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**Dominika Langenmayr**

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# Should tax policy favor high- or low-productivity firms?*

Dominika Langenmayr Andreas Haufler Christian J. Bauer

December 2012

**Abstract**

Heterogeneous firm productivity seems to provide an argument for governments to pursue 'pick-the-winner' strategies by subsidizing highly productive firms more, or taxing them less, than their less productive counterparts. We appraise this argument by studying the optimal choice of effective tax rates in an oligopolistic industry with heterogeneous firms. We show that the optimal structure of tax differentiation depends critically on the feasible level of corporate profit taxes, which in turn depends on the degree of international tax competition. When tax competition is moderate and profit taxes are high, favoring high-productivity firms is indeed the optimal policy. When tax competition is aggressive and profit taxes are low, however, the optimal tax policy is reversed and low-productivity firms are tax-favored.

**Keywords:** business taxation, firm heterogeneity, tax competition
**JEL Classification:** H25, H87, F15

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Affiliations: Langenmayr: University of Munich, dominika.langenmayr@lrz.uni-muenchen.de. Haufler: University of Munich and CESifo, andreas.haufler@lrz.uni-muenchen.de. Bauer: Allianz SE, Munich and CESifo, christian.j.bauer@gmail.com. Financial support from the Bavarian Graduate Program in Economics (Langenmayr) and from the German Research Foundation (Haufler and Bauer) is gratefully acknowledged.

# 1 Introduction

Corporate taxes do not fall equally on all firms, but affect firms of varying size and productivity in different ways. Such asymmetries may arise for several reasons. A first one is that the tax law treats profits and losses unequally. While firms pay taxes on profits immediately, they can offset losses only against positive income. This discriminates between large and small firms, because the former have more opportunities to offset losses in some product lines against profits in others (Mirrlees et al., 2011).[1] A further reason for diverging effective tax rates on firms of different size is the degree of corporate tax noncompliance, which has been shown to rise with firm size (Hanlon et al., 2007). These differences are reinforced in an international setting which favors large, multinational enterprises (MNEs) as profit shifting opportunities allow them to exploit international tax differences in a tax-minimizing way.[2] Egger et al. (2010), for example, estimate that a foreign-owned subsidiary of a MNE saves one third of the taxes that a comparable domestic unit would have to pay in a high-tax country.

All these features of current tax systems suggest that large (multinational) firms pay lower effective tax rates than small (domestic) firms. A possible rationale for this discrimination in tax policy is that larger firm size is empirically correlated with higher productivity and higher wages (Oi and Idson, 1999).[3] Thus, firm heterogeneity raises the question of whether countries should pursue 'pick-the-winner' strategies, that is, tax-discriminate in favor of large, multinational businesses as a means to divert production towards the most productive firms.

The present paper addresses this issue. We derive the optimal pattern of capital taxes when effective tax rates can vary for firms with different productivities and profit taxation is limited by international tax competition. In this setting we show that offering

[1] Auerbach (2007, Table 4) documents the quantitative importance of this effect for the United States. Corporations reported annual losses of 350-400 billion USD in aggregate in each of the years 2001-2003, representing roughly two thirds of positive corporate profits in the same years.

[2] See e.g. Huizinga and Laeven (2008) for a recent and detailed analysis of profit shifting. Relevant channels for profit shifting include, for example, international debt shifting (Desai et al., 2004), and the allocation of patents (Dischinger and Riedel, 2011).

[3] Productivity differences between firms have been at the core of recent empirical and theoretical research in international trade. This research stresses that more productive firms self-select either into the export market (Melitz, 2003), or into foreign direct investment (Helpman et al., 2004), and that they are larger in equilibrium than less productive firms.

tax preferences to more productive firms may indeed be optimal, but the case for such tax preferences is systematically reduced as economic integration proceeds and tax competition becomes more aggressive.

We derive this argument in a small open economy model where firms in an oligopolistic sector produce at two different cost or productivity levels. The government may differentiate the tax base according to the different cost levels, so that the resulting effective tax rates can differ between low-cost and high-cost firms. In addition to the tax bases, the small country chooses a uniform profit tax rate, but it is constrained in this choice by international tax competition. We incorporate tax competition in a simple way, replicating the well-known result that economic integration reduces the equilibrium level of the corporate profit tax. In this set-up the optimally differentiated tax policy results from the trade-off between raising the aggregate productivity by shifting production to the low-cost firms, and the incentive to indirectly tax foreign-owned profits via a broader tax base, which raises more revenue when applied to the low-cost firms.

Our main result is that the optimal solution to this trade-off depends critically on the rate of profit taxation that is feasible in the presence of tax competition with an outside tax haven. Granting tax advantages to the low-cost, multinational firms turns out to be the optimal policy when tax competition is moderate and the possibility to tax the resulting profits is accordingly high. In contrast, when tax competition from the tax haven is aggressive and the feasible rate of profit taxation is low, the pattern of discrimination is reversed and a broader tax base is applied to high-productivity firms. These results are shown to hold for both quantity and price competition among firms, and for different assumptions about firm ownership.

In sum, our analysis thus predicts a fall in the tax advantages of large, productive MNEs as a result of economic integration and tighter corporate tax competition. And indeed, recent developments in tax policy seem to point in this direction. One well-noted trend is the substantial fall in statutory corporate tax rates: among the OECD members these averaged around 50% in the early 1980s, but the average has fallen to 30-35% by 2010 (OECD, 2011). A similar trend can also be observed in less-developed parts of the world (Klemm and van Parys, 2012). There is a widespread consensus in the literature that one of the key factors in explaining this development is the international competition for mobile capital, firms and profits.[4]

At the same time, many countries have recently undertaken unilateral measures aimed

[4]See Devereux et al. (2008) for econometric evidence and Auerbach et al. (2010) for a recent survey.

at limiting the tax advantages of multinational firms. A first example is the proliferation of thin capitalization rules, which restrict the ability of MNEs to engage in international debt shifting. In the mid-1990s less than one half of all OECD members had adopted thin capitalization rules, but this share has risen to roughly two thirds in 2005 (Buettner et al., 2012, Table 1).[5] A second example is the number of large-scale state investment subsidies offered to multinational firms in Europe, which has peaked in the early 2000s and has dropped significantly since then (Haufler and Mittermaier, 2011, Table 1). A third example comes from less-developed countries, where tax holidays – periods of reduced or no profit taxation – are a major policy measure to attract FDI. In a broad sample of countries, the average length of tax holidays has fallen from more than four years in the late 1980s to around 2.5 years in 2005 (Klemm and van Parys, 2012, Fig. 1).

The coexistence of these seemingly opposing trends is particularly noteworthy, because one would expect that increasing competition for mobile, multinationals firms would lead to *more*, not fewer, tax advantages for MNEs. The existing literature on discriminatory tax competition has indeed argued that governments will discriminate in favor of those tax bases that display the highest degree of international mobility. In contrast, we show in this article that reduced tax advantages for profitable multinationals can be the optimal policy response to economic integration when tax discrimination is instead based on productivity differences between firms. Our analysis thus offers a rationale for the above-mentioned recent trends in corporate tax policy, which cannot be explained by existing paradigms.[6]

Our analysis is related to several strands of previous research. A first strand is the literature on preferential tax regimes. Janeba and Peters (1999) and Keen (2001) compare discriminatory and non-discriminatory tax competition in a setting with two tax bases that differ in their degree of international mobility. Peralta et al. (2006) ask under which conditions countries may have an incentive to tax-discriminate in favor of MNEs

[5]The German corporate tax reform of 2008 is a prominent example for a reform explicitly aimed at limiting the tax advantages of MNEs. It reduced the German corporate tax rate and simultaneously introduced a rigorous ceiling on the tax-deductibility of interest payments, which was tailored so as to apply exclusively to highly profitable, multinational firms.

