

Trade costs and the implications of devolved corporate tax-setting

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Abstract

We set up a trade model where three countries compete for an exogenous number of firms. Our innovation lies in the geography of the model. Of the three countries, one is the hub through which all trade takes place. We establish the initial allocation of industry across the countries in the absence of tax competition. We then examine the implications for corporate tax levels when the countries compete with each other to attract firms and determine the resulting location of economic activity.

Keywords: corporate taxes, devolution, trade costs

JEL Classification: F15, F23, H25, H73

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1. Introduction

This paper seeks to determine how devolution of corporate tax-setting powers might affect the level and geographic distribution of economic activity and impact on the welfare of the citizens of a country. Our original motivation was our desire to shed some light on the implications of increased fiscal autonomy for the member nations in the United Kingdom. As a result, the “hub and spoke” geographic structure we have adopted tries to reflect the economic relationships within the UK and between it and the wider European market, though our analysis may be applicable to other situations.

At the centre of our analysis are the attempts by governments to attract inward foreign direct investment (FDI). FDI results in increased local production and employment and we assume that this local production of the good yields higher social benefits than imports. This reflects what seems to be a widely-held government view. There are many possible reasons why, independently of capital income and tax/subsidy payments, host countries may favour local production. In our analysis in this paper, we use the framework introduced by Haufler and Wooton (1999) where trade between any two countries is costly. As a result, the market price is lower (and consumer surplus higher) under local production compared to importation of the product. Benevolent governments will recognise this and seek to attract FDI.¹

Our starting point is the two-country model of Haufler and Wooton (2010) in which two nations compete to attract firms from an oligopolistic industry. This paper, and our companion piece, Darby, Ferrett and Wooton (2012), increase the number of countries. While the other paper examines the outcome of tax competition between m heterogeneous countries,

¹ Beyond this motivation, there may be labour market benefits from inward FDI. MNEs may offer wage premia above workers’ outside options, a polar case of which occurs when inward FDI relieves involuntary unemployment (Haaparanta, 1996 and Bjorvatn and Eckel, 2006). Alternatively, inward FDI may be associated with localised technological spillovers to indigenous firms (Fumagalli, 2003 and Olsen and Osmundsen, 2003).

the current paper focuses on a model with a (more modest) three countries.² What further distinguishes the papers is that we assume here that one of the three countries occupies a central point geographically such that all traded goods must pass across its frontiers at least once. This “hub” country can trade directly with each of the other two nations but, in contrast, firms located in a “spoke” country can only access the consumers of the other peripheral country by shipping it through the core. As shipping goods across national frontiers is assumed to be costly, firms located in the spokes are at a disadvantage in serving their markets, as compared to those firms located in the hub. This situation is illustrated in Figure 1.

FIGURE 1 ABOUT HERE

There are alternative interpretations or applications of the model that might shine some light on current policy questions. One is that the model represents a single country whose geography means that trade between some provinces is more expensive than others. Thus it could represent industrial activity on an island such as Great Britain, where trade between Scotland and Wales must take place through England. The model could then be used to analyse the potential for the two relatively disadvantaged provinces using corporate tax-setting powers to offset their geographical disadvantages. Another modelling possibility would be to consider a two-country setting where one of the countries has two centres of economic activity that are physically distant from one another. This might characterise trade within the UK (between Scotland and England) and with the European market. The implication of this is that movement of goods between nodes within this “bicentric” country will also be costly and the location of firms within a country, as well as their number, will play a role. If one of this country’s nodes (England) is closer to the foreign market, this will be the hub through which all exports and imports pass. The other node (Scotland) is therefore geographically disadvantaged in its chances of attracting the FDI of firms aiming to service consumers across the entire region.

² Haufler and Wooton (2006) have a 3-country, single-firm model of tax competition in a regional setting where the focus is on the implications of tax harmonisation of taxes between two of the nations.

This has the potential to create a tension between citizens resident in one node relative to those in the other and may lead to calls for different rates of corporate taxation of firms in order to offset the locational disadvantages of one centre relative to the other.³

Our analysis develops as follows. In section 2 we present the basic hub and spoke model and examine the geographic distribution of firms in the absence of any corporate tax competition. We then consider the incentives facing a single country to use a lower tax (or subsidy) to attract additional firms in section 3, Section 4 extends the analysis to consider the non-cooperative tax equilibrium in the region where symmetry is imposed on the model, in that both spokes are assumed to be of the same size and have the same trade costs with the hub. Section 5 concludes.

