenue raised with a given tax instrument for each unit of private income foregone.

The inverse MCF for the external barrier may be stated as:

$$\left\{-\frac{dG^E}{dX}\right\}=1+\varepsilon^P+\gamma\lambda\frac{\left(2T^N-T^P\right)+(1-\lambda)\left(T^M-T^P\right)}{2E^P} \quad (33)$$

where ε^P is the elasticity of θ^{Pd} with respect to t^C-t^E or equivalently the elasticity of θ^{Pf} with respect to $t^{C^*}-t^{E^*}$. The three terms represent the mechanical effect, the behavioral effect and the general equilibrium effect respectively. It is easy to see that $\varepsilon^P\geq 0$ so that the behavioral effect is positive: raising t^E reduces the tax saving associated with internal debt in planning firms and the latter respond by bringing the debt–asset ratio closer to the efficient level $\tilde{\theta}$. Moreover, the general equilibrium effect is unambiguously positive: raising t^E increases the tax burden on marginal planning firms, which are replaced by more productive marginal national and multinational firms in the new equilibrium. In sum, the MCF associated with t^E is below unity.

The inverse MCF for the internal barrier may be stated as:

$$\left\{-\frac{dG^I}{dX}\right\}=1+\varepsilon^M-\gamma(1-\lambda)\frac{\left(T^M-2T^N\right)+\lambda\left(T^M-T^P\right)}{2E^M} \quad (34)$$

where ε^M is the elasticity of θ^{Mf} with respect to t^I. It is easy to see that $\varepsilon^M\leq 0$ so that the behavioral effect is negative: raising t^I adds to the tax disadvantage of internal debt in multinational firms and the latter respond by bringing the debt–asset ratio further away from $\tilde{\theta}$. Moreover, the general equilibrium effect is unambiguously negative: raising t^I increases the tax burden on marginal multinational firms, which are replaced by less productive marginal national and planning firms in the new market equilibrium. In sum, the MCF associated with t^I is above unity.

The inverse MCF for the corporate tax may be stated as:

$$\left\{-\frac{dG^C}{dX}\right\}=1-\psi\varepsilon^P-\gamma\lambda\psi\frac{\left(2T^N-T^P\right)+(1-\lambda)\left(T^M-T^P\right)}{2E^P} \quad (35)$$

where:

$$\psi\equiv\frac{\left(\theta^{Pd}+\theta^{Pf}\right)E^P}{E^N+2E^M+\left(2-\theta^{Pd}-\theta^{Pf}\right)E^P}.$$

The behavioral effect is negative: raising t^C adds to the tax advantage of debt in planning firms and the latter respond by bringing the debt–asset ratio away from the efficient level $\tilde{\theta}$. Moreover, the general equilibrium effect is unambiguously negative: an increase in t^C reduces the profits of national firms and multinational firms by more than the profits of planning firms and therefore causes marginal national and multinational firms to be replaced by less productive marginal planning firms in the new equilibrium. In sum, the MCF associated with t^C is above unity.

Since the MCF associated with t^E is below unity and the MCFs associated with t^I and t^C are above unity, the optimal tax policy must involve a prohibitive external barrier. We thus compare the inverse MCFs associated with t^I and t^C given that t^E is prohibitively high. Evaluating Eqs. (34) and (35) at $\lambda=0$ yields:

$$\left\{-\frac{dG^I}{dX}\bigg|t^E \text{ prohibitive}\right\}=1+\varepsilon^M-\gamma\frac{\left(T^M-2T^N\right)}{2E^M} \quad (36)$$

$$\left\{-\frac{dG^C}{dX}\bigg|t^E \text{ prohibitive}\right\}=1. \quad (37)$$

In the absence of planning firms, the inverse MCF is below unity for t^I and exactly unity for t^C. Intuitively, t^I distorts the capital structure of multinational firms and introduces a productivity wedge between multinational and national firms. On the other hand, t^C leaves both the capital structure of multinational firms and the overall allocation of resources between multinational and national firms undistorted. It follows that the optimal tax system involves a zero internal barrier.