[6]We do not claim, of course, that mobility-based approaches to discriminatory tax competition are unimportant. For example, a recent development in several EU countries, including the United Kingdom and the Benelux countries, is to offer significantly reduced tax rates for knowledge-intensive firms. This preferential tax treatment is clearly driven by the high international mobility of intellectual capital. For an analysis of these so-called 'patent boxes', see Griffith et al. (2012).

by not monitoring international profit shifting. More recently, several papers have analyzed - with diverging conclusions - the role of tax havens, which allow countries to tax-discriminate in favor of internationally mobile firms (Slemrod and Wilson, 2009; Hong and Smart, 2010; Johannesen, 2012). In all these papers, equilibrium patterns of tax differentiation arise from differences in the international mobility of tax bases, whereas productivity differences between firms are ruled out.

A second related literature strand considers tax and subsidy competition in settings with heterogeneous firm productivity. Some papers in this area model the competition for internationally mobile firms (e.g. Davies and Eckel, 2010; Haufler and Stähler, 2013), whereas others focus on profit shifting (Krautheim and Schmidt-Eisenlohr, 2011) or entry subsidies (Pflüger and Suedekum, 2013). None of these papers, however, allows for taxes or subsidies that differ between the heterogeneous firms.

Also relevant to our setting is the recent literature on industrial policy. Aghion et al. (2012), for example, show that subsidies to sectors with intense competition foster productivity and innovation. In their model, however, the differentiation of policies depends on the market structure in different sectors, not on the productivity of individual firms. Finally, Gersovitz (2006) derives the optimal pattern of income and consumption taxes when both have differential effects on firms with varying productivity. He does not tie his results to the effects of tax competition, however, and many of his findings have to rely on simulation results.

The plan of the article is as follows. Section 2 lays out our benchmark model in which heterogeneous firms are taxed by a general corporate profit tax which is applied to differentiated tax bases. Section 3 derives the market equilibrium. Section 4 analyzes the optimal structure of capital taxes and relates this pattern to the degree of economic integration. Section 5 discusses the robustness of our results. Section 6 concludes.

# 2 The benchmark model

We study a small open economy that produces and consumes two homogenous goods, $X$ and $Y$. Firms in the $Y$ industry (the numeraire sector) are homogenous and operate under perfect competition. The $X$ sector has an oligopolistic market structure and the firms producing in this sector differ with respect to their unit cost. Consumers in the small economy hold a total endowment of $K$ units of capital, which is the only variable input in the production of both goods. Producing one unit of $Y$ requires $1/r$ units of

capital. Capital and the numeraire $Y$ can be freely traded internationally at the fixed world interest rate $r$.[7]

The focus of our analysis lies on the corporate tax structure that the small country's government applies to the heterogeneous firms in the $X$ sector. To keep the model as simple as possible, we assume that good $X$ is a non-traded good. This assumption ensures that corporate tax policy directly affects the domestic market equilibrium, without incorporating the attenuating effects arising from import and export markets. It is well-known from the literature that the effects of domestic tax policies are qualitatively similar when costly international trade is permitted.[8]

## 2.1 Consumers

Consumers are homogeneous. A quasilinear utility function represents their preferences over the two private goods $X$ and $Y$:

$$U = aX - \frac{1}{2}\, bX^2 + Y^D, \tag{1}$$

where $Y^D$ is the quantity demanded of the numeraire, and $a, b > 0$ are parameters.

Utility maximization is subject to the budget constraint $Y^D + pX \leq I$, where $p$ is the price of good $X$ in the small country. To determine national income $I$, we need to specify the international allocation of profits. In our benchmark model we assume that all profit income in the $X$ industry accrues to foreigners.[9] National income is then

$$I = rK + T, \tag{2}$$

where $rK$ is the exogenous capital income of the small country's representative consumer and $T$ is tax revenue, which the government redistributes to the consumer as a lump-sum payment. Utility maximization yields linear demand functions

$$X = \frac{a-p}{b}, \qquad Y^D = I - pX, \tag{3}$$

which imply that all income changes affect only the demand for the numeraire good $Y$.

[7] Free trade in both $Y$ and $K$ implies that the model does not specify where the numeraire good is produced. This, however, is immaterial for all our results.

[8] As a result of transport costs, foreign-produced goods remain more expensive than domestically produced goods. Thus a setting with costly international trade maintains the motive for tax policy to expand domestic production in an imperfectly competitive market and to increase domestic consumer surplus (see, e.g. Haufler and Wooton, 2010).

[9] This assumption is relaxed in Section 5, where we introduce domestic ownership of profit income.

## 2.2 Producers

In the oligopolistic $X$ sector, there is an exogenously given number of $n$ potential entrants ('firms'). Each of these firms possesses one unit of a specific factor, labelled 'intellectual property' (such as a license or patent), which it can employ profitably in the imperfectly competitive industry. This factor is indispensable for the production of good $X$ but is limited in availability. Consequently, at most $n$ firms can engage in the production of good $X$. Since the number of firms is exogenously constrained, pure profits are earned by the owners of the fixed factor. As we discussed earlier, we assume in our benchmark model that this factor is fully owned by foreigners.

Production of good $X$ additionally requires capital as the only variable factor of production. Firms in the industry are heterogeneous, differing in their (exogenous) capital requirement per unit of good $X$. For reasons of concreteness and tractability, we assume that there are only two possible levels of unit capital requirements, $c_L$ and $c_H$, where the indices $L$ and $H$ respectively denote a low-cost and a high-cost firm. This simplifying assumption allows us to derive closed-form solutions for all variables. Differing input requirements translate into different unit costs of the two firm types, given by $c_L r$ and $c_H r$, respectively.

Due to the existence of pure profits, firms with different variable costs can co-exist in equilibrium. In total, there are $n_L$ low-cost firms and $n_H$ high-cost firms, with $n_H + n_L = n$. The output of a firm of type $i$ is denoted by $x_i$, so that industry output $X$ is

$$X = n_L x_L + n_H x_H. \tag{4}$$

We assume that firms in the $X$ sector engage in quantity competition.[10] In equilibrium, a low-cost firm will produce more output than a high-cost firm. We will therefore also refer to the low-cost and the high-cost firms as 'large firms' and 'small firms', respectively. Moreover, we will also interpret the low-cost firms as multinational firms and the high-cost firms as national firms. This follows the empirical and theoretical results from the international trade literature that multinational firms are more productive, on average, than national firms (Helpman et al, 2004). The distinction between multinational and national firms will become important when we introduce international profit shifting opportunities below.

[10] In Section 5 we analyze an alternative market structure where goods are differentiated and firms compete over prices. We show there that this setting yields the same qualitative conclusions as the homogeneous Cournot model.

