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Incentives to Tax Foreign Investors

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Abstract

This paper shows that a small country can have incentives to tax inbound FDI even in a setting with perfect competition and free entry. While firms make no aggregate profits worldwide due to free entry, they make taxable profits in foreign production locations because their costs are partly incurred in their home countries. These profits are not perfectly mobile because firm productivity varies across locations. Consequently, the host country does not bear the entire burden of a tax on foreign firms, giving rise to an incentive to impose taxes. The standard zero optimal tax result can be recovered in this model under an apportionment system that ensures zero economic profits in each location.

JEL Classification: H87; H25; F23

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1 Introduction

A central result in open economy public finance suggests that small countries should not impose taxes on inbound FDI (Gordon, 1986).[1] This is because a small country faces a perfectly elastic supply of capital, and so the burden of a tax on foreign investors falls entirely on domestic labor. It would therefore be preferable to directly tax labor instead of unnecessarily distorting inbound investment. The existing literature has interpreted this result to be an implication of the Diamond-Mirrlees (1971) framework, where firms are perfectly competitive and households receive no pure profits.

The current paper explains why it can be optimal for a small country to tax inbound FDI even in a perfectly competitive setting with free entry that is consistent with the Diamond-Mirrlees framework. I study a setting where firm productivity differences arise from uncertainty associated with entry. After paying fixed entry costs in their home countries, firms learn their productivity in each country, choose their production location, and produce under decreasing returns to scale. Free entry into production ensures that potential entrants make no profits in expectation, and hence there are no profits that accrue to households.[2]

Despite the fact that firms make no aggregate profits worldwide, they make taxable profits in foreign production locations because entry costs are incurred in their home country. These profits are not perfectly mobile because due to the ex-post productivity differences between firms, some firms are inframarginal in their decision to produce in a particular country. By taxing foreign firms, the host country is able to tax away a portion of the profits of these inframarginal firms. While this will generally affect business creation incentives in the rest of the world, a small country does not internalize this effect because of its negligible size. Hence, domestic agents do not bear the entire burden of the tax, giving rise to an incentive to impose taxes on foreign investors.

The benchmark zero tax result can be recovered in this setting under a specific system of cost apportionment. If the initial entry costs were somehow apportioned to a country proportionately to the total profits earned in the country, there would be no economic profits location-by-location, just as in the standard models. With such an apportionment system, the host country would have no incentive to tax foreign investors. We can therefore interpret optimal zero tax results as implicitly assuming an apportionment regime that guarantees zero profits in each location.

[1] See also Dixit (1985), Razin and Sadka (1991), and Gordon and Hines (2002) for alternative versions of this argument.

[2] Dharmapala et al. (2011) use this type of production structure – with perfect competition, firm heterogeneity and free entry – to study optimal taxation with administrative costs while otherwise remaining within the Diamond-Mirrlees framework. This entry process is also similar to Melitz (2003).

Such an apportionment could be implemented through a specific royalty payment from the foreign affiliate to its parent. The royalty payment would have to be equal to the maximum that an unrelated party would be willing to pay for the parent's technology. Such a system would not, however, be incentive-compatible because the host country would have an incentive to either tax or limit the deductibility of the royalties.[3] I also discuss several reasons why this theoretical royalty regime does not correspond to the actual system in place in the world.

In addition to the optimal zero tax results, this paper is related to a literature that studies business taxation in the presence of location rents (e.g. Mintz and Tulkens, 1996; Huizinga and Nielsen, 1997). This literature shows that countries can have incentives to impose taxes on foreign investors if some of the profits earned by firms in a location could not have been earned elsewhere in the world. The current paper explains how location rents from the standpoint of a host country can exist even in a setting where free entry ensures that potential producers break even in expectation and therefore households receive no pure profits. This point is substantively important because it shows that a rent-like motive for taxing foreign investors can exist even when firms are fully subjected to competitive pressures.

This paper also makes a contribution to a growing literature on international taxation with heterogeneous firms. Most papers in this literature study settings with imperfect competition,[4] and imperfect competition can independently break the zero optimal tax result because of the pre-existing distortion it generally introduces (Keen and Lahiri, 1998). Burbidge et al. (2006) study interjurisdictional taxation in a perfectly competitive model with heterogeneous firms. They analyze a setting without free entry where households receive pure profits, deviating in this respect from Diamond-Mirrlees. The current paper, by contrast, is able to study international taxation with firm heterogeneity without departing from the Diamond-Mirrlees framework. It is thereby also able to highlight the importance of the implicit apportionment regime in settings with heterogeneous firms.

The rest of the paper is structured as follows. Section 2 presents the model. Section 3 studies the optimal tax problem. Section 4 discusses apportionment and royalties. Section 5 concludes.

[3] Huizinga (1992) and Gordon and Hines (2002) make related points in the context of the R&D expenditures of multinational enterprises.

