Why does the Corporate Tax Rate Fall in Europe? The Role of Heterogeneous Relocation Costs.

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Abstract: As both trade costs and corporate income taxes have been in decline across the globe, this association has often been taken as causal. In fact, evidence supporting the idea that trade openness is associated with declining corporate tax rates is well documented in the empirical literature for the OECD. However, this is not consistent with the common prediction of the New Economic Geography (NEG) literature: a decline in trade costs should serve to increase corporate tax rates in the core. This paper serves to remedy this violation through introducing heterogeneous relocation costs. I show that in the Footloose Entrepreneur (FE) model of Pflüger (2004) a reduction in trade costs can give rise to the observation that corporate tax rates have been decreasing in both the periphery and the core. This result stems from the fact that the core needs to retain increasingly more capital to remain the (partial) core as trade costs fall. As such, the core will start competing over the more mobile type of capital when trade costs decrease, driving the corporate tax rates down in both the core and the periphery.

Keywords: economic integration, trade costs, corporate income tax rate, heterogeneous relocation costs.

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The views stated in this thesis are those of the author and not necessarily those of the supervisor, second assessor, the Erasmus School of Economics or the Erasmus University of Rotterdam. Any supportive material are available upon request.

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1 Introduction

The decline in corporate tax rates across the globe over the past four decades has raised increasing concerns regarding equity and the ability of the government to provide public goods (Cai and Treisman, 2005). In response to these falls in the corporate tax rate the Ruding commission advised the EU to impose a lower bound of 30% on the corporate tax rate of EU member states in 1992 (Devereux, Lockwood, and Redoano, 2003). Similar initiatives were launched subsequently by the OECD where the aim was to address countries that had too low corporate tax rates. More recently, the Biden administration has also proposed a worldwide minimum tax rate of 21% on US corporations as to curb the"race-to-the-bottom" (Rappeport and Tankersley, 2021). However, during the academic debate that ensued it became apparent that the effectiveness and desirability of such policies is contingent on what is driving the declines in the corporate tax rate. In specific, the academic debate highlighted three possible causes of the decreases in the corporate income tax rate: (1) increased capital mobility, (2) increased economic integration and (3) increased political economic influence of capitalists.

Firstly, tax rates could decrease due to an increase in capital mobility. If the declines in the corporate tax rate are driven by an increase in capital mobility governments will then start to compete more intensely over this scarce resource, which is in line with conventional economic wisdom.[1] Nevertheless, this competition is typically wasteful and a lower bound on corporate tax rates can constitute a Pareto improvement. Secondly, increased economic integration could also erode the incentive for firms to locate near to one another, thereby diminishing the taxable rents that accrue from such clustering and driving down corporate tax rates (Baldwin and Krugman, 2004; Borck and Pflüger, 2006).[2] In this case such harmonisation would be only beneficial to the country with the most capital and a minimum corporate tax rate would merely serve to reduce the welfare of the periphery. Thirdly, capital may locates near to each other for no other reason than to promote their political interests and increase their electoral power (Persson and Tabellini, 1992). Again, low capital tax rates are then optimal from the perspective of the country that is home to most capitalists and as a result a lower bound on the corporate tax rate does not constitute a Pareto improvement.

Since optimal policy thus depends on what has been causing the decreases in the corporate tax rate it is critical to correctly identify the mechanism that brings about these declines. However, what has been driving the tax rate declines is subject of debate which has yet to be resolved. In particular, all of the three proposed reasons for why the corporate tax rate has been in decline over the past four decades have difficulty matching the stylised facts presented in section 2. Although the agglomeration based narrative manages overcomes many of the problems that the other two rationales have (Baldwin, & Krugman, 2004), it has one major flaw. The NEG models generally imply that the agglomeration rent is bell-shaped as is thus the tax rate of the core (Baldwin et al., 2003; Borck and Pflüger, 2006). That is, the tax rate set by the core increases at high trade costs and decreases at low trade costs. However, micro-level empirical studies find that the tax rate of large municipalities within the same country increase their tax rates as trade costs decline.[3] Assuming that trade costs are smaller within a country than between countries, this implies that we should observe increases in the tax rate as economic integration grows. In fact, the simulations of Borck and Pflüger (2006) reveal that at reasonable levels of trade costs the corporate tax rate should indeed increase in the core, rather than decrease.

This implication is however not in line with the empirical literature. Indeed, as one might expect a survey of the empirical literature on tax competition indicates that there exists a robust negative association between trade openness and corporate tax rates at the country level (Adam et al., 2013). In this paper I will however show that the NEG literature can be aligned with the empirical evidence. That

[1]See for instance Zodrow and Mieszkowskie (1986) and Wilson (1986).

[2]Henceforth, economic integration is meant in the sense of good market integration, not factor market integration.

[3]See for instance Fréret and Maguain (2017) for France, Crabbé and de Bruyne (2013) for Belgium, Jofre-Monseny (2013) for Spain, and Koh, Riedel and Böhm (2013) for Germany.

is, it will be argued that decreasing trade costs *can* be driving the observed declines in the corporate tax rate. In order to show this I extend the Footloose Entrepreneur (FE) model put forth by Borck and Pflüger (2006) with heterogeneous relocation costs. In particular, I assume that there exist two types of capitalists: imperfectly mobile capitalists and perfectly mobile capitalists. When trade costs are high the core prefers to retain only the imperfectly mobile capitalists as it can raise its taxes slightly without inducing any relocation of the imperfectly mobile capitalists. However, as trade costs fall the pressure to agglomerate strengthens and for any country to remain the core it will need to retain increasingly more capital. Hence, at lower trade costs the core will need to obtain some perfectly mobile capitalists and as such it starts to compete with the periphery over the most mobile type of capitalists. As a result, the fall in trade costs causes the corporate tax rate in both the core and the periphery to decline.

In section 2 of this paper I will first turn to some stylised facts regarding the development of the corporate income tax rate during the 1980s and the 1990s. This is due to the fact that during the period thereafter tax competition moved towards the shifting of profits on paper, rather than displacing physical activity. Nonetheless, the study of what has been driving tax rate competition in the past can provide better insight into what drives tax competition when implementing policies that induce competition over physical activity[4]. In addition, as the characteristics that shaped tax rate competition during the 1980s and 1990s are probably still present today it may also yield some insight as how to deal with contemporary profit shifting. The second part of section 2 then shows how trade costs have behaved during the last part of the 20th century. Although this simply portrays a possible association I will then also review some empirical studies which have attempted to quantify the causal relation between tax rates and trade costs. The model of Borck and Pflüger (2006) will then be extended with heterogeneous relocation costs for capitalists in section 3. Section 4 derives the conditions for the goods market to be in equilibrium, while the location equilibrium and tax equilibrium are studied in sections 5 and 6, respectively. Finally, section 7 briefly discusses the results and their implications, as well as some possible extensions and limitations. Section 8 concludes.

2 Taxes and Trade Costs in Europe: Stylised Facts

To get a clear idea of how trade costs might have influenced the development of corporate income tax rates I will mainly consider the development of the corporate tax rate in Europe. This is due to the fact that Europe has been subject to extensive economic integration reforms rendering it a prime example of how trade costs may have influenced corporate tax rates. In order to be able to evaluate how well the model is able to explain the stylised facts that are presented here, the analysis will largely follow the model structure. In specific, the model contains two countries which are designated as the (partial) core or the (partial) periphery depending on the fraction of the capital stock that is located within said country. In line therewith I divide Europe into two regions. One representing the core and the other the periphery. In particular, all former European Coal and Steel Community (ECSC) member states[5] (excluding Luxembourg) are referred to as the core-5. The region that is designated as the periphery then consists of four countries: Spain, Portugal, Ireland and Greece. Throughout the remainder of the paper I will refer to this last set of countries as the periphery-4.

The reason that this specific subdivision has been chosen is threefold. First, this manner of subdividing Europe follows the analysis of Baldwin and Krugman (2004) and is thus consistent with previous literature on the topic. Second, although data on statutory corporate income tax rates is read-

[4]See for instance the DBCFT policy proposal of the US republican party (Hebous, Klemm, and Stausholm, 2019), which can have real effects when exchange rates exhibit imperfect adjustment or the conditions for the Lerner symmetry do not apply. This latter case is particularly probable as there are significant deviations from the generalised (sufficient) conditions posited by Costinot and Werner (2019). Similarly, if profit shifting has been strongly regulated it could also be that competition turns to displacing physical activity as the real rate of return matters again.

[5]That is: Germany, France, Italy, Belgium and the Netherlands.

ily available this is not the case for more insightful measures such as for instance the effective average tax rate (EATR). Drawing upon the work of Devereux, Griffith and Klemm (2002) such tax rates can however be computed for the countries mentioned above. Third, the subdivision also makes sense from a core-periphery perspective. In fact, the Investment and Capital Stock Dataset (ICSD) of the IMF indicates that the core-5 has 84.2% of the total private capital stock of the two regions during 1980-2000 (IMF, 2019). Hence, the division of Europe in the core-5 and periphery-4 yields stylised facts that can be contrasted with model outcomes.

2.1 Trends in corporate income tax rates

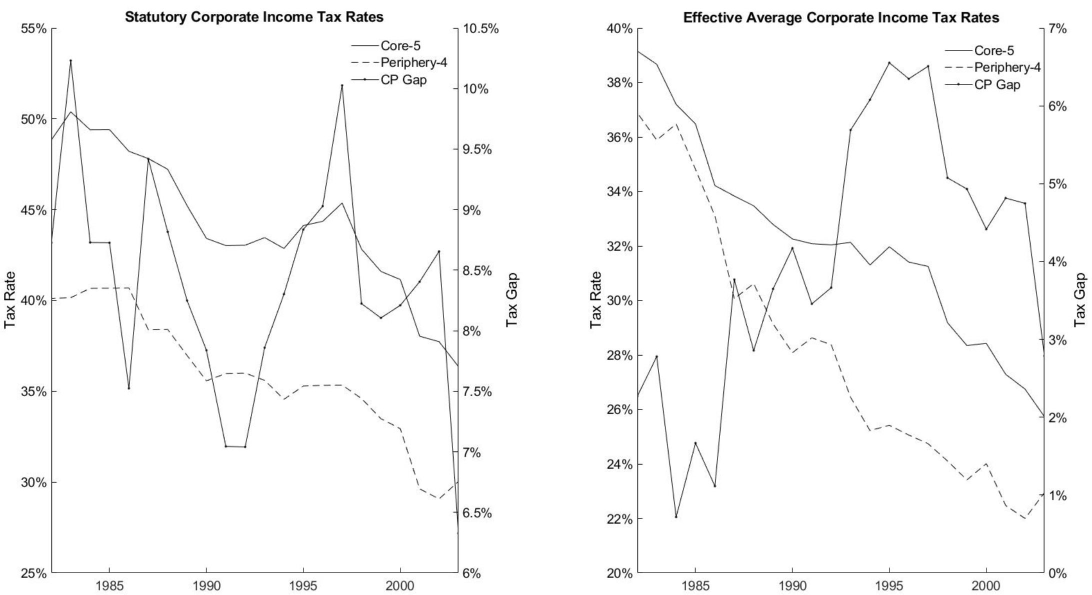

Figure 1: The panel to the left shows the development of the unweighted average statutory corporate income tax rate in both the core-5 and the periphery-4. The panel to the right shows the development of the unweighted average of the effective average corporate income tax rate in the core-5 and the periphery-4. The gap between the two regions is plotted in both panels on the right axis. Data from Devereux and Griffith (2002).

Although I have referred to the corporate income tax rate as if it were a well-defined concept up until this point, this definition requires refinement. In fact, over time many different measures have been proposed to quantify the corporate tax rate as the best known metric, the statutory corporate tax rate, does not accurately capture the fact that it is common practice to give corporations tax credits or allowances which serve to reduce the actual tax burden. As such, a fall in statutory tax rates need not necessarily be to the detriment of a country if it were to simultaneously increase the tax base by decreasing tax credits or allowances (Devereux and Sørensen, 2006). Three measures that can compensate for such simultaneous rate slashing and base broadening are the effective marginal tax rate (EMTR), the effective average tax rate (EATR) and the corporate-tax-revenue-to-GDP ratio. Like the rationales above, each metric has again its advantages and drawbacks. In this section I choose to look at the EATR. The primary reason for choosing this rate is the fact that it is in line with the way the corporate tax rate has been incorporated in the model in section 3.[6]

[6]This is not the only reason for looking at the EATR rather than the corporate-tax-revenue-to-GDP ratio or the EMTR. For instance, the corporate tax revenue to GDP ratio requires far less assumptions than the computation of the forward looking EATR. However, the ratio can vary not just because of firm activity and their tax payments. Moreover, the metric is not robust to weighting and can provide evidence for any trend. The EMTR and the EATR by contrast require similar assumptions regarding the rate of depreciation, how investments are financed, the required rate of return and the inflation

Figure 1 shows that both the statutory corporate income tax rate and the EATR share a similar downward trend. In fact, the EATR fell with about 13% during two consecutive decades. Moreover, it is clear that over the period 1980-2000 the statutory tax rate exceeds that of the EATR which is consistent with the observation that governments grant tax exemptions, tax credits and write-off allowances to firms. Hence, it would appear that the cutting of tax rates have not been fully compensated by base broadening attempts. Another striking feature is that the difference in the EATR between the core-5 and the periphery-4 is strictly positive and exhibits a bell-shape.[7] It is important to note that the capital abundant (core) countries typically have higher corporate tax rates. It is this feature that is particularly troublesome for the rationales involving increased capital mobility and greater electoral influence. In particular, Baldwin and Krugman (2004) show that standard tax competition models indicate that countries with lower tax rates should attract more capital. Similarly, political economic based rationales imply that tax rates in countries with many capitalists should be lower (Persson & Tabellini, 1992). This brings us to the following two stylised facts:

F1: The effective average corporate tax rate has been declining over the period 1980-2000 across Europe, both in the periphery and the core.

F2: The effective average corporate tax rate is higher in the core than in the periphery in Europe over the period 1980-2000, although this difference increased up until 1994 and decreased thereafter.

Although the introduction to this section shortly touches upon the division of capital between the two regions, it is evident that both regions have some capital. That is to say, there is a partial periphery and a partial core rather than a pure periphery and a pure core. Here, pure refers to the notion that the pure core has all capital. In addition, similar countries may choose to set there tax rates differently such as the Netherlands and Belgium, Norway and Sweden and Austria and Switzerland. Again, this last fact runs contrary to the standard capital competition models that are based on increases in capital mobility (Baldwin and Krugman, 2004). In specific, countries that are similar are in such models predicted to have equal tax rates. Therefore, two additional stylised facts are:

F3: The effective average corporate tax rate can be different between countries that are relatively similar.

F4: The effective average corporate tax rate gives rise to the result that capital is present in both the core and the periphery, that is there exist partial agglomerations and not pure agglomerations.

2.2 Trends in trade costs

That tax rates have thus been declining seems evident in light of the discussion above. However, for economic integration to have played any role therein we need that economic integration has been increasing during the period studied above. The question then becomes how we should quantify economic integration. Generally economic integration or goods market integration requires an estimate of the costs of trade. This would typically require information regarding local and foreign infrastructure, the logistics sector, tariff and non-tariff bariers (NTBs), procedural delays and the opportunity costs thereof, to just name a few.[8] Extensive data on these sources of trade costs are generally not available

rate. However, whereas the EMTR is useful for considering firm investment decisions at the margin the EATR is more informative for discrete location decisions as used in the model in section 3 (Devereux and Hubbard, 2003). In addition, it is what the government collects on average rather than at the margin that matters for its ability to meet its objectives. Devereux and Sørensen (2006) provide a detailed discussion on how these measures are constructed and their reliability/relevance.

[7] Note that this is consistent with the observation of Baldwin and Krugman (2004). However, they use the tax revenue to GDP ratio rather than the EATR.

[8] See Moïsé and Le Bris (2013) for a more exhaustive list of the types of costs to which international transactions are subject.

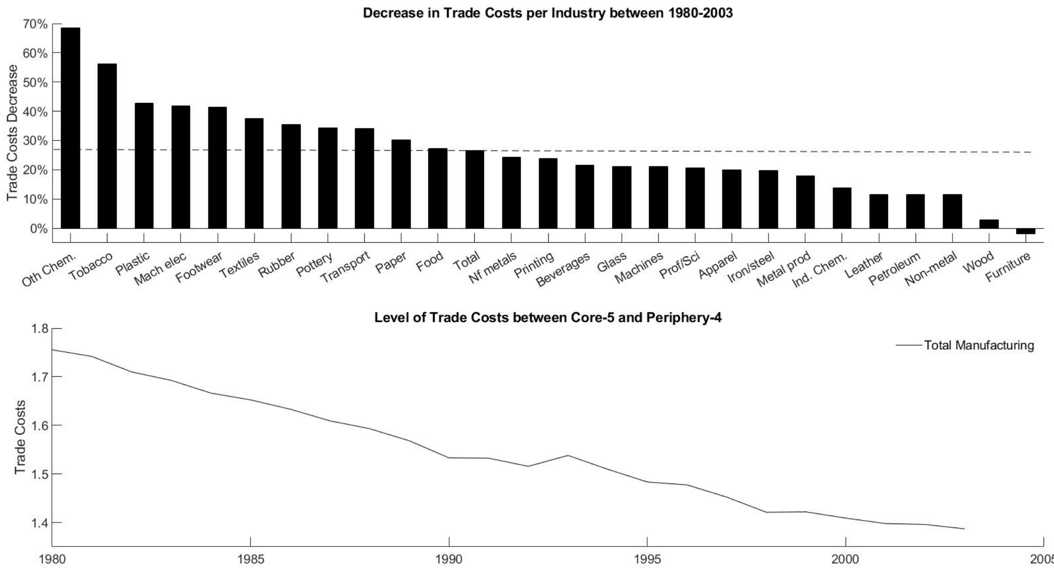

Figure 2: The top panel shows the percent decrease in model-consistent trade costs between the core-5 and the periphery-4 over the period 1980-2003 for 24 industries (excl. miscellaneous and miscellaneous petroleum). The bottom panel shows the development of the level of trade costs between the core-5 and the periphery-4 for the total manufacturing sector. After 2000 the internal flow of Greece is not reported any longer and trade costs have thus been estimated using only Spain, Portugal and Ireland.

(Head and Mayer, 2000; Chen and Novy, 2012). As such it has been common practice to rely on model-consistent indirect estimates instead. In specific, Chen and Novy (2012) document that for a relatively wide variety of models trade costs in the form of iceberg transport costs[9] can be indirectly inferred from the trade volumes between two countries or regions, depending on the adopted utility functions and production technologies.

Although the model by Borck and Pflüger (2006) is not one of the models discussed by Chen and Novy (2011), it is possible to show that the trade flows implied by this model is isomorphic to those described by Chen and Novy. Given that direct measures are neither readily available for the countries listed above, nor for the specific subdivision of Europe that has been chosen in section 2.1, I instead resort to inferring trade costs from trade data. The data used here has been obtained from the Trade-Production database of CEPII, which contains bilateral trade flows for 26 manufacturing industries across 225 countries during the period 1980 to 2006 (De Sousa, Mayer, & Zignago, 2012). The absence of bilateral trade flow data for sectors other than those in the manufacturing sector does not pose a large problem to the analysis as the trade costs in the model are assumed to be on manufactured commodities. Consistent with the model described by Borck and Pflüger (2006), it can then be shown that the level of trade costs between region i and j, denoted by τ_{ij}, can be computed as $\tau_{ij} \equiv (x_{ii}x_{jj}/x_{ij}x_{ji})^{1/2\sigma}$, where x_{ij} is the trade flow from region i to region j and σ denotes the elasticity of substitution between the manufacturing varieties.[10]

To compute internal trade flows I add to the internal flows of the countries that make up a region the trade flows between the countries in said region and impose that internal flows be positive.[11] The procedure for obtaining bilateral trade flows between the core-5 and the periphery-4 involves simply

[9]That is, trade costs are proportional to the value of the item that is being traded. Similarly, one can interpret such trade costs a a constant fraction of goods being lost in transit.