To simplify notation, we normalize $c_L \equiv 1$ and define the capital requirement of high-cost firms as $c_H \equiv 1 + \Delta$ (with $\Delta > 0$). Our analysis focuses on the case where the productivity gap $\Delta$ is sufficiently small (relative to the firm's profit opportunities) so that even the high-cost firms make positive profits in equilibrium. This condition is derived in Appendix 1. In the absence of government intervention, all firms will therefore produce. As a result of government policy, the high-cost firms may, however, anticipate negative profits and thus choose not to enter the market. In this case only the $n_L$ low-cost firms remain active in the market.

## 2.3 Government

The government of the small country taxes profits at the statutory corporate tax rate $t$, which applies uniformly to all firms. In addition, the government decides on the share of capital costs $\delta_i$ that is deductible from the corporate tax base. These tax base deductions will generally affect the two firm types differently. Larger low-cost firms may, for example, use loss offset provisions more effectively, or they may (in the interpretation as a MNE) be able to engage in financial arbitrage transactions that permit them to deduct a larger share of their capital costs.[11] The reverse type of tax discrimination is also possible, however, when small, high-cost firms receive capital subsidies or special tax deductions to promote their market entry or business expansion.[12]

With this specification of the tax system, the net-of-tax profits $\pi_i^n$ of a firm of type $i$ are given by

$$\pi_i^n = (p - c_i)x_i - t(p - \delta_i c_i)x_i \quad \forall\, i \in \{L, H\}, \tag{5}$$

where the first term on the right-hand side gives the gross profits and the second term gives the total tax payments, which depend on the tax rate and the taxable profit base.

In the following it proves convenient to represent the differences in the determination

[11] See Desai et al. (2004) for empirical evidence on tax-minimizing financing structures within MNEs. Even in the absence of explicit profit shifting strategies by multinational firms, the effective tax rate on MNE's profits will be lower when more productive firms self-select into an integrated production structure, whereas the transfer price for tax purposes is determined by less productive firms, which outsource the production of intermediate inputs (Bauer and Langenmayr, 2012).

[12] Support programs for small businesses have proliferated in recent years. See Mirrlees et al. (2011) for a detailed description of the tax advantages of small businesses in the United Kingdom, and OECD (2010) for a listing of the most important support schemes for small and medium-size enterprises (SMEs) in OECD member states.

of tax bases for heterogeneous firms by firm-specific taxes $\tau_L$ and $\tau_H$ on the capital input costs. Defining

$$1 + \tau_i \equiv \frac{(1 - t\delta_i)}{(1 - t)} \quad \forall\, i \in \{L, H\}, \tag{6}$$

and introducing the normalized marginal costs $c_L = 1$ and $c_H = 1 + \Delta$, equation (5) can be rewritten as:

$$\pi_L^n \equiv (1-t)\pi_L = (1-t)x_L\,[p - (1+\tau_L)\,r], \tag{7a}$$

$$\pi_H^n \equiv (1-t)\pi_H = (1-t)x_H\,[p - (1+\tau_H)\,(1+\Delta)\,r]. \tag{7b}$$

Here $\pi_i$ denotes the profits of a firm of type $i$ after the incorporation of taxes or subsidies on capital inputs, but before the deduction of the corporate profit tax. In general, the capital input taxes $\tau_L$ and $\tau_H$ in (7a)–(7b) can be positive or negative. As is seen from (6), the tax on capital inputs is positive when capital costs are less than fully deductible from the corporate tax base ($\delta_i < 1$). In contrast, when the tax deductibility of capital inputs exceeds their true value ($\delta_i > 1$), the capital input tax is negative (i.e., a subsidy).

The formulation in eqs. (7a) and (7b) allows a simple representation of the government's ability to affect production decisions both on the intensive margin (how much each firm produces) and on the extensive margin (whether or not a firm enters the market). Irrespective of the sign of optimal capital input taxes, the tax system favors the low-cost firms if $\tau_L < \tau_H$, whereas it favors the high-cost firms if $\tau_L > \tau_H$.

International tax competition limits the scope of the government for choosing its statutory corporate tax rate $t$. We model tax competition by assuming that low-cost firms are able to shift profits into an outside tax haven. The government's aggregate tax revenues are then

$$T = t[(1-\alpha)n_L\pi_L + n_H\pi_H] + \tau_L n_L x_L r + \tau_H n_H x_H (1+\Delta) r. \tag{8}$$

Here $0 \leq \alpha \leq 1$ denotes the share of their profits that low-cost, multinational firms shift to the tax haven so that they declare only the share $(1-\alpha)$ in the small country. We impose no constraint on the sign of $T$. As is seen from equation (2), positive tax collections are redistributed to the representative consumer lump sum. Conversely, if total tax revenue from the corporate tax system turns negative, then lump-sum taxes are available to finance effective subsidy payments to firms.

# 3 Market equilibria

Our following analysis is based on a two-stage game. In the first stage, the government chooses its tax policy parameters $(t, \tau_L, \tau_H)$, taking into account the impact of taxation on intensive and extensive margins of production, consumer prices, and profit shifting. In the second stage, both types of firms choose their output levels given the tax system, and the multinational firms additionally choose their optimal level of profit shifting.

We solve the model by backward induction and derive the market outcomes in the last stage. We separately consider two cases. In the first, both low-cost and high-cost firms are active in the market. In the second, only the low-cost firms produce, as the tax policy makes entry unattractive for the high-cost firms.

**Low-cost and high-cost firms active.** When all firms compete over quantities in a Cournot oligopoly, maximizing profits in (7a)–(7b), subject to (3) and (4), gives optimal quantities as

$$x_L = \frac{a - (1+\tau_L)r + n_H[(1+\tau_H)(1+\Delta)r - (1+\tau_L)r]}{b(1+n)}, \tag{9a}$$

$$x_H = \frac{a - (1+\tau_H)(1+\Delta)r + n_L[(1+\tau_L)r - (1+\tau_H)(1+\Delta)r]}{b(1+n)}. \tag{9b}$$

Comparing (9a) and (9b) immediately shows that $x_L > x_H$ when both firms face the same capital input tax ($\tau_L = \tau_H$). For later use, we derive the effects of capital input taxes on firm-specific output levels:

$$\frac{\partial x_L}{\partial \tau_L} = \frac{-(1+n_H)r}{b(1+n)} < 0, \qquad \frac{\partial x_L}{\partial \tau_H} = \frac{n_H(1+\Delta)r}{b(1+n)} > 0,$$

$$\frac{\partial x_H}{\partial \tau_H} = \frac{-(1+n_L)(1+\Delta)r}{b(1+n)} < 0, \qquad \frac{\partial x_H}{\partial \tau_L} = \frac{n_L r}{b(1+n)} > 0\ . \tag{10}$$

Thus, raising $\tau_i$ lowers the output of all firms of type $i$, but increases the output of the other type $j$ as a result of strategic interaction in quantities.