[4] See, for example, Chor (2009), Baldwin and Okubo (2009), Davies and Eckel (2010), Haufler and Stähler (2013), Pflüger and Südekum (2013), Bauer et al. (2014), and Langenmayr et al. (2015).

2 Model

2.1 Households

I study a setting with two countries: a small country and the rest of the world. The representative household in each country consumes a tradable final good that will serve as the numeraire, and is endowed with labor and capital. Labor is internationally immobile with the wage in country i given by w_i, while capital is mobile with rental rate r. Given the numeraire choice, welfare in country i is given by the income of the representative household:

$$V_i = w_i L_i + rK_i + T_i,$$

where L_i and K_i are the inelastic supplies of labor and capital, respectively; and T_i is government revenue rebated lump sum to the household. Note that there are no profits that enter into the household's budget because free entry will guarantee zero aggregate profits in equilibrium.

There are two points to note here in connection with Diamond and Mirrlees (1971). First, the presence of a lump sum transfer indicates that I am studying a first-best problem instead of a second-best one as in much of the optimal tax literature. This is not an important difference in the context of the current paper because my main result is that the optimal tax rate on inbound FDI is positive. If such a tax is optimal even in a first-best sense, it will be optimal a fortiori when considering a second-best problem.

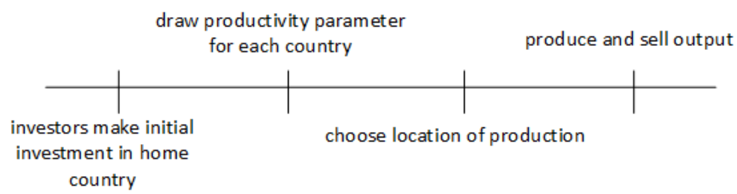
Second, the Diamond-Mirrlees framework requires that households receive no pure profits, either because there are no pure profits or because pure profits are taxed away at 100%. In this paper, the requirement that households receive no pure profits will be satisfied directly without a 100% tax on profits. This means that there are no pure profits in this model in the sense relevant for the Diamond-Mirrlees theorem, even though individual firms produce under decreasing returns to scale.[5]

2.2 Overview of Production

Figure 2.1 shows the logical timing of the events in the model. Ex-ante identical and risk-neutral investors in each country pay fixed costs in their home country in order to engage in production. By doing so, they draw a productivity parameter for each country from a

[5] See Dharmapala et al. (2011) for more on the connection between this type of setup and Diamond-Mirrlees.

Figure 2.1: Timing of Events



bivariate distribution. The investors then choose where to produce on the basis of these productivity draws.[6] This is thus a setting with firm-specific comparative advantage that arises from idiosyncratic uncertainty associated with entry.

A free entry condition will guarantee that investors make no profits in expectation net of the initial fixed costs they incur. Since there are a continuum of firms, zero expected profits will imply that there are no aggregate profits. This in turn means that the representative household in each country receives no pure profits from the activities of the firms that it owns. An individual firm, however, can make positive or negative ex-post profits.

Firms with different levels of productivity can co-exist in equilibrium despite perfect competition because each firm has a decreasing returns to scale production function. The presence of decreasing returns could be interpreted in two ways. First, it could reflect span-of-control considerations as in Lucas (1978). Second, it could reflect the presence of some firm-specific capital as in Burbidge et al. (2006). In the latter interpretation, the initial investment that enables production is the process by which this firm-specific capital is brought into existence. We could thus interpret the entry process as capturing an R&D investment with an uncertain return.

2.3 Firm Problem

With this basic setup in mind, we can analyze the model backwards starting with the firm's problem following location choice. A firm will be indexed by a vector of productivity parameters $(\tilde{z}_1, \tilde{z}_2)$, where $\tilde{z}_i$ is the productivity parameter for production in country i. A firm with productivity parameter $\tilde{z}_i$ that has chosen to produce in country i and whose home country is j, solves the following problem:

[6] What is essential for the main result in the paper is that firms receive some signal of their productivity in both countries before choosing where to produce. The main result would still hold if there is some additional uncertainty that is only resolved following location choice.

$$\max_{l,k} \quad (1-\tau_{ij})\left[\tilde{z}_i F_{ij}(l,k) - w_i l - rk\right],$$

where the choice variables l and k are the quantities of labor and capital, respectively; τ_{ij} is the tax rate faced by a firm in country i that is from country j. I will assume that domestic firms are untaxed: $\tau_{ii} = 0$.[7] This allows us to write τ_{ij} simply as τ_i without any ambiguity.