2. The model

We consider a region in which countries compete to attract a fixed number of firms. These firms produce an homogeneous good, labelled x , in an oligopolistic industry. A second, private good, the numeraire commodity z , is produced under conditions of perfect competition. Every household in the region supplies a single unit of labour. The numeraire industry, which uses labour as the only input, is freely traded resulting in the international equalisation of the wage in that industry as w . Trade costs play an important role in the model. It is assumed that z is freely traded while x is subject to trade costs.

The region is composed of 3 countries, a hub country H , and two spoke countries A and B . The internationally immobile population is divided into households, each of which supplies labour effort and consumes the good produced in the region. The residents of the countries earn only wage income, while profit income accrues to capital owners that reside in an outside

³ As reported by McKinnon (1994), there is some evidence that Scotland's greater distance from the European market disadvantages manufacturers located in Scotland. The Scottish Government (2009) states that "(a)round 30% of the freight being transported in Scotland originates from, or is destined for, locations outside Scotland. This is either transported directly through Scotland's ports, and airports or by road or rail through ports or airports in England - or is moved directly to or from England and Wales (representing a major market for the exports and imports of Scotland.)"

country. The countries may differ in size where there are n_H households in the hub and n_A and n_B households in spoke country A and B , respectively. The population of the region is normalised to unity and so $n_H + n_A + n_B = 1$.

We assume that the cost of shipping a unit of good x between H and A is σ and between H and B is τ . As there is no direct trade route between the two spokes, all shipments of good x between these two countries must pass through the hub and, consequently, face a higher cost for transshipment of $(\sigma + \tau)$.⁴

2.1 Consumers

Consumers in all countries are assumed to have identical preferences for the goods, given by

$$u_i = \alpha x_i - \frac{\beta}{2} x_i^2 + z_i. \quad (1)$$

Moreover, total income from the business tax (as detailed below), denoted by T_i , is redistributed equally and in a lump-sum fashion to the households in each country (or centre, once tax-setting powers are devolved). The budget constraint for a representative consumer in country i is then

$$w + \frac{T_i}{n_i} = z_i + p_i x_i, \quad (2)$$

where p_i is the price of good x in country i . Utility maximisation leads to inverse-demand curves $\alpha - \beta x_i$. Aggregating the demand for good x over all consumers yields market demand curves, denoted X_i :

$$X_i = \frac{n_i(\alpha - p_i)}{\beta}. \quad (3)$$

⁴ To keep the analysis relatively simple, we have assumed that there are no economies from long-distance shipping and that the cost of trade between the two spokes is the sum of the costs of hub-spoke trade.

2.2 *The oligopolistic industry*

There are k firms in total, based outside the region. Each of these firms possesses one unit of “knowledge capital” (such as a license or patent) that can be profitably employed in the imperfectly competitive industry x . This factor is indispensable for the production of good x but limited in availability such that, at most, k firms can engage in production. In addition, each firm faces fixed and identical costs of setting up a production facility in any country. These costs are assumed to be sufficiently large to ensure that each firm will set up, at most, one production plant in the region. Thus each firm will serve the regional market from one of the countries in the region. Firms are assumed to be identical except with respect to the location of their production facilities. Location matters because of the trade costs associated with exports to a firm’s foreign market.

Labour is the only variable input in good x production. Each unit of good x requires the efforts of γ workers, where γ is chosen so that production of x does not exhaust each country’s labour supply. Given this, the marginal cost of production can be defined as $\omega \equiv \gamma w$.⁵ The cost of exporting each unit of output is τ , which effectively raises the marginal cost of serving the foreign market to $(\omega + \tau)$. We are assuming that all of the trade costs are “real”, taking the form of, say, transport costs or administrative barriers to the free movement of goods between countries. There are no (endogenously determined) tariffs between the countries as we assume that the region is a free-trade-area.

Firms are assumed to behave as Cournot competitors and are able to segment their markets, choosing the quantities to sell on each market independently.⁶ The total operating profit of a firm based in each production location is therefore

⁵Since the wage w is equalised across the countries, it does not enter the location decision of firms in our model. Thus the firms’ choice of location is not driven by labour costs.