It is easy to verify that for $t^I=0$, the tax saving from tax planning Γ equals zero exactly when $t^E=t^C$, hence the external barrier is prohibitive if and only if it exceeds the corporate tax rate ($t^E \geq t^C$). Finally, note that since internal barriers and external barriers raise no revenue, the entire public good must be financed with the corporate tax. The size of the labor force constrains the number of production plants to $1/h$. Under the optimal tax policy, each plant pays taxes t^C. It follows that $t^C=\overline{G}h$ satisfies the revenue constraint with equality.

Proof of Proposition 2. Private disposable income in Home under asymmetric policies is given by Eq. (24). Differentiating Eq. (24) with respect to a tax rate t^k yields the non-cooperative analogue to Eq. (28), i.e. an equation relating tax changes in Home to changes in private disposable income in Home:

$$-\frac{dX}{dt^k}=\begin{array}{c} E^N\frac{\partial T^N}{\partial t^k}+E^M\frac{\partial T^M}{\partial t^k}+E^P\frac{\partial T^P}{\partial t^k} \\ -h\left\{E^{M*}+E^{P*}\right\}\frac{dw}{dt^k}+h\left\{E^M+E^P\right\}\frac{dw^*}{dt^k} \end{array}. \tag{38}$$

The first line represents the direct effect of the tax change on profits. The second line represents the indirect effect through wage changes: Increases in w (w^*) increase (decrease) private consumption by transferring rents from multinational and planning firms resident in Foreign (Home) to workers in Home (Foreign). We use Eq. (31) to derive the following equations relating tax changes to wage changes:

$$\frac{dw}{dt^k}=-\frac{1}{2h}\left(\frac{\partial T^N}{\partial t^k}+\lambda\frac{\partial T^{P*}}{\partial t^k}+(1-\lambda)\frac{\partial T^{M*}}{\partial t^k}\right) \tag{39}$$

$$\frac{dw^*}{dt^k}=-\frac{1}{2h}\left(\lambda\frac{\partial\left(T^P-T^N\right)}{\partial t^k}+(1-\lambda)\frac{\partial\left(T^M-T^N\right)}{\partial t^k}\right) \tag{40}$$

where we have used that $\partial T^{N^*}/\partial t^k=0$ since taxes in Home do not fall on national firms in Foreign.

Let D^j denote the tax bill paid to Home by a firm of type j. The government revenue of Home may thus be stated as follows:

$$G=E^ND^D+E^MD^M+E^PD^P+E^{M*}D^{M*}+E^{P*}D^{P*}. \tag{41}$$

Home collects revenue from all firms in Home as well as multinational and planning firms in Foreign.

In order to prove Proposition 2, we consider five cases (A)–(E) that cover all possible policy vectors given the absence of internal barriers and show that only (E) is an equilibrium.

(A) An initial policy vector with $t^E \geq t^C$ *and* $t^{E^*} \geq t^{C^*}$. External barriers are prohibitive and no planning firms exist, hence domestic and foreign avoiders with $\alpha_i > \alpha^M$ operate multinational firms with the following tax bills payable in Home:

$$D^M=t^C+\tilde{\theta}t^C$$
$$D^{M*}=\left(1-\tilde{\theta}\right)t^C.$$

Corporate tax rates are at the level that satisfies the revenue constraints with equality, that is $t^C=t^{C*}=h\overline{G}$. Consider a reform in Home that reduces t^E to a level marginally below t^C. The reduction in t^E induces avoiders with $\alpha_i > \alpha^M = \alpha^{M^*}$ to replace multinational firms with planning firms where operating subsidiaries in Home are financed with direct loans from tax haven subsidiaries and operating subsidiaries in Foreign are financed with conduit loans from tax haven subsidiaries through Home. This leads to the following tax bills payable in Home:

$$D^P=\left(1-\theta^{Pd}\right)t^C+\theta^{Pd}t^E+\theta^{Pf}t^E$$
$$D^{P*}=\left(1-\theta^{Pf*}\right)t^C+\theta^{Pf*}t^E+\theta^{Pd*}t^E.$$

As t^E approaches t^C from below, the debt levels chosen by planning firms approach $\tilde{\theta}$, hence Home experiences a discrete revenue gain of approximately $2E^{P*}\tilde{\theta}t^C$ reflecting that the debt of multinational firms operated by avoiders in Foreign, which was subject to corporate tax in Foreign prior to the reform, is subject to the external barrier of Home after the reform. This discrete revenue gain dominates revenue changes caused by changes in the optimal debt–asset ratio θ and general equilibrium effects since these effects are proportional to the distance t^C-t^E and therefore become infinitely small as t^E approaches t^C from below. Turning to the effect on X, note that starting from $t^E=t^C$, it holds that $\partial T^P/\partial t^E=\partial T^{P*}/\partial t^E=\tilde{\theta}$. It follows from Eqs. (38)–(40) that starting at $t^E=t^C$, a small change $dt^E<0$ increases X by $-2E^P\tilde{\theta}dt^E>0$. In sum, the proposed reform increases X without violating the budget constraint, hence the initial policy vector is not consistent with equilibrium.