$F(.)$ exhibits decreasing returns to scale and is assumed to be homogeneous of degree $\lambda < 1$. Under this homogeneity assumption, the pre-tax variable profit function $\pi_{ij}(w_i, r, \tilde{z}_i)$ can be written as $\tilde{z}_i^{1/(1-\lambda)}\pi_{ij}(w_i, r)$ (see Appendix A.1 for the proof). For notational simplicity, I will define $z_i \equiv \tilde{z}_i^{1/(1-\lambda)}$ and work with z_i instead of $\tilde{z}_i$ henceforth. The pre-tax variable profit function is then $z_i\pi_{ij}(w_i, r)$. We can also define the supply and factor demand functions that arise from the firm's problem as follows: $x_{ij}(w_i, r, z_i)$, $l_{ij}(w_i, r, z_i)$ and $k_{ij}(w_i, r, z_i)$.

The tax system here allows for the deduction of all variable capital expenses and so the tax is essentially a cash-flow tax. Such a tax does not distort the firm's intensive margin decision regarding how much labor and capital to use in production. However, the tax will still be distortionary because it will affect a firm's extensive margin decision concerning which country to produce in. Due to the presence of this extensive margin distortion, the assumption that variable costs are fully deductible does not qualitatively alter the main argument made in this paper. Even if the tax base included the regular return to capital, part of the tax burden would still fall upon foreigners.

A consideration that I have ignored here is that of potential royalty payments from the foreign affiliate to its parent for the use of the parent's technology. This is an important question that I postpone to section 4.

A firm chooses which country to produce in by comparing the profits it would make in each. It will locate in country i if it makes more profits by producing in i than in it would in the alternative country:

$$(1-\tau_{ij})\, z_i\pi_{ij}(w_i, r) \geq (1-\tau_{-ij})\, z_{-i}\pi_{-ij}(w_{-i}, r),$$

where the notation $-i$ refers to the country that is not i. We can define the set of firms from j that locate in i as follows:

$$\Theta_{ij} = \{z : (1-\tau_{ij})\, z_i\pi_{ij}(w_i, r) \geq (1-\tau_{-ij})\, z_{-i}\pi_{-ij}(w_{-i}, r)\} \tag{2.1}$$

Further, I define the boundary set of Θ_{ij} – where the weak inequality defining the set holds as an equality – as $\partial\Theta_{ij}$.

[7] Domestic firms being untaxed is not essential to the central point of this paper. This assumption allows us to clearly see that the incentives to tax foreign investors do not arise from potential fiscal externalities.

2.4 Free Entry and Market Clearing

So far, I have discussed the problem solved by firms that have already drawn their productivities. I now turn to the entry process. A potential firm can choose to pay fixed costs and thereby draw a productivity vector z from a bivariate distribution $G(z)$ with density $g(z)$. Across firms, the draws are independently and identically distributed. I assume that the components of z are not perfectly correlated and that z is bounded below at zero and has a finite upper-bound. These assumptions guarantee an interior solution where at least some investors choose each production location.

In equilibrium, a potential entrant makes zero expected profits net of the initial fixed costs. The required fixed costs in terms of labor and capital will be denoted f_i and ϕ_i, respectively. The free entry condition in country j is then:

$$\sum_i \int_{\Theta_{ij}} (1 - \tau_{ij}) z_i \pi_{ij} (w_i, r) g(z) dz \leq f_j w_j + \phi_j r \tag{2.2}$$

The left-hand side of (2.2) gives us the expected profits of a potential entrant. We need to sum over i because a firm could choose either country as the location of production. If there is entry in equilibrium, the free entry condition will hold with equality. Since there are a continuum of firms, the free entry condition implies that aggregate profits net of the fixed costs are equal to zero. Note that the presence of a continuum of firms also implies that there is no aggregate uncertainty in this model.

The model is closed by market clearing conditions for the final good and for the factors of production. For the final good, the condition is:

$$\sum_i (w_i L_i + r K_i + T_i) = \sum_i \sum_j m_j \int_{\Theta_{ij}} x_{ij} (w_i, r, z_i) g(z) dz, \tag{2.3}$$

where m_j is the measure of entrants from country j. Since there is a single final good and this good is the numeraire, the demand for the good – the left-hand side – is equal to world income. The term on the right-hand side of (2.3) is the world supply of the good. We sum over j to take into account the production of firms from each country and sum over i to aggregate across both locations of production. The market clearing conditions for labor and capital are:

$$L_i = \sum_j m_j \int_{\Theta_{ij}} l_{ij} (w_i, r, z_i) g(z) dz + m_i f_i \tag{2.4}$$

$$\sum_i K_i = \sum_i \sum_j m_j \int_{\Theta_{ij}} k_{ij}\left(w_i, r, z_i\right) g(z) dz + \sum_i m_i \phi_i \tag{2.5}$$

The two terms on the right-hand side of the factor market clearing conditions capture the fact that each factor is used to pay the fixed costs as well as being a direct input into production. Note that we sum over i for capital but not labor because capital is internationally mobile and so this market clears worldwide rather than on a country-by-country basis.