⁶In equilibrium, firms will receive a lower producer price for their exports than for goods destined for the domestic market. The trade structure is simply a generalisation of the “reciprocal dumping” model of Brander and Krugman (1983).

$$\begin{aligned}
\pi_A &= (p_A - \omega)x_{AA} + (p_H - \omega - \sigma)x_{HA} + (p_B - \omega - \sigma - \tau)x_{BA}, \\
\pi_H &= (p_A - \omega - \sigma)x_{AH} + (p_H - \omega)x_{HH} + (p_B - \omega - \tau)x_{BH}, \\
\pi_B &= (p_A - \omega - \sigma - \tau)x_{AB} + (p_H - \omega - \tau)x_{HB} + (p_B - \omega)x_{BB},
\end{aligned} \tag{4}$$

where π_i is the pre-tax profit of a firm based in country i and x_{ji} represents sales in country j by a firm based in country i , $i = \{A, H, B\}$. A firm is at a cost disadvantage in its export market as the marginal cost of exports is higher than that for domestic sales. Consequently an exporter will sell less in a market than an indigenous rival.

Suppose that of the k firms selling in country i , k_i firms are “local” in that they have their production facility in the country, while the remaining $(k - k_i)$ firms service the market from other countries within the region. Maximising (4), taking into account demand (3), and solving yields the total sales and price of good x in each location:

$$\begin{aligned}
X_A &= n_A \frac{(\alpha - \omega)k - [\sigma k_H + (\sigma + \tau)k_B]}{\beta(k+1)}, & p_A &= \frac{\alpha + \omega k + [\sigma k_H + (\sigma + \tau)k_B]}{k+1}; \\
X_H &= n_H \frac{(\alpha - \omega)k - [\sigma k_A + \tau k_B]}{\beta(k+1)}, & p_H &= \frac{\alpha + \omega k + [\sigma k_A + \tau k_B]}{k+1}; \\
X_B &= n_B \frac{(\alpha - \omega)k - [(\sigma + \tau)k_A + \tau k_H]}{\beta(k+1)}, & p_B &= \frac{\alpha + \omega k + [(\sigma + \tau)k_A + \tau k_H]}{k+1}.
\end{aligned} \tag{5}$$

In each country, the consumer price is a rising function of the number of active firms in the *other* countries. In other words, whatever the size of the industry, having more firms producing locally intensifies domestic competition and drives down consumer prices.

Substituting the prices in (5) into (4) yields the pre-tax profits of firms dependent on the location of their production facilities:

$$\begin{aligned}
\pi_A &= \frac{n_A[A + \sigma k_H + (\sigma + \tau)k_B]^2 + n_H[A - \sigma(k_H + 1) + (\tau - \sigma)k_B]^2 + n_B[A - \sigma k_H - (\sigma + \tau)(k_B + 1)]^2}{\beta(k+1)^2}, \\
\pi_S &= \frac{n_A[A - \sigma k_A + \tau k_B - \sigma]^2 + n_H[A + \sigma k_A + \tau k_B]^2 + n_B[A + \sigma k_A - \tau k_B - \tau]^2}{\beta(k+1)^2}, \\
\pi_B &= \frac{n_A[A - (\sigma + \tau)(k_A + 1) - \tau k_H]^2 + n_H[A + (\sigma - \tau)k_A - \tau(k_H + 1)]^2 + n_B[A + (\sigma + \tau)k_A + \tau k_H]^2}{\beta(k+1)^2},
\end{aligned} \tag{6}$$

where $A \equiv a - \omega$. Notice the symmetry in the profits for A and B , as all of their exports must pass through the hub, H . We define the differential between profits for two firms located in countries i and j , respectively, as $\Gamma_{ij} \equiv \pi_i - \pi_j$.

2.3 Location in the absence of tax competition

Suppose, initially, that firms face no taxes on their earnings. In this situation, the equilibrium will be characterised by the earnings of all firms in the region being the same, that is $\pi_A = \pi_H = \pi_B$. Solving (6), reveals the geography of the region, that is the international allocation of economics activity that is consistent with equal profits for all k firms.

$$\begin{aligned}
k_A^* &= \frac{(\sigma + \tau)(k + 1 - 4n_H n_A) - 2\tau n_H(k - 1 + 2n_H) - 8An_H n_B}{8\sigma n_H(1 - n_H)}, \\
k_B^* &= \frac{(\sigma + \tau)(k + 1 - 4n_H n_B) - 2\sigma n_H(k - 1 + 2n_H) - 8An_H n_A}{8\tau n_H(1 - n_H)}, \\
k_H^* &= k - k_A^* - k_B^*.
\end{aligned} \tag{7}$$

We can substitute the equilibrium allocations of industry (7) into (5) to find the prices and sales in each of the countries.