Combining the market demand for good $X$ in (3) with aggregate output from (4) and equilibrium quantities in (9a)–(9b) gives the equilibrium price as an increasing function of both types' unit costs and capital input taxes:

$$p = \frac{a + n_L(1+\tau_L)r + n_H(1+\tau_H)(1+\Delta)r}{1+n}. \tag{11}$$

Maximized profits, before deduction of the corporate profit tax $t$, are then given by

$$\pi_L = bx_L^2, \qquad \pi_H = bx_H^2. \tag{12}$$

Evaluating the utility function (1) with the optimal demands for $X$ and $Y$ using (2), (8), (11), and (12), we get indirect utility as

$$V = \frac{b}{2}\left(n_L x_L + n_H x_H\right)^2 + rK + tb(\alpha n_L x_L^2 + n_H x_H^2) + \tau_L n_L x_L r + \tau_H n_H x_H \left(1+\Delta\right) r, \tag{13}$$

with equilibrium quantities given by (9a)–(9b).

**Only low-cost firms active.** Given that no profit income accrues to domestic consumers in our benchmark setting, if it is optimal for tax policy to drive one set of firms from the market, then it is always optimal to eliminate the high-cost firms. When only the low-cost firms remain in the market, output per firm in (9a) and the market price equation (11) reduce to

$$\tilde{x}_L = \frac{a-(1+\tau_L)r}{b(1+n_L)}, \qquad \tilde{p} = \frac{a+n_L(1+\tau_L)r}{1+n_L}\ , \tag{14}$$

where the tilde refers to variables in the equilibrium with low-cost firms only. Gross profits for each low-cost firm are then $\tilde{\pi}_L = b(\tilde{x}_L)^2$. The representative consumer's indirect utility in this case is

$$\tilde{V} = \frac{b}{2}\ \left(n_L \tilde{x}_L\right)^2 + rK + tb(\alpha n_L \tilde{x}_L^2) + \tau_L n_L \tilde{x}_L r, \tag{15}$$

with the equilibrium quantity $\tilde{x}_L$) given in (14).

**Profit shifting decision.** A separate decision for the low-cost, multinational firms is to determine the optimal degree of profit shifting. We assume that the MNE has the opportunity to shift profits to a tax haven, where profits are taxed at the (low) tax rate $t_0$. Shifting profits imposes costs on firms, however, which may consist of transaction costs, fees for legal counseling, or the expected costs of being caught and fined. We assume that the costs of profit shifting are proportional to the fraction of profits shifted abroad. These costs are given by $s_0\alpha\pi_L$, where the parameter $s_0 \in [0,1]$ denotes the share of profits that is absorbed by the shifting costs. Thus, when the multinational firm declares a fraction $\alpha$ of its profits in the tax haven, its after-tax profits $\pi_L^n$ are

$$\pi_L^n = \pi_L[\alpha\left(1-t_0\right) + (1-\alpha)(1-t) - s_0\alpha]. \tag{16}$$

Maximizing (16) with respect to $\alpha$ gives the optimal profit shifting decision

$$\alpha^* = \begin{cases} 0 & \text{if} \quad t \leq t_0 + s_0 \\ 1 & \text{if} \quad t > t_0 + s_0. \end{cases} \tag{17}$$

Under the assumption of proportional shifting costs, the low-cost firms will thus shift either all of their profits into the tax haven, or none at all.[13]

# 4 Optimal policy

We now derive the optimal tax policy chosen by the small country's government, which correctly anticipates the optimal behavior of firms and consumers. The central question we address is whether, in the presence of firm heterogeneity, the government has an incentive to tax-discriminate in favor of either the low-cost or the high-cost firms. As we will see, this decision is critically affected by the statutory corporate profit tax rate that the government is able to levy, given the competition from the outside tax haven.

Since the low-cost firms' profit shifting decision (17) is unaffected by the capital input taxes $\tau_i$ in our simple setup, we can solve the government's problem sequentially. First, the tax authorities choose the optimal profit tax rate $t$, taking into account that profits can be shifted to the tax haven. Second, the government imposes – possibly differentiated – taxes or subsidies $\tau_i$ on the capital inputs used by each firm.

## 4.1 Tax competition and the profit tax rate

Given the low-cost firms' decision to either shift all or none of their profits [eq. (17)], the home country has the following choice. It can either set its profit tax at a sufficiently low rate to ensure that profit shifting is not worthwhile; or, alternatively, it can switch to a high-tax regime where it forgoes all revenues from taxing the profits of the low-cost multinationals, but instead taxes the profits of the high-cost firms at the maximum rate. Our analysis focuses on the first regime, in which the home country prevents all profit shifting by setting

$$t^* = t_0 + s_0 \equiv s. \tag{18}$$

[13]Excluding partial profit shifting at the level of each firm is a conventional assumption in the recent profit shifting literature, which incorporates firm heterogeneity. See e.g. Krautheim and Schmidt-Eisenlohr (2011), or Elsayyad and Konrad (2012).

Clearly, the higher are the shifting cost parameter $s_0$ and the haven's tax rate $t_0$, the higher is the profit tax rate $t^*$ that still allows to tax the low-cost firms. In the following we combine the two exogenous parameters $t_0$ and $s_0$ to a single value, $s$, which measures the degree of tax competition to which the small country is exposed.

Appendix 2 derives the equilibrium in the alternative regime where the small country sets $t > s$ and taxes the profit income of the high-cost firms only. The appendix also states the precise condition under which the small country will choose one or the other regime. While the possibility of a regime switch is interesting, it has been studied in detail elsewhere (e.g. Janeba and Peters, 1999). Moreover, it is obvious that the core issue underlying our analysis can only be usefully addressed when both firms are taxed in equilibrium.

It should be emphasized that our objective in this section is not to provide a detailed model of profit shifting into a tax haven. Rather, the purpose is to link the corporate tax rate in the small country to exogenous changes in its economic environment, as measured by the parameter $s$, and equation (18) does this in the simplest possible way. At the core of our analysis are the effects of a reduction in $s$, i.e. closer economic integration and accordingly tighter tax competition, on the optimal pattern of differentiated capital input taxes $\tau_i$. This is the issue to which we turn now.

## 4.2 Optimally differentiated capital input taxes

Having chosen the profit tax rate $t$, the government determines its corporate tax bases by setting capital input taxes (or subsidies) $\tau_i$. Taken together, these tax parameters yield the effective tax burden, which may differ for firms with different productivity levels. The tax choices $\tau_i$ affect the entrants' participation constraints. We start with the case where the tax burden does not deter market entry by the high-cost firms.

**Low-cost firms and high-cost firms active.** Maximizing (13) with respect to $\tau_L$ and $\tau_H$ and using (10) results in two interdependent first-order conditions for $\tau_L$ [eq. (19a)] and $\tau_H$ [eq. (19b)]. Straightforward simplifications yield:

$$-bX - 2sb[x_L + (x_L - x_H)n_H] + x_L b(1+n) = \tau_L r(1+n_H) - \tau_H(1+\Delta)rn_H, \quad (19a)$$

$$-bX - 2sb[x_H - (x_L - x_H)n_L] + x_H b(1+n) = \tau_H(1+\Delta)r(1+n_L) - \tau_L rn_L. \quad (19b)$$

The first effect on the left-hand side (LHS) of (19a)–(19b) is an *output effect*. This effect is negative for an increase in either $\tau_L$ and $\tau_H$ as capital input taxes further

decrease production in the imperfectly competitive $X$-industry. Moreover, the output effect is equally strong for the two capital input taxes $\tau_i$.