3 Optimal Taxation

3.1 Preliminaries

This section analyzes the optimal taxation of foreign firms from the standpoint of the small country, which will be denoted as country 1. The small country takes r and w_2 as given. Since it has a negligible effect on the aggregate profits of foreign firms, it also takes the mass of entrants in the rest of the world, m_2, as given. The variables that are endogenous from the point of view of the small country are its domestic wage, the set of firms that choose to site in the country, and the mass of domestic firms. These variables are determined by country 1's labor market clearing condition, the location choice problem of firms, and by country 1's free entry condition. The nature of the small country assumption here is similar to Demidova and Rodriguez-Clare (2009, 2013) and Bauer et al. (2014) but in a perfectly competitive setting rather than a monopolistically competitive one.

Before turning to the government's problem, it will be useful to define several terms. The total after-tax profits made by foreign firms in country 1 is given by:

$$\left(1-\tau_1\right) \Pi_{12} = \left(1-\tau_1\right) m_2 \int_{\Theta_{12}} z_1 \pi_{12}\left(w_1, r\right) g(z) dz$$

Next, we can define the inframarginal profits earned by foreign firms in country 1 as:

$$R_{12} = m_2 \int_{\Theta_{12}} \left[\left(1-\tau_1\right) z_1 \pi_{12}\left(w_1, r\right) - z_2 \pi_{22}\left(w_2, r\right)\right] g(z) dz$$

The term inside the integral defining inframarginal profits is the difference between the after-tax profits made by a foreign firm in country 1 and the profits it would make if it produced in country 2. Thus, R_{12} captures the profits made by foreign affiliates in excess of what they would require in order to site in country 1. These inframarginal profits are location rents from the standpoint of the host country. They are not true rents in a global sense, however, because these profits enter into the foreign free-entry condition rather than accruing to foreign households. In Appendix A.2, I derive the derivatives of $(1-\tau_1)\,\Pi_{12}$ and R_{12} for later use.

3.2 Taxes, Welfare and the Optimal Tax Rate

We can now study the welfare effects of host-country taxation. I will focus on an equilibrium where there are no domestically owned firms and leave the simpler case with domestic firms to Appendix A.3. Recall that due to the choice of numeraire, welfare is given by the representative household's income:

$$V_1 = w_1 L_1 + r K_1 + \tau_1 \Pi_{12}$$

The effect of the tax on welfare is:

$$\frac{dV_1}{d\tau_1} = \frac{dw_1}{d\tau_1} L_1 + \Pi_{12} + \tau_1 \frac{d\Pi_{12}}{d\tau}$$

We can evaluate this expression at $\tau_1 = 0$ to obtain:

$$\begin{aligned} \left.\frac{dV_1}{d\tau_1}\right|_{\tau_1=0} &= \frac{dw_1}{d\tau_1} L_{12} + \Pi_{12} \\ &= -\left.\frac{dR_{12}}{d\tau_1}\right|_{\tau=0}, \end{aligned}$$

where L_{12} is the total labor used by firms from country 2 producing in country 1. The second equality above is derived in Appendix A.2. To interpret the above result, note that $dR_{12}/d\tau_1$ is the effect of taxes on the inframarginal profits of foreign affiliates. This term captures the portion of the tax incidence that is not borne by domestic agents, since a reduction in the inframarginal profits of foreign affiliates does not affect incentives to locate in country 1. Unsurprisingly, host country taxation will reduce these inframarginal profits (see Appendix A.3 for the formal proof) and so the small country will necessarily benefit from a sufficiently small tax:

$$\left.\frac{dV_1}{d\tau_1}\right|_{\tau_1=0} = -\left.\tfrac{dR_{12}}{d\tau_1}\right|_{\tau=0} > 0$$

In addition to showing that a small tax will improve welfare, we can also derive a formula for the optimal tax rate (see Appendix A.4 for the derivation):

$$\tau_1* \quad = \quad \frac{dR_{12}/d\tau_1}{\frac{d}{d\tau_i}(1-\tau_1)\Pi_{12}} \tag{3.1}$$

This formula shows that the optimal tax rate depends on two key expressions. The numerator, as discussed earlier, captures the effect of the tax that is not borne by domestic agents. To the extent the tax is borne by foreigners, the optimal tax rate will be higher. The denominator captures the overall responsiveness of after-tax profits to host-country taxation. If profits are very responsive to taxes, we expect a greater behavioral distortion, and so the optimal tax rate will be smaller.

A key point to note throughout this analysis is that all of the derivations here would be the same whether the total mass of entrants in the rest of the world, m_2, is determined by free entry or just fixed at some exogenous value. This is because either way, it is fixed from the standpoint of the small country which has a negligible effect on the aggregate worldwide profits of foreign firms. As a result, even though there are no rents that accrue to foreign households, from the standpoint of the small country, the situation is no different from one where the foreign households did receive rents from the activities of its firms.