[10]The derivation of the implied trade trade costs measure is provided at the end of Appendix A.

[11]Some countries in the sample such as Belgium and the Netherlands for instance reexport giving rise to negative net of export internal flows. In addition, this assumes that internal trading frictions are negligible which is most probably not true. As such, these trade costs give a 'back-of-the-envelope' impression of the development of trade costs.

adding the trade flows between any country in a region to any country in the other region. Using the same elasticity of substitution as I use for model calibration in section 3 (i.e. setting $\sigma = 6$) trade costs can then be derived with relative ease. As expected, Figure 2 shows that trade costs have declined for almost every manufacturing industry except for the manufacturing of furniture over the period 1980 to 2003. Moreover, at the beginning of the 1980s trade costs for the manufacturing industry as a whole were about 75% of the value of the product being traded. However, at the turn of the millennium these trade costs had fallen substantially to about 38% of the value of the product being traded.[12]

One might wonder whether the fall in trade costs documented in Figure 2 is merely a product of the specific model and industry that has been chosen. In general, the gravity based estimates in Figure 2 are relatively robust to different modelling assumptions given that many of the most recent models in international trade have isomorphic trade costs expressions as shown by Chen and Novy (2011). As such, using a different model than that described in section 3, Jacks et al. (2008) also document falling trade costs albeit of a slightly smaller magnitude.[13] Moreover, since Jacks et al. (2011) do not exclude agricultural sectors it would seem that limiting our scope to only the manufacturing sector has not misrepresented the general tendency in trade costs. Nevertheless, it may have caused the level of trade costs presented above to be slightly understated as trade costs on agricultural goods have been typically larger and more stable than those on manufactured goods (Tombe, 2015; Arvis et al., 2013). In fact, a trade cost of 38% is on the low end as Chen and Novy estimated manufacturing trade costs to be at 110% between 11 EU member states during 1999-2003.[14]

Yet, could it be that the decrease in the indirect trade cost estimates is simply an artifact of the recent theoretically inspired trade literature? Although no conclusive case can be made this is unlikely to be the case. In fact, direct measures of trade costs tend to support the idea that trade costs have been declining during the period 1980 to 2003 as well. In particular, Hummels (2007) documents that *ad valorem* transport costs have been decreasing due to technological improvements since 1984 for ocean freight and the beginning of the 1970s for air freight. Both air freight rates as well as the ocean freight rate for bulk goods have fallen substantially since 1970.[15] However, for non-bulk goods ocean freight rates have not come down as much since the invent of containerisation around 1950. Instead Hummels (2007) argues that the main decrease in transport costs for those commodities stems from the reduced shipping times. These cost savings appear quite substantial as Hummels and Schaur (2013) document that each day a good is in transit amounts to a 2% *ad valorem* tariff for manufactured goods and a 3.1% for agricultural goods. A difference that can probably be attributed to the fact that agricultural produce is more perishable. In addition, other forms of trade costs between the two regions, such as tariff barriers and non-tariff barriers, have also been reduced throughout the EU as a result of the Single Market Program. Therefore, direct measures of trade costs also seem to indicate that trade costs have fallen strongly over the period 1980-2003.As such, we derive two additional stylised facts:

F5: Trade costs have been substantially declining by about 36 percentage points during the period 1980-2003, based on indirect trade costs measures.

F6: Trade costs have fallen but remain probably above 38% of the value of the product being shipped, based on indirect trade costs measures.

[12]Note that due to assuming that there exist no internal trade frictions within the regions this would probably decrease the absolute level of trade costs.

[13]Their trade cost index indicates a decline of about 25% in trade costs for France during the second globalisation wave.

[14]This difference is predominantly due to the fact that they also include the UK and use sector specific elasticities of substitution/adjusted productivity heterogeneity parameters. Other studies such as that of Anderson and van Winscoop (2004) estimate for US-Canada trade in 1993, including agricultural exports, an ad valorem tariff equivalent between of 35%-95% depending on σ. Similarly, Eaton and Kortum (2002) estimate trade costs between 19 OECD countries to range between the 47% and 174%. Again the magnitude depends on σ.

[15]Ocean freight rates for bulk goods have shown a decline by about 65%-75% during 1970-1995 (Lundgren, 1996)

2.3 Post hoc ergo propter hoc?

When combining F1 and F5 presented above we obtain an unambiguous association between declining trade costs (increasing globalisation) on the one hand and falling corporate income tax rates on the other. However, this begs the questions whether it is a mere association or whether we are indeed observing a causal relationship. In fact, given the estimated increases in capital mobility during the period 1980-2000 (see Zodrow, 2010, for a detailed discussion) one could argue that the declines in the corporate tax rate we have witnessed need not be the result of falling trade costs. To a large extent this notion could be readily justified as some studies indicate that capital mobility has been driving down the corporate capital tax rates. Indeed, a meta-study conducted by Adam et al. (2013) using 23 papers regarding the empirical impact of globalisation on capital tax rates documents that recent studies tend to find a negative relation between capital mobility and corporate tax rates when using the Quinn (1997) index of capital mobility. This result turns out to be rather robust as also Haufler and Wooton (1999), Winner (2005) and Bretschger (2010) find that capital mobility tends to decrease the corporate income tax rate that is levied using various metrics.

Nevertheless, a vast part of the empirical literature also employs trade openness as a measure for globalisation. Such measures are arguably more closely linked to goods market integration, i.e. falling trade costs, instead of capital market integration. Adam et al. (2013) note that more recent papers which employ trade openness metrics also tend to report that there exists a negative relationship between globalisation (good market integration) and capital tax rates. As such, capital mobility need not necessarily be the only force driving down tax rates. Moreover, this is also in line with the notion that at lower levels of aggregation there seems to be strong evidence that agglomeration economies matter across the EU for setting the corporate income tax rate purposes, it would seem reasonable if economic integration would have had some impact given that the New Economic Geography literature indicates it to be a key determinant for the strength of agglomeration economies.[16] Nevertheless, the NEG literature does not seem to be able to rationalise the stylised facts presented in section 2.

More specifically, Baldwin et al. (2003) note that the agglomeration rent in many CP models and derivatives thereof is typically bell-shaped. As such, Baldwin and Krugman (2004) find that at high trade costs the tax rate of the core increases while at low levels of trade costs the tax rate of the core decreases. Meanwhile, the tax rate in the periphery does not change as their model admits only pure agglomerations and the optimal tax rate for Foreign is thus zero. The are three important observations already. First, the fact that traditional CP models admit only pure agglomerations clearly violates F4. Second, the implication that the tax rate of the periphery has remained constant violates F1. Third, the fact that the tax rate in Home must have been increasing to give rise to the observed bell shaped tax differential also violates F1. Moreover, given that (1) firm-level/municipality-level studies have found that a fall in trade costs serves to increase the corporate tax rate and that (2) trade costs between municipalities or within a country are typically smaller than between countries, we would expect a fall in trade costs to only increase the tax rate in the core. That is, we are still on right, upward sloping part of the bell where trade costs are relatively high. Hence, CP models are not able to provide a consistent rationale for the bell-shaped difference in taxes between the core and the periphery, violating F2.

Borck and Pflüger (2006) subsequently extended the conclusions of Baldwin and Krugman (2004) to a Footloose Entrepreneur (FE) model that admits partial agglomerations. However, this in and of itself does not serve to remedy any of the violations of the stylised facts mentioned above. In fact, the relevant equilibria in their paper for which a bell-shape is observed are pure agglomeration equilibria. In addition, simulations of the model by Borck and Pflüger (2006) show that for reasonable calibrations

[16] Studies using firm-level/municipality-level data consistently show that agglomeration economies, that is hubs, set their taxes in excess of the peripheries in France (Fréret,& Maguain, 2017), Belgium (Crabbé,& de Bruyne, 2013), Spain (Jofre-Monseny, 2013) and Germany (Koh, Riedel, & Böhm, 2013). Although little empirical research pertains to the importance of agglomeration economies across countries regarding tax rate setting, this view does have some support across a sample of OECD countries (Garretsen, & Peeters, 2007) and the EU-15 (Hansson, & Olofsdotter, 2013).

the core only starts to reduce its tax rate once trade costs fall below 17.5% of the value being shipped, while the periphery then sets its tax rate at zero as at such low trade costs the equilibria are pure-core and pure-periphery equilibria. Despite the fact that the model by Borck and Pflüger thus admits partial agglomerations it still violates F1, F2, F4 and F6. Similarly, Haufler and Wooton (2010) extend the analysis of Baldwin and Krugman to Footloose Capital (FC) model in which capital is owned by a third party and where there is trade in homogeneous goods under oligopolistic competition. Under these conditions they find that at high trade costs the corporate tax rate may fall in response to a decrease in trade costs. However, one major drawback in such analysis is that the FC model sacrifices many realistic features of traditional CP models (Baldwin et al., 2003) in favor of analytical tractability. In fact, they assume that capital is owned by a third party, while generally domestic investment tends to strongly exceed foreign investment. In addition, their model implies that the tax differential ought to be U-shaped instead of bell-shaped, thereby violating stylised fact F2.

Despite the empirical evidence it would thus seem that the NEG literature does not support the idea that falling trade costs can have been driving the observed declines in the corporate tax rates. In the remainder of this paper I will however argue that a causal relationship between the fall in corporate income tax rates and the fall in trade costs, while still at high levels (F6), can be justified using agglomeration based narrative. Furthermore, the theoretical justification for such a causal relationship given in this paper stems from the fact that trade costs can influence what type of capital, in terms of mobility, is displaced. In specific, as trade costs fall countries start to compete over more mobile types of capital and the capital that moves at the margin becomes the more mobile type of capital. Therefore, the rationale given in this paper effectively implies that the competing rationales based on capital mobility and trade costs need not compete at all. In fact, I argue that part of the observed changes in capital mobility can actually be caused by changes in trade costs. Therefore, the distinction that it is capital mobility that is driving the observed declines in corporate tax rate may be true in the sense that it is directly causing the changes. However, capital mobility can also mediate between trade costs and corporate tax rates. As such, the reason for why corporate tax rates have fallen during the 1980s and the 1990s is probably more intricate than previously thought.

3 The Model

To be able to model corporate tax setting in the presence of agglomeration economies it is necessary to explicitly model the location decisions of firms. To that end Krugman (1991) introduced the core-periphery (CP) model in which firm location, and thus agglomeration, is endogenously determined. One major drawback to such models is that they typically cannot be solved analytically and as such do not readily lend themselves for detailed analysis. The reason that such models are generally difficult to solve is due to the fact that the return to capital determines the manufacturing prices (Baldwin et al., 2003). As such, numerous alterations have been proposed giving rise to two prominent classes of models: the footloose capital (FC) model and the footloose entrepreneur (FE) model. The idea of both types of models is however essentially the same, they impose assumptions to create independence between the return to capital and the manufacturing prices. Yet, where the FE style models preserve most features of the CP models, the FC style models tend to lose more CP features as they additionally impose that capital income is repatriated.

In this paper I will use a FE model developed by Borck and Pflüger (2006) for two reasons. First, it preserves some analytical tractability whilst not deviating too far from the canonical CP model. Second, in contrast to standard FE and CP models it allows for partial agglomerations to arise which is arguably more realistic (see F4). As such, most of the description of the model given below is analogous to that in Borck and Pflüger, except for the implementation of rigidity's in the location decision of capital. This section will start with laying out the physical environment and continues by briefly justifying the parameter calibration used in subsequent sections. At the end of this section I will then specify the sequencing of events in the model.

3.1 The physical environment: households, firms and governments

Following Pflüger (2004), the world is divided into two regions, Home and Foreign[17], each inhabited by households that are either endowed with a unit of labour (L), called the labourers, or with a unit of capital (K), called the capitalists or entrepreneurs. However, whereas the labourers cannot change their location, capitalists can change their location. Despite this marked difference both types of households share the same quasi-linear preferences over a manufactured good (C_X) and an agricultural good (C_A). That is,

$$U_h \equiv \alpha \ln(C_{X,h}) + C_{A,h},\ C_{X,h} \equiv \left(\int_0^N x_{i,h}^{\frac{\sigma-1}{\sigma}} di + \int_N^{N+N^*} x_{j,h}^{\frac{\sigma-1}{\sigma}} dj \right)^{\frac{\sigma}{\sigma-1}},\ \alpha > 0,\ \sigma > 1 \tag{1}$$

where the manufactured good consists out of a combination of domestic manufacturing varieties (x_i) and foreign manufacturing varieties (x_j), and where $h \in \{L, K\}$ denotes the household type.[18] On the basis of the utility that a capitalist household gets in Home and in Foreign it will then choose whether it is beneficial to change its location. However, changing location is costly as the capitalist would faces several obstacles when relocating such as language, cultural and informational barriers. In addition thereto capitalists that reallocate may also be confronted with a higher cost of doing business as compared to native capitalists since they can have less access to local financial institutions or simply face a greater cost of complying with regulation.[19] Hence, for capitalist s to move it needs to be the case that the change in utility due to moving exceeds its cost of relocating, denoted with $\mu_s > 0$. Equation 2 then gives the condition on which a capitalist of type s moves from Home to Foreign (first expression) and from Foreign to Home (second expression),

$$U^*_{Ks} - U_{Ks} - \mu_s > 0 \text{ or } U_{Ks} - U^*_{Ks} - \mu_s > 0 \tag{2}$$

Here it is important to note that equation (2) explicitly allows for the fact that not all capitalists face the same relocation costs. For the purpose of tractability, but without loss of generality, let us assume that there exist only two types of capitalists, i.e. $s \in \{1, 2\}$. In addition, to contrast the analysis with that of Borck and Pflüger (2006) let us set $\mu_1 = 0$ and $\mu_2 > 0$ such that there is one type of capitalist that is perfectly mobile and another type of capitalist that is not. The total number of capitalists in each region is then denoted by $K^{(*)} \equiv K_1^{(*)} + K_2^{(*)}$ where the subscript signifies the type of capitalist and the prevalence of the perfectly mobile capitalists is then denoted by $\eta \equiv (K_1 + K_1^*)/(K + K^*)$. It is furthermore convenient to also define the share of capitalists in Home as $\lambda \equiv \lambda_1 + \lambda_2$, with $\lambda_1 \equiv K_1/(K+K^*)$ and $\lambda_2 \equiv K_2/(K+K^*)$. Whereas every capitalist is mobile across regions, albeit that some are more mobile than others, capitalists are assumed to be immobile across sectors as capital is only used in the production of manufacturing varieties. Moreover, the agricultural sector requires one unit of labour per unit of output, that is $L_A = C_A$, whereas the production of a manufacturing variety requires one unit of capital (irrespective of type) and labour proportional to the amount of the variety produced, that is $L_i = c(X_i + X_i^*)$.[20]

[17] Here Home represents in essence the core-5 and Foreign represents the periphery-4. As per convention Foreign is denoted with an asterisks.

[18] Here the utility function of each household depends on its consumption of the agricultural good and the manufactured good. Since the parameter α and the prices are assumed household invariant, heterogeneity in the consumption of either good can thus be ascribed to the income of each household. In what follows the parameters are chosen as to have $C_{A,h} > 0$ for every household. Since $C_{X,h}$ is then void of any income effect we have that $C_{X,h} = C_X$ (same applies to the varieties).

[19] See for instance Michelacci and Silva (2007) for reasons why local capitalists (entrepreneurs) have an advantage over non-local capitalists (entrepreneurs).

[20] The total demand for variety i at Home is denoted by X_i and in Foreign by X_i^*

In addition, the two sectors differ furthermore in the market structure that is assumed. The CES preferences across differing manufacturing varieties in the household utility function effectively provides the firms that produce the manufacturing varieties with some market power, therefore giving rise to monopolistic competition in the manufacturing industry. By contrast, the agricultural commodity is assumed to be homogeneous. Hence, given constant returns to scale in the agricultural industry and free entry and exit, said industry is effectively one with perfect competition. As such, the production technology assumed for the agricultural sector then imposes that the income of a household with labour is unity, independent of whether it chooses to be employed in the manufacturing or the agricultural sector.[21] Note that one could alternatively also normalise the price of the agricultural good to unity as these two ways of normalising are equivalent.

The earnings of a capitalist, which we denote with R, is yet to be determined. Let a firm producing a manufacturing variety i be able to charge a different price in each region and let it reimburse the capitalist with some fixed amount R. Then the profit made by said producer of variety i, where foreign total demand X_j^* already accounts for the trade costs τ that are incurred in shipping ones variety, can be written as:

$$\pi_i(P_i, P_i^*) = (P_i - c)X_i + (P_i^* - c)X_i^* - R \tag{3}$$

Any split of the profits left after compensating the labour that has been employed in production is feasible and agreeable to both the producer and the capitalist. That is, $R \in (0, (P_i - c)X_i + (P_i^* - c)X_i^*]$. To then uniquely determine R we impose that the capitalist acts as if it were to own the firm.[22] That is, the firm optimises its profits while treating R as fixed and the payment to the capitalist is subsequently set equal to the profits that remain after having paid the wage bill. Alternatively, Borck and Pflüger (2006) interpret R to enforce a zero profit condition in the manufacturing sector. Although, the framework so far enables us to determine the income of both types of households, we have not yet explicitly discussed why the location decision of capitalists matters.

In the current model the location decision is primarily driven by the classical proximity versus concentration trade-off and a difference in tax rates. In particular, locating near to ones customers increases demand for ones variety as these are no longer subject to trade costs as well as reduces the price of the foreign varieties which the capitalist consumes. However, if capitalists concentrate together in a single region this may also serve to reduce profits as competition becomes fiercer. Hence, in this simple model the incentives for the capitalist to relocate stem purely from the trade costs that are incurred in shipping ones variety to the other market. In what follows it is assumed that the cost of transporting a good between the two regions is symmetric and proportional to the value of the commodity being shipped, that is they are iceberg trade costs. That is, if a product is being shipped only $1/\tau$ units of said product arrives at its destination. In order to keep the analysis tractable it is further assumed that only manufacturing varieties are subject to such trade costs, and that the agricultural good can be traded freely.

Despite the fact that the discussion regarding trade costs has revealed that agricultural goods are probably subject to considerable trade costs, this assumption serves to simplify the analysis in subsequent sections as it induces wage equalisation. Hence, since there are no differences in labour costs, wages cannot drive the relocation decisions of firms. This is however at odds with much of the literature examining the choice of firm location in the EU during the 1990s, see for instance Braconier and Ekholm (2002), Bevan and Estrin (2004) and Bellak et al. (2008). Nevertheless, since the core-5 is larger than periphery-4 in terms of labour endowment this would appear to strengthen agglomeration

[21] Naturally this requires that labour is employed in the agricultural sector and thus not all labour should be absorbed by the manufacturing industry. This does matter for the possible values of the parameter estimates (see Borck and Pflüger, 2006). In the remainder all parameter values are chosen such that this condition is satisfied.