(B) An initial policy vector with $t^{C^*}>t^{E^*}>0$ *and* $t^E>t^{E^*}$. Planning firms use conduit loans through Foreign to finance subsidiaries in Home, hence

$$D^P=\left(1-\theta^{Pd}\right)t^C$$
$$D^{P*}=\left(1-\theta^{Pf*}\right)t^C.$$

Consider a reform in Home that reduces t^E to t^{E^*} and adjusts t^C to satisfy the revenue requirement with equality. The reduction in t^E induces planning firms to finance subsidiaries in Home with direct loans, hence

$$D^P=\left(1-\theta^{Pd}\right)t^C+\theta^{Pd}t^E$$
$$D^{P*}=\left(1-\theta^{Pf*}\right)t^C+\theta^{Pf*}t^E.$$

The reduction in t^E thus causes a discrete increase in G equal to $(E^P\theta^{Pd}+E^{P^*}\theta^{Pf^*})t^{E^*}$ reflecting that the debt of operating subsidiaries in Home, which was previously subject to the external barrier of Foreign, is now subject to the external barrier of Home. Setting $t^E=t^{E^*}$ does not affect t^{RE} and therefore leaves X unchanged. Reducing t^E to t^{E^*} thus increases G and leaves X unchanged. This allows for a small reduction in t^C, which increases X without violating the budget constraint. It follows that the initial policy vector is not consistent with equilibrium.

(C) An initial policy vector with $t^E=t^{E^*}>0$. Planning firms use direct loans to finance operating subsidiaries, hence:

$$D^P=\left(1-\theta^{Pd}\right)t^C+\theta^{Pd}t^E$$
$$D^{P*}=\left(1-\theta^{Pf*}\right)t^C+\theta^{Pf*}t^E.$$

Consider a reform in Home that reduces t^E marginally. The reduction in t^E induces planning firms to finance subsidiaries in Foreign with conduit loans through Home, hence

$$D^P=\left(1-\theta^{Pd}\right)t^C+\theta^{Pd}t^E+\theta^{Pf}t^E$$
$$D^{P*}=\left(1-\theta^{Pf*}\right)t^C+\theta^{Pf*}t^E+\theta^{Pd*}t^E.$$

Home thus experiences a discrete revenue gain of $(E^P\theta^{Pf}+E^{P^*}\theta^{Pd})t^E$ reflecting that the debt of operating subsidiaries in Foreign, which was subject to the external barrier of Foreign prior to the reform, is subject to the external barrier of Home after the reform. This discrete revenue gain dominates revenue changes caused by changes in the optimal debt–asset ratio θ and general equilibrium effects since these effects are proportional to the distance $t^E - t^{E^*}$ and therefore become infinitely small as t^E approaches t^{E^*} from below. It follows from Eqs. (38)–(40) that starting at $t^E = t^{E^*}$, a small change $dt^E < 0$ increases X by $-E^P(\theta^{Pd} + \theta^{Pf})dt^E > 0$. In sum, the proposed reform increases X without violating the budget constraint, hence the initial policy vector is not consistent with equilibrium.

(D) An initial policy vector with $t^E = 0$ and $t^{E^*} > 0$. Planning firms use conduit loans through Home to finance subsidiaries in Foreign. Both countries earn zero revenue from the external barrier and corporate tax rates are at the level that satisfies the revenue constraints with equality, that is $t^C = t^{C*} = \tau h\overline{G}$. Consider a reform in Home that increases t^E marginally and adjusts t^C to satisfy the revenue requirement with equality.