$$\begin{aligned}
X_A &= \frac{n_A}{\beta} \left\{ A - \sigma + \frac{\sigma - \tau}{4(1 - n_H)} - \frac{n_B[2A - (\sigma + \tau)]}{(k+1)(1 - n_H)} \right\}, \quad p_A = \omega + \sigma - \frac{\sigma - \tau}{4(1 - n_H)} + \frac{n_B[2A - (\sigma + \tau)]}{(k+1)(1 - n_H)}; \\
X_H &= \frac{n_H}{\beta} A - \frac{\sigma + \tau}{4\beta}, \quad p_H = \omega + \frac{\sigma + \tau}{4n_H}; \\
X_B &= \frac{n_B}{\beta} \left\{ A - \tau + \frac{\tau - \sigma}{4(1 - n_H)} - \frac{n_A[2A - (\sigma + \tau)]}{(k+1)(1 - n_H)} \right\}, \quad p_B = \omega + \tau - \frac{\tau - \sigma}{4(1 - n_H)} + \frac{n_A[2A - (\sigma + \tau)]}{(k+1)(1 - n_H)}.
\end{aligned} \tag{8}$$

We see from (8) that trade costs impact on both the price in each national market and the quantity that is sold there. For a spoke country, its trade cost with the hub has a direct effect, but the rival spoke's trade cost also effects the level of economic activity.

2.4 Government

Each national government is assumed to have as its goal the maximisation of the welfare of its households, where welfare is the sum of the consumer surplus, tax revenue, and wage income.⁷

$$W_i \equiv S_i + T_i + n_i w, \quad (9)$$

S_i is country i 's total consumer surplus in the market for the imperfectly competitive good,

$$\begin{aligned} S_A &= \frac{n_A [Ak - \sigma k_H - (\sigma + \tau) k_B]^2}{2\beta(k+1)^2}, \\ S_H &= \frac{n_H [Ak - \sigma k_A - \tau k_B]^2}{2\beta(k+1)^2}, \\ S_B &= \frac{n_B [Ak - \tau k_H - (\sigma + \tau) k_A]^2}{2\beta(k+1)^2}, \end{aligned} \quad (10)$$

Consumer surplus in each country is rising in the total number of firms in the industry, k , as this intensifies competition and reduces producer prices in all countries. High trade costs reduce consumer surplus as they lower international competition. In addition, the greater the number of firms located in other countries reduces consumer surplus, as consumer prices are lower when more firms produce locally. This gives each nation an incentive to attract firms to its home jurisdiction.

T_i is the total corporate tax revenue collected by country i ,

$$T_i = t_i k_i. \quad (11)$$

We are assuming that profits are taxed at source by the host countries of the firms, with t_i being the lump-sum tax imposed on each firm by country i . The tax differential between countries i

⁷ We are assuming that all profit from the activities of the imperfectly competitive firm are repatriated to their foreign owners.

and j is defined to be $\Delta_{ij} \equiv t_i - t_j$. Higher taxes expand the budget sets of the nation's households, but will drive away firms to lower tax regimes.

The third term of national welfare is assumed to be unchanging, as wage income remains the same regardless of where workers are employed. We assume that the jobs provided by the oligopolistic industry offer the same wage as that in the numeraire industry.⁸

2.5 Corporate taxes

Firms are concerned with their after-tax earnings, thus they must subtract from their pre-tax profits (6) the lump-sum tax of the country in which they are located. In deciding upon where to invest, firms will compare profits net of taxes and locate in the most profitable location. The locational equilibrium for the industry is characterised by

$$\Pi_{ij} - \Delta_{ij} = 0 \quad (12)$$

for every pairwise combination of investment locations.

We can solve for country i 's equilibrium number of firms in the presence of taxes, k_{it} , as deviations from the number of firms in the country in the absence of taxes (7),

$$\begin{aligned} k_{At} &= k_A^* - \frac{\beta(k+1)}{8n_H(1-n_H)} \frac{\Delta_{AH}}{\sigma^2} + \frac{\beta(k+1)(2n_H-1)}{8\sigma\tau n_H(1-n_H)} \Delta_{BH}, \\ k_{Ht} &= k_H^* + \frac{\beta(k+1)(\sigma+\tau)}{8\sigma\tau n_H(1-n_H)} \left(\frac{\Delta_{AH}}{\sigma} + \frac{\Delta_{BH}}{\tau} \right) - \frac{\beta(k+1)}{4\sigma\tau(1-n_H)} (\Delta_{AH} + \Delta_{BH}), \\ k_{Bt} &= k_B^* - \frac{\beta(k+1)}{8n_H(1-n_H)} \frac{\Delta_{BH}}{\tau^2} + \frac{\beta(k+1)(2n_H-1)}{8\sigma\tau n_H(1-n_H)} \Delta_{AH}. \end{aligned} \quad (13)$$

