Article

Public Finance Review
1-26

DOI: 10.1177/1091142117729434
journals.sagepub.com/home/pfr

Equilibria and Location Choice in Corporate Tax Regimes

Ben J. Niu[1]

Abstract

This article considers the impact of preferential, base-specific taxation on equilibrium revenues. While policy makers have argued that it generates a prisoner's dilemma result, there is mixed support in the academic literature. Using a more plausible model with asymmetric base elasticities and heterogeneity of both firms and countries, I find that preferential taxation can generate greater revenues if countries exhibit sufficient productivity and/or population asymmetry. It is also less distortionary except in cases where moving costs are fully deductible. Allowing for noncorrelated, cross-country profits is the key factor as it generates base expansion effects.

Keywords

tax competition, preferential taxation, international, corporate taxation

[1]Department of Economics, St. John Fisher College, Rochester, NY, USA

Corresponding Author:
Ben J. Niu, Department of Economics, St. John Fisher College, Kearney Hall RM415, Rochester, NY 14618, USA.
Email: bniu129@gmail.com

Continued globalization has increased the mobility of economic factors. This has generated both the need and ability to attract new, outside bases for governments. One particular policy is the usage of a preferential tax regime. Whereas a nonpreferential regime imposes a uniform tax rate on all its firms, a preferential regime allows for base discrimination. In particular, foreign firms and capital are granted lower statutory rates than their domestic counterparts. For example, the Irish Finance Act of 1980 lowered the corporate income tax rate from 32 percent to 10 percent for manufacturing-related sectors. These preferential rates were extended in 1987 to other sectors, such as technology and finance, because of their strong ties to foreign firms and investment.[1]

Despite Ireland's success, the European Union (EU) and Organization for Economic Cooperation and Development are against preferential taxation and have moved to ban such practices. The fear is that decoupling the bases will generate a race to the bottom for more mobile firms. Specifically, policy makers view this as a prisoner's dilemma scenario. Unilaterally, each country can generate weakly greater tax revenue by switching to the preferential regime, as it is simply a less constrained version (Janeba and Peters 1999). This targeted taxation produces a positive, differentiation effect. However, the concern lies over the resulting equilibrium revenues when *all* countries adopt the preferential regime. If everyone engages in base discrimination, there is a concurrent and negative strategic effect because of increased tax competition. Thus, the net impact depends on the relative strengths of these two effects.

The economic literature lacks a strong consensus because differences in the modeling assumptions affect this balance. Janeba and Peters (1999) analyzed a two country model where they compete over a shared, mobile base. They found that preferential taxation is harmful because it heavily depresses revenues from the mobile base. Conversely, Keen (2001) found that the opposite was true in a model with two shared bases. Intuitively, the preferential regime focuses the harmful effects of tax competition on the relatively mobile base while shielding the more immobile base. Janeba and Smart (2003) rebutted this finding by arguing that the Keen (2001) result was a special case when aggregate bases are fixed. Other papers, such as Haupt and Peters (2005), Burbidge, Cuff, and Leach (2006), Bucovetsky and Haufler (2007), and Mongrain and Wilson (2017), have furthered this debate by considering the additional factors of home bias, country asymmetry, and heterogeneous moving costs, respectively.[2]

This article contributes to the literature by considering a more plausible model that incorporates two major differences. First, base elasticities are

assumed to be asymmetric. With previous papers such as Janeba and Smart (2003), bases are free-floating and exist internationally. An inelastic (elastic) base is therefore inelastic (elastic) for all competing countries. This symmetric elasticities assumption has typically been used to model internationally mobile capital. Conversely, the asymmetric elasticities assumption is more appropriate when modeling firm behavior. Because they tend to have a geographic anchor, that is, firms consider some country "home," this shifts the nature of competition as shown in figure 1. Country A's domestic base is now simultaneously Country B's (potential) foreign base. With moving costs, each base is relatively inelastic from the perspective of the domestic country but relatively elastic from the perspective of the foreign country. Furthermore, empirical work detailing a "home bias" in investment locations suggests that asymmetry is appropriate even in the case of capital.[3]

Second, the model incorporates heterogeneity of firms both within and across countries. Importantly, the latter introduces noncorrelated, cross-country profits; that is, firms vary in their potential profitability abroad. This heterogeneity in (gross) profits reflects firm-specific productivity differences that may arise because of geographic market factors, for example, oil refineries locating near oil fields. Noncorrelated profits also allow for natural, tax-free movement. With most previous models, switching is inefficient because they are driven solely by tax savings. In this model, movement also allows for firms to re-sort along productivity gradients. Moreover, movement is bidirectional even in cases of identical countries. As such, the model generates positive, aggregate base effects in the form of a *base expansion effect*.[4]

The remainder of this article proceeds as follows. The second section outlines the analytical model, its limitations, and the numerical model. The third section presents the two main results. The preferential regime tends to generate lower equilibrium revenues when competing countries are very similar, but higher revenues when they are sufficiently asymmetric in regard to productivity and/or population. Greater country-level differences mitigate the negative impact of the strategic effect by decreasing the proportion of marginal, tax-sensitive firms. Countries have less incentive to engage in tax competition. This is further aided by the base expansion effect. Relatedly, the preferential regime is also less distortionary in regard to natural firm movement. This generates larger, aggregate firm profits. The preferential regime only becomes more distortionary when moving cost deductibility is added to the model. Specifically, high deductibility now causes excess movement. The fourth section relates this model to the previous literature with the discussion in the fifth section.

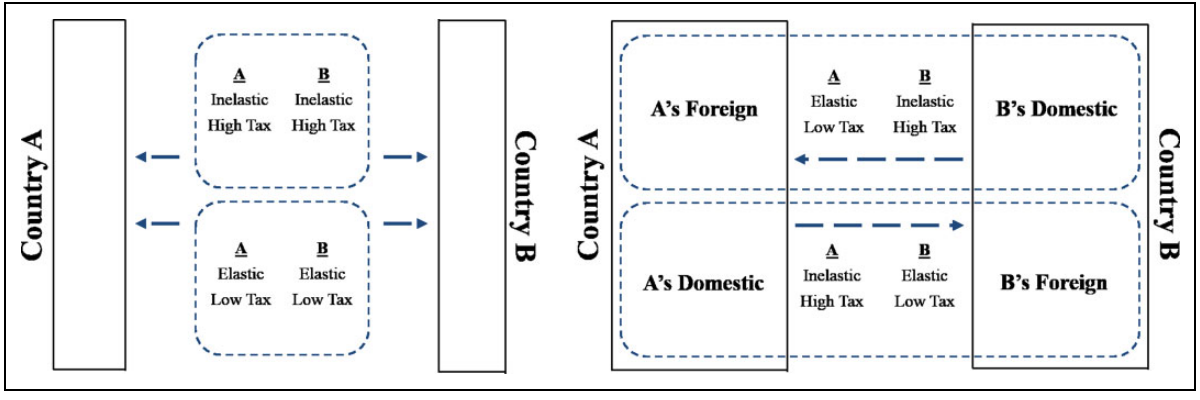

Figure 1. Symmetric (left) versus asymmetric (right) elasticities.