4 Apportionment and Royalties

4.1 Cost Apportionment and the Optimal Zero Tax Result

In the model from the previous sections, foreign affiliates make taxable economic profits in a host country despite the fact that there are no aggregate profits worldwide. We can obtain zero profits location-by-location in this setting if we assume that costs are apportioned in a particular manner. Specifically, we require that the fixed entry costs somehow be apportioned to each country proportionately to the profits made in that country. Multiplying a free entry condition (2.2) that holds with equality by the mass of firms that enter in country j, we obtain:

$$m_j \sum_i \int_{\Theta_{ij}} (1-\tau_{ij})\, z_i \pi_{ij}\,(w_i, r)\, g(z) dz = m_j f_j w_j + m_j \phi_j r$$

This condition simply states that the total profits of investors from country j excluding fixed costs are equal to the total fixed costs incurred in entry. If a share s_{ij} of the profits of firms from j were earned from production undertaken in i, the proposed system would apportion fixed costs equal to $s_{ij}\,(m_j f_j w_j + m_j \phi_j r)$ to country i. Consequently, the total profits apportioned to country i net of the fixed costs would be equal to zero:

$$s_{ij}\sum_{i}\int\limits_{\Omega_{ij}^{n}}(1-\tau_{ij})\,m_{ij}z_{i}\pi_{ij}\left(w_{i},r\right)g(z)dz-s_{ij}\left(m_{j}f_{j}w_{j}+m_{j}\phi_{j}r\right)=0$$

With such an allocation of entry costs, there would be no taxable economic profits in the host country, and so the basis for the positive optimal tax on foreign investors would no longer be present. A cash flow tax – which is the type of tax considered in the previous sections – would raise no revenue. If marginal capital expenses were not fully deductible, then the benchmark optimal zero tax results would hold directly since the small country takes r as given. Hence, we can interpret the existing results from the literature as implicitly assuming a system that apportions costs so that economic profits are equal to zero in each location.

4.2 Royalties

The type of profit allocation discussed in the previous subsection could be implemented with an appropriate royalty payment from a foreign affiliate to its parent for the use of the firm's technology. If the foreign affiliate in i pays as royalties the profits that will be earned by the asset, $z_i\pi_{ij}\left(w_i,r\right)$, to the parent in j, the affiliate's pre-tax profits net of the royalty payment would be $z_i\pi_{ij}\left(w_i,r\right)-z_i\pi_{ij}\left(w_i,r\right)=0$. In this way, there would be no taxable profits in i. This particular royalty payment would correspond to the maximum amount that an unrelated party would be willing to pay if it knew the productivity of the asset.

Such a royalty system would not be incentive-compatible. The host country would have an incentive to either limit the deductibility of the royalty payments or impose taxes on the royalties (c.f. Huizinga, 1992). In fact, the royalties here would be identical to what I have been calling profits thus far, and the entire analysis as applied to profits would then directly apply to royalties instead. These considerations suggest that the incentives to tax royalties can be very similar to the incentives to tax profits.[8]

A further point to note is that the royalty system in place in the world does not conform to this theoretical ideal even aside from deduction limitations and taxes on royalties. First, only certain specific aspects of a parent's overall contribution to its affiliate's productivity will trigger royalty payments in reality. For example, if an affiliate is productive as a result of its parent's business culture or the quality of its general administration, this will generally not give rise to corresponding royalty payments. To the extent that such factors are important, the affiliate would be able to make greater profits net of the royalty payments.

[8] It is also consistent with the fact that most countries do impose taxes on cross-border royalty payments.

Second, the royalty under this ideal system has to be the *maximum* that an unrelated party would be willing to pay. By contrast, any asset price between $z_j \pi_{ij}(w_i, r)$ – the profit the parent could make by producing at home – and $z_i \pi_{ij}(w_i, r)$ could entail mutual gains for two unrelated parties. Thus, even a "legitimate" arms-length price for the asset would in general leave some economic profits to the foreign country. Finally, the informational requirement for such a royalty system would be unrealistic in most contexts. It would be extremely difficult for either an unrelated party or a tax authority to determine the profitability of a technology prior to its use in production.[9]

More broadly, this analysis highlights the fact that the choice of royalty system could lead to either increased or decreased incentives to impose source-based taxes. Moving closer to an international royalty regime that ensures no economic profits location-by-location would have an effect that is similar to a coordinated reduction of taxes on foreign investors. On the other hand, a royalty system that leaves more economic profits to foreign affiliates could strengthen governments' capacities to raise revenue by taxing foreign investors.

[9]In this paper, I focus on firms' choices concerning the real location of production rather than the location in which profits are reported (in contrast to Krautheim and Schmidt-Eisenlohr, 2011). A natural extension for future work is to study the implications of firms' incentives to set royalty payments to shift profits in this type of setting.