It is clear from the second terms of the equations in (13) that spoke countries lose firms as a result of their imposing taxes higher than that set in the hub. The impact is mitigated by the (square of the) trade cost between the spoke and the hub. The loss of firms directly benefits the hub but, in addition, may also result in an increase in firms in the other spoke. Thus, in each of the expressions for the number of firms in a spoke country, the third term is positive if the

⁸ It is possible to include some sort of wage premium for jobs in the footloose industry. This is likely to create the same incentives for attracting firms as consumer surplus, so we do not pursue it in this paper.

population of the hub is at least half of the total population in the region ($2n > 1$). This means that, if the hub is sufficiently large, a spoke's tax increase will cause an exodus of firms to both the hub and the other spoke.

2.6 Unilateral taxation

Suppose that the corporate tax rate is the same across all of the countries. This might reflect the situation where the three countries are, in fact, constituent nations of a federal state that sets the corporate tax for the entire region. For simplicity, we assume that this initial tax level is zero. We now allow for the possibility that these tax powers are devolved to one or more of the countries and investigate how its tax deviates from that of the rest of the region.⁹

By differentiating (9), taking into account (10) and (13), we can find the optimal tax that would be chosen by each of the countries.

$$\begin{aligned}
t_A^* &= \frac{4n_H(1-n_H)}{\beta(k+1)} \frac{\sigma \left\{ 4\sigma(1-n_H)(k+1)k_A^* - n_A \left[Ak - \sigma k_H^* - (\sigma + \tau) k_B^* \right] \right\}}{4(1-n_H)(k+1) - n_A n_H}, \\
t_H^* &= \frac{4n_H(1-n_H)}{\beta(k+1)} \frac{\sigma \tau \left\{ 4\sigma \tau (k+1) k_H^* - (\sigma + \tau) \left[Ak - (\sigma k_A^* + \tau k_B^*) \right] \right\}}{(\sigma + \tau)^2 (4k + 3 + n_H) - 16\sigma \tau (k+1) n_H}, \\
t_B^* &= \frac{4n_H(1-n_H)}{\beta(k+1)} \frac{\tau \left\{ 4\sigma(1-n_H)(k+1)k_B^* - n_A \left[Ak - \tau k_H^* - (\sigma + \tau) k_A^* \right] \right\}}{4(1-n_H)(k+1) - n_B n_H}.
\end{aligned} \tag{14}$$

For each of the spoke countries, the denominators in (14) are positive whenever the hub is not overwhelmingly large (that is, n_H is sufficiently less than one). For these countries, the size of the tax is proportionate to the trade cost with the hub. Whether the tax is positive or negative (a subsidy) depends upon the relative sizes of the two terms in the numerator of the second term in each of the expressions. The first of these is proportional to the number of firms located in the country and reflects the fact that a higher tax increase revenues for the government. The second term is directly related to (5), the level of sales in the domestic market: a higher tax will drive

⁹ This can be seen as an extremely stylised approach to the issue of devolving taxation powers within the UK, where the competition to attract firms is focused on those enterprises already located within the borders of the country but sufficiently footloose that they may be induced to relocate due to a more favourable tax environment.

out some firms, leaving the local market less competitive. The denominator of the second term in the optimal tax of the hub is less easily signed, though the numerator shares similar components to those of the other nations' tax expressions.

It is clear from (14) that the countries have incentives to deviate from the tax levels of their trading partners and, indeed, respond to any shifts in taxes that the other countries may make. The task is then to determine what the equilibrium taxes will be in such a strategic setting. We therefore turn to finding the Nash taxes.

3. Symmetry

In order to examine the relative importance of being at the core of the region as opposed to being on the periphery, it will be useful to introduce a degree of symmetry across the spoke countries. Suppose that the two spokes are identical in size, each having a population of $n_S = (1 - n_H)$, while their costs of transporting goods to and from the hub are the same and equal to τ . This configuration of countries is illustrated in Figure 2.