The second effect on the LHS is a *profit capturing effect*. It indicates the fraction of an increase in aggregate profits that the small country can appropriate. Given that all (net) profit income accrues to foreigners in our benchmark model, the small country's share in aggregate profit income is determined solely by its profit tax rate. Since $x_L > x_H$ always holds in equilibrium (see below), the second term is unambiguously negative in (19a) while its sign is ambiguous in (19b). Importantly, we can also infer that the second term in (19a) is unambiguously smaller (i.e., more negative) than in (19b). This is because an increase in $\tau_L$ diverts production from the more productive to the less productive firms and thus has a stronger negative effect on aggregate profits than an increase in $\tau_H$.

The third effect on the LHS is a *tax base effect*, which is unambiguously positive for an increase in either $\tau_L$ or $\tau_H$. It stands for the additional revenue from a marginal increase in the capital tax base. This effect is unambiguously larger in (19a) than in (19b), because the larger output of the low-cost firms is associated with a larger capital tax base.

The sum of these three effects determines the sign of the interdependent capital input taxes $\tau_L$ and $\tau_H$ in equilibrium. These taxes will be positive when the positive tax base effect dominates the negative output and profit capturing effects. Other things equal, this is more likely when tax competition is aggressive ($s$ is low) and the feasible profit tax rate $t$ is accordingly low. Thus, the set of optimal capital taxes solves the trade-off between expanding output in the imperfectly competitive industry, and maximizing the tax revenue from the rents accruing to foreigners. The *relative* taxation of capital inputs in the low-cost and in the high-cost firms depends on whether the difference in the third terms (the tax base effects) or the difference in the second terms (the profit capturing effects) dominates.

Having discussed the isolated effects of changes in $\tau_i$, we can now turn to the reduced-form solutions for the optimal capital input taxes. Solving the equation system (19a)–(19b) gives:

$$\tau_L = \left(\frac{1}{2} - s\right)\frac{2bx_L^*}{r}, \qquad \tau_H = \left(\frac{1}{2} - s\right)\frac{2bx_H^*}{(1+\Delta)r}, \tag{20}$$

where $s$ is given in (18) and the reduced-form output levels of each firm type are

$$x_L^* = \frac{(a-r)(1-s) + \Delta r n_H/2}{b(1-s)[2(1-s)+n]}, \quad x_H^* = \frac{[a-(1+\Delta)r](1-s) - \Delta r n_L/2}{b(1-s)[2(1-s)+n]}. \tag{21}$$

Equation (20) shows that both capital input taxes are unambiguously falling in $s$ and thus, from (18), in the feasible rate of profit taxation $t$. Intuitively, positive capital input taxes are an indirect way of taxing foreign profits in the $X$-industry, but this comes at the cost of aggravating the production distortion arising from imperfect competition. Therefore, capital inputs will be subsidized when the feasible rate of profit taxation is sufficiently high ($s > 1/2$), but they are taxed when profit tax rates are low as a result of increased profit shifting opportunities.[14]

In the title of this paper we ask the question of whether capital input taxes should be lower or higher for low-cost firms, as compared to their high-cost competitors. We are now able to provide an answer to this question by analyzing eqs. (20) and (21). Note first from (21) that equilibrium output of a low-cost firm is always higher than the output of a high-cost firm, irrespective of any differences in capital taxes. This implies that the positive second terms in (20) are unambiguously larger for $\tau_L$. Thus $\tau_L < \tau_H$ holds (and low-cost firms are tax-favored) if and only if the feasible rate of profit taxation is sufficiently high ($s > 1/2$). In this case capital inputs are subsidized in all firms, but the subsidy level is higher in low-cost firms. In contrast, when economic integration reduces the feasible rate of profit taxation below $t = s < 1/2$, then all firms' capital inputs are taxed, but the tax is now higher for the low-cost firms.

The intuition for this reversal in the tax pattern comes from the changing relative importance of the *profit capturing* and *tax base effects* in (19a)–(19b). When the small country's profit tax can capture a large share of the profits in the $X$-industry, then the optimal policy is to give a tax preference to the low-cost firms to increase aggregate production. When the government can tax only a small percentage of the profits in the $X$-industry, however, it taxes the larger base of low-cost firms more heavily to exploit the capital tax base.

Total tax revenues, resulting from the combined impact of profit taxes and taxes on capital inputs, are always positive in equilibrium. Using (18), (20) and (12) gives

$$T = s(n_L\pi_L + n_H\pi_H) + \tau_L x_L r n_L + \tau_H x_H(1+\Delta) r n_H = b(1-s)(n_L x_L^2 + n_H x_H^2) > 0. \quad (22)$$

This shows that, even though consumer surplus is included in the objective function [eq. (13)], it can never be optimal for the small country to leave foreign-owned profits in the $X$-industry completely untaxed.

[14] In this sense, equation (20) represents a simple way of explaining the tax-rate-cut-cum-base-broadening reforms of corporate income taxation that have taken place in many countries during the last decades. See Devereux et al. (2002) for a detailed account of these developments.

Lastly, we compute the maximized utility level of the individual in the case where both low-cost and high-cost firms are active in equilibrium by substituting (22) along with (21) in (13). After simplifying, this yields

$$V^* = \frac{2(1-s)\left\{n(a-r)^2 - n_H r\Delta\left[2(a-r) - r\Delta\right]\right\} + n_H n_L r^2\Delta^2}{4b(1-s)[2(1-s)+n]} + rK, \tag{23}$$

which serves to compare the individual's welfare level with that achieved in different tax regimes.

**When are all firms active in equilibrium?** We now consider the possibility that the optimal policy drives all high-cost firms from the market. The relevant objective function is then given by (15), from which the optimal capital tax and the resulting output per low-cost firm follow:

$$\tilde{\tau}_L = \left(\frac{1}{2} - s\right)\frac{2b\tilde{x}_L^*}{r}, \qquad \tilde{x}_L^* = \frac{(a-r)}{b[2(1-s)+n_L]}\ . \tag{24}$$

Consequently, if only the low-cost firms are active in the market, the optimal tax on their capital inputs is again negative when $s > 1/2$, but positive when $s < 1/2$. This pattern is thus the same as in the case where all firms are active, and the intuition is also analogous. Capital input subsidies, which increase output towards its efficient level, will only be in the interest of the small country's government if it is able to tax a sufficiently high share of the resulting increase in the firms' profits. In the extreme case where the cost of shifting profits become prohibitive ($s = 1$), so that the government can tax profits completely, the capital subsidy will become so high that it induces the first-best level of output in the market.

Using (24) in (15) yields the maximized indirect utility when only the low-cost firms produce:

$$\tilde{V}^* = \frac{n_L(a-r)^2}{2b[2(1-s)+n_L]} + rK. \tag{25}$$

In the last step, we determine the critical level of $s$ above which the government wants to eliminate the high-cost firms from the market. Equating (23) and (25) shows that this is the case when

$$\bar{s} = 1 - \frac{n_L r\Delta}{2[a - r(1+\Delta)]}\ . \tag{26}$$

It is straightforward to show that (26) implies a critical tax rate of $\bar{t} = \bar{s} > 1/2$ iff the condition $\Delta < (a-r)/[r(n_L+1)]$ is fulfilled. But we have already shown in Appendix 1 [eq. (A.1)] that this condition must be fulfilled when high-cost firms enter the market

in the absence of government intervention. Thus we can infer that it can only be optimal for the government to keep the high-cost firms from entering the market when $t = s > 1/2$, i.e. in a regime where it is already discriminating against these firms.