As a first step of the analysis, we use Eqs. (39) and (40) to derive the following non-cooperative analogue to Eq. (32), i.e. an equation relating tax changes in Home to changes in government revenue in Home:

$$\frac{dG}{dt^k} = \left\{ \begin{array}{l} E^N \dfrac{\partial D^N}{\partial t^k} + E^M \dfrac{\partial D^M}{\partial t^k} + E^P \dfrac{\partial D^P}{\partial t^k} + E^{M*} \dfrac{\partial D^{M*}}{\partial t^k} + E^{P*} \dfrac{\partial D^{P*}}{\partial t^k} \\ + E^M \left\{ \dfrac{\partial D^M}{\partial \theta^{Mf}} \dfrac{\partial \theta^{Mf}}{\partial t^k} \right\} + E^P \left\{ \dfrac{\partial D^P}{\partial \theta^{Pd}} \dfrac{\partial \theta^{Pd}}{\partial t^k} + \dfrac{\partial D^P}{\partial \theta^{Pf}} \dfrac{\partial \theta^{Pf}}{\partial t^k} \right\} \\ + E^{M*} \left\{ \dfrac{\partial D^{M*}}{\partial \theta^{Mf*}} \dfrac{\partial \theta^{Mf*}}{\partial t^k} \right\} + E^{P*} \left\{ \dfrac{\partial D^{P*}}{\partial \theta^{Pd*}} \dfrac{\partial \theta^{Pd*}}{\partial t^k} + \dfrac{\partial D^{P*}}{\partial \theta^{Pf*}} \dfrac{\partial \theta^{Pf*}}{\partial t^k} \right\} \\ -\dfrac{\gamma}{2} \left[\begin{array}{c} (1-\lambda)\left(D^N - D^{M*}\right) \left\{ \dfrac{\partial T^N}{\partial t^k} - \dfrac{\partial T^{M*}}{\partial t^k} \right\} + \\ \lambda \left(D^N - D^{P*}\right) \left\{ \dfrac{\partial T^N}{\partial t^k} - \dfrac{\partial T^{P*}}{\partial t^k} \right\} + \\ \lambda(1-\lambda)\left(D^{M*} - D^{P*}\right) \left\{ \dfrac{\partial T^{M*}}{\partial t^k} - \dfrac{\partial T^{P*}}{\partial t^k} \right\} + \\ (1-\lambda)\left(D^N - D^P\right) \left\{ \dfrac{\partial T^N}{\partial t^k} - \dfrac{\partial T^P}{\partial t^k} \right\} + \\ \lambda\left(D^M\right) \left\{ \dfrac{\partial T^M}{\partial t^k} \right\} + \\ \lambda(1-\lambda)\left(D^M - D^P\right) \left\{ \dfrac{\partial T^M}{\partial t^k} - \dfrac{\partial T^P}{\partial t^k} \right\} \end{array} \right] \end{array} \right. . \tag{42}$$

To determine whether the contemplated reform increases X, we use Eqs. (38) and (42) to compute the MCF associated with each of the two tax instruments t^E and t^C from the perspective of Home. Since the initial market equilibrium is symmetric, we simplify the expressions by dropping asterisks. Moreover, since all planning firms face the same real external barrier, that is t^E, and therefore choose the same debt–asset ratio of operating subsidiaries, we can use the simplifying notation $\theta^P \equiv \theta^{Pd} = \theta^{Pf} = \theta^{Pd^*} = \theta^{Pf^*}$.

We evaluate Eqs. (38) and (42) for $t^k = t^E$ at $t^I = t^{I^*} = t^E = 0$ and $t^{E^*} > 0$:

$$-\frac{dX}{dt^E} = 2E^P\theta^P \tag{43}$$

$$\frac{dG}{dt^E} = 4E^P\theta^P + 2E^P\theta^P\varepsilon^P + 2\gamma(1-\lambda)(1+\lambda)\left(\theta^P\right)^2 t^C \tag{44}$$

where $\varepsilon^P > 0$ is the elasticity of θ^{Pd} and θ^{Pf^*} with respect to the tax saving associated with internal lending $t^C - t^E$. The external barrier falls on the debt of all planning firms, however, only in the case of planning firms resident in Home does it directly reduce private consumption in Home. This explains that the mechanical effect of t^E on government revenue is twice as large as the reduction in private consumption. The behavioral effect of t^E on government revenue is positive since it reduces the tax advantage of shifting profits to tax havens and thus induces planning firms to reduce their debt–asset ratio. The general equilibrium effect of t^E on government revenue is also positive since the workers in Home initially shed by planning firms are absorbed by national firms and foreign multinational firms both contributing more to the government revenue in Home. Likewise, workers in Foreign initially shed by planning firms are partly absorbed by multinational firms contributing more to the government revenue in Home. Dividing Eqs. (43) and (44), one obtains:

$$\left\{-\frac{dG^E}{dX}\right\} = 2 + \varepsilon^P + \frac{\gamma(1-\lambda)(1+\lambda)\theta^P t^C}{E^P}. \tag{45}$$