FIGURE 2 ABOUT HERE

This simplifies the expressions substantially. Thus the number of firms in each country in the absence of corporate taxes collapses from (7) to

$$k_S^* = \frac{(k+1)\tau - 2n_H A}{4\tau n_H}, \quad k_H^* = \frac{2(A + k\tau)n_H - (k+1)\tau}{2\tau n_H}. \quad (15)$$

It is apparent from (15) that the trade cost between and the relative size of the markets in the hub and the spokes determines whether the spokes capture any of the firms in the oligopolistic industry. Each spoke has to have a large-enough home market, that is sufficiently isolated from the hub to make it worthwhile for firms to locate away from the core. Thus, only if $\tau > 2n_H A / (k+1)$ will the hubs diversify in their production. When corporate taxes are imposed, (13) changes to

$$\begin{aligned}
k_{Hi} &= k_H^* + \frac{\beta(k+1)(\Delta_{S1H} + \Delta_{S2H})}{4\tau^2 n_H}, \\
k_{Si} &= k_S^* - \frac{\beta(k+1)[\Delta_{SiH} - (2n_H - 1)\Delta_{SjH}]}{8\tau^2 n_H (1 - n_H)},
\end{aligned} \tag{16}$$

where $\{\Delta_{SiH}, \Delta_{SjH}\} \in \{\Delta_{S1H}, \Delta_{S2H}\}$, $i \neq j$.

3.1 Optimal taxes

Suppose that each of the countries now sets a corporate tax to maximise its welfare, conditional on the taxes set by the other countries in the region. The reaction functions for the countries are

$$\begin{aligned}
t_H &= \frac{2\tau n_H \{2\tau[(k+1)k_H^* + k_P^*] - Ak\}}{\beta(k+1)(4k+3)} + \frac{2k+1}{2(4k+3)}(t_{S1} + t_{S2}), \\
t_{Si} &= \frac{4\tau n_H (1 - n_H) \{ \tau(k_H^* + 2(4k+5)k_P^*) - Ak \}}{\beta(k+1)[8(k+1) - n_H]} + \frac{8(1 - n_H)(k+1)}{8(k+1) - n_H} t_H - \frac{4(k+1) - (8k+7)n_H}{8(k+1) - n_H} t_{Sj}.
\end{aligned} \tag{17}$$

Solving (17), substituting (15) yields the Nash corporate taxes t_{SN} and t_{HN} for a spoke nation and the hub, respectively:

$$\begin{aligned}
t_{SN} &= \Theta(1 - n_H) \left[4\tau(k+1)^3 + \tau k n_H (8k^2 + 20k + 11) - A n_H (16k^2 + 23k + 8) \right], \\
t_{HN} &= \Theta \left\{ \tau(2k+1)(k+1)^2 + \tau k n_H \left[(12k^2 + 26k + 13) - n_H (2k+3)(4k+3) \right] \right. \\
&\quad \left. - A n_H \left[(4k^2 + k - 2) - k n_H (6k+5) \right] \right\},
\end{aligned} \tag{18}$$

where $\Theta \equiv \tau / \left\{ \beta(k+1)^2 [8k+7 - 4(k+1)n_H] \right\} > 0$. The tax levels in the Nash equilibrium associated with different distributions of the region's population are illustrated in Figure 3. It is clear that the relatively larger a country is, the higher its tax. Thus when the hub is small (e.g., with 25% of the population in the hub compared to 37.5% in each spoke), the hub provides a subsidy to its firms while the spokes charge taxes. The reverse is true when the spokes have relatively small shares of the population. Three additional aspects are worth noting. Firstly the race to the bottom is limited, as there is a range of the population allocation over which all countries impose taxes. Secondly, the central position of the hub still confers benefits, in that when the countries are equally sized, the hub sets a higher tax than either spoke. Finally, the

trade cost has a strong positive impact on the levels of tax in both hub and spokes. Thus efforts to reduce trade costs may result in lower tax rates and, from (15), further concentration of firms in the hub. Consequently, depending upon the impact on consumer surplus, transport infrastructure investments may have a negative impact on the region.¹⁰

FIGURE 3 ABOUT HERE

While messy, the expressions in (18) seem to reflect the tension facing nations between generating revenue from high taxes on local firms with the desire to retain domestic industry in order to maximise consumer surplus.¹¹ Figure 4 illustrates how taxes in the Nash equilibrium mitigate some of the effects of geography. The dashed lines show the numbers of firms captured by countries as a function of their populations. The distribution of firms across the region is less extreme when countries use corporate taxes, imposing taxes when they are attractive to firms and offering subsidies when they are geographically disadvantaged.