[22] This is the reason that these models are typically referred to as footloose entrepreneur models: the capitalist acts as the entrepreneur.

forces by lowering the price of the agricultural good and reducing the cost of labour in the core-5 vis-à-vis the periphery-4. Assuming that such agglomeration forces are not strong enough to render partial agglomerations unstable, this would then leave the remainder of the analysis largely unchanged. As such, although allowing for trade costs in the agricultural sector would promote realism, it would also reduce the tractability sought after by employing a FE model without apparently changing any of the results of the analysis.

Finally, the taxes levied on the income of capitalists by the government in each region can also influence the location decision of capitalists. In particular, the income that the capitalist receives is taxed by the government of the region where it resides and is equivalent to a tax per unit of capital. That is, a capitalist residing in Home (Foreign) obtains an after tax income of $R - t$ ($R^* - t^*$). In contrast to most of the public finance literature the government does not provide a public good and as such we cannot derive a social welfare function. In fact, in this model taxation would be purely wasteful as the tax revenue is not used for the provision of a public good or redistribution. Instead, following Baldwin and Krugman (2004) and Borck and Pflüger (2006) a quadratic social welfare function is adopted which depends positively on the income generated by the tax and negatively on a squared term of the level of taxation.

$$W(t, K) = Kt - \frac{t^2}{2}, \quad W^*(t^*, K^*) = K^*t^* - \frac{(t^*)^2}{2} \tag{4}$$

This last term essentially represents some form of dead weight loss (DWL) caused by the tax as if the government would provide some public good while distorting household consumption. The reason for this simplifying modelling choice is threefold. First, given the fact that this model does not aim at explaining the changes in taxes due to political reasons, the inclusion of an endogenous social welfare function would serve to unduly complicate the analysis as compared to adopting one with commonly found features.[23] Second, the inclusion of a public good in the household utility function would serve to create a so-called amenities linkage (Baldwin *et al*, 2003) which effectively provides another incentive to agglomerate. Again, as long as such an amenities linkage is not too strong, the analysis would continue to yield the same insights. Third, adopting such a welfare function is conventional in the NEG taxation literature rendering this paper comparable thereto. Hence, the reason for imposing the welfare function above is akin to the assumption regarding trade costs on agricultural products. It preserves simplicity and parsimony without effectively compromising on the generalisability of the results documented in the paper. Finally, to mute trade cost induced catastrophe I assume that there exists a political penalty in Home for loosing the core such that keeping the core is incentive compatible for any level of trade costs.[24]

3.2 Sequencing of events

To solve for the equilibrium taxes it is necessary to specify when all actors make their choices. In the model considered in the paper the timing is as depicted by the game tree below. First the government of Home sets its taxes after which the Foreign government sets it taxes. Hence, the tax game is essentially a Stackelberg game where Home (core-5) is the leader and Foreign (periphery-4) is the follower. Given the tax rates the capitalists then decide where to locate and thus determine the share of capitalists in each region, i.e. λ. Here it is assumed that the most mobile type of capitalists move first. Given the allocation of capital that has then come about, firms then decide what to charge their customers in response to which the customers, capitalists and labourers in both regions, adjust their optimal consumption bundle.

[23]Note that this would involve weighing the utility of labourers, native capitalists and non-native capitalists, possibly differing by mobility.

[24]This is an assumption Borck and Pflüger also make although they do not list this explicitly. The significance and implication of this assumption will be elaborated upon in section 6.

Using backward induction we can then solve for the equilibrium tax rates of the governments. Hence, to find all equilibria of the game described above we effectively rely on the notion that for a game with perfect recall, a finite number of players and all actors choosing sequentially there must exist a sub-game perfect Nash equilibrium (Tadelis, 2013). This also explains one striking deviation from the traditional taxation literature: instead of setting taxes simultaneously (Cournot tax game), taxes are set sequentially (Stackelberg tax competition). This has been done to induce sequential choice and thus guarantee the existence of a sub-game perfect Nash equilibrium. If one were to opt for Cournot competition in the tax game instead, then the fact that the number of choices of the agents is not finite and that the share of capitalists located in Home (λ) in equilibrium is not continuous over the tax spaces could, and will (see Borck and Pflüger, 2006), render the notion of a sub-game perfect Nash equilibrium insufficient to solve the game posed above. Therefore, we adopt Stackelberg competition in tax rates, where Home (core-5) sets its tax rate first.

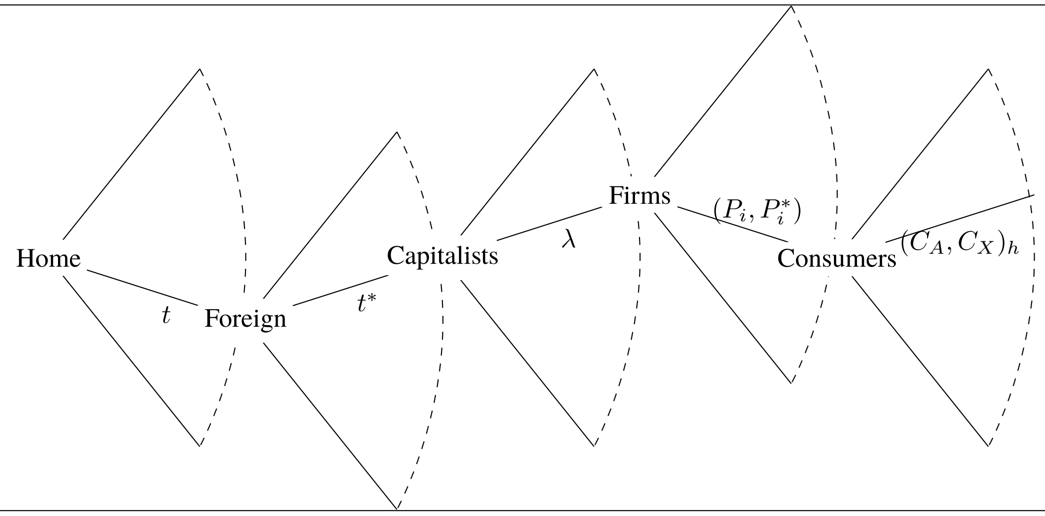

Diagram 1: Game tree representing the timing of events in the sequential game as well as the choices and players. Please note that all capitalists are also consumers.

The analysis in the remainder of the paper will be based on finding the Nash Equilibrium in three sub-games. First, the equilibrium on the goods market will be characterised in section 4. In specific, with equilibrium on the goods market it is meant that (1) households choose there consumption bundles optimally and (2) firms set prices to maximise profits, while treating the allocation of capitalists (λ) and tax rates (t and t^*) as given. Second, section 5 will then be aimed at determining the equilibrium allocation of capital taking into account the goods market equilibrium that corresponds to said allocation, while treating the tax rates as given. Third, section 6 is devoted to studying the tax equilibrium where governments take into account the implications of their tax rates on the allocation of capitalists as determined per section 5.

3.3 Choice of parameters

In order to solve the model we need to set the share of expenditures of a labourers income on manufactured goods (α), the elasticity of substitution (σ) and the relative amount of labour to capital in each region ($\rho \equiv L/(K + K^*)$ and $\rho^* \equiv L^*/(K + K^*)$). For the purpose of comparability I use the parameters as chosen by Borck and Pflüger (2006). In specific, they choose $\alpha = 0.3$, $\sigma = 6$ and $\rho = \rho^* = 1$. Here $\alpha = 0.3$ implies that the final consumption of manufactured goods is about 30% of the expenditures of Labourers. Using the 2006 World Input-Output Tables (WIOT) this fraction is relatively reasonable given that the average of expenditures on manufacturing goods (C-class sectors) in final consumption by households is about 24% and ranges from roughly 9.5% in Luxembourg to 43.9% in Romania. The average has however slowly risen up to today rendering $\alpha = 0.3$ rather acceptable. For the elasticity of substitution parameter less straightforward evidence is available since the model employs a less conventional upper-tier utility function that is not CES-based.

Nonetheless, if we ignore this issue, typical estimates depend greatly on which type of manufacturing industry is chosen (Feenstra, 1996). For instance, the landmark study by Broda and Weinstein (2006) regarding the elasticity of substitution between manufacturing varieties documents an average elasticity of substitution in manufacturing industries of 6.8 on the SITC-3 level with a standard error of about 1.2. Likewise, estimates by Hertel et al. of the elasticity of import substitution (which is the same as σ in the model), also averages around 7.0 using the 40 manufacturing sectors in global trade analysis project (GTAP). In addition, Romalis (2007) finds that the mean elasticity of substitution varies between 6.2 and 10.9. Among EU manufacturing sectors in specific, about 31.9% of industries have a elasticity of substitution between 5 and 7, and the average elasticity of substitution is roughly 7.1. Hence, the choice for $\sigma = 6$ is quite agreeable, albeit somewhat at the low end.

In our model the labour-to-total-capital ratios are set to equal unity. That is, $\rho = \rho^* = 1$. This would signify that there are twice as many labourers as there are capitalists (entrepreneurs). To put this into perspective, a study by Michelacci and Silva (2007) finds that for Italy and the US that there are circa three times as many Labourers as there are Capitalists (entrepreneurs). This is due to the fact that about 23% of the US working population are entrepreneurs, whereas 77% are either blue or white collar workers according to the last US census. Even though extrapolation of these figures for the remainder of the core-5 and the periphery-4 would imply that $\rho = \rho^* = 1.5$ is more reasonable if the labour market in both regions are of equal size[25], I choose to set $\rho = \rho^* = 1$. This is primarily due to the fact that I aim to preserve comparability with Borck and Pflüger (2006) and that changing ρ and ρ^* has minimal effects on the numerical simulations. Furthermore, good estimates of the cost of relocation do not exist to the best of my knowledge (see Zodrow, 2010, on this matter) and I simply impose that type 1 capitalists are perfectly mobile ($\mu_1 = 0$) and comprise 15% of the capitalist population ($\eta = 0.15$) for the purpose of exposition. Type 2 Capitalists are assumed to be imperfectly mobile ($\mu_2 = 0.0025$ which is typically 1.67% of the capitalist their income).

4 The Goods Market Equilibrium

First, we consider the demand for the agricultural and composite manufactured good per household type. Each household needs to choose the optimal amount of $C_{A,h}$ and C_X given its income, Y_h, the price level for the agricultural good (which is unity by assumption[26]) and the price level of composite manufactured good denoted by P. As such, the consumer has the following decision problem:

$$\max_{C_{A,h},C_{X,h}} U_h(C_{A,h}, C_{X,h}), \quad \text{s.t.} \quad C_{A,h} + PC_{X,h} \leq Y_h \tag{5}$$

Since U_h is locally non-satiated we have that the constraint binds and we find that it is optimal for the household to choose $C_{A,h} = Y_h - \alpha$ and $C_{X,h} = C_X = \alpha P^{-1}$ if $Y_h - \alpha \geq 0$ which is satisfied with parameter values described in section 3.3 and $C_A = 0$ and $C_X = Y_h P^{-1}$ otherwise (see appendix A for derivations). However, in order for the household to be able to consume as many units of the composite manufactured good as possible, it will want to minimize the price paid for each unit of the composite manufactured good by choosing the amount used of each variety. As such, the household faces a second decision problem:

$$\min_{\{x_i\}_{i=0}^{N},\{x_j\}_{j=N}^{N+N^*}} \int_0^N P_i x_i di + \int_N^{N+N^*} (\tau P_j) x_j dj \quad \text{s.t.} \quad \left(\int_0^N x_i^{\frac{\sigma-1}{\sigma}} di + \int_N^{N+N^*} x_j^{\frac{\sigma-1}{\sigma}} dj \right)^{\frac{\sigma}{\sigma-1}} = 1 \tag{6}$$

[25]Since the core-5 is larger in terms of its labour force than the periphery-4 this is not wholly accurate. I will return to this fact however in the discussion of the results.

[26]This is due to the fact that the agricultural sector is perfectly competitive. As such, we have that P_A equals the marginal cost of producing the agricultural good which is, given the production technology, equal to the wage earned by a labourer.

where the objective function is the price level of the manufactured consumption good (P), $\tau > 1$ represents the trade cost parameter and the subscript h on the manufacturing varieties has been dropped. This decision problem represented by equation (6) then yields the demand for the manufacturing varieties, $\left\{\{x_i\}_{i=0}^{N}, \{x_j\}_{j=N}^{N+N^*}\right\}$, per unit of the composite good C_X. Finally, these demands can then be scaled with the number of composite manufactured goods the household optimally wants to consume to find the per household demand for each variety.[27]. Abusing notation slightly, let $x_i^{(*)}$ and $x_j^{(*)}$ now denote the per household demand in Home (Foreign) for variety i produced in Home and variety j produced in Foreign, respectively. Then the demand for such varieties is,

$$x_i = \alpha P_i^{-\sigma} P^{\sigma-1},\ x_j = \alpha(\tau P_j)^{-\sigma} P^{\sigma-1},\ x_i^* = \alpha(\tau P_i^*)^{-\sigma}(P^*)^{\sigma-1},\ x_j^* = \alpha(P_j^*)^{-\sigma}(P^*)^{\sigma-1} \tag{7}$$

As such, since $Y_h - \alpha \geq 0$ we have that the demand for the manufacturing varieties per household is independent of the type of household. Hence, the total demand for variety i in Home can be expressed as $X_i = (L+K)x_i$ and the total demand for variety i in Foreign is given by $X_i^* = (L^*+K^*)x_i^*$. Since the goods market needs to clear, the total demand for a variety needs to equal the total supply for each variety. Hence, in equilibrium the firms set their prices as to maximize profit taking into account how consumers react to there price changes. Therefore the firm producing variety i (i.e. located in Home) needs to set its prices as to:

$$\max_{P_i, P_i^*} \pi_i(P_i, P_i^*) \ \text{ s.t. } \ X_i = (L+K)\alpha P_i^{-\sigma} P^{\sigma-1},\ X_i^* = (L^*+K^*)\alpha(\tau P_i^*)^{-\sigma}(P^*)^{\sigma-1} \tag{8}$$

This yields that $P_i = P_i^* = c\sigma/(\sigma-1)$, which implies that for the household to consume a single unit of the composite manufactured good it needs to pay $P = c\sigma/(\sigma-1)(N+\tau^{1-\sigma}N^*)^{\frac{1}{1-\sigma}}$.[28] Note that the number of varieties is directly linked to the number of capitalists in each region and as such we can effectively replace N and N^* with K and K^*. The above optimisation procedures jointly constitute a equilibrium on the goods market. Yet, to fully characterise the demand for every commodity by each household we still have to determine the gross earnings of capitalists. In line with the discussion in section 3.1 the rent, R (R^*), paid to capitalists in Home (Foreign) is set equal to the profits that remain after compensating labour. That is, we set $\pi_i(P_i, P_i^*) = 0$ where the definition for P has been substituted into the definitions for X_i and X_i^* as per equation 8. From this we find that the payment to the capitalist can then be expressed as:

$$R = \frac{\alpha(L+K)}{\sigma(K+\tau^{1-\sigma}K^*)} + \tau^{1-\sigma}\frac{\alpha(L^*+K^*)}{\sigma(\tau^{1-\sigma}K+K^*)},\ R^* = \tau^{1-\sigma}\frac{\alpha(L+K)}{\sigma(\tau^{1-\sigma}K+K^*)} + \frac{\alpha(L^*+K^*)}{\sigma(K+\tau^{1-\sigma}K^*)} \tag{9}$$

Here it is presumed that the number of capitalists in the world ($K + K^*$) is exogenous (though not its allocation across regions) and can without loss of generality be normalised to unity. As such, we can then rewrite R and R^* in terms of the share of capitalists in Home, λ. Furthermore, let us for notational convenience denote trade openness, $\tau^{1-\sigma}$, with ϕ. Then the expressions for R and R^* can be rewritten to state that:

$$R(\lambda) = \frac{\alpha}{\sigma}\left(\frac{\rho+\lambda}{\lambda+\phi(1-\lambda)} + \phi\frac{\rho^*+(1-\lambda)}{\phi\lambda+(1-\lambda)}\right),\ R^*(\lambda) = \frac{\alpha}{\sigma}\left(\phi\frac{\rho+\lambda}{\phi\lambda+(1-\lambda)} + \frac{\rho^*+(1-\lambda)}{\lambda+\phi(1-\lambda)}\right) \tag{10}$$

Finally, using the expressions that characterise optimal firm and household behaviour we can then write out the pay-offs to the households as functions of the share of capitalists in Home, the tax rates set by the governments and the parameters of the model. In specific, the indirect utility function *before* allowing for any relocation of a household of type $h \in \{L, K\}$ in Home (Foreign), denoted $V_h^{(*)}$, is represented by the following expression:

$$V_h^{(*)}(\lambda, t, t^*) = \alpha \ln \alpha - \alpha \ln P^{(*)}(\lambda) + Y_h^{(*)}(\lambda, t, t^*) - \alpha \tag{11}$$

[27]Here the fact is used that the composite manufactured good is a homogeneous combination of the manufacturing varieties for such scaling to be valid.

[28]To obtain this expression one needs to optimise profits for the manufacturer of variety j, produced in Foreign, as well. See appendix A for details on the derivations.

5 The Location Equilibrium

To find a location equilibrium we need to have that at some allocation of capitalists, λ, no capitalist in Home or Foreign has an incentive to relocate. As described in section 3.1 this occurs whenever $U_{Ks}^* - U_{Ks} - \mu_s \leq 0$ and $U_{Ks} - U_{Ks}^* - \mu_s \leq 0$ for all types of capitalists, that is $\forall s \in \{1, 2\}$. Using the expression derived above for the indirect utility function we can then define that an allocation of capital (λ) constitutes an equilibrium iff:

$$V_K^*(\lambda, t, t^*) - V_K(\lambda, t, t^*) - \mu_s \leq 0 \;\text{ and }\; V_K(\lambda, t, t^*) - V_K^*(\lambda, t, t^*) - \mu_s \leq 0,\ \forall s \tag{12}$$

Equivalently this could also be rewritten as $|V_K - V_K^*| \leq \mu_s$. Therefore which allocations of capitalists constitute an equilibrium allocation can be effectively reduced to studying the behaviour of $V_K - V_K^*$, while treating tax rates as given. Recognising that the net income of a capitalist in Home can be written as $Y_K(\lambda, t, t^*) = R(\lambda) - t$ and that the net income of a capitalist in Foreign can be written as $Y_K^*(\lambda, t, t^*) = R^*(\lambda) - t^*$, it is then possible to write $V_K - V_K^*$ as an explicit function of the share of capitalists in Home, the tax rate set by Home and the tax rate set by Foreign.

$$V_K - V_K^* = \underbrace{\underbrace{\frac{\alpha}{1-\sigma}\ln\left(\frac{\phi\lambda + (1-\lambda)}{\lambda + \phi(1-\lambda)}\right)}_{\equiv \alpha \ln(P^*/P)} + \underbrace{\frac{\alpha(1-\phi)}{\sigma}\left(\frac{\rho + \lambda}{\lambda + \phi(1-\lambda)} - \frac{\rho^* + (1-\lambda)}{\phi\lambda + (1-\lambda)}\right)}_{\equiv R - R^*}}_{\equiv \Omega(\lambda)} - (t - t^*) \tag{13}$$

From equation (13) we know that the benefit of relocating net of relocation costs can be broken down into two parts. The first is an expression involving the allocation of capitalists and the second is an expression of the tax rates in both regions. In this case simply the tax differential. As such, I follow Borck and Pflüger (2006) by first studying the tax game without paying any attention to the impact of taxes (section 5.1-5.3), i.e. setting $t = t^* = 0$, before continuing to study the location equilibrium with taxes that can differ (section 5.4). However, since the possible location equilibria also critically depend on the relocation cost, section 5.1 first addresses the event in which all capitalists are perfectly mobile to which I refer as the standard Borck and Pflüger case. Section 5.2 will then introduce relocation costs by assuming that all capitalists are imperfectly mobile. Finally, section 5.3 will allow for heterogeneous relocation costs thus combining the analysis of sections 5.1 and 5.2.