Clearly, the inverse MCF associated with t^E is strictly larger than unity since the first term (the mechanical effect) is larger than unity and the second and third terms (the behavioral and general equilibrium effects) are strictly positive.

We then evaluate Eqs. (38) and (42) for $t^k = t^C$ at $t^I = t^{I^*} = t^E = 0$ and $t^{E^*} > 0$:

$$\begin{aligned} -\frac{dX}{dt^C} = {} & E^N + 2E^M + 2E^P\left(1-\theta^P\right) \\ & + \left\{ E^M \lambda \theta^{Mf} + E^P\left(\theta^P - (1-\lambda)\theta^{Mf}\right) \right\} \end{aligned} \tag{46}$$

$$\frac{dG}{dt^C} = \left\{ \begin{array}{c} E^N + 2E^M + 2E^P\left(1-\theta^P\right) \\ -E^M\theta^{Mf}\left(\varepsilon^{Mf*} - \varepsilon^{Mf}\right) - E^P\theta^P\left(\varepsilon^{Pf*} + \varepsilon^{Pd}\right) \\ -\gamma\left\{\lambda(2-\lambda)\left(\theta^P\right)^2 + (1-\lambda)(1+\lambda)\left(\theta^{Mf}\right)^2\right\} t^C \end{array} \right. \tag{47}$$

where ε^{Mf^*}, ε^{Mf}, ε^{Pf^*} and ε^{Pd} are the elasticities of θ^{Mf^*}, θ^{Mf}, θ^{Pf^*} and θ^{Pd} with respect to t^C. It is straightforward to show that the behavioral effect of t^C on government revenue (second line) is unambiguously negative. Intuitively, an increase in t^C induces firms to erode the corporate tax base in Home by increasing loans to operating subsidiaries in Home, that is $\varepsilon^{Mf^*} > 0$, $\varepsilon^{Pf^*} > 0$ and $\varepsilon^{Pd} > 0$, and reducing loans from parent companies in Home, that is $\varepsilon^{Mf} < 0$. Finally, the general equilibrium effect of t^C is negative. Intuitively, an increase in t^C causes a net shift of entrepreneurial resources from firms with large corporate tax bases in Home to firms with smaller corporate tax bases in Home. Since the corporate tax is the only tax that generates revenue, this shift of entrepreneurial resources unambiguously reduces tax revenue in Home.

Dividing Eqs. (46) and (47), one could obtain an expression for the inverse MCF associated with t^C from the perspective of an individual country, i.e. $\{-dG^C/dX\}$. For the present purposes, it is, however, sufficient to note that $\{-dG^C/dX\} < 1$ since the mechanical effect is smaller than unity and the behavioral and general equilibrium effects are strictly negative.

In sum, the MCF associated with t^E is unambiguously smaller than the MCF associated with t^C, hence the proposed reform increases X. It follows that the initial policy vector is not consistent with equilibrium.

(E) An initial policy vector with $t^E = t^{E^*} = 0$. Both countries earn zero revenue from the external barrier and corporate tax rates are at the level that satisfies the revenue constraints with equality, that is $t^C = t^{C*} = \tau h\overline{G}$. This implies that $t^{RE} = 0$ and that

$$D^P = \left(1-\theta^{Pd}\right)t^C$$

$$D^{P*} = \left(1-\theta^{Pf*}\right)t^C.$$

An increase in t^E induces planning firms to finance subsidiaries Home with conduit loans through Foreign, hence t^{RE} is unchanged at zero and X remains the same. Moreover, D^P and D^{P^*} are unchanged and G remains the same. For $t^{E^*}=0$, any $t^E \geq 0$ therefore gives rise to the same X and the same G for an unchanged level of t^C. Since each country, given the policies of the other country, is unable to change its own policies in a way that increases X while still satisfying the revenue constraint, the proposed policy vector is a Nash equilibrium.