FIGURE 4 ABOUT HERE

4. Conclusions and future research

In this paper we have set up a simple model of intra-regional tax competition for foreign direct investment. The novelty in our approach is the geography of the region, where we have assumed that one of the nations is a hub through which all international trade must take place. We believe that this structure is applicable to trade amongst countries at the periphery of a large region. Indeed, the implications of devolving tax-setting powers to sub-national governments in the UK generated the initial motivation for this paper.

We plan to investigate this dimension in the next stage of the paper. Given the internal tensions inherent in a hub-and-spoke country, we can analyse the implications of that country

¹⁰ Becker and Fuest (2010) consider the implications for tax competition and welfare of transport infrastructure investments in a 3-country model.

¹¹ If the oligopolistic industry were to bring “better” jobs, this latter incentive to retain domestic firms would be reinforced.

shifting from setting a single, corporate tax on firms operating anywhere in the country to a devolved tax-setting regime where each devolved government sets a corporate tax that recognises the different trading conditions facing firms investing in its part of the larger nation. Our goal would then be the comparison of the equilibria associated with the two regimes, in terms of the impact of devolution on the aggregate level of economic activity in the country, how it is divided and the consequent impact on the welfare of citizens of each part of the nation.

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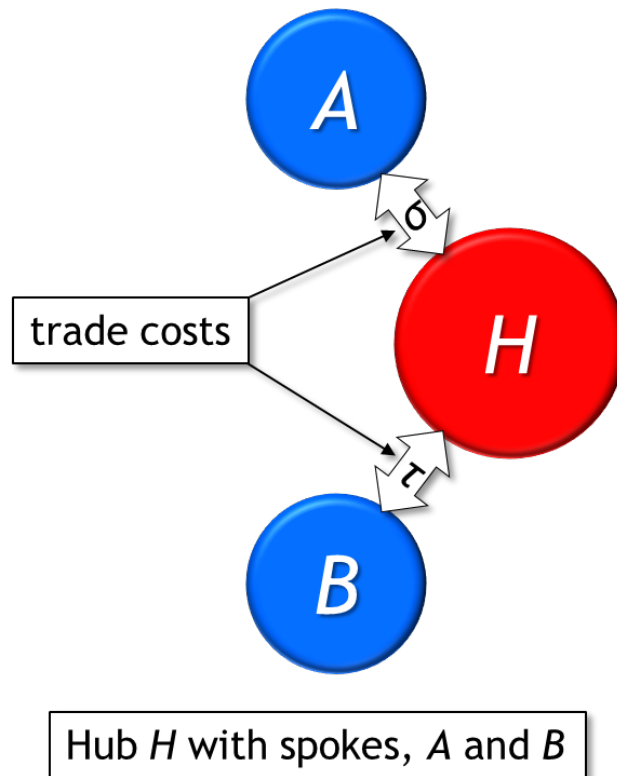