5 Conclusion

This paper shows that a small host country can have incentives to tax inbound FDI even in a perfectly competitive setting with free entry. While investors make no aggregate profits worldwide due to free entry, they make taxable profits in foreign production locations because part of their costs are incurred in their home country. Due to productivity differences between firms, some firms will be inframarginal in a location, and so these taxable profits will not be perfectly mobile. By taxing foreign investors, a host country can partly tax these inframarginal profits, giving rise to an incentive to impose taxes. The zero optimal tax results in the literature (e.g. Gordon, 1986) can be recovered in this setting under a system that apportions the initial investment costs to a location proportionately to the total profits made in the location so as to ensure that there are no taxable economic profits in any location.

A literature based on Diamond and Mirrlees (1971) has served as the basis for much of the policy advice in the area of international taxation. The current paper shows that one important piece of advice that is usually taken to be an implication of this framework – that small countries should not impose source-based investment taxes – need not hold even within the Diamond-Mirrlees framework. The reason for this is that location rents justifying taxes on inbound FDI can exist from the standpoint of a host country even in a setting where expected profits are competed away by entry. This analysis thus identifies incentives to tax inbound FDI that can exist even when firms are fully subjected to competitive pressures.

A Proofs

A.1 Profit Function Property

In this appendix, I show that we can write the variable pre-tax profit function in the following separable form: $\pi_{ij}(w_i, r, \tilde{z}_i) = \tilde{z}_i^{1/(1-\lambda)}\pi_{ij}(w_i, r)$. First, note that from the homogeneity of the production function, we can use Euler's rule to obtain:

$$[F_l(.)l + F_k(.)k] = \lambda F(.),$$

where$\lambda < 1$ is the returns to scale parameter. The first-order conditions are: $\tilde{z}_i F_l(l^*, k^*) = w_i$ and $\tilde{z}_i F_k(l^*, k^*) = r$, where l^* and k^* are the optimal choices of l and k, respectively. Using the first-order condition, the firm's variable profits before taxes are:

$$\begin{aligned} \pi_{ij}(w_i, r, \tilde{z}_i) &= \tilde{z}_i F(.) - \tilde{z}_i F_l(.)l^* - \tilde{z}_i F_k(.)k^* \\ &= \tilde{z}_i F(.) - \lambda \tilde{z}_i F(.) \\ &= \tilde{z}_i (1-\lambda) F(.) \end{aligned}$$

Thus, the firm's variable profits are proportional to its sales. Next, we can differentiate maximized profits, $\tilde{z}_i F(.) - wl - rk$, with respect to $\tilde{z}_i$ using the envelope theorem to get:

$$\begin{aligned} \frac{d\pi_{ij}(.)}{d\tilde{z}_i}\frac{\tilde{z}_i}{\pi_{ij}(.)} &= F(.)\frac{\tilde{z}_i}{\pi_{ij}(.)} \\ \frac{d\pi_{ij}(.)}{d\tilde{z}_i}\frac{\tilde{z}_i}{\pi_{ij}(.)} &= F(.)\frac{\tilde{z}_i}{\tilde{z}_i(1-\lambda)F(.)} \\ \frac{d\pi_{ij}(.)}{d\tilde{z}_i}\frac{\tilde{z}_i}{\pi_{ij}(.)} &= \frac{1}{1-\lambda} \end{aligned}$$

The above expression is a separable differential equation and can be solved as follows:

$$
\begin{aligned}
\frac{1}{\pi_{ij}(.)}d\pi_{ij}(.) &= \frac{1}{1-\lambda}\frac{1}{\tilde{z}_i}d\tilde{z}_i \\
\int \frac{1}{\pi_{ij}(.)}d\pi_{ij}(.) &= \frac{1}{1-\lambda}\int \frac{1}{\tilde{z}_i}d\tilde{z}_i \\
\log \pi_{ij}(.) &= \frac{1}{1-\lambda}\log \tilde{z}_i + c \\
\log \pi_{ij}(.) &= \log \tilde{z}_i^{1/(1-\lambda)} e^c \\
\pi_{ij}(w_i, r, \tilde{z}_i) &= \tilde{z}_i^{1/(1-\lambda)} e^c,
\end{aligned}
$$

where c is a constant of integration. In order to solve for the constant e^c, we can set $\tilde{z}_i$ equal to 1 (an arbitrary choice) to obtain:

$$\pi_{ij}(w_i, r, 1) = e^c$$

If we define $\pi_{ij}(w_i, r) \equiv \pi_{ij}(w_i, r, 1)$, then the profits of an individual firm can be expressed as being proportional to a general term that is common to all firms: $\pi_{ij}(w_i, r, \tilde{z}_i) = \tilde{z}_i^{1/(1-\lambda)} \pi_{ij}(w_i, r)$.