5.1 The location equilibrium with perfectly mobile capitalists and no taxes

In the absence of a taxes ($t = t^* = 0$) and relocation costs ($\eta = 1$) the benefit of relocation for a capitalist in Foreign is $V_K - V_K^* = \Omega(\lambda)$, while for a capitalist in Home it is $V_K^* - V_K = -\Omega(\lambda)$. Hence, whenever $\Omega(\lambda) = 0$ we have that neither capitalists in Home, nor in capitalists in Foreign, are willing to relocate. Hence, relocation is purely driven by the agglomeration of capitalists in a region, i.e. λ. From section 3.1 it is known that the incentive to agglomerate is driven by two reasons: trade costs and tax differences. Since the latter incentive has been muted in the current analysis, the equilibrium capital allocation is determined solely by trade costs. As a result, the function $\Omega(\lambda)$ is not only highly non-linear in λ, but also very sensitive to the chosen level of trade costs. As such, I will first discuss what values of λ constitute an equilibrium for a given level of trade costs, before discussing how the benefit of relocating to Home ($\Omega(\lambda)$) behaves with respect to trade costs.[29]

[29]Note that I provide intuition rather than a formal solution due to the fact that $\Omega(\lambda) = 0$ may have multiple equilibrium allocations and as such the implicit equation cannot be readily solved. This is where the FC models still preserve analytical tractability as there is an explicit solution for the equilibrium allocation, whereas FE models merely have an implicit equilibrium condition. To find all the location equilibria I instead use the `fzero` solver in MATLAB. Since $\rho = \rho^*$ I divide the the possible allocation space into three regions as there are at most three equilibria (see Robert-Nicoud, 2005): $[0, 0.5)$, $[0.5, 0.5]$ and $(0.5, 1]$.

To first study which capital allocations are possible equilibria we focus on the function $\Omega(\lambda)$ when $\tau = 1.35$, which has been depicted in Figure 3. Starting at $\lambda = 0$ in Figure 3, we see that the benefit of relocating to Home is positive (i.e. $\Omega(0) > 0$) and as such capital has an incentive to migrate from Foreign to Home. As a consequence the share of capitalists increases in Home (λ) and this process continues until roughly 5% of all capitalists is located in Home as at that point there no longer exists a benefit of relocating to Home (i.e. $\Omega(0.05) = 0$). Suppose however that Home would initially have had 30% of all capital before capital is allowed to relocate instead of 0%. In this scenario, we would have that the benefit of relocating to Home is negative and therefore the benefit of relocating to Foreign is positive. Therefore, the share of capital in Home (λ) declines and this continue to happen until again roughly 5% of all capitalists is located in Home as at that point there no longer exists a benefit to relocating to Foreign (i.e. $\Omega(0.05) = 0$). Using identical logic, but starting from 70% and 100%, it becomes apparent that these starting allocations would cause in equilibrium 95% of capital to be located in Home. Finally, if Home starts with 50% of all capital in the world then it is immediately in equilibrium. However, this equilibrium is referred to as unstable given that any slight change in the capital allocation would bring about a large change in the equilibrium allocation.

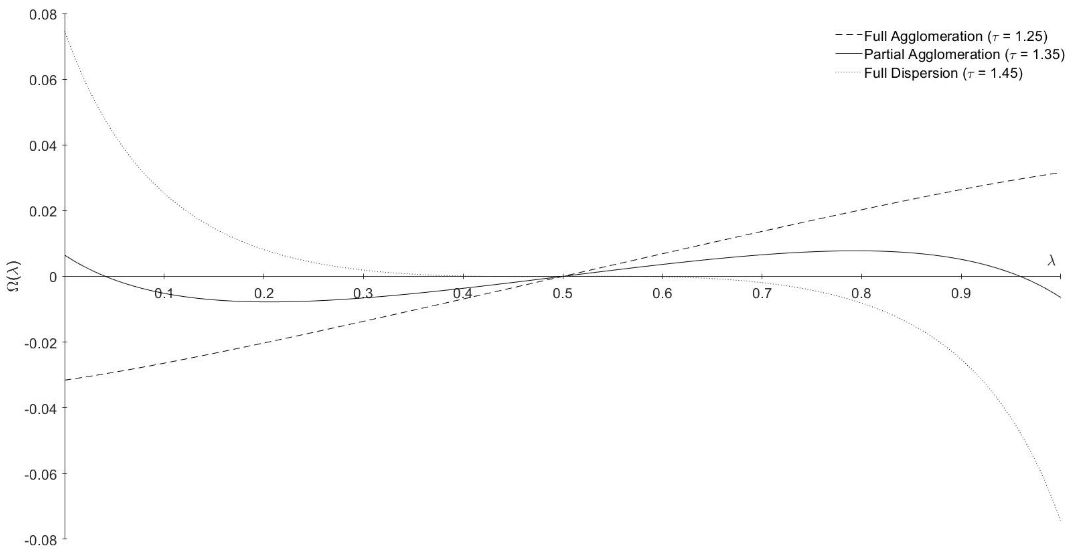

Figure 3: The benefit of relocating to Home ($\Omega(\lambda)$) at three different levels of trade costs and with parameters as described in section 3.3. Here $\mu_s = 0$ and $t - t^* = 0$.

However, Figure 3 also shows that whether a certain allocation can be a stable equilibrium depends strongly on the level of trade costs. For instance, when trade costs are very high (i.e. $\tau = 1.454$) and goods markets are relatively isolated we have that capitalists will change location until 50% of capitalists are located in Home irrespective of the initial allocation of capitalists (i.e. $\lambda = 0.5$ is a stable equilibrium). By contrast, when trade costs are very low (i.e. $\tau = 1.279$) and goods markets are relatively integrated, then capitalists will want to agglomerate in the region where the majority of capitalists start out and the symmetric equilibrium is no longer a stable equilibrium. Nevertheless, there does seem to be a clear pattern visible when one graphs the stable equilibrium allocations across the different trade costs (see Figure 4). At high trade costs ($\tau > \tau_b$) capital naturally disperses. This natural tendency seems to slowly disappear as trade costs fall. In specific, lower trade costs ($\tau_f < \tau < \tau_b$) first lead to the formation of partial agglomeration and eventually, when trade costs become very low ($\tau < \tau_f$), capital agglomerates fully in either region. To explain why this specific pattern emerges we need to disentangle the forces that determine $\Omega(\lambda)$: relative prices and income differences.

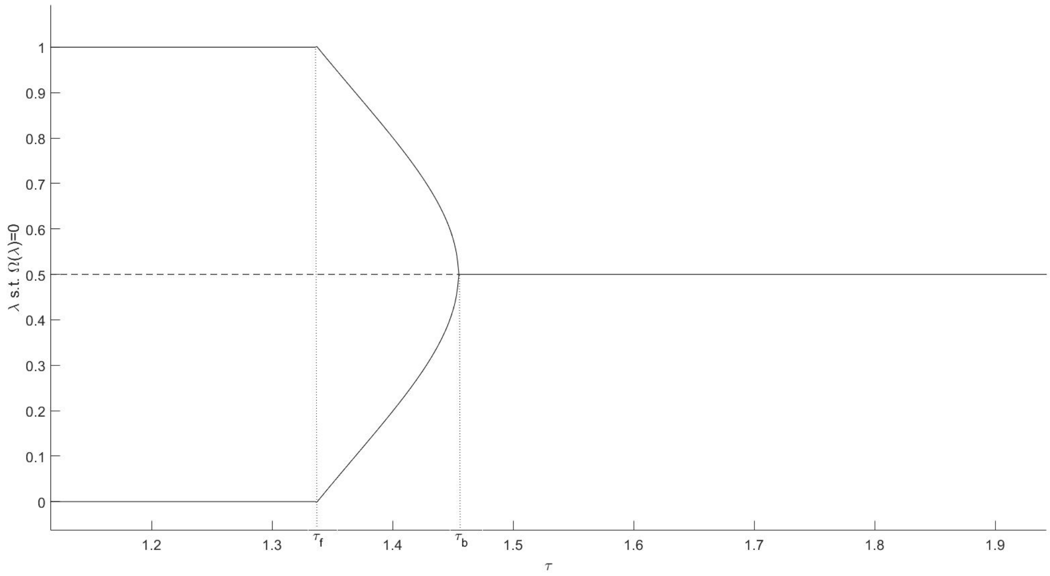

Figure 4: Bifurcation diagram which depicts all equilibria for the share of capital in Home, λ. Stable equilibria are those on the solid line, whereas unstable equilibria are depicted by a dashed line. Parameter values are as per section 3.3.

Let us first focus on the effect of relative prices (first term in equation 13) on the incentive to agglomerate. Given that capitalists as consumers prefer low prices to high prices, any increase in the price level in Foreign vis-à-vis the price level in Home will cause capitalists in Home to become relatively better off. Hence, keeping everything else equal this will increase the incentive for capitalists in Foreign to move to Home. In fact, one way to decrease the price level in Home is by increasing the fraction of Capitalists in Home (λ) as this expands the number of varieties which are no longer subject to trade costs, thereby effectively realizing a cost saving. Thus, the price level in Foreign increases even more, further increasing the incentive for Foreign capitalists to relocate. Therefore, when looking only at the effect of moving on the relative price levels the departure of one capitalist deteriorates the well being of the capitalists that remain through increasing the price level. The effect of a change in location thus reinforces the incentives to change location for other capitalists and it forms an intuitive centripetal force in the model (see appendix B for proof of this assertion).

The way in which the differences in return on capital across regions (second term of equation (13)) affects the incentive to agglomerate is relatively straightforward. Given that capitalists as consumers prefer more income to less income, any fall in returns in Foreign vis-à-vis the returns in Home will cause capitalists to be better off in Home. One important factor that affects the return differential is the share of capitalists in Home. In specific, a rise in the number of capitalists in a region has two effects on the capitalists already residing there. First, it increases the demand for their varieties as the new capitalist consumes them. Second, it decreases the demand from labourers and other capitalists for their variety as they substitute away to the variety produced by the new capitalist as it has become cheaper, given that it is no longer subject to trade costs. Therefore, the level of trade costs plays an important role in determining whether additional agglomeration increases the income of capitalists in the region or whether it deteriorates the income of capitalists in the region.[30] If the former is the case then, everything else equal, the relocation of one capitalist to Home provides an incentive to other capitalists to also move to Home. If the latter is the case then capitalists will tend to disperse more. Hence, whether the return differential is a centripetal or centrifugal force is not *ex ante* clear.

[30]In this case it depends on the effect on the quantity sold. This is due to the fact that prices for individual varieties are fixed in equilibrium (see section 4). As a result, only a change in quantity thus effects the profits of the firm and thus the income of a capitalist.

As shown in appendix B it turns out that if trade costs are high ($\tau > 1.12$) the return differential acts as a centrifugal force. This is due to the fact that if goods markets are relatively isolated a concentration of capitalists effectively reduces the quantity demanded of every variety and thus causes capitalists to disperse. If trade costs are low ($\tau < 1.12$) the opposite happens and additional capitalists expand the market more than that they induce substitution (the cost saving motive is less due to the fact that trade costs are already low) to the variety which production location has changed. As a result, the return differential acts as a centripetal force when trade costs are sufficiently low. Finally, the bifurcation witnessed in Figure 4 can be explained using this decomposition. For trade costs $\tau > \tau_b = 1.454$ the centrifugal effect from the return differential dominates the centripetal force exerted by the relative prices. However, as trade costs decrease ($1.337 = \tau_f < \tau < \tau_b = 1.454$[31]) the centrifugal force exerted by the return differential weakens and combined with the centripetal force exerted by the relative prices (which also weakens, but less so) partial agglomerations are rendered stable. Finally, when trade costs become very low ($\tau < \tau_f$) the centrifugal force exerted by the return differential is dominated by the centripetal force generated by the cost saving motive embedded in the relative prices[32].

Since trade costs essentially drive which location equilibria can be sustained most attention has naturally been devoted to the parameter τ. However, I conclude this section with a brief discussion of the impact that the other parameters have on the location equilibria. Firstly, when the expenditures on the manufactured consumption good of each household, α, increases the benefit of relocation is exacerbated ($\Omega(\lambda)$ is stretched). Although an increase in the elasticity of substitution, σ, primarily stretches the net-of-tax utility differential as well, more fierce competition or stronger love for variety also causes partial equilibria to emerge at higher levels of trade openness (i.e. displaces the τ_b and τ_f). In fact, if $\sigma \to \infty$ the net-of-relocation-cost benefit of moving tends to zero as the return on capital tends to zero as the prices that are charged converge to the marginal cost.[33] The last parameter that had to be calibrated, the labour-to-total-capital ration or $\rho^{(*)}$, determines the market size. Therefore setting $\rho = \rho^* = 1.5$, which is more in line with empirical data, results in higher returns to Capital and enlarges the effect of the return differential on the benefit of relocating to Home. Asymmetry between ρ and ρ^* would be indicative of one country being larger than the other. Let us assume that $\rho > \rho^*$, as a consequence at very high trade costs the location equilibrium would become $\lambda > 0.5$, which reflects that capitalists prefer to locate in large markets. That is, there exists a natural large country advantage in the model (see Pflüger, 2004).

5.2 The location equilibrium with imperfectly mobile capitalists and no taxes

So far the model considered in section 5.1 is identical to that of Borck and Pflüger (2006). In this section we are going to depart from the standard Borck and Pflüger model and analyse the situation in which all capitalists are subject to relocation costs. In specific, it is assumed that $t - t^* = 0$ and that $\eta = 0$. The benefit of relocating from Foreign to Home is then given by $V_K - V_K^* = \Omega(\lambda) - \mu_2$ whereas the benefit of relocating to Foreign from Home equals $V_K^* - V_K = -\Omega(\lambda) - \mu_2$. As such, for a given allocation to be a location equilibrium we require that $\Omega(\lambda) - \mu_2 \leq 0$ and that $\Omega(\lambda) + \mu_2 \geq 0$. Hence, relocation costs effectively give rise to an inaction band as seen in Figure 5. If the zero of the relocation benefit function lies between the upper band and the lower band no capitalist has an incentive to move. However, if both bands exceed (fall below) zero then capitalists in Foreign (Home)

[31] Deriving these levels can be done through realizing that in order to move from the symmetric equilibrium to a setting with partial equilibria the derivative of $\Omega(\lambda)$ with respect to λ needs to change sign. Hence, we need to solve for τ when $\frac{\partial\Omega(\lambda)}{\partial\lambda}|_{\lambda=\frac{1}{2}} = 0$. To find τ_f we need to know for solve $\Omega(1) = 0$ and $\Omega(0) = 0$ for τ given that after that point only $\lambda = 1$ and $\lambda = 0$ are viable equilibria. Note that $\tau_f < \tau_b$ (Robert-Nicoud, 2005).

[32] It is important to note that it could be the case that even at very high trade costs the symmetric equilibrium could still be unstable. That is, the effect of the price differential always outweighs the competition effect. To make sure that this is not the case I impose the so-called No-Black-Hole-Condition (NBHC) which requires that competition is sufficiently high (Fujita, Krugman, & Venables, 1999), $\sigma > 2$.

[33] Formally, we have assumed that $Y_h \geq \alpha$ and as such this limiting case can only be valuated once $\alpha \to 0$.

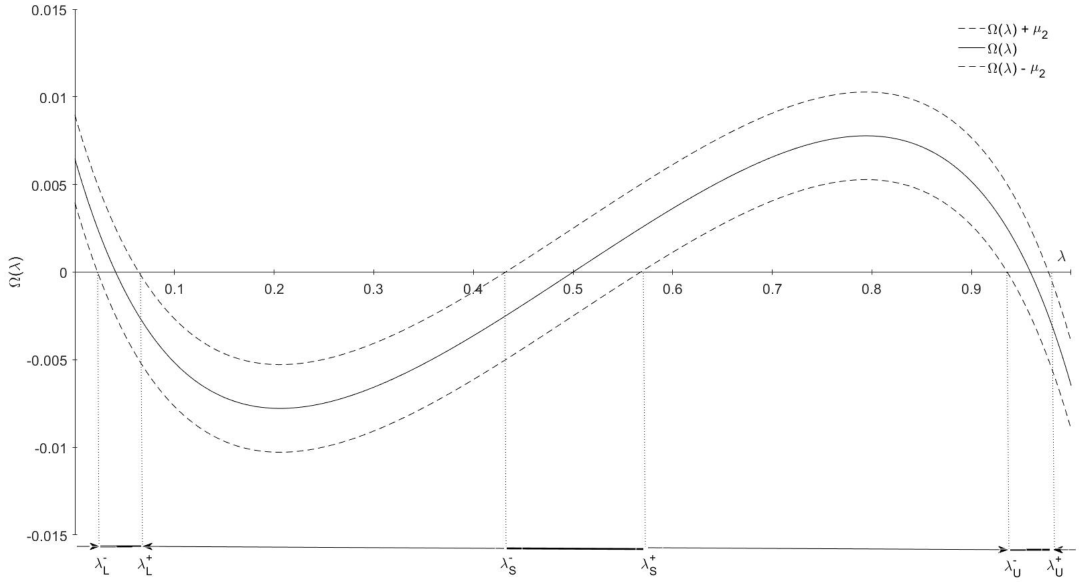

Figure 5: $\Omega(\lambda)$ between the upper band, $\Omega(\lambda) + \mu_2$, and the lower band, $\Omega(\lambda) - \mu_2$ where $\tau = 1.35$ and $\mu_2 = 0.0025$. Equilibrium values of λ are depicted marked by thick black on the horizontal axis and the development of λ if not in equilibrium are depicted using arrows on the horizontal axis. Parameters used are as per section 3.3.

will start to move to Home (Foreign) and thus increase (decrease) λ until either band has crossed zero once again. On the horizontal axis in Figure 5 a line has been drawn where its thick parts indicate the location equilibria. In addition, the line also depicts the direction in which λ changes whenever the allocation is not an equilibrium using arrows.

In the case depicted in figure 5 we have that whenever $\lambda \in (\lambda_L^+, \lambda_S^-)$ both bands are below zero capitalists will have an incentive to move from Home to Foreign, which ultimately results in λ decreasing until $\lambda = \lambda_L^+$. Analogous thereto, when $\lambda \in (\lambda_S^+, \lambda_U^-)$ capitalists will instead move to Home until $\lambda = \lambda_U^-$, as both bands exceed zero. An interesting difference with respect to the standard Borck and Pflüger case is that there are no longer three allocations which constitute an equilibrium. Instead, any $\lambda \in [\lambda_L^-, \lambda_L^+] \cup [\lambda_S^-, \lambda_S^+] \cup [\lambda_U^-, \lambda_U^+]$ can be an equilibrium. However, since any allocation just outside the interval around the symmetric equilibrium does not bring about an equilibrium allocation in the interval around the symmetric equilibrium, this interval is referred to as (boundary) unstable. Repeating this analysis for different trade costs then yields a similar bifurcation diagram as in section 5.1 (see Figure 6), albeit that the lines have now become intervals.