Finally, we compute the corporate tax rate that satisfies the revenue requirement given that internal and external barriers are zero and raise no revenue. Using symmetry, government revenue from the corporate tax can be written as:

$$G = \left\{E^N + 2E^M + 2E^P\left(1-\theta^P\right)\right\}t^C.$$

Using Eq. (23), this expression may be restated as:

$$G = \frac{1}{h}\left\{\frac{E^N + 2E^M + 2E^P\left(1-\theta^P\right)}{E^N + 2E^M + 2E^P}\right\}t^C$$

where $1/h$ is the number of operating subsidiaries in Home and the expression in curly brackets is the average corporate tax base in Home for these subsidiaries. Inserting the revenue requirement $G = \overline{G}$ and rearranging, one obtains:

$$t^C = \left\{\frac{E^N + 2E^M + 2E^P}{E^N + 2E^M + 2E^P(1-\theta^P)}\right\}h\overline{G}.$$

Proof of Lemma 1. Without loss of generality, we can interpret the subgame comprised by stages two and three as a non-cooperative game where Home sets t^E and t^C subject to $t^E \leq \bar{t}^E$ and Foreign sets t^{E^*} and t^{C^*} subject to $t^{E*} \leq \bar{t}^E$ given that $t^I = t^{I^*} = 0$. This game is identical to EU-style corporation except for the constraints on t^E and t^{E^*}. Cases (B)–(E) of the Proof of Proposition 2 apply and imply that $t^E = t^{E^*} = 0$ in the unique Nash equilibrium. The corporate tax rate that satisfies the revenue requirement given that effective internal and external barriers are zero is also derived in the Proof of Proposition 2.

Proof of Lemma 2. We first note that when nominal internal and external barriers are set at strictly positive levels in the first stage, countries can choose strictly positive levels of effective internal and external barriers in the second stage by choosing non-zero enforcement levels. Hence, all tax instruments represent possible sources of revenue and countries optimally choose to use the revenue sources that maximize private disposable income while satisfying the revenue constraint. We also note that when Foreign fully enforces the nominal barriers, that is $z^{I^*} = z^{E^*} = 1$, planning firms never choose to finance plants in Foreign with conduit loans through Home since the tax cost of conduit finance $t^{I^*} + t^E$ is at least as high as the tax cost of direct finance t^{E^*} regardless of the policy choices made by Home. Moreover, planning firms never choose to finance plants in Home with conduit loans through Foreign since the tax cost of conduit finance $t^I + t^{E^*}$ is at least as high as the tax cost of direct finance t^E regardless of the policy choices made by Home. Similarly, when Home fully enforces nominal barriers, planning firms do not engage in conduit financing.

We proceed by deriving the MCF associated with each of the three tax instruments from the perspective of Home under the assumption that Foreign fully enforces fiscal barriers, that is $z^{I^*} = z^{E^*} = 1$. In order to prove that $z^I = z^{I^*} = z^E = z^{E^*} = 1$ is an equilibrium in the second stage, it suffices to show that the MCFs associated with t^E and t^I respectively are smaller than the MCF associated with t^C. When this holds, Home optimally sets $z^I = z^E = 1$ so as to raise as much revenue as possible with fiscal barriers at a low marginal cost and as little revenue as possible with the corporate tax at a higher marginal cost. It follows that Home's best response to full enforcement in Foreign is full enforcement and, by symmetry, Foreign's best response to full enforcement in Home is full enforcement, hence full enforcement is a Nash equilibrium.

Since we consider small changes to a symmetric market equilibrium, we simplify subsequent expressions by dropping asterisks on E^J for $J = N, M, P$ and applying the definition $\theta^P \equiv \theta^{Pd} = \theta^{Pf} = \theta^{Pd^*} = \theta^{Pf^*}$. Evaluating Eqs. (38) and (42) for $t^k = t^E$ at $t^I = t^{I^*} = t^E = t^{E^*} = 0$ yields:

$$-\frac{dX}{dt^E} = E^P\theta^P \tag{48}$$

$$\frac{dG}{dt^E} = 2E^P\theta^P + 2E^P\theta^P\varepsilon^P + \gamma\lambda(2-\lambda)\left(\theta^P\right)^2 t^C. \tag{49}$$