A.2 Expressions for $d\Pi_{12}/d\tau_1$ and $dR_{12}/d\tau_1$

This Appendix derives expressions for $d\Pi_{12}/d\tau_1$ and $dR_{12}/d\tau_1$.

$$
\begin{aligned}
\frac{d\Pi_{12}}{d\tau_1} &= -m_2 \int\limits_{\Theta_{12}} l_{12}(w_1, r, z_1) \frac{dw_1}{d\tau_1} g(z)dz \\
&+ m_2 \int\limits_{\partial\Theta_{12}} (v \cdot u) z_1 \pi_{12}(.) g(z)ds \\
&= -L_{12}\frac{dw_1}{d\tau_1} + m_2 \int\limits_{\partial\Theta_{12}} (v \cdot u) z_1 \pi_{12}(.) g(z)ds, \qquad \text{(A.1)}
\end{aligned}
$$

where L_{12} is the total labor used by foreign firms in country 1. In taking the derivative (first equality above), I use a generalization of Leibniz's rule for differentiating an integral. The first term captures the change in profits that arises from a change in the profits of inframarginal firms, using Hotelling's Lemma to differentiate the profit function. The second term captures the change in profits due to a change in the set of firms that locate in the country. The term v is a two-dimensional vector that captures how the boundary set changes with the tax rate (i.e. the "velocity" of the boundary set), u is the unit normal vector and ds is the surface differential.

The derivative of R_{12} can be derived in a similar manner:

$$\begin{aligned}
\frac{dR_{12}}{d\tau_1} &= -\Pi_{12} - m_2 \int\limits_{\Theta_{12}} (1-\tau_1)\, l_{12}(w_1, r, z_1) \frac{dw_1}{d\tau_1} g(z) dz \\
&+ m_2 \int\limits_{\partial\Theta_{12}} (v \cdot u) \left[(1-\tau_1)\, z_1 \pi_{12}(.) - z_2 \pi_{22}(.) \right] ds \\
&= -\Pi_{12} - m_2 \int\limits_{\Theta_{12}} (1-\tau_1)\, z_1 l_{12}(w_1, r, z_1) \frac{dw_1}{d\tau_1} g(z) dz \\
&= -\Pi_{12} - (1-\tau_1)\, L_{12} \frac{dw_1}{d\tau_1} \qquad \text{(A.2)}
\end{aligned}$$

The third term after the first equality captures the change in the set of firms locating in the country as a result of the tax rate change. It is equal to zero because firms on the boundary set $\partial\Theta_{12}$ make no inframarginal profits by definition.

A.3 Positive Optimal Tax Rate

This appendix proves that the optimal tax rate is positive. I first deal with the case without domestic firms – the case discussed in the main text – before turning to the simpler case with domestic firms. For the case without domestic firms, the main text shows that the optimal tax rate will be positive if $dR_{12}/d\tau_1 < 0$.

$$R_{12} = m_2 \int\limits_{\Theta_{12}} \left[(1-\tau_1)\, z_1 \pi_{12}(w_1, r) - z_2 \pi_{22}(w_2, r) \right] g(z) dz$$

$$\frac{dR_{12}}{d\tau_1} = m_2 \int\limits_{\Theta_{12}} \left\{ z_1 \frac{\left[d\,(1-\tau_1)\, \pi_{12}(w_1, r) \right]}{d\tau_1} \right\} g(z) dz$$

In differentiating this term, we are again using the fact that firms on the boundary set make no inframarginal profits and so the derivative of the integral is simply the integral of the derivative. A firm that is on the boundary set, i.e. $z \in \partial\Theta_{12}$, will be indifferent between locating in country 1 and country 2:

$$\begin{aligned} (1-\tau_1)\, z_1 \pi_{12}(w_1, r) &= z_2 \pi_{22}(w_2, r) \\ (1-\tau_1)\, \pi_{12}(w_1, r) &= a_{12} \pi_{22}(w_2, r)\,, \end{aligned} \tag{A.3}$$

where a_{12} is the cutoff value of z_2/z_1 that defines the indifferent firms. For later use, note that (A.3) implies a function $a_{12} = \gamma(w_1, \tau_1)$, with $\partial\gamma/\partial w_1 < 0$ and $\partial\gamma/\partial\tau_1 < 0$.

Differentiating (A.3), we obtain:

$$\frac{d}{d\tau_1}\left[(1-\tau_1)\, \pi_{12}(w_1, r)\right] = \frac{da_{12}}{d\tau_1} \pi_{22}(w_2, r)$$

Thus:

$$\begin{aligned} \frac{dR_{12}}{d\tau_1} &= m_2 \int\limits_{\Theta_{12}} \left[z_1 \frac{da_{12}}{d\tau_1} \pi_{22}(w_2, r)\right] g(z) dz \\ &= \frac{da_{12}}{d\tau_1} \times m_2 \int\limits_{\Theta_{12}} \left[z_1 \pi_{22}(w_2, r)\right] g(z) dz \end{aligned}$$

Hence, the sign of $dR_{12}/d\tau_1$ will be the same as the sign of $da_{12}/d\tau_1$. Since higher taxes will cause firms to leave country 1, it follows that the new marginal firm will be one that is relatively more productive in country 1, i.e. $da_{12}/d\tau_1 < 0$. To show this formally, we need to use the labor market clearing condition.