Model

Basic Structure

Assume that countries A and B are playing a single period, simultaneous Nash game in corporate tax rates. Timing in the model is as follows. Each country is first endowed with a continuum of mass N_A and N_B firms, respectively. This stock constitutes the domestic bases for A and B. Each firm then receives its profit pair (π_A, π_B). A firm characterized by a draw of (0.5, 0.8), for example, stands to generate 0.5 in *gross, pretax* profits if they locate in A or 0.8 if they locate in B. Profit pairs follow a bivariate uniform distribution with support $\pi_A \in [0, \bar{\pi}_A]$ and $\pi_B \in [0, \bar{\pi}_B]$. The density function is given by $f(\pi_A, \pi_B) = \frac{1}{\bar{\pi}_A \bar{\pi}_B}$.[5] This distribution generates both within- and cross-country heterogeneity of firms.

Knowing only the distribution, the two countries simultaneously set their domestic and foreign tax rates, t and T, to maximize tax revenues.[6] Country A's domestic rate, t_A, applies to its domestic firms (those originally from A that remain in A), whereas its foreign rate, T_A, applies to foreign firms (those originally from B that move into A). The analogous is true for B's tax rates. Firms then make their location choices under full information. For a firm originally in A, they will switch if net profit is higher in B. This is shown in equation (1), where c denotes a positive moving cost. The inclusion of c is crucial to the model because it differentiates the domestic and foreign base elasticities. If firms are perfectly mobile, regime choice becomes redundant as equilibria in the two regimes would be identical.[7] Finally, profits are realized and tax revenues are collected.

$$\overbrace{\underbrace{\pi_B}_{\text{profit in B}} - \underbrace{T_B\pi_B}_{\text{tax payment in B}} - \underbrace{c}_{\text{moving cost}}}^{\text{Net Profit: Move to Country B}} > \overbrace{\underbrace{\pi_A}_{\text{profit in A}} - \underbrace{t_A\pi_A}_{\text{tax payment in A}}}^{\text{Net Profit: Stay in Country A}}. \quad (1)$$

Firm Movement

Profit homogeneity is the common assumption in most previous papers. As such, firms only moved to take advantage of tax differences. Comparatively, movement is novel in this model because it occurs naturally in the absence of taxes. The noncorrelated, cross-country profits imply that firms can also move to take advantage of greater productivity. Moreover, movement is bidirectional even in the case of symmetric countries. This contrasts with models of asymmetric productivity, for example, Marceau, Mongrain,

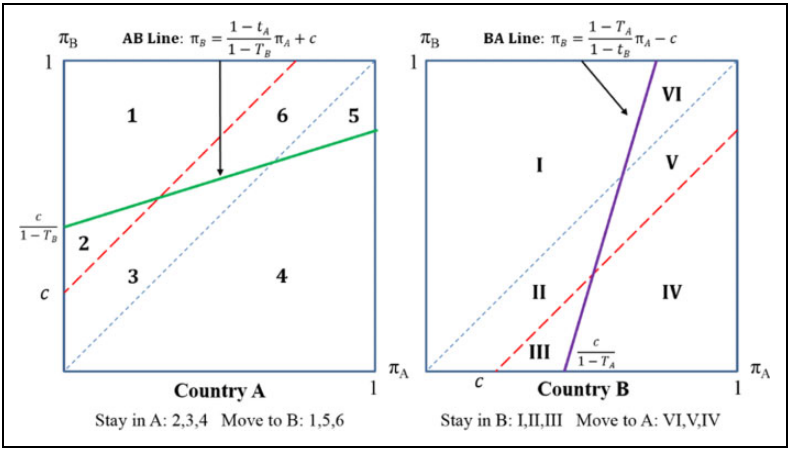

Figure 2. Distribution of firms: $(\bar{\pi}_A, \bar{\pi}_B, N_A, N_B, c) = (1, 1, ?, ?, c)$.

and Wilson (2010), where movement is unidirectional from the less to the more productive country. The symmetric case is shown in figure 2. Firms on the 45° line are equally profitable at home or abroad. Those to the left (right) are less (more) profitable in A. This reflects differences in the geographic availability of inputs as in the case of hydroelectricity generation. It can also reflect regional differences in demand as in the case of vegemite. Absent any barriers, firms located to the right of the lines will stay in (move to) A while those to the left move to (stay in) B. With positive moving costs, movement is now inhibited in areas 3, 6, II, and V.

The introduction of taxes is depicted by the solid AB and BA moving lines. For an arbitrary set of rates, areas 5 and 6 (VI and V) highlight new, tax-induced firm movement from A to B (B to A). Conversely, areas 2 and III highlight those firms that are no longer moving. Competition therefore focuses primarily on those firms located close to the 45° line. Because of their smaller cross-country profit gradients, these elastic firms are the main targets of tax competition. Conversely, the more inelastic firms are located in the northwest and southeast corners. Given their relatively high profit gradients, tax differences are unlikely to alter the location choice decision. As such, these firms represent the cores for B and A, respectively.

Country Parameters

At the country level, the model also accounts for differences in productivity and population. Country-level *productivity* or profitability can be captured

by varying the supports of the profit distribution, $\bar{\pi}_A$ and $\bar{\pi}_B$. Consider the $(\bar{\pi}_A, \bar{\pi}_B) = (2, 1)$ scenario. For every firm in B, there is a corresponding firm in A that generates twice as much profit. As a whole, A is twice as productive as B. Under more general cases of asymmetry, this implies that firms in A are $\frac{\bar{\pi}_A}{\bar{\pi}_B}$ proportionally more profitable. This is equivalent to having a country-level, profit multiplier.[8] Graphically, changing the productivity stretches the square distribution in figure 2.

Analogously, country-level *population* is given by the N_A and N_B terms. Note that population refers to the number of firms, not the number of people. Because the continua are of mass one, the N terms act as multipliers. A larger, more populous country therefore has a larger stock of original firms. As with country-level productivity, symmetric population refers to the case of $(N_A, N_B) = (1, 1)$ with asymmetric cases captured by varying $N_A > 1$. Population does not affect the distribution of firms, so it does not change the graphical representation in figure 2.