How do optimal capital input taxes change at $s > \bar{s}$? Since $\bar{s} > 1/2$, we know from (24) that the remaining $L$-firms will surely be subsidized. Also, substituting (26) into the low-cost firms' optimal output choice in (24) confirms that the resulting market price in good $X$ is just equal to $(1 + \Delta)r$ at $\bar{s}$. Therefore any weakly positive capital input tax on high-cost firms suffices to keep these firms from entering the market.

We are now in the position to state our main result:

**Proposition 1** *The pattern of optimally differentiated taxation is a function of the degree of international tax competition.*

**(i)** *With weak tax competition ($s > \bar{s} > 1/2$), the government subsidizes the capital inputs of the low-cost firms and deters entry by the high-cost firms.*

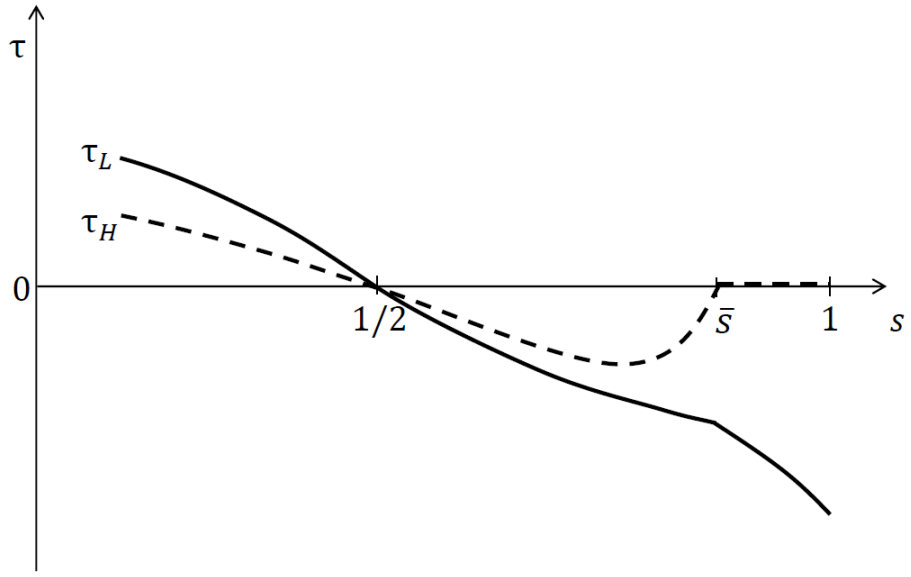
**(ii)** *With moderate tax competition ($1/2 < s < \bar{s}$), the government subsidizes capital inputs of both firms and the optimal policy favors the low-cost firms ($\tau_L < \tau_H$).*

**(iii)** *With aggressive tax competition ($s < 1/2$), the government taxes capital inputs of both firms and the optimal policy favors the high-cost firms ($\tau_L > \tau_H$).*

Figure 1 illustrates this proposition. Start at the right end of the graph, where $s > \bar{s}$. In this regime of *weak tax competition*, only the low-cost firms are active in equilibrium. The capital input tax on low-cost firms, $\tau_L$ (solid line), is strongly negative, whereas $\tau_H$ (dashed line) is set to zero (or any positive level) to keep the high-cost firms from entering the market. The high-cost firms become active when economic integration proceeds and $s$ falls below $\bar{s}$. In this regime of *moderate tax competition* ($1/2 < s < \bar{s}$), the government subsidizes both low- and high-cost firms. The capital input subsidy is higher for the low-cost firms. Both the subsidies and the preferential treatment of the low-cost firms decline as $s$ falls. At $s = 1/2$, capital input taxes for both firm types are zero and the graphs for $\tau_L$ and $\tau_H$ intersect. For $s < 1/2$ we reach the regime of *aggressive tax competition* where both capital input taxes are positive. Moreover, the tax on low-cost firms exceeds the tax on high-cost firms on account of the larger tax base effect. This pattern of discrimination in maintained as $s$ continues to fall.[15]

[15]Recall, however, that for very low levels of $s$ the small country will find it optimal to discretely

Figure 1: Optimal input taxes and economic integration




# 5 Discussion and extensions

This section discusses the robustness of our results when some of the assumptions made in the benchmark model are relaxed.

**Home ownership of firms.** In our benchmark model we have assumed that all profits accrue to foreigners. We now analyze the implications when domestic residents (partly) own the rent-generating production factor ('intellectual property'). Then, domestic consumers receive a share $\beta_i \leq 1$ of the *after-tax* profits of firms of type $i$.

The market equilibria and the analysis of tax competition carry over to this alternative setting from our benchmark analysis in Sections 3 and 4.1. The optimal firm-specific capital input taxes $\tau_i$ change, however, as now also the untaxed part of profits matters for domestic welfare. The expanded expression for national welfare is:

$$V = \frac{b}{2}X^2 + [t + \beta_L (1-t)] \left(bn_L x_L^2\right) + [t + \beta_H (1-t)] \left(bn_H x_H^2\right) + \tau_L n_L x_L r + \tau_H n_H x_H r + rK.$$

Using (18), the optimal capital taxes can be computed as

$$\tau_L = \left[\frac{1}{2} - s - \beta_L(1-s)\right] \frac{2bx_L^*}{r}, \qquad \tau_H = \left[\frac{1}{2} - s - \beta_H(1-s)\right] \frac{2bx_H^*}{(1+\Delta)\, r}\,. \tag{27}$$

raise its tax and let the low-cost, multinational firms shift all their profits to the tax haven (see Appendix 2).

Equilibrium output levels of each firm type are now

$$x_L^* = \frac{(a-r)(1-s)(1-\beta_H) + \Delta r n_H/2}{b(1-s)\left\{(1-\beta_H)\left[n_L + 2(1-s)(1-\beta_L)\right] + n_H(1-\beta_L)\right\}},$$

$$x_H^* = \frac{(a-r)(1-s)(1-\beta_L) + \Delta r\left[n_L/2 + (1-s)(1-\beta_L)\right]}{b(1-s)\left\{(1-\beta_H)\left[n_L + 2(1-s)(1-\beta_L)\right] + n_H(1-\beta_L)\right\}}.$$

Comparing the optimal tax expressions (27) with those of our benchmark case (20) shows that domestic ownership of firms generally reduces the level of capital input taxes, as the incentive to tax foreign-owned profits is now diminished. This is seen from the first terms of (27). The critical level of $s$ leading to zero capital input taxes is now given by $s_i^+ = (1-2\beta_i)/(2-2\beta_i)$, and it will differ between the two sets of firms to the extent that the domestic ownership shares differ. Thus, an additional factor now affects the differential taxation of low-cost and high-cost firms. For example, if home ownership is larger in the nationally operating high-cost firms ($\beta_H > \beta_L$), then this will add an argument to tax-discriminate in favor of high-cost firms.

As long as $\beta_i < 1$, however, the basic tax pattern established in the previous section remains valid. In particular, at given levels of $\beta_i$, a fall in the profit shifting costs $s$ will tend to increase capital input taxes (or reduce capital input subsidies) for both firm types. Moreover, the tax increase will still be more pronounced for the low-cost firms, due to the stronger incentive to tax the remaining share of foreign-earned income by means of a higher capital input tax.