The new bifurcation diagram (Figure 6) deviates from the old bifurcation diagram (Figure 4) in two notable ways. First, the level of trade costs at which three disjoint equilibrium intervals arise, τ_b' is lower than τ_b. The reason for this is that for $\tau \in (\tau_b', \tau_b)$ the magnitude of the incentive to relocate due to agglomeration benefits (or costs), that is $\Omega(\lambda)$, is relatively small. Therefore, whenever $\tau \in (\tau_b', \tau_b)$ the benefit of relocating is sizable enough to give rise to partial agglomerations when capital is perfectly mobile, but this benefit is not large enough to also give rise to partial agglomerations when capital is imperfectly mobile.[34] Second, at very low trade costs increasingly more allocations constitute an equilibrium as again the benefit of relocating becomes small. Moreover, as τ tends to unity the benefit of relocating tends to zero ($\Omega(\lambda) \to 0,\ \forall\lambda$). In fact, for $\tau = 1$ we have that relocation does not occur as $V_K - V_K^* = 0$ for $\forall\lambda$ if $t = t^* = 0$. As such, the apparent deviations from the old bifurcation diagram can be readily accredited to the fact that the incentive to move is too weak for less mobile capitalists, which is especially noticeable at very low trade costs and at high trade costs

[34] Here I refer to a partial agglomeration as any equilibrium in an interval that is disjoint from the interval about the symmetric allocation.

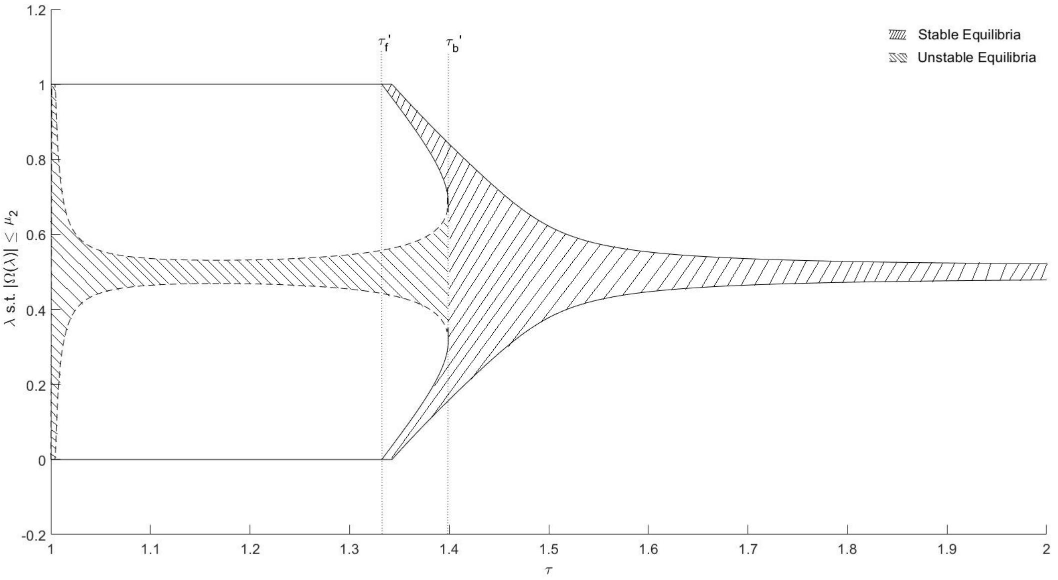

Figure 6: Bifurcation diagram which depicts all equilibria for the share of Capital in Home, λ, with relocation cost $\mu_2 = 0.0025$. Stable equilibria (at the boundary) are those between (or on if $\tau < \tau_f'$) a solid line, whereas unstable equilibria (at the boundary) are depicted between the dashed lines. Again parameter values are chosen in line with section 3.3.

The reason for why this happens at these two distinct levels of trade costs is however a little bit more intricate. At high trade costs ($\tau \in (\tau_b', \tau_b)$) the centrifugal pressure from the return differential (do not locate near to each other as this will decrease profits as less of a specific variety can be sold) and the centripetal pressure exerted by the difference in price levels (locate near to each other as this causes consumption prices to decline) balance out around $\lambda = 0.5$. At low trade costs both the return differential and the difference in price levels exert too little pressure to agglomerate, causing the benefit of relocating to become too small to warrant much relocation. This in turn gives rise to the observation that the interval about the symmetric equilibrium expands at very low trade costs. Hence, despite the fact that the bifurcation diagram deviates on some particular points this is all consistent with the intuition developed previously, albeit that the size of the benefit of relocating net of relocation costs matters in contrast to the standard Borck and Pflüger case.

5.3 The location equilibrium with both types of capitalists and no taxes

Finally, let there exist capitalists which are perfectly mobile and capitalists that are imperfectly mobile, i.e. $\eta \in (0, 1)$, and let $t = t^* = 0$. In addition, let us presume that Home initially starts with all capitalists (in line with Baldwin and Krugman (2004) and Borck and Pflüger (2006)) and that the most mobile capitalists relocate first. In this scenario we have that for $\lambda \in (1 - \eta, 1]$ the equilibria are as described in section 5.1 since the capitalists that relocates at the margin is by definition perfectly mobile. For any allocation $\lambda \in [0, 1-\eta]$ the last capitalist that relocates is essentially of the imperfectly mobile type and the equilibria are then those described in section 5.2. As such, allowing for both types of capitalists essentially requires us to retrace our steps in the previous sections. In fact, it is clearly visible from Figure 7 that for $\lambda \leq 1 - \eta$ zero should be between the bands as to constitute an equilibrium (as per section 5.2), whereas for $\lambda > 1 - \eta$ the benefit of moving should be exactly zero as not to induce any movement (as per section 5.1). An important difference that characterises the current case in contrast with the two previous cases is the notion that the right most location equilibrium can change from an interval to a point depending on the level of trade costs since we assumed that perfectly mobile capital moves first and that initially all capital is located in Home.

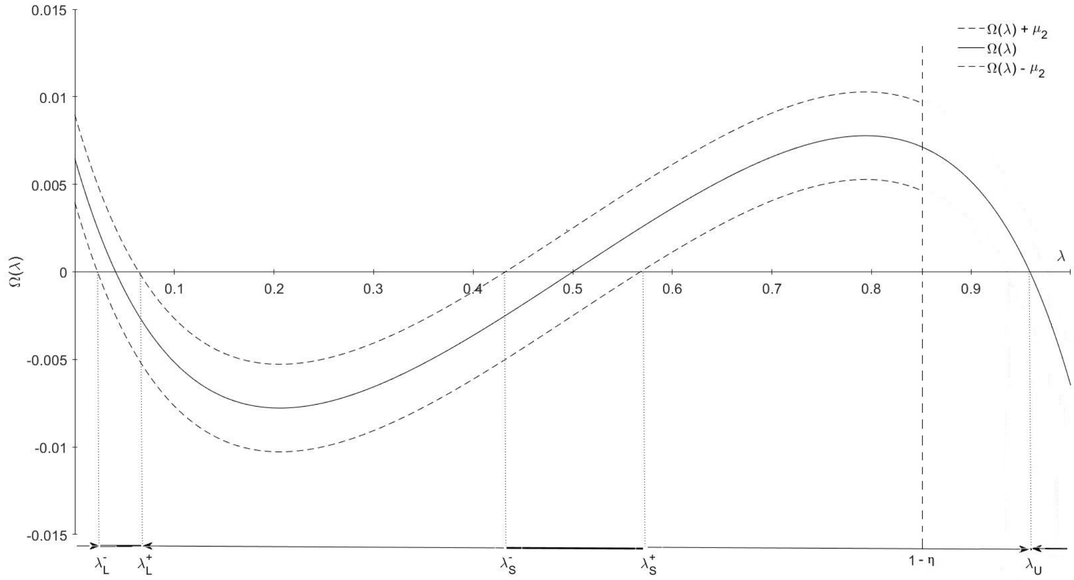

Figure 7: $\Omega(\lambda)$ between the upper band, $\Omega(\lambda) + \mu_2$, and the lower band, $\Omega(\lambda) - \mu_2$ where $\tau = 1.35$ and $\eta = 0.15$, $\mu_1 = 0$ and $\mu_2 = 0.0025$. Equilibrium values of λ are depicted marked by thick black on the horizontal axis and, if not in equilibrium, the development of λ is depicted using arrows. Parameters used are as per section 3.3.

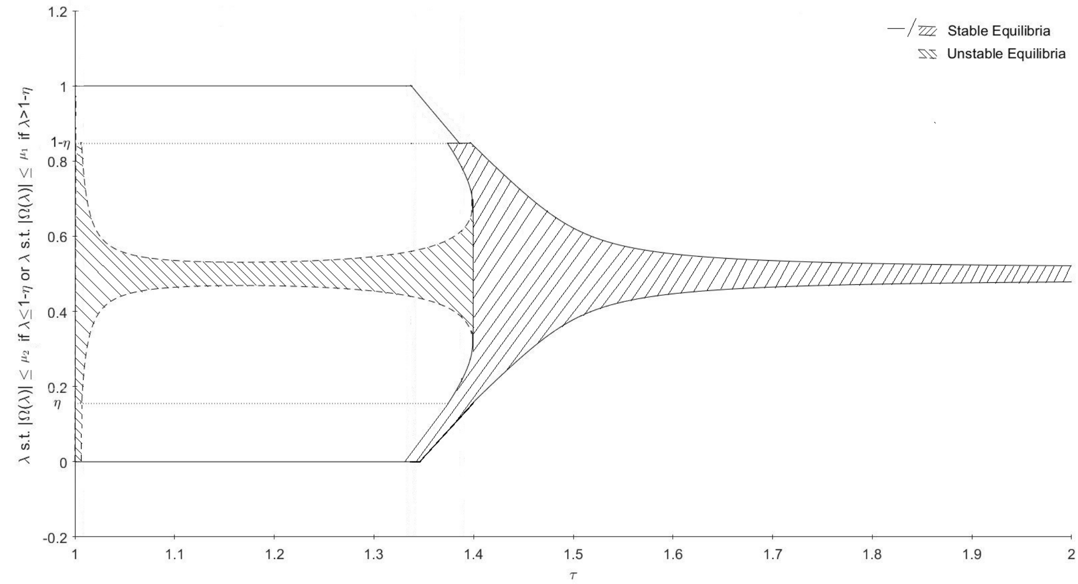

Figure 8: Bifurcation diagram which depicts all equilibria for the share of Capital in Home, λ, with relocation cost $\mu_1 = 0$, $\mu_2 = 0.0025$, and $\eta = 0.15$. Stable equilibria (at the boundary) are those between (or on if $\tau < \tau_f'$) a solid line, whereas unstable equilibria (at the boundary) are depicted between the dashed lines. Again parameter values are chosen in line with section 3.3. Here the asymmetric shape of the bifurcation diagram about the allocation $\lambda = 0.5$ is due to the fact that all capital is assumed to be initially in Home.

For instance, when trade costs are low as they are in Figure 7, the rightmost location equilibrium is λ_U as opposed to an interval of stable location equilibria (see Figure 5). However, if trade costs are sufficiently high then centripetal forces are relatively weak and as a result there is more dispersion in equilibrium. If this dispersion is sufficiently large the allocation of capitalists in equilibrium is low and the location equilibrium is fully determined by the immobile type of capital. As a result, higher trade costs give rise to an interval of allocations around the rightmost location equilibrium as depicted in the bifurcation diagram in Figure 8, which is identical to those depicted in Figure 6. Of course, this bifurcation diagram has been drawn given that Home starts out with all of the capitalists as otherwise the initial distribution of capitalists needs to be specified per type. The reason that this assumption is typically employed is to deal with the multiplicity of location equilibria which can be observed in the bifurcation diagrams. Moreover, this simplifying assumption allows us to focus only on the (partial) equilibria where Home is the partial core. However, this assumption is sufficient rather than necessary. In fact, it can be relaxed to state that the initial stock of capital located in Home is to the right of where the benefit of relocating net of relocation costs attains its interior maximum. Hence, although this assumption might appear to be strong, it can be relaxed quite somewhat, but simply serves to circumvent any undue complication of the analysis.

5.4 The location equilibrium with both types of capitalists and taxes

Since we assume that we start out in a pure core-periphery setting we can now allow for tax differentials with relative ease. Note that equation (13) implies that capitalists who are perfectly mobile do not move if $V_K - V_K^* = \Omega(\lambda) - (t - t^*) = 0$, or stated differently $\Omega(\lambda) = (t - t^*)$. That is, the benefit of locating together due to agglomeration benefits in Home as opposed to locating in Foreign ($\Omega(\lambda)$) should be equal to the difference in taxes between Home and Foreign (i.e. taxed away). The imperfectly mobile capitalists will not move from Foreign to Home when $\Omega(\lambda) - (t - t^*) - \mu_2 \leq 0$ and from Home to Foreign when $-\Omega(\lambda) + (t - t^*) - \mu_2 \leq 0$. Rearranging those expressions location equilibria need to satisfy that $\Omega(\lambda) - \mu_2 \leq t - t^* \leq \Omega(\lambda) + \mu_2$. Upon contrasting these conditions with those derived in sections 5.1 and 5.2 it becomes clear that the only difference stems from the fact that the zero's have been replaced by $t - t^*$. In other words, whereas we previously determined the possible location equilibria through finding where the benefit of relocating that can be accredited to agglomeration ($\Omega(\lambda)$) is equal to zero (or where zero lies between the bounds), we now need to determine where the benefit of relocating that can be accredited to agglomeration ($\Omega(\lambda)$) is equal to $t - t^*$ (or where $t - t^*$ lies between the bounds).

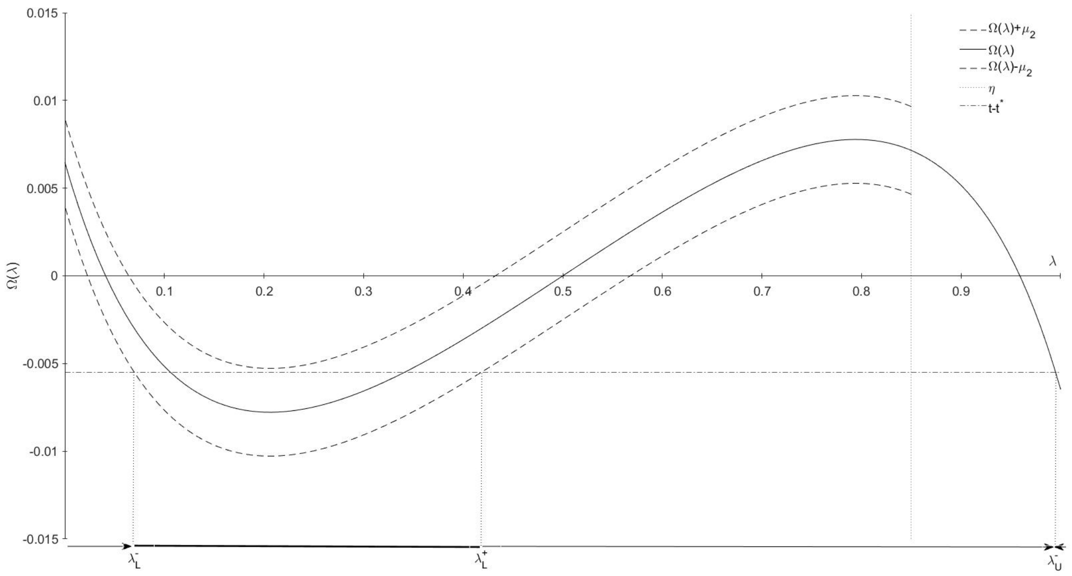

Figure 9: $\Omega(\lambda)$ between the upper band, $\Omega(\lambda) + \mu_2$, and the lower band, $\Omega(\lambda) - \mu_2$ where $\tau = 1.397$, $\eta = 0.15$, $\mu_1 = 0$ and $\mu_2 = 0.0025$. The tax differential, $t - t^*$ has been set equal to -0.0055. Equilibrium values of λ are depicted marked by thick black on line below the graph and, if not in equilibrium, the development of λ is depicted using arrows. Parameters used are as per section 3.3.

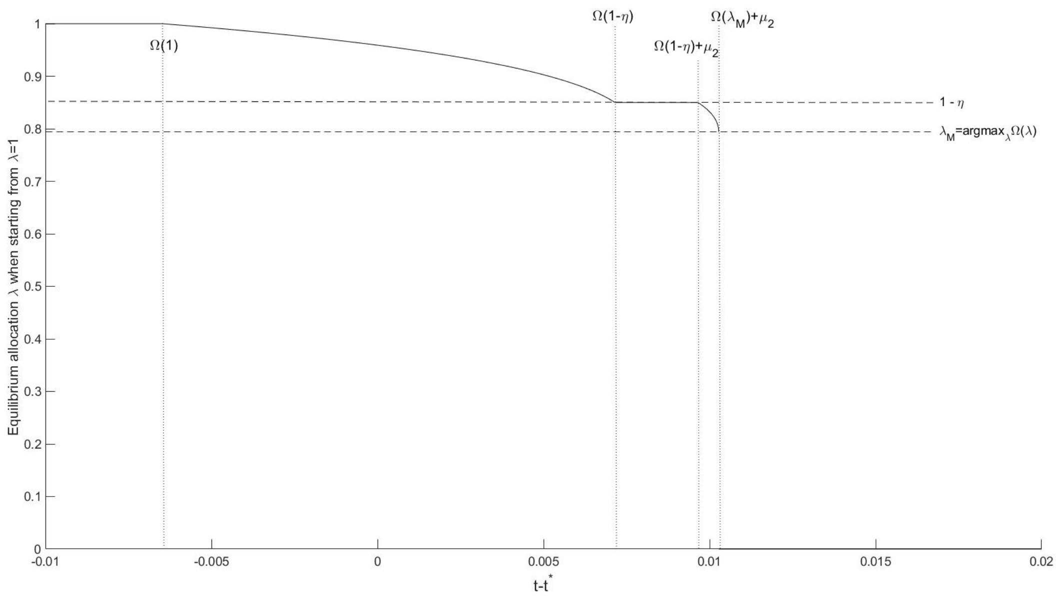

Figure 10: The solid line depicts the location equilibrium that comes about for a given tax differential, $t-t^{*}$, when initially all capital is located in Home. Parameters used are as per section 3.3 and consistent with Figure 9.

Before analysing how the equilibrium allocation changes as the tax differential is changed we first what location equilibria can arise for a arbitrary given tax differential. Let us, for example first examine what the location equilibria are when the tax differential, denoted by $t-t^{*}$, is set to -0.0055 as in Figure 9. As depicted by the horizontal axis there is a single rightmost equilibrium allocation (λ_U^+) and an interval of equilibrium allocations on the left ($\lambda \in [\lambda_L^-, \lambda_L^+]$). In contrast to the analyses before it thus need not be the case that for every tax differential the symmetric equilibrium is an equilibrium. Moreover, it need not be the case that there are two equilibrium intervals which can be seen for $\tau = 1.35$ in the bifurcation diagram in Figure 8. From Figure 9 it becomes also clear that if Home starts out with all capitalists and were to set its tax rate 0.0055 units (of the agricultural good) below that of Foreign, it would end up with roughly 98% of all capitalists. In that case only a small fraction of all perfectly mobile capitalists would have relocated to Foreign.