Government's Problem

$$\begin{aligned}\text{Total revenue } (TotRev_A) = \text{domestic revenue } (DomRev_A) \\ + \text{ foreign revenue } (ForRev_A).\end{aligned} \tag{2}$$

Governments are assumed to be tax revenue maximizers. This simplifies the calculations but also provides for a more straightforward analysis because of the variability of social welfare functions. Moreover, revenue maximization is likely to be the actual goal for governments. Consider A's revenue functions: total revenue in equation (2) is broken down into domestic revenue from firms that remain in A and foreign revenue from firms that switch from B. Tax competition occurs in the setting of A's domestic rate versus B's foreign rate (t_A and T_B) and A's foreign rate versus B's domestic rate (T_A and t_B). Under the preferential regime, maximizing total revenue is equivalent to separately maximizing domestic and foreign revenues.

$$\begin{aligned}DomRev1 = N_A \int_0^{\bar{\pi}_A} \bar{\pi}_B(t_A\pi_A)\left(\frac{1}{\bar{\pi}_A\bar{\pi}_B}\right)d\pi_A - N_A \int_0^{\bar{\pi}_A} \left(\bar{\pi}_B - \frac{(1-t_A)\pi_A + c}{1-T_B}\right) \\ (t_A\pi_A)\left(\frac{1}{\bar{\pi}_A\bar{\pi}_B}\right)d\pi_A \text{ if } \frac{(1-T_B)\bar{\pi}_B - c}{1-t_A} > \bar{\pi}_A,\end{aligned} \tag{3}$$

$$DomRev2 = N_A \int_0^{\bar{\pi}_A} \bar{\pi}_B(t_A\pi_A)\left(\frac{1}{\bar{\pi}_A\bar{\pi}_B}\right)d\pi_A - N_A \int_0^{\frac{(1-T_B)\bar{\pi}_B - c}{1-t_A}} \left(\bar{\pi}_B - \frac{(1-t_A)\pi_A + c}{1-T_B}\right) (t_A\pi_A)\left(\frac{1}{\bar{\pi}_A\bar{\pi}_B}\right)d\pi_A \text{ if } \frac{(1-T_B)\bar{\pi}_B - c}{1-t_A} \leq \bar{\pi}_A, \tag{4}$$

$$ForRev1 = N_B \int_{\frac{c}{1-T_A}}^{\bar{\pi}_A} \left(\frac{(1-T_A)\pi_A + c}{1-t_B}\right)(T_A\pi_A)\left(\frac{1}{\bar{\pi}_A\bar{\pi}_B}\right)d\pi_A \text{ if } \frac{(1-t_B)\bar{\pi}_B + c}{1-T_A} > \bar{\pi}_A, \tag{5}$$

$$ForRev2 = N_B \int_{\frac{c}{1-T_A}}^{\frac{(1-t_B)\bar{\pi}_B + c}{1-T_A}} \left(\frac{(1-T_A)\pi_A + c}{1-t_B}\right)(T_A\pi_A)\left(\frac{1}{\bar{\pi}_A\bar{\pi}_B}\right)d\pi_A + N_B \int_{\frac{(1-t_B)\bar{\pi}_B + c}{1-T_A}}^{\bar{\pi}_A} (\bar{\pi}_B)(T_A\pi_A)\left(\frac{1}{\bar{\pi}_A\bar{\pi}_B}\right)d\pi_A \text{ if } \frac{(1-t_B)\bar{\pi}_B + c}{1-T_A} \leq \bar{\pi}_A. \tag{6}$$

Domestic (*DomRev*) and foreign (*ForRev*) revenue, given by equations (3) to (6), are calculated by integrating over the relevant regions from figure 2. Because the AB and BA moving lines can intersect to either side of the corner, this generates four possible cases. For the AB line, a relatively low foreign rate from B pushes the intersection to the right. This causes A's corner firm to exit (*DomRev1*). Conversely, a relatively high foreign rate shifts it to the left. A's corner firm now stays in A (*DomRev2*). Similarly, a relatively low domestic rate for B pushes the BA line intersection to the right. B's corner firm chooses to stay in B (*ForRev1*). Conversely, a high domestic rate pushes it to the left and causes B's corner firm to exit (*ForRev2*). These four functions capture revenues under the preferential regime.[9]

$$\begin{aligned} TotRev1 &= DomRev1 + ForRev1 \quad \text{if } \frac{(1-\tau_B)\bar{\pi}_B - c}{1-\tau_A} > \bar{\pi}_A \text{ and } \frac{(1-\tau_B)\bar{\pi}_B + c}{1-\tau_A} > \bar{\pi}_A \\ TotRev2 &= DomRev2 + ForRev1 \quad \text{if } \frac{(1-\tau_B)\bar{\pi}_B - c}{1-\tau_A} \leq \bar{\pi}_A \text{ and } \frac{(1-\tau_B)\bar{\pi}_B + c}{1-\tau_A} > \bar{\pi}_A \\ TotRev3 &= DomRev2 + ForRev2 \quad \text{if } \frac{(1-\tau_B)\bar{\pi}_B - c}{1-\tau_A} \leq \bar{\pi}_A \text{ and } \frac{(1-\tau_B)\bar{\pi}_B + c}{1-\tau_A} \leq \bar{\pi}_A \end{aligned} \tag{7}$$

Under the nonpreferential regime, the domestic and foreign functions are given by the same expressions. However, the base-specific rates are replaced by the uniform rates: $t_A = T_A \equiv \tau_A$ and $t_B = T_B \equiv \tau_B$. Correspondingly, Country A must maximize total revenue (*TotRev*) as a combined function. This reduces the four preferential cases to the three nonpreferential cases shown in equation (7). These correspond to the *DomRev1*/*ForRev1*, *DomRev2*/*ForRev1*, and *DomRev2*/*ForRev2* cases, respectively.

Numerical Modeling Parameters

First-order conditions, shown in the Online Appendix, highlight the analytical limitations of the model. With the exception of the *DomRev1* case, the optimal rates are all characterized by cubic or quartic root functions. This intractability is a common issue in the literature and a major reason why previous papers have focused on simplified models. Keen (2001) assumes that the bases depend only on the rate differentials. Janeba and Smart (2003) fix the differential to equal a constant.[10] Both methods generate tractability by reducing the number of choice variables, but at the cost of more general applicability.

Conversely, this model is solved numerically. Tax rates are bounded between 0 and 1 in discrete increments of 0.001 (0.1 percent). Given the previously defined functions, MATLAB (R2011a) is used to calculate revenues and best responses under different combinations of rates.[11] Intersections in these best responses matrices therefore identify the pure strategy equilibria under the two regimes. Although more efficient methods exist, the thorough approach is more appropriate as corner solutions and multiple equilibria are common concerns in these tax competition models.[12]

Equilibria are derived for various cases. In the main simulations, productivity asymmetry is modeled for $\bar{\pi}_A \in [1, 100]$ and $\bar{\pi}_B = 1$. Likewise, population asymmetry is modeled for $N_A \in [1, 100]$ and $N_B = 1$. Moving costs are varied for $c \in [0, 0.3]$. Although positive costs are crucial, the impact of varying costs is not a point of focus in the analysis. The basic model is also expanded to include moving cost deductibility. This becomes relevant for the location choice analysis. Let α denote the proportion of c that firms can deduct. This decreases taxable liabilities in equation (1) from $T_B\pi_B$ to $T_B(\pi_B - \alpha c)$ and has a corresponding effect in the revenue functions (Online Appendix). Deductibility is varied for $\alpha \in [0, 1]$, with the zero deductibility case being the baseline model.