**Bertrand competition with heterogeneous goods.** In the model presented so far, firms compete over quantities and produce a homogeneous good. An alternative model of an imperfectly competitive industry considers firms that compete over prices while producing heterogeneous, but substitutable, goods.[16] Here, we will briefly summarize the results of this alternative market structure. For clarity we look at only two firms, which differ in both their productivity and in the good they produce. We assume that a firm with input cost $c_i$ produces good $x_i$. Again, we normalize the input cost levels so that $c_L = 1$ and $c_H = 1 + \Delta$.

[16] In a Bertrand model with homogenous goods, only the low-cost firms would produce. Price competition among them would bring prices down to their marginal cost $r$, whenever $n_L \geq 2$. Bertrand competition in homogeneous goods thus eliminates the policy trade-off that is at the heart of our model by ruling out the - empirically observed - concurrent production of firms with different cost levels.

As in our benchmark model [eq. (1)], preferences over the imperfectly substitutable goods are represented by a quadratic, quasi-linear utility function (Singh and Vives, 1984)

$$U = a(x_L + x_H) - \frac{b}{2}(x_L^2 + x_H^2) - \gamma x_L x_H + Y^D, \qquad 0 < \gamma < b, \tag{28}$$

where $(\beta/\gamma)$ measures the degree of heterogeneity between the two goods. Given these preferences, firm $i$ faces an inverse demand curve $p_i = a - bx_i - \gamma x_j$ and sets its profit-maximizing prices accordingly.

Anticipating firm behavior, the government determines its tax policy. The feasible profit tax rate is again limited by international tax competition and is set according to (18). Optimal capital input are equal to[17]

$$\tau_L = \left(\frac{1}{2} - s\right) \frac{2(b^2 - \gamma^2)x_L^*}{br}, \qquad \tau_H = \left(\frac{1}{2} - s\right) \frac{2(b^2 - \gamma^2)x_H^*}{b(1+\Delta)r}, \tag{29}$$

with equilibrium output levels of each firm given by

$$x_L^* = \frac{(b-\gamma)(a-r)\left[(b+y)(1-s) + b/2\right] + \gamma r \Delta b/2}{2(b^2-\gamma^2)\left[(b+\gamma)(1-s)+b/2\right]\left[b(3/2-s) - \gamma(1-s)\right]} b,$$

$$x_H^* = \frac{(b-\gamma)(a-r)\left[(b+\gamma)(1-s) + b/2\right] - \left[b^2(3/2-s) - \gamma^2(1-s)\right] r\Delta}{2(b^2-\gamma^2)\left[(b+\gamma)(1-s)+b/2\right]\left[b(3/2-s) - \gamma(1-s)\right]} b.$$

Comparing (29) with (20) shows that the pattern of capital input taxation is unchanged from our benchmark model, and optimal tax rates depend again on the degree of international tax competition. If tax competition is moderate and profit taxation at relatively high rates is feasible ($t = s > 1/2$), the motive to expand output dominates in the setting of optimal capital input taxes and the low-cost firm receives the higher subsidy. In contrast, when tax competition is aggressive and feasible profit tax rates are low ($t = s < 1/2$), the low-cost firm's larger tax base leads to it being taxed more heavily by the capital input tax. The basic trade-off for tax policy that determines the optimal differentiation of capital input taxes is thus the same under quantity and under price competition of the heterogeneous firms.[18]

[17] For a complete derivation see Appendix 3.

[18] Note that the *level* of capital input taxes and subsidies falls in (29) when the substitutability of goods is increased (i.e., $\gamma$ rises, but remains below $b$). This is because a higher substitutability of goods under price competition leads to higher output and lower profits for both firms; hence the motives to expand output and to tax foreign-owned profits simultaneously decline.

**Additional policy instruments and partial profit shifting.** Another extension arises when the small country's government has an additional policy instrument at its disposal to influence the profit shifting costs $s$. It is straightforward to infer from (23) that maximized utility in our benchmark case is unambiguously rising in $s$. Therefore, the small country has an incentive to engage in costly measures that increase $s$ and thus reduce tax avoidance via profit shifting. This extension is particularly relevant in settings where partial profit shifting by the low-cost, multinational firms is allowed. If measures to control profit shifting impose convex costs, the small country will only invest in this activity until the marginal gains from reduced profit shifting equal the marginal cost of the avoidance measure (Cremer and Gahvari, 2000; Johannesen, 2012).[19] Therefore, a fall in $s$ induced by economic integration will not be fully offset in the small country's policy optimum and the equilibrium level of the profit tax rate will still decline. Consequently, the basic effects on the choice of optimally differentiated input taxes $\tau_i$ will remain intact in such an extended framework. The difficulty that arises from this model extension is that all policy choices become interdependent when partial profit shifting by the low-cost firms is incorporated.

# 6 Conclusion

There is conclusive evidence that large, multinational firms are more productive, on average, than their smaller, domestic counterparts. In this article we have asked whether countries should therefore tax firms with different productivity levels at different effective tax rates to shift production towards the most productive businesses. Our analysis has shown that the motivation to tax discriminate according to productivity levels depends critically on the statutory corporate tax rate that is feasible in the presence of competition from an outside tax haven. When tax competition from the haven is moderate, then it is indeed optimal for the small country to introduce tax preferences for the larger, multinational firms, as this policy increases aggregate profits which can then be taxed to a sufficiently high degree. When competition from the tax haven becomes more aggressive, however, then the tax preferences for large firms are gradually

[19] In Cremer and Gahvari (2000) the costs are resources that have to be spent in order to limit tax avoidance. In Johannesen (2012) the costs are instead given by lost advantages of economic integration which arise when the home country taxes all cross-border interest income as a means to reduce profit shifting into tax havens.

reduced and eventually turned around. It then becomes profitable for the small country to impose the heavier tax on the low-cost, multinational firms as a means to indirectly capture the rents accruing to foreign-based owners of the firms, despite the aggregate productivity losses that this policy entails.

The model presented in this paper thus offers an explanation for existing trends to reduce tax advantages for highly productive, multinational firms vis-à-vis their less productive national competitors. We show that this can be interpreted as an optimal policy response to the need to cut corporate tax rates as a result of tightened international tax competition. In addition to the evidence presented in the introduction, there are other recent developments that point in the same direction. One is the overall broadening of corporate tax bases, which has been accompanied by a proliferation of special incentive schemes and tax deductions for small businesses (see OECD, 2010 and Mirrlees et al., 2011). The net effect of these changes is to increase the relative taxation of large firms. A different example is the increasing focus on tough regulation and competition in network utility markets, which reduce the pre-tax profits of privatized incumbents that in many cases are multinational firms.

These trends are noteworthy because they counteract the general tendency to favor internationally mobile over internationally immobile firms and activities. While the latter trend continues to be an important one, we have argued in this paper that differences in productivity and profitability across firms may be a complementary, and perhaps equally important, determinant of corporate tax policy.

Our analysis has been held deliberately simple, and it can be extended in several directions. It is conceptually straightforward (but computationally non-trivial) to add a foreign investment opportunity for the low-cost multinational firms, thus combining firm heterogeneity with respect to both mobility and productivity in a single, unified setting. Another interesting extension would be to endogenize the cost differentials between different firms, for example by modelling different internal labor markets within large and small firms (Oi and Idson, 1999), or by incorporating $R\&D$ choices in a heterogeneous firms' framework (Long et al., 2011). Finally, from an empirical perspective, it would be highly desirable to subject our main hypothesis to a rigorous econometric test, linking quantifiable indicators of tax advantages for highly productive, multinational firms to the development of statutory corporate tax rates.