Figure 1. Geography of the region

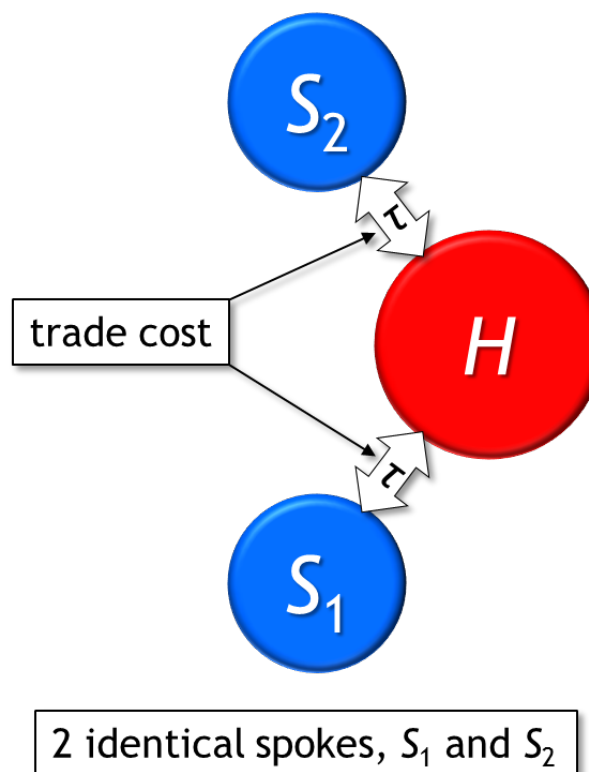


Figure 2. Hub and spoke region

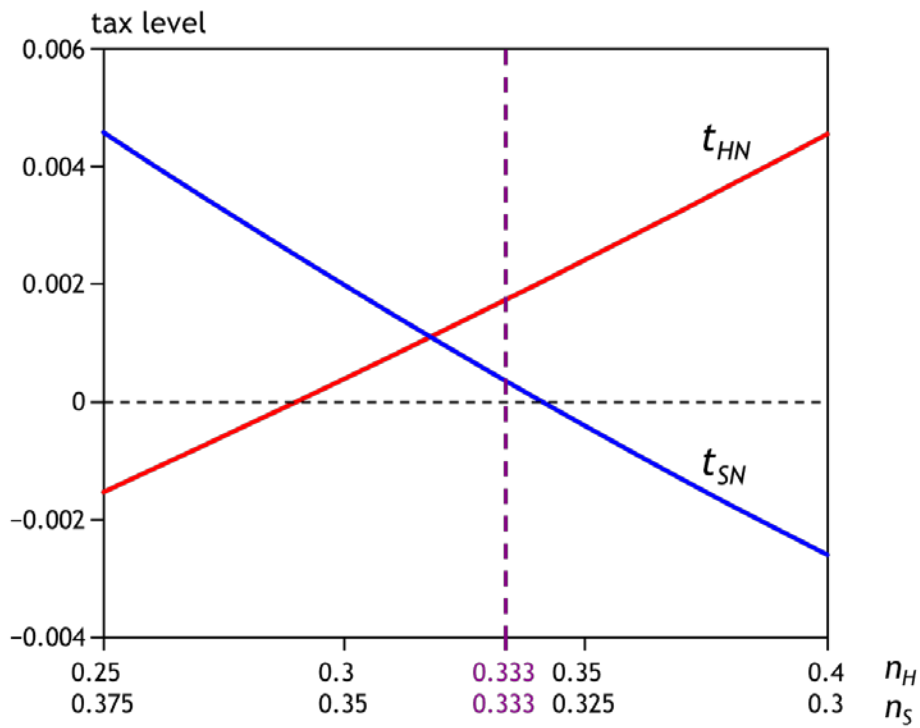


Figure 3. Nash taxes and country size

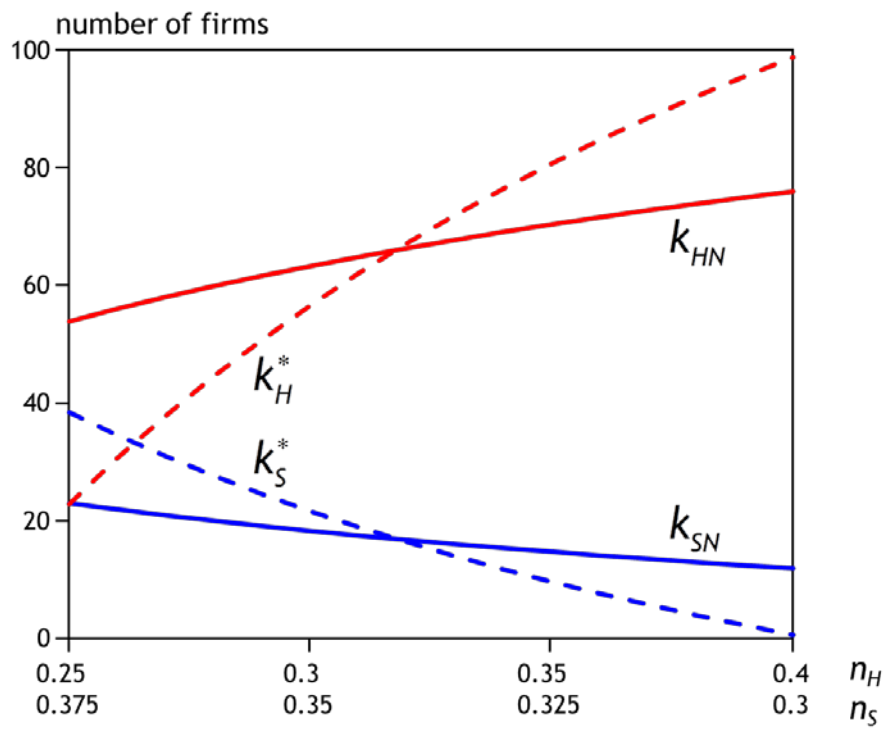


Figure 4. Nash taxes and location of industry