Now suppose that Home would set its tax rate 0.005 units above that of Foreign. In this case we repeat the analysis as in Figure 9 but for $t-t^{*} = 0.005$. In this case Home would retain about 87% of all capitalists when starting from $\lambda = 1$. Hence, in the model with partial agglomerations developed by Pflüger (2004) we obtain the classical tax rate versus tax base trade-off which is also described by Borck and Pflüger (2006). However, if Home were to raise its taxes still a little further, to say 0.0072, then all perfectly mobile capitalists would have moved to Foreign. Yet, the remaining capital faces a relocation impediment and as a result thereof they do not immediately respond to an additional change in the tax differential. inertia. In specific, Home can thereafter increase its tax rate in excess of that of Foreign by 0.0097 units while retaining all of the immobile capitalists.

After setting the tax differential at 0.0097 Home will gradually lose some of the imperfectly mobile capital if it were to increase its tax rate further above that of Foreign. However, once Home has set its tax rate 0.0103 units above that of Foreign it has about 79.4% of all capitalists as can be deduced from Figure 9. If Home were to increase its tax rate only slightly more, the $t-t^{*}$ line would never fall between the bounds again and as such all imperfectly mobile capital that remained in Home will move to Foreign, inducing so-called *discrete delocation*. That is, Home's tax rate exceeded that of Foreign to such an extent that it essentially tendered the core. The development of the location equilibrium for different values of the tax differential at $\tau = 1.35$ is depicted in Figure 10. Although the case depicted in Figure 10 (which is in line with Figure 9) has discrete delocation to a case where Home is the pure-periphery, this discrete delocation can be less extreme depending on the level of trade costs as instead of losing all capital Home will still have some capital after setting its tax rate in excess of the tax rate necessary to induce delocation when trade costs are low[35].

Hence, in order to study the tax game in the next section we have to (1) define $\lambda(t - t^*)$ and (2) study the behaviour of the tax differential that triggers discrete delocation. Now let the minimum share of capitalists in Home before discrete delocation occurs be denoted by λ_M, where $\lambda_M = \mathrm{argmax}_{\lambda \in (0.5,1]} \Omega(\lambda)$.[36] In addition, let us denote the share of capitalists that remain in Home after discrete delocation with λ_P.[37] To illustrate this suppose that Home were to increase the tax differential to just above 0.0103 when $\tau = 1.35$ (as in Figure 9). Then we would have that no capital would remain in Home and as a result the share of capital remaining after discrete delocation is zero ($\lambda_P = 0$). Then the function $\lambda(t - t^*)$ can be implicitly defined as:

$$\lambda(t-t^*) = \begin{cases} \lambda = 1 & \text{where } (\lambda, t-t^*) \in \mathcal{R}_1 \\ \Omega(\lambda) + \mu_1 = (t-t^*) & \text{where } (\lambda, t-t^*) \in \mathcal{R}_2 \\ \lambda = 1-\eta & \text{where } (\lambda, t-t^*) \in \mathcal{R}_3 \\ \Omega(\lambda) + \mu_2 = (t-t^*) & \text{where } (\lambda, t-t^*) \in \mathcal{R}_4 \\ \Omega(\lambda) + \mu_2 = (t-t^*) & \text{where } (\lambda, t-t^*) \in \mathcal{R}_5 \\ \lambda = 0 & \text{where } (\lambda, t-t^*) \in \mathcal{R}_6 \end{cases} \quad \text{if } \lambda_M \leq 1-\eta. \tag{14}$$

where the regions $\mathcal{R}_i$ are the restrictions on the tuple $(\lambda, t - t^*)$ such that $\lambda(t - t^*)$ is in equilibrium and single valued. Here these restrictions boil down to,

$$\begin{aligned} \mathcal{R}_1 &= \{(\lambda, t-t^*) \in \mathbb{R}^2 |\, t-t^* < \Omega(1) + \mu_1\} \\ \mathcal{R}_2 &= \{(\lambda, t-t^*) \in \mathbb{R}^2 | t-t^* \in [\Omega(1) + \mu_1, \Omega(1-\eta) + \mu_1),\ \lambda \in (1-\eta, 1]\} \\ \mathcal{R}_3 &= \{(\lambda, t-t^*) \in \mathbb{R}^2 | t-t^* \in [\Omega(1-\eta) + \mu_1, \Omega(1-\eta) + \mu_2]\} \\ \mathcal{R}_4 &= \{(\lambda, t-t^*) \in \mathbb{R}^2 | t-t^* \in [\Omega(1-\eta) + \mu_2, \Omega(\lambda_M) + \mu_2],\ \lambda \in [\lambda_M, 1-\eta)\} \\ \mathcal{R}_5 &= \{(\lambda, t-t^*) \in \mathbb{R}^2 | t-t^* \in (\Omega(\lambda_P) + \mu_2, < \Omega(0) + \mu_2],\ \lambda \in [0, \lambda_P)\} \\ \mathcal{R}_6 &= \{(\lambda, t-t^*) \in \mathbb{R}^2 | t-t^* \in [\Omega(0) + \mu_2, \infty)\} \end{aligned} \tag{15}$$

In the example illustrated in Figure 10, we have that the minimum share of capital that needs to be in the core before discrete delocation occurs is 79.4%, which is lower than $1 - \eta = 85\%$, and that $\mu_1 = 0$. As such the equilibrium allocation as a function of the tax rates of both countries is given by equation (14). In the case illustrated in Figure 10 there are effectively 5 regions instead of 6. First, the region $\mathcal{R}_1$ describes the tax differentials for which all capitalists decide to stay in Home. Second, the region $\mathcal{R}_2$ describes the location equilibria where only some of the perfectly mobile capitalists have moved to Foreign. Hence, on said region we need to have that for a location equilibrium to exist the perfectly mobile capitalists should no longer have an incentive to move, which for a given tax differential involves solving $\Omega(\lambda) + \mu_1 = (t - t^*)$ for λ. Third, once all the mobile capitalists have relocated to Foreign we have a region of inertia described by $\mathcal{R}_3$. Fourth, when the tax differential becomes large enough also imperfectly mobile capital starts to leave Home (region $\mathcal{R}_4$) and as such an equilibrium is attained at the moment that no imperfectly mobile capitalist in Home wants to relocate any more to Foreign. For that to be true we need to have that $V_K^* - V_K = -\Omega(\lambda) + (t - t^*) - \mu_2 = 0$, or equivalently $\Omega(\lambda) + \mu_2 = t - t^*$. Note that the tax differential can become at most $\Omega(\lambda_M) + \mu_2$

[35] In particular, the point where the benefit of relocating due to agglomeration ($\Omega(\lambda)$) achieves an interior maximum (λ_M) need not be the global maximum as $\Omega(0) \geq \Omega(\lambda_M)$ if $\tau > 1.352$

[36] Note that λ_M is defined as long as $\Omega(\lambda)$ is not a strictly decreasing function. That is, λ_M is defined whenever $\tau \in [1, 1.454)$.

[37] A more technical definition for λ_P would be the following. Let $S \equiv \{\lambda \in \mathbb{R} \,|\Omega(\lambda) = \Omega(\lambda_M) \text{ and } \lambda \neq \lambda_M\}$ then $\lambda_P = S$ if $S \neq \emptyset$ and $\lambda_P = 0$ if $S = \emptyset$.

as raising the tax gap any further would cause discrete delocation. Fifth, since $\lambda_P = 0$ we have that $\mathcal{R}_5 = \emptyset$ and as such we have no region in which Home is the partial periphery and where further increases in the tax differential thus induce a gradual tax base versus tax rate trade-off. Finally, the sixth region, $\mathcal{R}_6$, represents the one in which all capital has moved out of Home.

In addition we also have the case in which $\lambda_M > 1-\eta$ for which the equilibrium allocation as a function of the tax differential is given by equation (16):

$$\lambda(t-t^*) = \begin{cases} \lambda = 1 & \text{where } (\lambda, t-t^*) \in \mathcal{R}_1 \\ \Omega(\lambda) + \mu_1 = (t-t^*) & \text{where } (\lambda, t-t^*) \in \mathcal{R}'_2 \\ \Omega(\lambda) + \mu_2 = (t-t^*) & \text{where } (\lambda, t-t^*) \in \mathcal{R}'_5 \\ \lambda = 0 & \text{where } (\lambda, t-t^*) \in \mathcal{R}_6 \end{cases} \text{if } \lambda_M > 1-\eta \tag{16}$$

where the regions $\mathcal{R}'_i$ are the modified restrictions on the tuple $(\lambda, t-t^*)$ such that $\lambda(t-t^*)$ in equilibrium is single valued. Here the modified restrictions for the case that $\lambda > 1-\eta$ can be formulated as follows:

$$\begin{aligned} \mathcal{R}'_2 &= \{(\lambda, t-t^*) \in \mathbb{R}^2 | t-t^* \in [\Omega(1)+\mu_1, \Omega(\lambda_M)+\mu_1],\ \lambda \in [\lambda_M, 1]\} \\ \mathcal{R}'_5 &= \{(\lambda, t-t^*) \in \mathbb{R}^2 | t-t^* \in (\Omega(\lambda_P)+\mu_1, \Omega(0)+\mu_2],\ \lambda \in [0, \lambda_P)\} \end{aligned} \tag{17}$$

where $\mathcal{R}'_2$ is the region that describes the location equilibria where some of the perfectly mobile capitalists move to Foreign. However, since $\lambda_M > 1-\eta$ discrete delocation occurs when too many perfectly mobile capitalists have moved to Foreign, as opposed to the case in which discrete delocation occurs when too many imperfectly mobile capitalists have moved to Foreign (as in Figure 9 and equation 14). The region $\mathcal{R}_5$ describes the tax differentials for which discrete delocation has taken place resulting in Home becoming the partial periphery and where further increases in Homes tax rate yield a gradual base versus rate trade-off. Therefore, the maximum tax differential that can be sustained without bringing about discrete delocation, i.e. the tax shield due to agglomeration forces available to Home, is $\Omega(\lambda_M)+\mu_1$ whenever $\lambda_M > 1-\eta$ and $\Omega(\lambda_M)+\mu_2$ whenever $\lambda_M \leq 1-\eta$.

In order to examine when the delocation tax differential changes from $\Omega(\lambda_M)+\mu_2$ to $\Omega(\lambda_M)+\mu_1$ or vice versa it is necessary to document the behaviour of λ_M. Due to the fact that agglomeration in the current model is completely due to trade costs (see section 3.1 and 5.1) and λ_M represents the minimum share of capitalists that need to reside in Home, Home would effectively need to retain λ_M capitalists as not to tender the core and become the (partial) periphery as a result of discrete delocation. Since a fall in trade costs causes the incentive to agglomerate to increase, a fall in trade costs also serves to increase the minimum share of capitalists that need to be in Home in order for Home to stay the core. Hence, at high trade costs Home can effectively allow some of its immobile capital to move to Foreign and Home and Foreign choose to compete over immobile capital. However, as trade costs decrease Home will need to retain an increasingly larger fraction of its initial capital stock. As a result, competition first revolves around competing for less mobile capital at high trade costs, while it moves toward competing for the more mobile type of capital at low trade costs.

Since λ_M is thus a continuous and *strictly* decreasing function of trade costs we have that there must exist a level of trade costs at which the location equilibrium evolves from being described by equation (14) to being described by equation (16). As such, at said point the delocation tax differential falls by $\mu_2 - \mu_1$ units when $\lambda_M = 1-\eta$. This occurs at $\tau = 1.3278$ if $1-\eta = 0.85$. Although neither Home nor Foreign typically aim to set their tax rates equal to the delocation tax differential, as at that point a slight reduction in either country's tax rate induces a large increase in the number of capitalists in the respective country[38], this observation will nevertheless have a pivotal role in our discussion of the tax game and as such it is formalised by proposition 1 as follows:

[38] In specific, the elasticity of λ w.r.t. $t-t^*$ will tend to infinity at said point.

Proposition 1. *For $1-\eta > 0.5$ there exists a unique level of trade costs, henceforth referred to as $\tilde{\tau}$, at which the delocation tax differential falls with $\mu_2 - \mu_1$. More specifically, $\forall\tau$ s.t. $f^{-1}(1)^{\frac{1}{1-\sigma}} \leq \tau \leq \tilde{\tau}$ the delocation tax differential becomes $\Omega(\lambda_M) + \mu_1$, while $\forall\tau$ s.t. $\tilde{\tau} \leq \tau \leq \tau_b$ the delocation tax differential becomes $\Omega(\lambda_M) + \mu_2$.*

Proof. See Appendix C □

6 The Tax Equilibrium

Using the fact that we can express the location equilibrium in terms of the tax differential (see equations (14) and (16)) we can simplify the objective function of governments to $W(t, \lambda(t - t^*))$ and $W^*(t^*, \lambda(t - t^*))$. Since Foreign chooses its tax rate after Home has chosen its tax rate we can essentially formulate the optimisation problem with which the Home government is faced as

$$\max_t W(t, \lambda(t - t^*)), \text{ s.t. } t^* \in \underset{t^*}{\operatorname{argmax}}\, W^*(t^*, \lambda(t - t^*)) \tag{18}$$

Here the constraint incorporates the fact that whatever tax rate is set by Home, Foreign should respond to said tax rate optimally. Therefore the constraint effectively yields an implicit function $t^*(t)$ which Home takes into account when setting its own tax rate. In essence, Home can thus choose to set its tax rate as to (1) remain the (partial) core or (2) tender the (partial) core and become the (partial) periphery. Borck and Pflüger (2006) reason that this last case will never be optimal for Home as it is best for Home to act like a limit pricing monopolist.

However, given that $t^*(t)$ is increasing in t (see the analysis below) we have that the tax rates of both countries are strategic complements, which is consistent with the empirical evidence presented in section 2.1. As such, in spite of the fact that this setting is reminiscent of a limit pricing monopolist, the fact that their policies are strategic complements does not *ex ante* imply that Home will act like a limit pricing monopolist that retains the core no matter what. This is due to the fact that if the limit pricing monopolist becomes the partial periphery due to setting its tax rate 'too' high, it may compensate the decrease in its share of capitalists with a higher tax rate since Foreign will *also* choose to increase its tax rate. In fact, it can be shown in the current setting that for sufficiently high values of trade costs Home will optimally choose to tender the core.

This effect is however at odds with empirical evidence as during no time between 1980 and 2000 the core-5 was (or became) the periphery. In order to compensate for this I impose that discrete delocation is sufficiently costly to the government of Home such that it will never choose to tender the (partial) core as per section 3.1. This may at first seem purely artificial, yet upon closer examination this pattern is probably merely an artifact of the exogenously imposed timing in the tax game. In specific, it is well known in the endogeneous timing literature that which agent leads can change depending on parameters of the model. In fact, Kempf and Rota-Graziosi (2010) show that for a different tax game a 'smaller' jurisdictions can become the leader when one allows for endogenous timing. As such, the assumption that Home would not like to tender the core acts to correct for treating the timing of the tax game as exogeneous rather than endogenous. Another reason for using this assumption stems from the fact that Home anticipates that if it tenders the core it will need to set tax rates extremely low in the future to regain the core given that Foreign has a tax shield too as the benefit of relocating due to agglomeration benefits, $\Omega(\lambda)$, is symmetric (i.e. there exists some hysteresis).

Although this assumption does serve to simplify matters to some extent it is nevertheless still not straightforward to solve expression (18). Moreover, due to the fact that the location equilibrium is not differentiable everywhere and since it is for some intervals defined implicitly it is not necessarily permissible or useful to replace the constraint with its respective first order condition. One particular case which we can however examine with relative ease involves the case in which the benefit of relocating due to agglomeration ($\Omega(\lambda)$) is strictly increasing which is discussed in the first subsection. In this case $\lambda_M = 1$ and $\lambda_P = 0$, which results in a drastic simplification of the restrictions on $\lambda(t - t^*)$. In specific, if $t - t^* \leq \Omega(1)$ then $\lambda = 1$ and if $t - t^* > \Omega(1)$ then $\lambda = 0$. For this case to occur it is necessary that $\tau \in [1, 1.279]$. The second and third subsection discuss the arguably more relevant case which occurs when $\tau \in [1.279, 1.454]$ and where in the absence of taxes partial equilibria can be stable. However, the second subsection will revolve around analysing the location equilibrium when there is only one type of capitalist. The third section will discuss the case where there exist two types of capitalists. I do not examine any location equilibria when $\tau \in [1.454, \infty)$ as this case is simply an extension of sections 6.2 and 6.3.[39].

6.1 The tax equilibrium at low trade costs

To examine what taxes arise in equilibrium when $\tau \in [1, 1.279]$ it is instructive to replace the problem stated by expression (18) with an expression where the constrained has been substituted out by the relevant first order condition. That is, if the problem has an interior solution and $\lambda(t - t^*)$ is differentiable, the problem can be written as[40]

$$\max_t W(t, \lambda(t - t^*)), \text{ s.t. } t^* = \frac{1 - \lambda(t - t^*)}{1 - \lambda'_{t-t^*}(t - t^*)} \tag{19}$$

Here it is clear since $\Omega(\lambda)$ is strictly increasing that $\lambda \in \{0, 1\}$. In specific, for $t - t^* \leq \Omega(1) + \mu_1$ we have that in equilibrium $\lambda = 1$, whereas for $t - t^* > \Omega(1) + \mu_1$ it holds that $\lambda = 0$ in equilibrium. Therefore, it is permissable to replace the constraint with its FOC for $t - t^* \neq \Omega(1) + \mu_1$ and set $\lambda'_{t-t^*}(t - t^*) = 0$ since λ is constant at either zero or unity. Having established this, let us then start by ruling out that $\lambda = 0$ is an equilibrium as $\forall t$ it is the case that $W(t, 0) \leq 0 = W(0, 1)$. In other words, Home would never be worse of by taking the core and setting its tax rate to zero. Hence, if Home is the pure core it would ideally set $t = 1$, but in this case Foreign might have an incentive to undercut Home and induce delocation. That is, Foreign could set its tax rate $t^* < t - \Omega(1) - \mu_1$ if $t - \Omega(1) - \mu_1 \geq 0$. To see this we can use equation 19. In particular, if $\lambda = 1$ and $\lambda'_{t-t^*}(t - t^*) = 0$ then $t^* = 0$ Foreigns best option if it does not get the core yields $W^*(0, 0) = 0$. However if $t - \Omega(1) - \mu_1 > 0$ then it can set $0 < t^* < t - \Omega(1) - \mu_1$ and take the core from Home which would yield Foreign $W^*(t^*, 1) > 0$ and Home would get $W(0, 0) = 0$.

However, the question is whether Home could thus have kept the core and levied a positive tax rate such that $W(t, 1) > W(0, 0) = 0$. First, let us assume that $\Omega(1) + \mu_1 \leq 1$ which is always satisfied for the parameter values outlined in section 3.3. Let us propose that in such a case Home optimally sets $t = \Omega(1) + \mu_1$ as it yields the highest pay-off for Home. First we need to verify that Foreign does not have an incentive to take the core. Since, $t - \Omega(1) - \mu_1 = 0$ this is naturally satisfied. Then it needs to be shown that $W(\Omega(1) + \mu_1, 1) > W(0, 0) = 0$, which is the case whenever $\Omega(1) + \mu_1 > 0$. Provided that $\Omega(\lambda)$ is strictly increasing and that $\Omega(1/2)$ is always equal to zero it can be readily seen that $\Omega(1) > 0$. In addition, we also restricted $\mu_1 = 0$ and as a result we find that $\Omega(1) + \mu_1 > 0$ is true. Hence, Home will retain the core and set its tax rate as high as close to unity as possible without providing an incentive for Foreign to capture the core. For $\tau \in [1, 1.279]$ this is equivalent to setting $t = \Omega(1) + \mu_1$. Hence, the tax game equilibrium in this case can be explicitly expressed as:

[39] The reason that I have also not specified a location equilibrium function for $\lambda_M = \emptyset$ is due to the fact that this case is (1) 'straightforward' since $\Omega(\lambda)$ is strictly decreasing and thus invertible and (2) heterogeneity in mobility impediments change little since no delocation tax differential exists in this case.