The intuition for these expressions is identical to the intuition underlying Eqs. (43)–(44) derived in the Proof of Proposition 2 with the sole difference that in the current context with no conduit financing, t^E only falls on subsidiaries in Home so that $-dX/dt^E$ as well as the mechanical part of dG/dt^E is halved. Dividing Eqs. (48) and (49), we obtain the following expression for the inverse MCF associated with t^E from the perspective of an individual country:

$$\left\{-\frac{dG}{dX}\bigg|t^E\right\} = 2 + 2\varepsilon^P + \frac{\gamma\lambda(2-\lambda)\theta^P t^C}{E^P}. \tag{50}$$

Clearly, the inverse MCF associated with t^E is strictly larger than unity since the first term (the mechanical effect) is strictly larger than unity and the second and third terms (the behavioral and general equilibrium effects) are strictly positive.

Similarly, we evaluate Eqs. (38) and (42) for $t^k = t^I$ at $t^I = t^{I^*} = t^E = t^{E^*} = 0$ and find:

$$-\frac{dX}{dt^I} = \frac{1-\lambda}{2}\theta^{Mf}\left(E^M + E^P\right) \tag{51}$$

$$\frac{dG}{dt^I} = E^M\theta^{Mf*} + E^M\theta^{Mf*}\varepsilon^{Mf*} + \frac{1-\lambda}{2}\gamma\left\{\theta^{Mf*} - \lambda\left(\theta^P - \theta^{Mf*}\right)\right\}t^C \tag{52}$$

where ε^{Mf^*} is the elasticity of θ^{Mf^*} with respect to the tax cost of debt finance, $t^{C^*} + t^I$, which is strictly negative. The internal barrier falls on the internal debt of foreign multinational firms and thus only affects private consumption through its negative effect on wages. The behavioral effect of t^I on government revenue is positive since it induces foreign multinational firms to reduce internal loans to operating subsidiaries in Home. The general equilibrium effect of t^I on government revenue may be positive or negative. The ambiguity stems from the fact that workers initially shed by marginal foreign multinational firms following an increase in t^I may be absorbed by domestic national firms (generating a revenue gain proportional to θ^{Mf^*}) or foreign planning firms (generating a revenue loss proportional to $\theta^P - \theta^{Mf^*}$) in the new equilibrium. Dividing these two equations, we obtain the following expression for the inverse MCF associated with t^I from the perspective of an individual country:

$$\left\{-\frac{dG}{dX}\bigg|t^I\right\} = \frac{2}{1-\lambda}\frac{E^M}{E^M + E^P} - \frac{2}{1-\lambda}\frac{E^M}{E^M + E^P}\varepsilon^{Mf*} + \frac{\gamma\left[\theta^{Mf} - \lambda\left(\theta^P - \theta^F\right)\right]t^C}{\left(E^M + E^P\right)}. \tag{53}$$

It is straightforward to verify that when λ is not too large, the inverse MCF associated with t^I is strictly larger than unity since the mechanical effect (first term) is larger than unity and the behavioral effect (second term) and general equilibrium effect (third term) are strictly positive.

As shown in the Proof of Proposition 2, the MCF associated with t^C from the perspective of Home exceeds unity at $t^I = t^{I^*} = t^E = t^{E^*} = 0$ and thus exceeds the MCF associated with t^I and t^E provided that λ is not too large. It follows that full enforcement $z^I = z^{I^*} = z^E = z^{E^*} = 1$ is a Nash equilibrium in the second stage.

Finally, we characterize the corporate tax rate necessary to satisfy the revenue requirement. Government revenue may be written as

$$G = \left\{E^N + 2E^M + 2E^P\left(1-\theta^P\right)\right\}t^C + Q$$

where

$$Q = \left\{E^M\theta^{Mf} + 2E^P\theta^P\right\}\rho$$

is the revenue derived from internal and external barriers. Using Eq. (23) and the revenue requirement $G = \overline{G}$, one may rearrange to obtain the following expression for the corporate tax rate

$$t^C = \left\{\frac{E^N + 2E^M + 2E^P}{E^N + 2E^M + 2E^P\left(1-\theta^P\right)}\right\}h\left(\overline{G}-Q\right)$$

where E^N, E^M, E^P and θ^P are evaluated at the equilibrium.