Results

Result 1: Revenue Dominance

Result 1: The preferential regime tends to be revenue dominant when countries are sufficiently asymmetric in regard to productivity or population. This result is strengthened when productivity asymmetry runs counter to population asymmetry but is weakened when the two coincide.

The general intuition for Result 1 can be captured by the three revenue effects. The *differentiation effect* works in favor of the preferential regime. Decoupling the bases implies that the domestic (foreign) rates are generally higher (lower) than the uniform rates. This separation is preferable to a single tax rate that must trade-off between domestic and foreign considerations. In equilibrium, however, lower foreign rates pull down the competing domestic rates for both countries. Greater tax competition depressed rates and revenues. Thus, the *strategic (interaction) effect* works against the preferential regime. The third effect arises due to the noncorrelated, cross-country profits. Because of the profit differentials, incoming firms tend to be more profitable than exiting firms. Thus, the increase to the foreign base is typically greater than the decrease to the domestic base; that is, movement increases the aggregate tax bases. The *base expansion effect* therefore favors the preferential regime because it allows for greater firm movement.

The net revenue effect depends on the sum of these three individual effects. When countries are relatively similar, the nonpreferential regime is revenue dominant because the strategic effect dominates. As expected, competition is more intense between similar countries. Under asymmetry, the strategic effect decreases relative to the differentiation and base expansion effects. Higher productivity asymmetry stretches the distribution and decreases the proportion of tax sensitive firms. With less incentive to engage in tax competition, the preferential regime becomes revenue dominant. However, the effect of asymmetry is nonmonotonic. Moreover, including both productivity and population asymmetry can produce opposite results. When the two run counter to each other (more productive and less populous), the preferential regime becomes more revenue dominant. When they run concurrently, the nonpreferential regime is more revenue dominant.

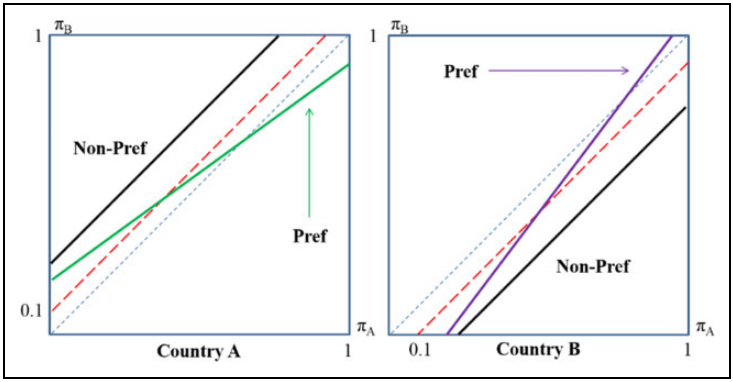

Figure 3. Moving lines: $(\bar{\pi}_A, \bar{\pi}_B, N_A, N_B, c) = (1, 1, 1, 1, 0.1)$.

To quantify the actual differences in equilibrium revenues, define the *revenue gap* for country j as the difference in js equilibrium revenue when both countries are using preferential regimes versus nonpreferential regimes. A positive revenue gap implies that country j does better revenue wise under the preferential regime. Consider the symmetric case depicted in figure 3: $(\bar{\pi}_A, \bar{\pi}_B, N_A, N_B, c) = (1, 1, 1, 1, 0.1)$. Equilibria under the two regimes are given by $(\tau_A, \tau_B) = (0.57, 0.57)$ and $(t_A, T_A, t_B, T_B) = (0.575, 0.455, 0.575, 0.455)$, with resulting revenues of $(TotRev_A^{NP}, TotRev_B^{NP}) = (0.367, 0.367)$ and $(TotRev_A^{P}, TotRev_B^{P}) = (0.3434, 0.3434)$.[13] The revenue gaps of -0.026 imply that the preferential regime generates 7.1 percent less revenue than the nonpreferential regime for each.[14]

Conversely, equilibria under the asymmetric case of $(\bar{\pi}_A, \bar{\pi}_B, N_A, N_B, c) = (2, 1, 1, 1, 0.1)$ are given by $(\tau_A, \tau_B) = (0.66, 0.55)$ and $(t_A, T_A, t_B, T_B) = (0.7, 0.64, 0.575, 0.425)$, with $(TotRev_A^{NP}, TotRev_B^{NP}) = (1.055, 0.246)$ and $(TotRev_A^{P}, TotRev_B^{P}) = (1.08, 0.2538)$. The two positive revenue gaps show that the preferential regime is now revenue dominant for both countries. Figure 4 graphs this positive relationship more generally as productivity asymmetry, $\bar{\pi}_A - \bar{\pi}_B$, increases.[15] With similar countries, the nonpreferential regime is revenue dominant. When asymmetry rises to 30 percent $(\bar{\pi}_A = 1.3)$ and 37 percent $(\bar{\pi}_A = 1.37)$, the two regimes generate the same equilibrium revenues for the more and less productive countries, respectively. Above these levels, the preferential regime becomes revenue dominant. At higher levels of asymmetry, the revenue gap remains positive but the effect is nonmonotonic.

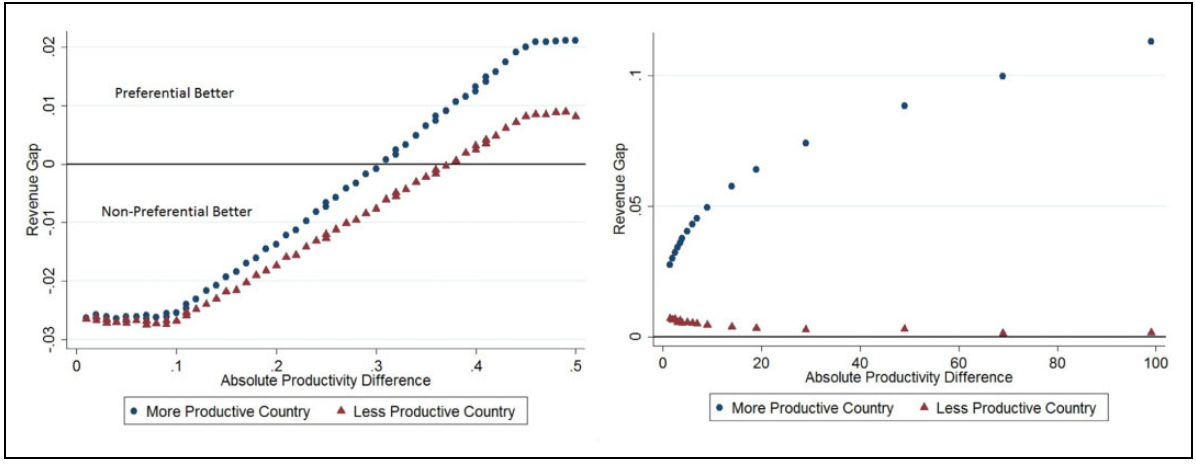

Figure 4. Revenue gap with productivity asymmetry: $(\overline{\pi}_A, \overline{\pi}_B, N_A, N_B, c) = (?, 1, 1, 1, 0.1)$.