With no domestic firms, the labor market clearing condition can be written as:

$$\begin{aligned} L_1 &= m_2 \int\limits_{\Theta_{12}} l_{12}(w_1, r, z_1)\, g(z) dz \\ &= m_2 \int\limits_0^{z_1^{max}} \int\limits_0^{a_{12} z_1} l_{12}(w_1, r, z_1)\, g(z) dz_2 dz_1, \end{aligned}$$

where z_1^{max} is the upper-bound on productivity for z_1. The right-hand side above is decreasing in w_1 and increasing in a_{12}. Thus, this expression defines a positive relationship between w_1 and a_{12}. Intuitively, at a fixed wage, the presence of more firms means that labor supply exceeds labor demand, necessitating an increase in the wage to restore equilibrium. We can express this relationship as a function: $a_{12} = \delta(w_1)$ with $\partial\delta/\partial w_1 > 0$. This function, together with $\gamma(w_1, \tau_1)$ defined earlier implies that an increase in τ_1 will shift down $\gamma(.)$ and cause a movement along $\delta(.)$ corresponding to a lower wage. Consequently, $dw_1/d\tau_1 < 0$ and $da_{12}/d\tau_1 < 0$. This should be unsurprising: higher taxes on FDI reduce the number of firms that site in the host country and reduce domestic wages.

The case with domestic firms operating in equilibrium is simpler from the point of view of optimal taxation because the domestic free-entry condition will fix w_1. To see this, consider the domestic free-entry condition, which now holds with equality:

$$\int_{\Theta_{11}} z_1 \pi_{11}(w_1, r)\, g(z)dz + \int_{\Theta_{21}} (1 - \tau_2)\, z_2 \pi_{21}(w_2, r)\, g(z)dz = f_1 w_1 + \phi_1 r$$

Differentiating this expression, we obtain:

$$\begin{aligned} -\frac{dw_1}{d\tau_1} \int_{\Theta_{11}} l_{11}(w_1, r, z_1)\, g(z)dz + \int_{\partial\Theta_{11}} (v \cdot u_1)\, z_1 \pi_{11}(w_1, r)\, g(z)ds & \\ + \int_{\partial\Theta_{21}} (1 - \tau_2)(v \cdot u_2)\, z_1 \pi_{21}(w_2, r)\, g(z)ds &= f_1 \frac{dw_1}{d\tau_1} \end{aligned}$$

The set of firms lost in the home country is necessarily the same as the set of firms gained in the foreign country (i.e. $\partial\Theta_{11} = \partial\Theta_{21}$). Since firms on the boundary make the same profits regardless of which country they produce in, the total profit loss for marginal firms is thus equal to zero: $\int_{\partial\Theta_{11}} (v \cdot u_1)\, z_1 \pi_{11}(w_1, r)\, g(z)ds + \int_{\partial\Theta_{21}} (v \cdot u_2)(1 - \tau_2)\, z_1 \pi_{21}(w_2, r)\, g(z)ds = 0$.[10] Consequently:

$$-\frac{dw_1}{d\tau_1} \left[\int_{\Theta_{11}} l_{11}(w_1, r, z_1)\, g(z)dz + f_1 \right] = 0$$

$$\frac{dw_1}{d\tau_1} = 0$$

Since $dw_1/d\tau_1 = 0$, it follows immediately that the optimal tax rate will be positive in this case.

A.4 Optimal Tax Formula

This appendix will derive a formula for the optimal tax rate. As shown in the main text, the first-order condition for the optimal tax problem is:

[10] Formally, this is because the unit normal vectors point in opposite directions (i.e. $u_1 = -u_2$).

$$L_{12}\frac{dw_1}{d\tau_1}+\Pi_{12}+\tau_1\frac{d\Pi_{12}}{d\tau_1}=0$$

Using (A.1) and (A.2), we can obtain the following:

$$\begin{aligned}
&(1-\tau_1)\frac{dw_1}{d\tau_1}L_{12}+\Pi_{12} \\
+\tau\left[m_2\int_{\partial\Theta_{12}}(v\cdot u)\,z_1\pi_{12}\,(.)\,g(z)ds\right] &= 0 \\
-\frac{dR_{12}}{d\tau_1}+\tau_1\frac{1}{1-\tau_1}\left[\frac{d}{d\tau_1}(1-\tau_1)\Pi_{12}-\frac{dR_{12}}{d\tau_1}\right] &= 0 \\
-\frac{dR_{12}}{d\tau_1}(1-\tau_1)+\tau_1\left[\frac{d}{d\tau_1}(1-\tau_1)\Pi_{12}-\frac{dR_{12}}{d\tau_1}\right] &= 0
\end{aligned}$$

Thus, the optimal tax rate is:

$$\tau_1* = \frac{dR_{12}/d\tau_1}{d\,(1-\tau_1)\,\Pi_{12}/d\tau_1}$$

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