Proof of Lemma 3. The proof proceeds by showing that from a social perspective the MCF associated with the combined use of effective internal and external barriers is smaller than the MCF associated with the corporate tax rate when evaluated at $t^I = t^{I^*} = t^E = t^{E^*} = 0$. This implies that increasing effective internal and external barriers and at the same time reducing the corporate tax rate to leave government revenue unchanged raise the level of private disposable income and thus welfare.

Use Eqs. (28) and (32) to derive the following expression for the inverse MCF associated with a combined increase in internal and external barriers evaluated at $t^I = t^{I^*} = t^E = t^{E^*} = 0$:

$$\left\{-\frac{dG^{E=I}}{dX}\right\} = 1 + \xi\varepsilon^P + \gamma\xi\lambda\frac{\left(\theta^{Pd}+\theta^{Pf}\right)\left(2T^N - T^P\right) + (1-\lambda)\left(\theta^{Pd}+\theta^{Pf}-\theta^{Mf}\right)\left(T^M - T^P\right)}{2E^P\left(\theta^{Pd}+\theta^{Pf}\right)} \quad (54)$$

where

$$\xi = \frac{E^P\left(\theta^{Pd}+\theta^{Pf}\right)}{E^M\theta^{Mf} + E^P\left(\theta^{Pd}+\theta^{Pf}\right)}.$$

The second term represents the behavioral effect, which is unambiguously positive. The increase in external barriers induces planning firms to bring debt levels closer to $\tilde{\theta}$, which represents a first-order welfare gain. The increase in internal barriers induces multinational firms to bring θ^{Mf} below $\tilde{\theta}$, however, since the finance structure of multinational is initially undistorted, the efficiency loss is second-order. The third term represents the general equilibrium effect, which is also unambiguously positive. The increase in external barriers reduces profits of planning firms whereas the increase in internal barriers reduces profits of multinational firms. The loss of profits is larger for planning firms than for multinational firms due to higher cross-border lending ($\theta^{Pd} + \theta^{Pf} > \theta^{Mf}$). Hence, there is a reallocation of entrepreneurial resources from marginal planning firms to more productive marginal national firms (reflected by the first part of the third term) and to more productive marginal multinational firms (reflected by the second part of the third term). There is also a reallocation of entrepreneurial resources from marginal multinational firms to marginal national firms, however, evaluated at a point where the allocation of resources between these two types of firms is undistorted, the associated efficiency loss is only second-order. The MCF associated with combined increase in internal and external barriers is therefore below unity. By comparison, it was shown in the Proof of Proposition 1 that the MCF associated with the corporate tax is above unity as long as external barriers are not prohibitive. It follows directly that increasing internal and external barriers marginally from an initial level of zero and reducing the corporate tax to hold government revenue constant allows governments to increase private disposable income and thus welfare.

Proof of Proposition 3. Without loss of generality, we can interpret the subgame comprised by stages two and three as a non-cooperative game where Home sets $\{t^I, t^E, t^C\}$ subject to the constraints that $t^I \le \overline{t}^I$ and $t^E \le \overline{t}^E$ and Foreign sets $\{t^{I^*}, t^{E^*}, t^{C^*}\}$ subject to the constraints that $t^{I*} \le \overline{t}^I$ and $t^{E*} \le \overline{t}^E$. In the first stage, countries optimally choose $\left\{\overline{t}^I, \overline{t}^E\right\}$ so as to pick out the best feasible non-cooperative equilibrium in the second stage. It follows from the Proof of Proposition 2 that an equilibrium with zero effective internal barriers $t^I = t^{I^*} = 0$ and positive effective external barriers $t^E > 0$ or $t^{E^*} > 0$ does not exist. Hence, the only feasible equilibrium with zero effective internal barriers is $t^I = t^{I^*} = t^E = t^{E^*} = 0$ and $t^C = t^{C*} = \tau h\overline{G}$. It follows from Lemma 1 that an equilibrium with positive effective barriers $t^I = t^{I^*} = t^E = t^{E^*} = \rho$ for $\rho \to 0$ and $t^C = t^{C*} = \tau' h\overline{G}$ is feasible and from Proposition 3 that this equilibrium is superior to the equilibrium $t^I = t^{I^*} = t^E = t^{E^*} = 0$ and $t^C = t^{C*} = \tau h\overline{G}$.

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