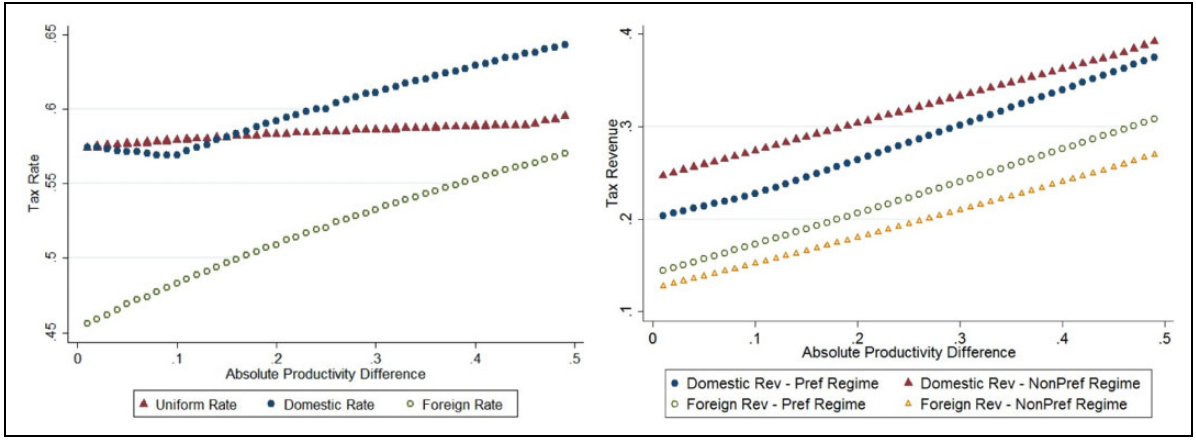

Figure 5. Breakdown of revenues and tax rates (more productive country A).

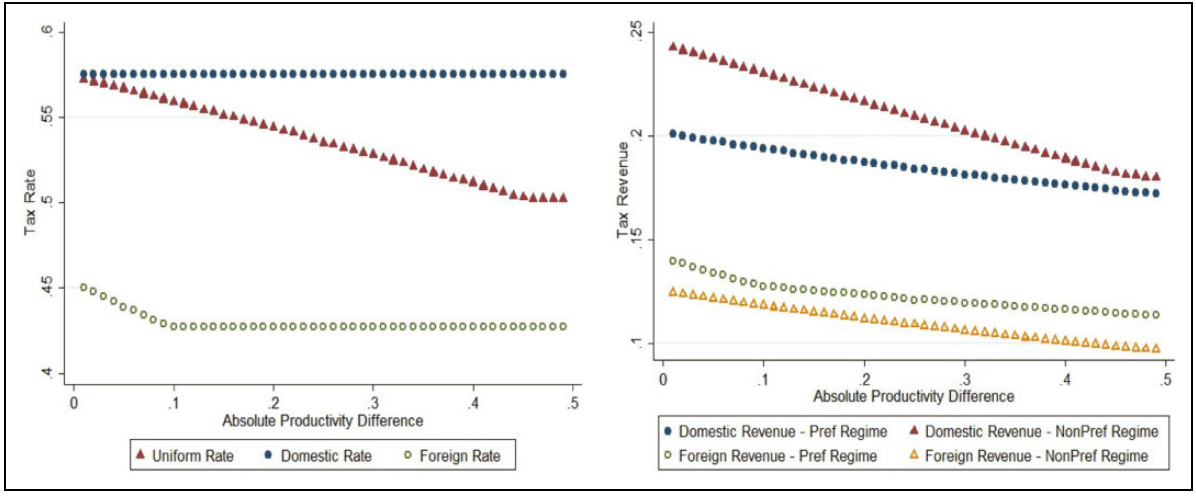

Figure 6. Breakdown of revenues tax rates (less productive country B).

This trend can also be explained by looking at the individual domestic and foreign components. Figures 5 and 6 plot revenues and rates for the more and less productive countries, respectively. Given the base elasticities, the domestic rates are weakly higher than the foreign rates under the preferential regime. Comparatively, the uniform rates sit in between the two, that is, $t \geq \tau \geq T$, because they have to balance both considerations. The larger tax gradient therefore allows for greater firm movement under the preferential regime. It generates relatively less domestic revenue but greater foreign revenue.[16] With symmetric countries, the domestic base is more valuable than the foreign base because of the moving cost. Domestic firms are both easier to tax and larger in aggregate. Because the nonpreferential regime has an advantage in regard to domestic taxation, the revenue gap is negative. With greater asymmetry, A is gaining a competitive advantage such that rates and revenues increase under both regime. This is especially true for the foreign base as evidenced by the shift in the uniform rate. Because it is moving closer to the foreign rate, the uniform rate is effectively decreasing. This is then reflected in the revenue and revenue gap. For B, this same pattern occurs but in the opposite direction. Note that its preferential rates are almost constant. This occurs because B is increasingly forced to focus on its core firms.

A similar pattern also exists with greater population asymmetry. However, there are two differences. First, the effect of population asymmetry is weaker. The revenue gaps change at approximately 300 percent ($N_A = 4$ and $N_B = 1$) and 400 percent ($N_A = 5$ and $N_B = 1$), for the less and more populous countries, respectively. Second, echoing a result found in other papers, the preferential regime tends to favor the smaller country because they benefit more from foreign revenues. Less common, however, is the fact that this model finds that larger countries can also do better.