[40] The constraint follows from noting that $\lambda(t - t^*)$ is a function, albeit implicit, of t^* and differentiating $W^*(t^*, \lambda(t - t^*))$ w.r.t. t^* and setting the FOC equal to zero. That is, $W^{*\prime}_{t^*} = (t^*, \lambda(t - t^*))(1 - \lambda(t - t^*)) + t^* \lambda'_{t-t^*}(t - t^*) - t^* = 0$. Here it is assumed that the second order condition has of course been met.

Proposition 2. *For any given τ (with $\tau \in [1, 1.279]$) the tax equilibrium is described by $(t, t^*)^{Eq} = (\Omega(1) + \mu_1, 0)$ with the corresponding allocation $\lambda^{Eq} = 1$ if $\eta > 0$ and by $(t, t^*)^{Eq} = (\Omega(1) + \mu_2, 0)$ with corresponding allocation $\lambda^{Eq} = 1$ if $\eta = 0$.*

The tax equilibrium is depicted in Figure 11. An important feature of the tax equilibrium at low trade costs is the characteristic bell-shape in the tax rate differential, as it is reminiscent of the observed 'bell-shape' in the tax gap between the core-5 and the periphery-4 (see F2). In addition, the tax gap is strictly positive which is in line with the notion that the corporate income tax rate in the core-5 has been consistently higher than the corporate income tax rate in the periphery-4 (see F2). Furthermore, the tax equilibrium depicted in Figure 11 also squares up with the idea that two countries that are relatively the same in terms of their labour-to-total-capital ratio ($\rho = \rho^*$) may end up with different tax rates (see F3). Hence, enhanced economic integration between the core-5 and the periphery-4 can thus have given rise to the observed bell-shape in the tax differential. As a similar result was documented by Baldwin and Krugman (2004) in the pure core-periphery setting this is typically construed as evidence for the fact that agglomeration may play an important role in the changes in the corporate tax rate which we have observed during the 1980s and 1990s. Moreover, Borck and Pflüger (2006) managed to generalise this 'bell-shape' in the tax differential to a setting with partial agglomerations. In fact, given that $\mu_1 = 0$ the tax equilibrium at low trade costs described here is identical to that of Borck and Pflüger (2006).

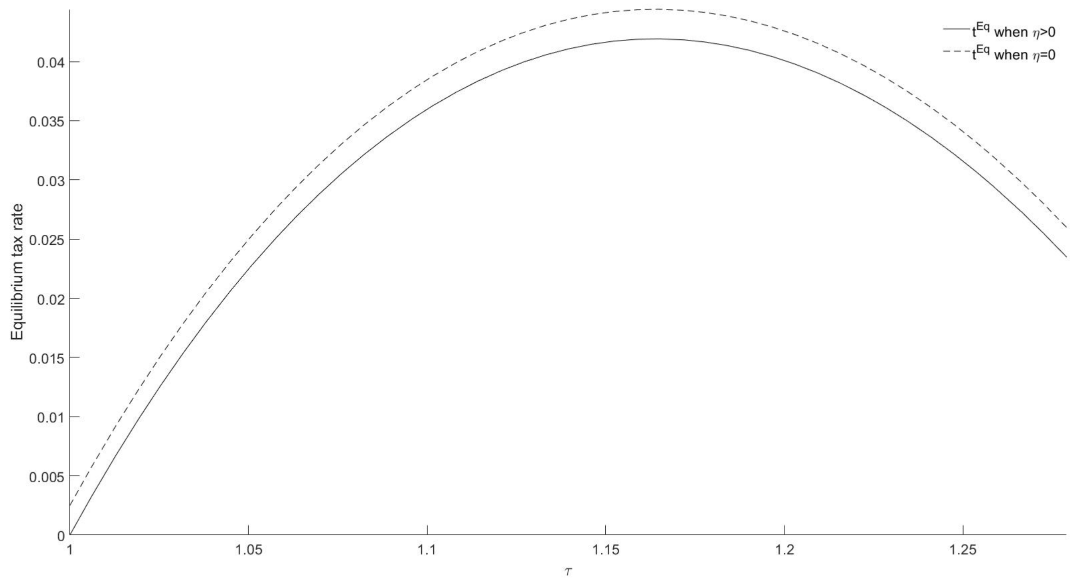

Figure 11: The solid line depicts the tax rate set by Home in equilibrium (and thus the tax differential since $t^* = 0$).

In spite of the fact that an agglomeration based rationale for the tax game as presented by Borck and Pflüger (2006) might seem reasonable as it allows for partial agglomerations there are some notable issues. First, as can be seen in Figure 11 the tax gap starts to decrease once trade costs fall below 17% of the value being shipped, which is not consistent with the notion that trade costs clearly exceeded 17% in 1994 (see F6). Second, the tax rate set by Foreign is constant (zero) at such low trade costs, while the corporate tax rate in the periphery-4 has also fallen substantially during the period 1980 till 2000 (see F1). Third, the increase in the tax gap is due to an increase in the tax rate of Home, however the tax rate in the core-5 has not been increasing before 1994 (see F1). Fourth, for this 'bell-shape' to occur we need to have that in equilibrium all capitalists choose to stay in Home, that is the periphery-4 should have no capitalists which is at odds with stylised fact 4. That is, despite the fact that Borck and Pflüger (2006) allow for the arguably more realistic setting in which partial agglomerations can exist, the relevant equilibrium is not characterised by such partial agglomerations.

6.2 The tax equilibrium at intermediate trade costs and no heterogeneity

In contrast to the analysis presented in section 6.1, determining the tax equilibrium at intermediate trade costs cannot be accomplished analytically. Instead, it is common to rely on numerical simulations. In this section we assume that there is only one type of capitalist, i.e. $\eta = 1$ (all perfectly mobile) or $\eta = 0$ (all imperfectly mobile). First, let $\eta = 1$. Then Home will choose its tax rate such that $t - t^*(t) < \Omega(\lambda_M) + \mu_1$ as in equilibrium $\lambda'_{t-t^*}(t - t^*) = 1/\Omega'_\lambda(\lambda)$[41], given that $\lim_{\lambda \to \lambda_M^+} \Omega(\lambda) \to 0^-$ and as a result $\lambda'_{t-t^*}(t - t^*) \to -\infty$. In other words, a small reduction in Home's tax rate would bring about a very large increase in Home's share of capitalists irregardless of the size of the capital mobility impediments. Hence, Home will set its tax rate such that in equilibrium it has more capitalists than λ_M as it would optimally want to have $\lambda'_{t-t^*}(t - t^*) = (t - \lambda)/(t - t^{*\prime}_t(t)t) > -\infty$. This is also clearly shown in Figure 12 which depicts the equilibrium allocation implied by equation (18).

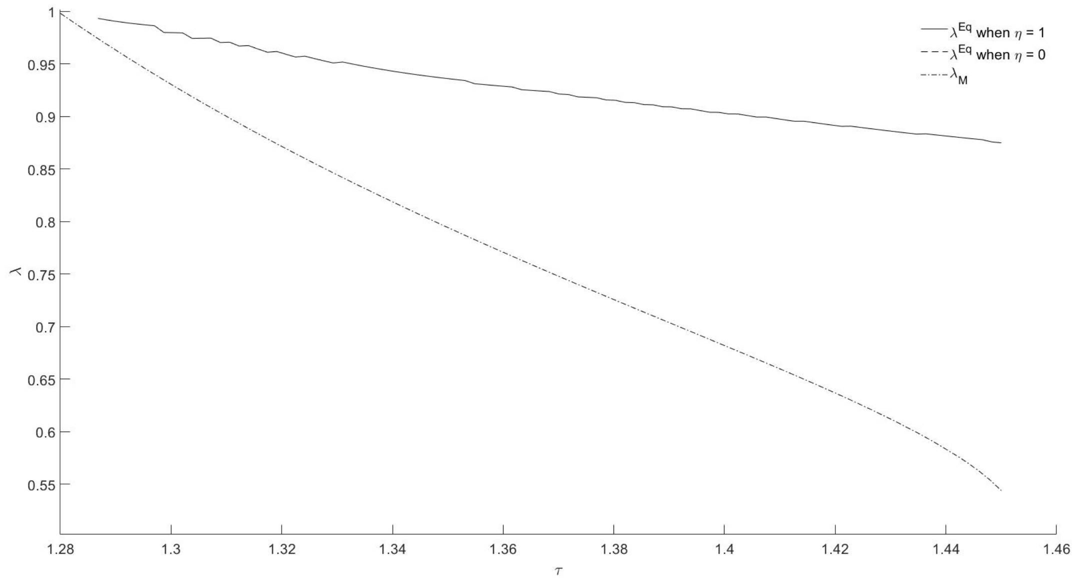

Figure 12: The solid line depicts the location equilibrium that corresponds to the equilibrium in the tax game with only perfectly mobile capitalists. The dotted line (on top of the solid line) depicts the location equilibrium that corresponds to the equilibrium in the tax game with only imperfectly mobile capitalists (type 2). Finally, the dash dotted line depicts the minimum share of capitalists at which discrete delocation occurs. Here all parameters are as per section 3.3.

However, as can be seen from Figure 12 the location equilibrium is invariant to a change in the level of capital mobility as $\eta = 1$ yields the same allocation equilibrium as $\eta = 0$. The tax game equilibrium has nevertheless changed. In fact, Home's tax rate differs with $\mu_2 - \mu_1$ units for any level of trade costs! *Id est* an increase in capital mobility across the board impacts the tax setting of Home but not that of Foreign. Since $\lambda \neq 1$ at any level of intermediate trade costs and since there is no discrete delocation we can focus on the equilibrium allocation in region $\mathcal{R}'_2$ when $\eta = 1$ (since $\lambda_M > 0$) and in region $\mathcal{R}_4$ when $\eta = 0$ (since $\lambda_M < 1$ and $\mathcal{R}_2 = \emptyset$). Therefore, the equilibrium for $\eta = 1$ is characterised by $\Omega(\lambda) + \mu_1 = t - t^*$, while for $\eta = 0$ it is characterised by $\Omega(\lambda) + \mu_2 = t - t^*$. Now suppose that the tax equilibrium when $\eta = 1$ is characterised as $(t', t^{*\prime})$. It can be readily verified that if $t'' = t' + (\mu_2 - \mu_1)$ that $(t'', t^{*\prime})$ should be a tax game equilibrium for $\eta = 0$. In specific, $\Omega(\lambda) + \mu_2 = t'' - t^* = t' + (\mu_2 - \mu_1) - t^*$ or simply put $\Omega(\lambda) + \mu_1 = t' - t^*$ which of course solves for $t^{*\prime\prime} = t^{*\prime}$ and the same allocation of capitalists That is, since this the condition on the location equilibrium has not changed and what was previously optimal to Foreign should still be optimal to Foreign the equilibrium tax rate of Foreign and the allocation equilibrium are unaffected by a change in relocation costs. This observation yields the following proposition:

[41]We have that in equilibrium $\Omega(\lambda(t - t^*)) + \mu_1 = t - t^*$ which implies that $\Omega'_\lambda(\lambda(t - t^*))\lambda'_{t-t^*}(t - t^*) = 1$.

Proposition 3. *For a given τ (with $\tau \in (1.279, 1.454]$) the tax game equilibrium is described by $(t, t^*)^{Eq} = (t', t^{*\prime})$ with corresponding allocation $\lambda^{Eq} = \lambda' < \lambda_M$ when $\eta = 1$ and by $(t, t^*)^{Eq} = (t' + (\mu_2 - \mu_1), t^{*\prime})$ with corresponding allocation $\lambda^{Eq} = \lambda' < \lambda_M$ when $\eta = 0$.*

The equilibrium tax rates of both regions are then depicted in Figure 13. As can be seen in Figure 12 there now exist partial agglomerations in equilibrium (consistent with F4). In addition, Figure 13 also shows that if economic integration increases (fall in trade costs) the tax rate of Foreign is decreases irregardless of the level of trade costs which is in line with stylised fact 1. The reason that the tax rate set by Foreign is falling as trade costs fall is due to the fact that the share of capitalists that are located in Home increases (see Figure 12). As a result thereof the marginal benefit of setting a higher tax rate goes down while the marginal cost remains the same. Therefore Foreign will in turn lower its tax rate as to equate its marginal benefit of an increase in tax rate with its marginal cost of raising its tax rate again. All of this occurs at (more) reasonable levels of trade costs (see F6). There are however three observations that conflict with the stylised facts outlined in section 2.1. First, the corporate income tax rate levied by Home increases with a fall in trade costs, while it should fall if trade costs were to be driving the declines in tax rates (see F1). Second, the tax gap increases whenever economic integration strengthens whereas stylised fact 2 indicates that it should be bell-shaped. Third, the tax gap becomes negative when trade costs are on the high end of the spectrum, which is at odds with stylised fact 2. This last mismatch can however be readily remedied through choosing $\mu_2 > 0.025$.

It is important to note that since Foreign has set its tax rate optimally as it simply accepts being the partial periphery independent of whether $\tau \in [1, 1.279]$ or $\tau \in (1.279, 1.454]$. As such, additional factor market integration (decrease in μ_2 and/or μ_1) will not incentivise Foreign to change its tax rate. As a result, Foreign will therefore have no incentive to partake in split-the-difference tax rate harmonisation efforts or minimum tax rate agreements (as proposed by the OECD), since Home is the only party that is adversely impacted by additional factor market integration (decrease in μ_1 or μ_2) as stated by propositions 2 and 3. In order for such policies to then enhance the welfare of both regions it should eliminate the incentive Foreign has to change its tax rate. This only occurs whenever one drops the constraint in equation (18) or sets $\lambda(t - t^*) = \lambda$. That is, for such policies to effectively enhance the welfare of both regions the allocation of capital should be agreed upon prior to setting ones taxes (planned economy). Note that such an arrangement in the current model is clearly welfare enhancing, albeit that it is not feasible if there exists no commitment mechanism.

To illustrate this, suppose the two regions would decide to split the capitalists equally and impose movement restrictions that prevent any capitalist from reallocating such that $\lambda(t - t^*) = \lambda$. Then the corresponding pay-offs to the regions are $(W(0.25, 0.5), W^*(0.25, 0.5)) = (0.125, 0.125)$. These exceed the maximum welfare across any level of trade costs that can be attained without such coordination. For instance, with $\mu_2 = 0.0025$ Foreign's maximum welfare is attained when $\tau = 1.45$ as $W^*(0.022, 0.875) = 0.002 < 0.125$, while for Home its maximum welfare at intermediate trade costs is attained when $\tau = 1.2868$ as $W(0.0235, 0.993) = 0.023 < 0.125$. However, if these movement restrictions are not enforceable, such that capitalists can still relocate, then the undercutting of Foreign causes the equilibrium to revert to the one described in this section. Note that if the game were to be repeated indefinitely the equilibrium described here is a Nash equilibrium in the interior of the convex hull spanned by the choice set (t, t^*, λ) in the outcome space $(W(t, \lambda), W^*(t^*, 1-\lambda))$. That is, we can apply the Folk theorem and sustain such capital restrictions provided that both regions are sufficiently patient. Hence, tax rate harmonisation or minimum bounds on the corporate tax rate in the presence of agglomeration economies requires additional capital restrictions which would appear to be sustainable. This finding thus clearly opposes the notion put forth by the classical tax competition models, which indicate that instituting a minimum tax rate agreement without capital restrictions would benefit all regions (i.e. a Pareto improvement).

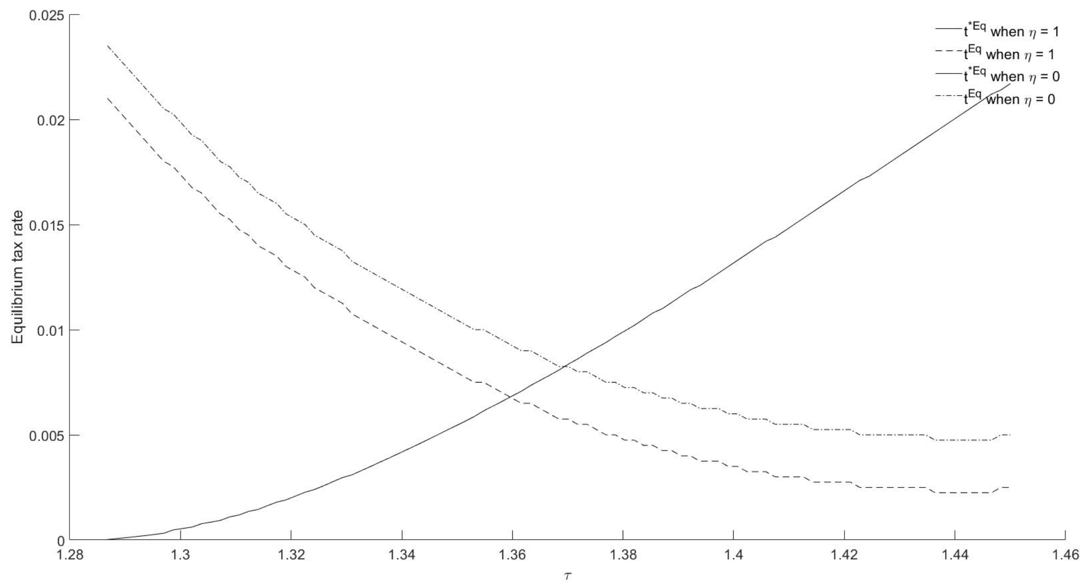

Figure 13: The solid line depicts the tax rate set by Foreign in a setting with exclusively perfectly mobile capitalists and a setting in which all capitalists are imperfectly mobile. The dashed line depicts the tax rate set in equilibrium by Home when there are only perfectly mobile capitalists (type 1). Finally, the dash dotted line depicts the tax rate set in equilibrium by Home when there are only imperfectly mobile capitalists (type 2). Here all parameters are as described in section 3.3.