# Appendix

## Appendix 1: The critical cost gap $\Delta$

This appendix derives an upper bound on the cost gap $\Delta$, which ensures that high-cost firms will find it profitable to enter the market for good $X$ in the absence of government intervention. For market entry by high-cost firms to occur, a necessary condition is that the market price that results from the supply of the low-cost firms alone exceeds the unit production costs of high-cost suppliers.

The inverse demand function when only low-cost firms produce is given by $p = a - bn_L x_L$. Standard profit maximization by oligopolists with the low cost level $r$ results in an output per low-cost firm of $x_L = (a-r)/[b(n_L+1)]$ and a resulting market price of $p = (a + n_L r)/(n_L + 1)$. This price exceeds the unit production costs $(1+\Delta)r$ of high-cost firms if and only if

$$\Delta < \bar{\Delta} = \frac{a-r}{(n_L+1)r}. \tag{A.1}$$

The condition derived in (A.1) is thus a necessary condition for high-cost firms to enter the market.[20]

## Appendix 2: A regime with complete profit shifting by MNEs

This appendix explores the outcomes if the small country sets its tax rate above $s$, thus accepting that MNEs shift their profits abroad. In this case the low-cost firms will set $\alpha^* = 1$ from (17) and not declare any profits in the small country. Once the threshold $t = s$ is surpassed, the small country's objective function is unambiguously rising in $t$ as profits are – from the small country's point of view – lost to foreign shareholders. Therefore the small country will tax the high-cost firms at the maximum rate, $\hat{t} = 1$, where the 'hat' denotes the regime with complete profit shifting by MNEs. Tax revenues in the small country are then given by

$$\hat{T} = n_H b \hat{x}_H^2 + \hat{\tau}_L n_L \hat{x}_L r + \hat{\tau}_H n_H \hat{x}_H (1+\Delta) r. \tag{A.2}$$

[20] Our treatment leaves out the possibility that low-cost firms collude and engage in predatory pricing to keep the high-cost firms out of the market. If this possibility is incorporated, the cost differential must be smaller than in (A.1) to ensure that high-cost firms will produce in equilibrium.

Optimal capital input taxes are derived by inserting (A.2) and firm's optimal quantities (9a)–(9b) in (1) and maximizing the resulting indirect utility function $\hat{V}$. This yields

$$\hat{\tau}_L = \frac{\Delta}{2}, \qquad \hat{\tau}_H = -\left\{ \frac{2[a-(1+\Delta)r] - n_L \Delta r}{2[n_H(1+\Delta)r]} \right\}. \tag{A.3}$$

As the low-cost firms now shift their profits abroad, the small country taxes their capital inputs instead. This enables it to capture some of the rents arising from the MNEs' productivity advantage. In contrast, capital inputs of high-cost, domestic firms are subsidized. The subsidy to high-cost firms increases aggregate output in the $X$ sector while the increased profits of high-cost firms are fully taxed away by the corporate profit tax $\hat{t}$.

The consumer's indirect utility in the case with complete profit shifting is derived by inserting (A.3) and the resulting optimized output levels (9a)–(9b) in (1). This gives

$$\hat{V} = \frac{2\left[a-(1+\Delta)r\right]^2 + n_L \Delta^2 r^2}{4b} + rK \equiv \frac{\Theta}{4b} + rK. \tag{A.4}$$

The corresponding value of indirect utility in the benchmark case without profit shifting is given in (23). Introducing $\Lambda \equiv n(a-r)^2 - 2n_H r\Delta(a-r) + n_H \Delta^2 r^2$, this can be written as

$$V^* = \frac{2(1-s)\Lambda + n_L n_H \Delta^2 r^2}{4b\left[2(1-s) + n_L + n_H\right](1-s)} + rK., \tag{A.5}$$

It will be optimal for the small country to prevent profit shifting, and to set its profit tax rate according to (18), if $V^*$ in (A.5) exceeds $\hat{V}$ in (A.4). This condition is:

$$V^* - \hat{V} \quad \propto \quad 2\Lambda + \frac{n_H n_L r^2 \Delta^2}{(1-s)} - [2(1-s) + n_H + n_L]\Theta > 0, \tag{A.6}$$

where $\Theta > 0$ and $\Lambda > 0$ are defined above. It is then straightforward to see that (A.6) is the more likely to be fulfilled, the lower is economic integration (the higher is $s$) and hence the higher is the feasible profit tax rate $t^*$ in the equilibrium without profit shifting. Moreover, (A.6) is more likely to be fulfilled when $\Delta$ is high so that the productivity difference between multinational and national firms is large. In this case, the low-cost multinational firms produce a large fraction of total output, thus making it more costly to forego the profit taxation of these firms in the high-tax ('hat') regime.

## Appendix 3: Bertrand competition with heterogeneous goods

This appendix derives optimal capital input taxes when two firms compete over prices and goods are heterogeneous. Preferences are given by a quadratic, quasi-linear utility

function [eq. (28)] in which two goods $(x_L, x_H)$ enter as imperfect substitutes. Consumer optimization leads to the following demand functions for the goods produced by the low-cost and the high-cost firm:

$$\begin{aligned} x_L &= \frac{a}{(b+\gamma)} - \frac{b}{(b^2-\gamma^2)}\, p_L + \frac{\gamma}{(b^2-\gamma^2)}\, p_H, \\ x_H &= \frac{a}{(b+\gamma)} - \frac{b}{(b^2-\gamma^2)}\, p_H + \frac{\gamma}{(b^2-\gamma^2)}\, p_L. \end{aligned}$$

Taking these demand functions into account, each firm sets its price to maximize profits, which are given by (7a)-(7b). Optimal prices thus are

$$\begin{aligned} p_L &= \frac{(b-\gamma)}{(2b-\gamma)}\, a - \frac{b}{(4b^2-\gamma^2)} \left[2b\,(1+\tau_L)\, r + (1+\tau_H)\,(1+\Delta)\, r\gamma\right], \\ p_H &= \frac{(b-\gamma)}{(2b-\gamma)}\, a - \frac{b}{(4b^2-\gamma^2)} \left[2b\,(1+\tau_H)\,(1+\Delta)\, r + (1+\tau_L)\, r\gamma\right]. \end{aligned}$$

The corresponding equilibrium quantities are

$$x_L = \frac{a(b-\gamma)(2b+\gamma) - (2b^2-\gamma^2)(1+\tau_L)r + b\gamma(1+\tau_H)(1+\Delta)r}{(2b^2-\gamma^2)^2 - b^2\gamma^2} b, \quad \text{(A.7)}$$

$$x_H = \frac{a(b-\gamma)(2b+\gamma) - (2b^2-\gamma^2)(1+\tau_H)(1+\Delta)r + b\gamma(1+\tau_L)r}{(2b^2-\gamma^2)^2 - b^2\gamma^2} b. \quad \text{(A.8)}$$

Maximizing the utility function (28) after inserting (A.7)-(A.8) yields the welfare maximizing capital input taxes, which are given by (29).

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