Finally, when considering both productivity and population asymmetry simultaneously, the model indicates that the preferential regime is revenue dominant when the asymmetries run in opposite directions. The left graph in figure 7 shows the impact of greater productivity asymmetry under the three cases. The higher pair of lines corresponds to the revenue gaps when A is more productive but has fewer firms. The lower pair of lines corresponds to the revenue gap when A is both more productive and more populous. The right graph shows a similar pattern when considering the impact of increasing population asymmetry. However, the trend reverses when productivity and population asymmetry run concurrently. Greater population asymmetry now decreases the revenue gap such that the nonpreferential regime is revenue dominant. Intuitively, there is too strong of

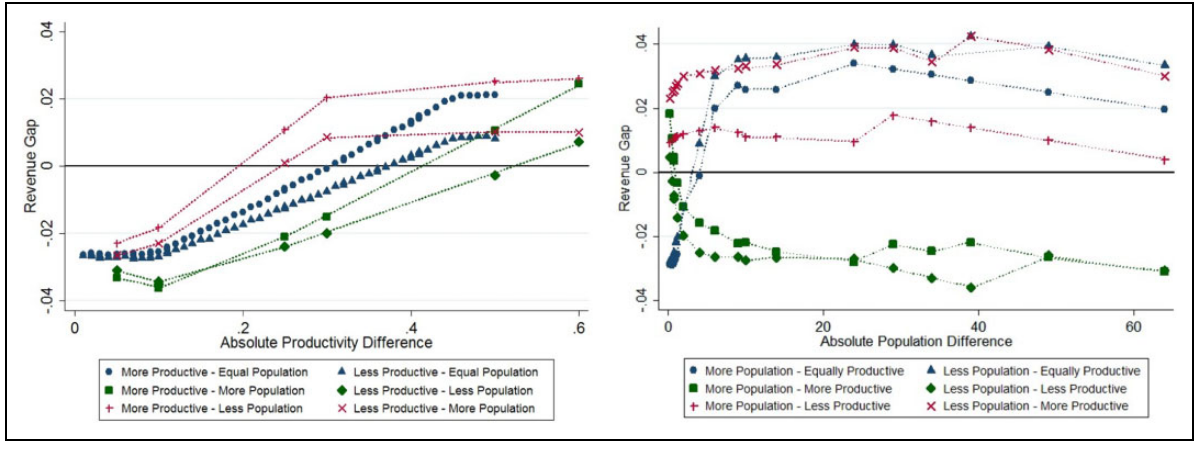

Figure 7. Revenue gap with productivity and population asymmetry.

an incentive to engage in tax competition. Smaller countries with fewer domestic firms always have an incentive to target the foreign base. However, being less productive also means that B must offer an even lower foreign rate to compensate for firms generating lower, gross profits. The strategic effect is magnified in these cases.

Result 2: Distortions to Location Choice

Result 2: The preferential regime is less distortionary in all cases. This only reverses when high degrees of moving cost deductibility are included in the model.

The second result focuses on the impact of taxes on natural firm movement. Figure 2 highlights the four wedges that can be generated when taxes are present. Some firms no longer move even though they would be more productive. Others may move even though they are less productive. In general, the model finds that the preferential regime generates less distortions to firm choice. This produces greater global, aggregate profits. Because of its larger tax differential, more firm movement occurs under the preferential regime. Importantly, this hinders natural movement to a lesser extent; that is, it allows for more productive re-sorting. The result is robust to productivity, population, and moving costs. However, it reverses when moving cost deductibility is introduced. Because firms do not fully internalize the moving cost, the preferential regime now generates excess movement. As such, the nonpreferential regime becomes less distortionary when deductibility exceeds 75 percent.

To quantify the specific distortions to location choice, define the total, net-of-moving cost profit (TNP) as the sum of all firms' gross profits less their moving costs.[17] TNP is maximized in the absence of taxes, as firms will naturally sort themselves according to their profit gradients and the moving cost. Because firm locations can be distorted by taxes, each set of rates generates a resulting TNP loss from this maximum TNP level. Analogous to the revenue gap, the *TNP gap* is therefore the difference in TNP loss between the preferential and nonpreferential equilibrium outcomes. Note that a positive TNP gap now implies that the preferential regime is more distortionary; that is, it results in a higher TNP loss.

Consider the symmetric and asymmetric cases depicted in figures 3 and 8. Both regimes hinder natural firm movement (denoted by the dashed

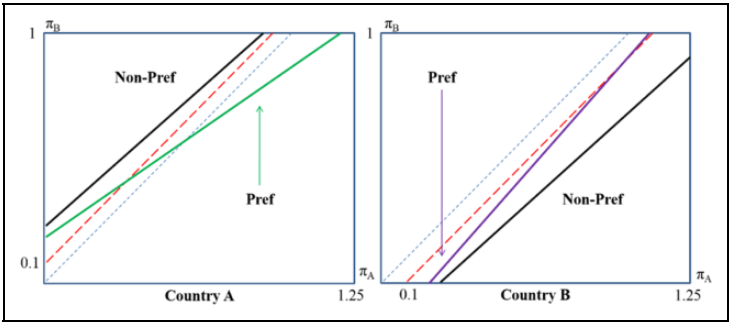

Figure 8. Moving lines: $(\bar{\pi}_A, \bar{\pi}_B, N_A, N_B, c) = (1.25, 1, 1, 1, 0.1)$.

lines). The preferential regime creates moving and nonmoving wedges. Comparatively, the nonpreferential regime creates only nonmoving wedges. However, these nonmoving wedges are much larger. The symmetric case in figure 3 generates TNP losses of 0.01426 (0.00442) under the nonpreferential (preferential) regimes. With a TNP gap of -0.00984, the preferential regime is 69 percent less distortionary. Similarly, the asymmetric case in figure 8 generates TNP losses of 0.01758 and 0.00890, respectively. The TNP gap of -0.00868 implies that the preferential regime is 46 percent less distortionary.[18] More generally, the preferential regime is found to be less distortionary in all cases of symmetry and asymmetry under the baseline model. As such, second welfare theorem-type arguments can be made to relate Results 1 and 2. This assumes that alternative, nondistorting tax instruments (e.g., a general EU tax in the Ireland scenario) can be used to make transfer payments.

This trend persists until moving cost deductibility is added to the base model. Although deductibility has a negligible, negative effect on the revenue gap, it is the most significant factor affecting the TNP gap. Higher deductibility decreases the effective moving cost faced by firms and allows for greater movement under both regimes. As such, the resulting TNP losses are decreasing with α. However, this is particularly true for the nonpreferential regime. When deductibility is greater than 75 percent, the expanded model shows that the nonpreferential regime is now less distortionary in most cases.[19] This occurs because higher deductibility tends to generate excess movement under the preferential regime, as evidenced in figure 9. In comparison to figure 3, figure 9 depicts the symmetric case but now under full deductibility. The equilibrium rates are given by $(\tau_A, \tau_B) = (0.56, 0.56)$ and $(t_A, T_A, t_B, T_B) = (0.545, 0.5, 0.545, 0.5)$.

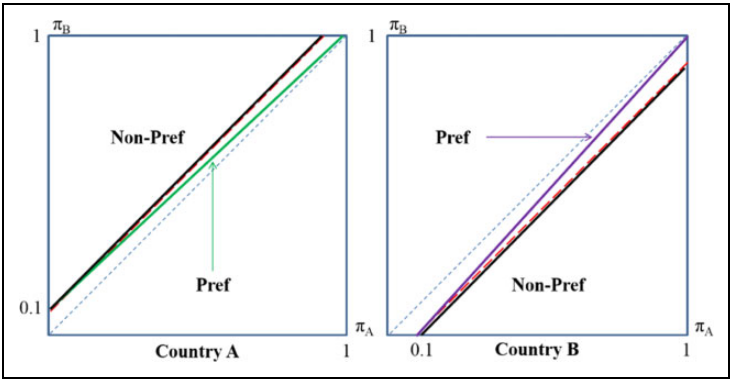

Figure 9. Moving lines: $(\overline{\pi}_A, \overline{\pi}_B, N_A, N_B, c) = (1, 1, 1, 1, 0.1)$ with $\alpha = 1$.

Notice that the nonpreferential moving lines coincide with the dashed, moving cost lines. As such, firm movement is undistorted, and TNP loss is 0. In comparison, moving wedges under the preferential regime indicate that too many firms are moving. With a TNP loss and TNP gap of 0.00237, the nonpreferential regime is now less distortionary.

The implications and importance of Result 2 depend on the nature of profitability in this model. If higher profits are driven by true productivity gains or cost savings, for example, locating near a required natural resource, then TNP loss is a usable proxy for traditional notions of efficiency. However, moving for higher profits can be inefficient if such gains are driven by greater market power. A social welfare function could potentially capture both aspects. In the context of this model, this function would likely be a combined measure of revenue and TNP. This is similar to the objective function used in Mongrain and Wilson (2017). Intuitively, firms contribute to government revenue not only via profit taxes but also indirectly via the income and sales taxes paid by its employees. Moreover, there may be nonrevenue benefits, for example, agglomeration effects, infrastructure development, and education spillovers. If deductibility is low (high), then it is likely that this combined social measure would find more (less) cases in favor of the preferential regime.

Relation to Existing Literature

There are a number of issues that prevent a direct nesting of this model with previous models. First and foremost are the differing base elasticity

assumptions. As highlighted in figure 1, the major separation lies in their effects on the tax rates. With asymmetry, competing rates in each base will always have a high–low, domestic–foreign dynamic. Conversely, symmetry implies that rates, most importantly in the elastic base, tend to coincide. This generates the possibility for a race to the bottom in the symmetric case, but not the asymmetric case. The current model is therefore incomparable with models such as Janeba and Smart (2003) or Marceau, Mongrain, and Wilson (2010), except in the redundant, perfect mobility scenario. Profit heterogeneity in the current model is also problematic, specifically in regard to papers where the base functions depend only on the tax rate differentials, for example, Haupt and Peters (2005). Such an assumption, while generating tractability in previous models, is implausible when firms are different. Tax rate levels matter in the current model because firm incentives vary at various points in the distribution. For example, a 20 percent tax gradient generates more potential savings for a $\pi = 0.6$ firm than a $\pi = 0.4$ firm. This would be crucial for a moving cost of 0.1.[20]

Thus, comparisons can only be done more generally by analyzing the effect of different modeling assumptions on the three revenue effects. For example, this model is relatively more positive toward the preferential regime largely because cross-country heterogeneity allows for a base expansion effect. Correspondingly, other models that allow for base expansion effects also tend to favor the preferential regime. Oshima (2010), for example, incorporates agglomeration, that is, positive spillovers from firms locating in higher densities. Similarly, Marceau, Mongrain, and Wilson (2010) consider an asymmetric model where one country generates higher returns. Both models relatively favor the preferential regime because greater movement has the potential to increase the aggregate bases. This pattern is also evident in the opposite direction. Janeba and Smart (2003) only allow for negative base effects in the form of capital flight. Correspondingly, their findings are more pessimistic.

The most comparable model in terms of basic structure is Mongrain and Wilson (2017). To my knowledge, it is the only other model that assumes asymmetric elasticities under the same domestic–foreign structure.[21] Moreover, it also incorporates positive moving costs. However, they differ in regard to the source of heterogeneity. Whereas the current model assumes heterogeneity of profits with fixed moving costs, the Mongrain-Wilson (MW) model assumes heterogeneity of moving costs with fixed profits. Firm movement is smooth in both models but for different reasons. This subtle difference generates a more pessimistic view of the preferential

regime. Specifically, they find a positive revenue gap only in cases where a large proportion of firms are perfectly mobile.

This difference is most apparent when considering the characterization of the relatively inelastic, core firms. In the current model, countries have both domestic and foreign cores, that is, firms with high-profit gradients. Moreover, these core firms tend to have higher, overall profits than the elastic firms. This reduces incentives for tax competition. In the MW model, profit homogeneity implies that countries only have domestic cores, that is, firms with high moving costs. These firms are also equally valuable. Thus, countries in the MW model have greater incentives to engage in tax competition. This generates a relatively stronger strategic effect. Moreover, homogeneity precludes the presence of a base expansion effect. Predictably, it is less favorable toward the preferential regime.

There are, however, two potential ways to bridge these two models. First, the MW model can be amended to allow for full moving cost deductibility. Even though gross profits are still identical, this would vary each firm's contribution to the tax base. All else being equal, low cost firms are more likely to switch and would pay more in taxes than the high cost firms. This produces a similar gradient to that in the current model. Including deductibility therefore decreases the relative value of the marginal firm and softens the strategic effect. As such, this version of the MW model would be closer to the current model. However, tractability is likely to be an issue because it relies on tax rate differentials to characterize the equilibria.

A second potential bridge would be to make the current model more similar to the MW model. This can be accomplished by assuming that cross-country profits are perfectly correlated. However, doing so eliminates the existence of pure strategy equilibria. This is a common issue in the literature. Most papers design their models to either generate existence, or simply assume necessary smoothness conditions. Alternatively, other papers such as Marceau, Mongrain, and Wilson (2010) consider mixed strategies. However, comparisons across highly differing models or equilibrium concepts are not ideal. Therefore, combining the two models, that is, having heterogeneity of both profits and costs, is a viable alternative. How this might affect the results depends on the correlation between a firm's profit pair and its moving cost. If the two are uncorrelated, then results would be similar to the current model. If the two are positively correlated, then results would likely be similar to the MW model.

Discussion

In the presence of asymmetric elasticities and profit heterogeneity, this article finds that the preferential regime can be revenue dominant under cases of sufficient asymmetry. Policywise, the model lends support toward the usefulness of bilateral tax treaties. Instead of completely banning preferential policies, countries may consider case-specific agreements. Note that the model can also be applied toward other situations such as the effect of interstate or interprovince firm movement. Moreover, the intuition is not limited solely to a corporate tax setting.

However, there are other relevant factors to consider. For example, the sophisticated behavior of multinationals and the impact of profit shifting are crucial given their prominence in the global market. Although the current model focuses on the behavior of singleton firms and capital, it is possible to incorporate multinationals by interpreting them as being a collection of individual firms. Therefore, each singleton represents a different department, arm, and/or subsidiary within the larger structure.

Similarly, profit correlation can act as a rough proxy for profit shifting. Consider the following example, firm i has the profit pair (0.5, 0.8). Ignoring taxes, it will locate in B and generate 0.8 in gross profits. Assume that taxes are lower in A and that the firm can perfectly and costlessly profit shift. The optimal choice for firm i would be to locate in B but report its 0.8 profit in A. Firm i's profit pair would effectively be (0.8, 0.8). Notice that this is equivalent to the perfect correlation assumption. Thus, higher levels of profit correlation can broadly capture the impact of greater shifting ability. Within the current model, higher profit correlation, that is, smaller profit gradients, theoretically depresses the base expansion effect. It also exacerbates the strategic effect because it diminishes the relative value of core firms. Assuming existence, this rationale implies that greater profit shifting behavior decreases the revenue gap and works against the preferential regime. This is indeed confirmed in Niu (2017). Although nonmonotonic, the revenue gap is generally decreasing with increasing profit correlation.

The composition of firms within each economy is also important. Firms that focus on activities such as financial holdings or research and development generally have lower gross profit variability between countries. If a significant portion of the economy is comprised of firms where profit is relatively independent of location, then the base expansion effect will be weaker. This likely reduces the potential revenue gap. Along the same lines, it is plausible that firms face uncertainty in their potential foreign profits.

Assume that firms receive a signal that equals the true profits plus an error term. If the error term is mean 0, then ex ante behavior will not change. Although ex post profits and revenues will vary, deviations are likely to be small in the aggregate. Uncertainty would only affect the results if the error terms were also correlated with profit. For example, the base expansion effect would be smaller if firms with higher profits were also more likely to receive lower signals and vice versa. There are certainly other factors that may impact the regime-revenue debate. This article leaves such discussions for future research.

Acknowledgments

I would like to thank Alan Deardorff, Reid Dorsey-Palmateer, James Hines, David Knapp, Andrei Levchenko, Nathan Seegert, Joel Slemrod, John D. Wilson, and the many discussants/referees for their helpful comments. Additionally, the numerical model would still be running if not for the resources of the Michigan CAC NYX/FLUX computing cluster.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Supplemental Material

Supplementary material for this article is available online.

Notes

1. Corporate tax revenue in Ireland went up from €497.178 to €820.632 million for the 1978 to 1980 and 1980 to 1982 periods. Likewise, they increased from €928.419 to €1413.015 million for the 1985 to 1987 and 1988 to 1990 periods.
2. See Genschel and Schwarz (2011) and Wilson (1999) for surveys of the theoretical tax competition literature. Devereux, Lockwood, and Redoano (2008) provide a survey of empirical trends.
3. See Lewis (1999) for a survey of home bias papers.
4. Aggregate base effects are also considered in other papers, for example, Baldwin and Krugman (2004) and Marceau, Mongrain, and Wilson (2010). However, the nature of such effects is different (see fourth section).

5. These profits can be generated under a monopolistic competition setting similar to a Melitz-style model. Each atom is a unit of capital that can locate domestically or abroad. Production is given by $q_{ij}(k) = \phi_{ij}k$ with ϕ_{ij} being a firm country-specific draw.
6. Only knowing the distribution prevents governments from offering firm-specific taxes. Although this does occur for large multinationals in some countries, it is not the focus of this article.
7. This revenue equivalence outcome has also been noted in a number of previous works, for example, Keen (2001). Base elasticities are assumed to be unequal in these models. The regime-revenue issue is analogous to a third degree, price discrimination problem. Group-specific prices, for example, adult versus child movie tickets, can only improve profits if the demand groups are different. Therefore, the model requires positive moving costs in order to generate significant, nonredundant results. This is discussed further in the Online Appendix.
8. Using the support method, as opposed to the productivity multiplier, simplifies the revenue functions. Asymmetry can also be modeled by changing the relative densities of high-/low-profit draws in the distribution. However, the proportional productivity in this model is more consistent with the international trade literature.
9. Domestic revenue is calculated indirectly by subtracting those firms that exit from the entire endowment. This method simplifies later calculations. The *ForRev2* case in equation (6) breaks up the foreign revenue region into the triangular and rectangular portions.
10. This assumes that the revenue effect of a small restriction on θ is consistent with a complete abolishment of preferential taxation, that is, the effect is monotonic. However, the current model highlights a number of nonmonotonic outcomes.
11. A majority of the computations were performed on the University of Michigan NYX/FLUX Cluster.
12. Multiple equilibria are more prevalent in the symmetric cases and when moving costs are 0.
13. The simulated rates are typically higher than the world average of 23 percent. Niu (2017) finds more plausible rates in a model using a bivariate Pareto distribution.
14. This outcome still holds for higher cases of symmetry, that is, $\bar{\pi}_A = \bar{\pi}_B > 1$. As overall productivity increases, the revenue gap decreases such that the nonpreferential regime is becoming even more revenue-dominant. Percentage wise, this difference is shrinking but is always negative. Thus, symmetry, not the actual productivity level, is driving this result.
15. Productivity in A is varied while holding $\bar{\pi}_B = 1$ fixed.

16. This corresponds with ring-fencing practices, whereby domestic firms are isolated and more heavily taxed. Domestic rates under the preferential regime are indeed higher. Although individual domestic firms certainly pay higher taxes under the preferential regime, the resulting overall domestic revenue is lower because the greater tax differential is leaving fewer firms that can be ring-fenced, that is, more domestic firms are leaving.
17. For a given set of tax rates, the revenue functions are evaluated with tax collection (the $t\pi$ term inside the integral) set at 100 percent. All other tax rates remain unaffected to maintain the same movement pattern.
18. Notice that the nonpreferential regime is actually less distortionary in A for the asymmetric case. However, it is far more distortionary in B where more firms should be moving to A. The equilibrium rates are $(\tau_A, \tau_B) = (0.585, 0.535)$ and $(t_A, T_A, t_B, T_B) = (0.6, 0.52, 0.575, 0.425)$.
19. When $\alpha = 0$, the TNP gap is negative in favor of the preferential regime in all cases. For $\alpha = 0.5$, a positive TNP gap appears only in a few cases, specifically those where asymmetries run concurrently. This switches for $\alpha \geq 0.75$. Under full deductibility, the TNP gap is now positive in nearly all cases, except for cases of high asymmetry when productivity and population run concurrently.
20. Profit heterogeneity is also important for existence. With homogeneity, movement occurs on an all-or-nothing level, so pure strategy equilibria are absent in most cases.
21. The 2017 version of this working paper was also previously cited under a different title: CESifo Working Paper No. 5688—Tax Competition with Heterogeneous Capital Mobility.

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Author Biography

Ben J. Niu is a professor in the Department of Economics at St. John Fisher College in Rochester, NY. He received his PhD in economics from the University of Michigan, Ann Arbor. His research focuses primarily on the geographic aspects of various government policies in the presence of borders and discontinuities. Examples of such policies include corporate taxation, carbon taxation, and state-level bottle deposits/redemptions.