6.3 The tax equilibrium at intermediate trade costs and with heterogeneity

Now let us assume that the share of perfectly mobile capitalists is 15% instead of 0% or 100% as in section 6.2. Although the location equilibrium expressed in equations (14) and (16) is no longer a 'nice' function of the tax gap, the share of capitalists in each country which is implied by the equilibrium in the tax game (depicted in Figure 14) can nevertheless be rationalised. With two types of capitalists Home essentially faces a trade-off between λ and t described by the following two options. First, Home can choose to let at all mobile capitalists migrate and increase its tax rate to exploit the fact that the imperfectly mobile capitalists are less inclined to move (i.e. subject to some inertia). Second, Home can alternatively choose to keep some of the perfectly mobile capitalists and accept that it needs to set its tax rate lower given that the perfectly mobile capitalists will be more inclined to change location. Whenever Home chooses this second option we must have that Home will choose the same location equilibrium as in section 6.2. To see why this must be true, note that in the second case the location equilibrium is essentially restricted to be in the region $\mathcal{R}_2^{(\prime)}$, which causes the location equilibrium to be determined by $\Omega(\lambda) + \mu_1 = (t - t^*)$ irrespective of λ_M. However, this would in optimum also be the case if $\eta = 1$ and as such the equilibrium induced by the second option is identical to the one described in section 6.2. Ergo we have the following proposition:

Proposition 4. *Let $(t, t^*)^{Eq} = (t', t^{*\prime})$ and λ' denote the tax equilibrium and its corresponding location equilibrium for a given τ (with $\tau \in (1.279, 1454]$) when $\eta = 1$. Furthermore, let $(t, t^*)^{Eq} = (t'', t^{*\prime\prime})$ and λ'' denote the tax equilibrium and its corresponding location equilibrium for a given τ (with $\tau \in (1.279, 1454]$) when $\eta \in [0, 1)$. If $\lambda'' \in (1 - \eta, 1]$ then $(t'', t^{*\prime\prime}) = (t', t^{*\prime})$ and if $\lambda'' \in (\lambda_M, 1 - \eta)$ then $(t'', t^{*\prime\prime}) = (t' + (\mu_2 - \mu_1), t^{*\prime})$.*

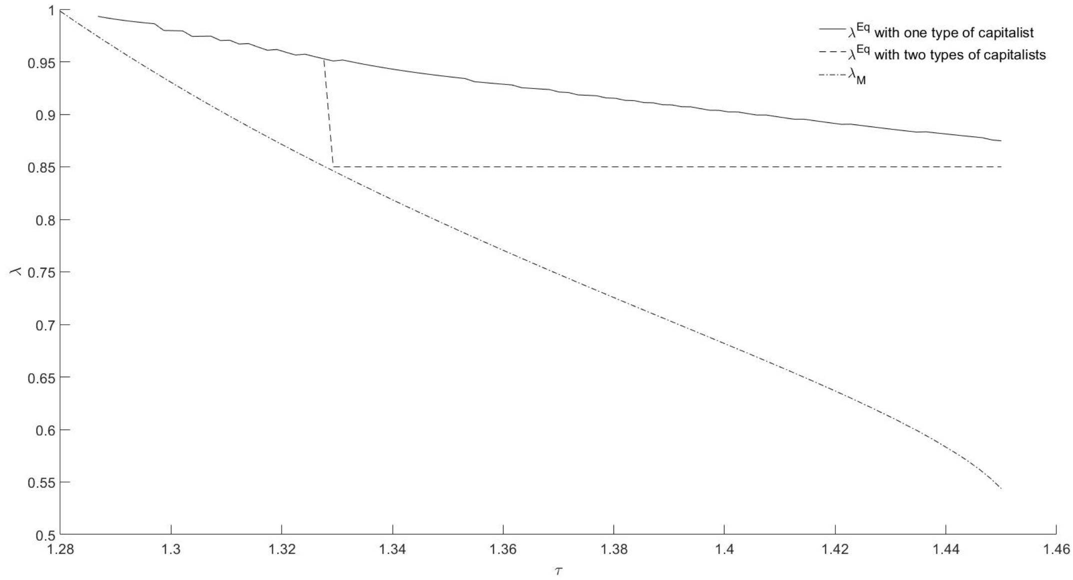

Figure 14: The solid line depicts the location equilibrium that corresponds to the equilibrium in the tax game with only one type of capitalist. The dashed line depicts the location equilibrium that corresponds to the equilibrium in the tax game with 85% imperfectly mobile capitalists and 15% perfectly mobile capitalists. Finally, the dash dotted line depicts the minimum share of capitalists at which discrete delocation occurs. Here all parameters are as per section 3.3 except for $\mu_2 = 0.01$, since the discretisation of the choice space of both governments is too granular when $\mu_2 = 0.0025$.

Perhaps a more intuitive interpretation of proposition 4 is the following. Through setting its tax rate Home can effectively decide whether Home and Foreign are going to compete over imperfectly mobile capital or perfectly mobile capital. As one might expect, the former allows Home to set a higher tax rate due to the fact that imperfectly mobile capital has some inertia, while the latter forces Home to set a lower tax rate (more fierce competition as perfectly mobile capital reacts quicker to a change in the tax rate differential). If Home then decides to compete over perfectly mobile capital ($\lambda'' \in (1-\eta, 1]$) it does not matter that there also exists imperfectly mobile capital as it will keep all imperfectly mobile capital anyway if it chooses not to tender all perfectly mobile capitalists to Foreign. As a result the tax equilibrium (and by extension the location equilibrium) is the same as if all capitalists had been perfectly mobile to begin with. Similarly, if Home opts to compete over imperfectly mobile capital ($\lambda'' \in (\lambda_M, 1-\eta)$ then at the margin it does not matter that there also exist perfectly mobile capital as all perfectly mobile capital would then already have migrated to Foreign. As a consequence, the tax equilibrium and the location equilibrium are the same as if there had only been imperfectly mobile capitalists. In short, it is the capitalist that moves at the margin that matters for tax setting rather than the composition of the capitalist population.

As can be seen in Figure 14, Home chooses to have $\lambda^{Eq} = 0.85$ for any $\tau \in (1.3278, 1.454]$. That is, it is welfare enhancing for Home to accept a lower share of the capitalist population and take advantage of the inertia of the imperfectly mobile capitalists as opposed to setting a lower tax to obtain a higher share of the capitalist population. In fact, Home continues to set its tax rate such that $\lambda^{Eq} = 0.85$ until $\tau = 1.3278$ (see section 5.4) after which it suddenly reverts back to the equilibrium described in section 6.2. The reason for this abrupt change is the fact that as trade costs fall below $\tau = 1.3278$ the minimum share of capitalists that Home needs to retain as to remain the core increases (see proposition 1) above 85%. Therefore, once trade costs have fallen below $\tau = 1.3278$ Home also needs to retain some of the perfectly mobile capitalists as to continue being the partial core. As a result, Home resorts back to the 'old' equilibrium as per proposition 4. This reversal to the equilibrium described in section 6.2 is also clearly visible in the tax equilibrium as depicted in Figure 15.

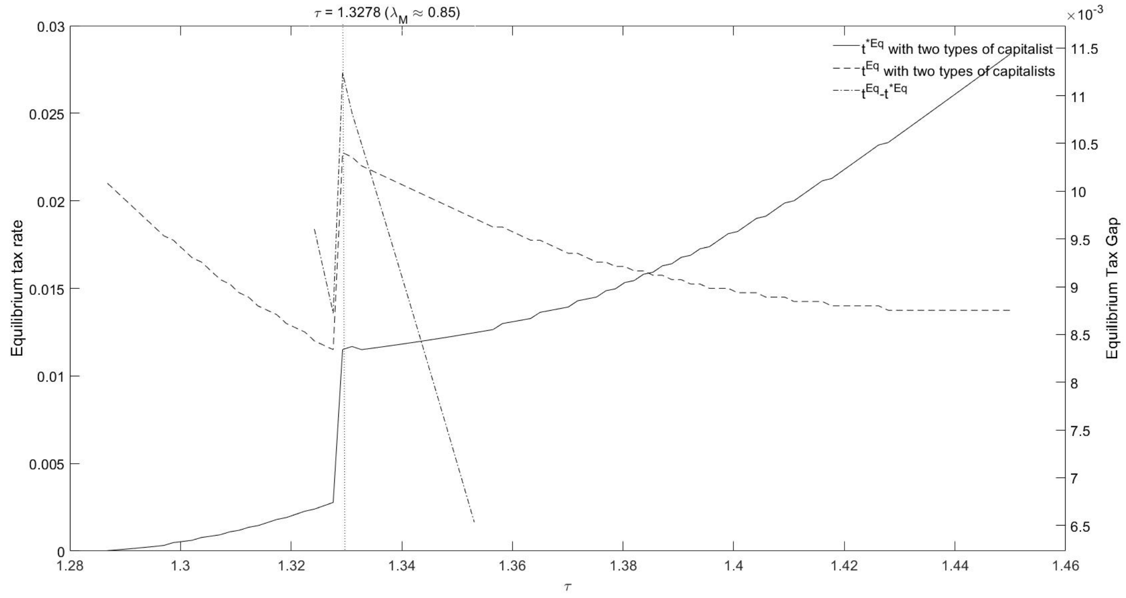

Figure 15: The solid line depicts the tax rate set by Foreign when $\eta = 0.15$, $\mu_1 = 0$ and $\mu_2 = 0.01$. The dashed line depicts the tax rate set in equilibrium by Home when $\eta = 0.15$, $\mu_1 = 0$ and $\mu_2 = 0.01$. The tax gap is depicted for values of trade costs close to where the location equilibrium reverts to the location equilibrium chosen when there would be only one type of capitalist (see Figure 14). All remaining parameters are as described in section 3.3.

In fact, once Home switches from competing over imperfectly mobile capital to competing over the perfectly mobile capital there is a significant drop in tax rates in Home and Foreign alike. Hence, heterogeneity in relocation costs can cause the tax rate in Home to fall as a consequence of falling trade costs. Hence, this observation is consistent with the idea that falling trade costs *can* drive the observed falls in the corporate tax rate. Although the tax rate set by Home increases when trade costs fall if $\tau \neq 1.3278$, I conjecture that a continuum of relocation costs with substantial dispersion would yield a continuous decline in the tax rate of Home as observed for the core-5 during 1980s and 1990s (see stylised fact 1).[42] Moreover, as can be seen in Figure 15 the tax gap takes on a 'bell-shape' which is consistent with stylised fact 2. Furthermore, Figure 14 shows that unlike Baldwin and Krugman (2004) and Borck and Pflüger (2006) heterogeneity in relocation costs can give rise to these patterns at substantially higher levels of trade costs and with partial agglomerations rather than in a pure core-periphery setting (i.e. it satisfies F4 and comes closer to meeting F6).

7 Discussion and Extensions

Throughout the 1980s, 1990s and 2000s many possible explanations for the staggering decreases in the corporate tax rate have been proposed. However, most of these explanations introduce some puzzling implications that do not align with what has been observed empirically (see Table 1). In order to resolve some of these puzzling implications I have augmented the Footloose Entrepreneur model proposed by Borck and Pflüger (2006) with heterogeneity in relocation costs and found that trade costs can in fact be a viable explanation for the observed declines in the corporate tax rate across Europe during the 1980s and 1990s. Moreover, the development in the corporate tax rate across Europe appears to be largely consistent with the notion that the increased economic integration in the presence

[42]Note that introducing more than two types of capitalists works essentially the same. Home is then continuously 'forced' out due to the increasing share of capitalists that it needs to retain. However, it cannot be ruled out that the declines in Home's tax rate were in part also driven by an a leftward shift in the distribution of relocation costs. That is, an overall increase in capital mobility could also explain part of the declines (see proposition 2 and 3), though the policy implications are identical to those mentioned in section 6.2.

of agglomerations has shifted competition from less mobile types of capital to more mobile types of capital. In conclusion, both increases in factor market integration and goods market integration can be to the detriment of a government's ability to levy a corporate tax rate and impede the government from providing a public good. However, factor market integration impacts the (partial) core rather than the (partial) periphery while goods market integration can impact both regions.

Table 1: Comparison of (traditional) models in terms of their ability to explain the stylised facts of section 2.

Model	F1	F2	F3	F4	F6	Explanation
Standard Tax Competition Model	✓	×	×	✓	✓	Increase in Capital Mobility
Persson and Tabellini (1992)	∼	×	✓	×	✓	Increase in Electoral Influence
Baldwin and Krugman (2004)	×	✓	✓	×	×	Decrease in Trade costs (i.e. F5)
Borck and Pflüger (2006)	×	✓	✓	×	×	Decrease in Trade costs (i.e. F5)
Borck and Pflüger (2006)	✓[43]	✓	✓	✓	∼	Decrease in Trade costs (i.e. F5)
+ heterogeneous relocation costs						(and increase in Capital Mobility)

The fact that only the (partial) core stands to gain from tax rate harmonisation or the imposition of a minimum bound to limit the (partial) periphery in its ability to undercut the (partial) core, which is in line with the findings of Baldwin and Krugman (2004). As such, this result can be readily generalised to a setting with heterogeneous relocation costs and partial agglomerations. In addition, this result also provides a rationale for why many of the proposed 'split-the-difference' tax rate harmonisation initiatives and corporate tax rate minimum bound plans have been primarily promoted by major OECD countries. Such policies could nevertheless be welfare enhancing to both regions if they were to be augmented with capital restrictions. However, since policy makers have imperfect information this may in turn induce an inefficient resource allocation that could potentially outweigh any benefits from the increase in tax revenues. Moreover, it is exactly the free movement of resources and goods that are essential to an optimal currency area and the single market itself. Instead, it can be welfare enhancing to temper goods market integration and factor market integration as to allow the core and the periphery to coordinate on a equilibrium in which both can set higher tax rates.[44]

For future research it may prove fruitful to dedicate some effort to documenting relocation costs. The reason therefore is twofold. First, given that relocation costs are typically poorly documented (Zodrow, 2010) and that heterogeneity therein appears to be an important determinant for the development of the corporate tax rate, it can help us understand the development of the corporate tax rate better. Second, since the tax rates and the tax gap can exhibit a highly non-linear pattern (see Figure 15) this paper should serve as a warning against extrapolating trends in the corporate tax rate if they do not take into account heterogeneity in relocation costs. Despite, the fact that data on the exact values for the share of perfectly moble capitalists and the size of the mobility impediment is not available, this

[43] If one would allow for more types of capitalists or decreasing relocation costs across time.

[44] In the simulation with two types of capitalists the welfare of Home for a level of trade costs just above $\tau = 1.3278$ was 0.0191, while it was reduced to 0.0109 once Home had to start competing over the most mobile capitalists (note that if trade costs would fall by an additional 3.74 percentage points Home would become equally well off again). Similarly, Foreign had a welfare of 0.0017 when trade costs were just above 1.3278, while this was reduced to 0.0001 once Home and Foreign start to compete over the most mobile type of capital (and would become worse off for every subsequent decrease in trade costs).

does not have great bearing on the analysis given that all of the results obtained above are relatively robust against variations in those parameters.

In particular, if one were to alter the share of perfectly mobile capitalists to say 30%, then Figure 14 would still be very similar. In fact, the equilibrium allocation would remain at 70% until it is forced out again once trade costs decrease below 1.392.[45] As a result the fall in the tax rates as depicted in Figure (15) would then occur at $\tau = 1.392$. Similarly, if the share of perfectly mobile capitalists were to be only 5%, then the equilibrium allocation would be 95% and would be forced out once trade costs would fall below 1.311.[46] As such the fall in tax rates would also occur at a lower level of trade costs, namely 1.311. Hence, a change in η has a predictable outcome. Finally, μ_2 governs the size of the jump in the tax rates at the level of trade costs where the type of capitalists that is competed over changes. In this case, an increase in $\mu_2 - \mu_1$ causes there to be a larger jump downward in the tax rates. The fall in the tax gap at any point does however not change. This is due to the fact that the tax rate of the periphery falls in response to a reduction in its share of the capitalists population as the core reverts to the equilibrium of section 6.2. Throughout this paper we have taken μ_2 to be only a very small fraction of ones income. As such, it would appear to be logical that in reality the decreases in the tax rates in either country implied by the model would be more pronounced.

Despite the fact that a New Economic Geography based explanation augmented with heterogeneous relocation costs can resolve some puzzling implications of previously proposed rationales for the development of the corporate tax rate, there are still some issues that are left to future work. First, I have imposed an assumption that Home will never tender the core (i.e. a form of catastrophe penalty in the welfare function), which has been rationalised by the fact that the timing of the tax game is exogenous. Yet, it should be verified that once timing is endogenised Home would indeed be the (partial) core for any level of (reasonable) trade costs. Second, as capital agglomerates in the core-5 the model would predict that the manufacturing industry should shrink in the periphery-4, which does not appear to have occurred during the 1980s and 1990s. This implied change in the pattern of trade could probably be accommodated if one would additionally allow for vertical linkages to drive agglomeration. Therefore, it may be good to introduce additional realism to see whether the predictions can also match up with trends in trade data. Third, the model employed in this paper is static while the phenomena that ought to be explained is dynamic. As such, it is essential to verify whether the results obtained here can be generalised to a setting that accounts for dynamics, like capital stock formation and where relocation costs are drawn from some distribution upon creation. Lastly, it should be examined in a dynamic game to what degree a first stage in which the regions could commit to capital restrictions would alter the tax equilibrium in the current setting and in NEG models more generally.

8 Conclusion

To conclude, in this paper I have discussed several major mismatches between previously given rationales for the persistent fall in the corporate tax rate and empirical observations. To that end, I have augmented the FE model by Borck and Pflüger (2006) with heterogeneous relocation costs, which has been shown to be sufficient to align the NEG literature with the empirical literature. Hence, the observed declines in the corporate tax rate during the period 1980 to 2003 can be driven by falling trade costs. In specific, I document that as trade costs fall the capitalist that moves at the margin becomes more mobile and as a consequence competition over capital shifts from competing over the less mobile capital to competing over the more mobile capital. As such, a decrease in trade costs can ultimately results in a fall in the corporate tax rate in both the core and the periphery.

[45] Simulations of these robustness checks can be provided at request.

[46] If the homogeneous equilibrium allocation would be below 95% then so would the equilibrium allocation with heterogeneous capitalists.

9 References

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A Derivations of Goods Market Equilibrium

A.1 Household Demand Consumption Goods [Eq (5)]

To be shown is that $C_X = \alpha P^{-1}$ and that $C_A = Y_h - \alpha$.

Proof. Optimizing the utility function in equation (1) subject to the budget constrained described in text in section 2.1 gives the following Lagrangian:

$$\Gamma(C_X, C_A, \gamma) = \alpha \ln(C_X) + C_A - \gamma(PC_X + C_A - Y_h) \tag{20}$$

Which in has as its first order conditions:

$$\begin{aligned} \partial\Gamma(C_X, C_A, \gamma)/\partial C_X &= \alpha/C_X - \gamma P = 0 \\ \partial\Gamma(C_X, C_A, \gamma)/\partial C_A &= 1 - \gamma = 0 \\ \partial\Gamma(C_X, C_A, \gamma)/\partial\gamma &= Y_h - PC_X - C_A = 0 \end{aligned} \tag{21}$$

And from the second first order condition we have that $\gamma = 1$ and as such we can solve the first of the first order conditions to state that $C_X = \alpha P^{-1}$. Substituting this solution for C_X into the third first order condition then yields the expression for the demand for the agricultural good, $C_A = Y_h - \alpha$. Naturally, if $Y_h \leq \alpha$ then non-negativity constraint on C_A binds and one can readily find that $C_A = 0$ and $C_X = Y_h P^{-1}$. □

A.2 Household Demand per Manufacturing Variety [Eq(7)]

To be shown is that $x_i = \alpha P_i^{-\sigma} P^{\sigma-1}$ and that $x_j = \alpha(\tau P_j)^{-\sigma} P^{\sigma-1}$.

Proof. The household minimizes the cost of procuring a single unit of the manufactured good which gives the following Lagrangian where the $\tilde{x}_k$ signifies the *per unit of manufacturing good* demand for variety k:

$$\Gamma(\tilde{\mathbf{x}}_i, \tilde{\mathbf{x}}_j, \gamma) = \int_0^N P_i \tilde{x}_i di + \int_N^{N+N^*} \tau P_j \tilde{x}_j dj - \gamma \left(\left(\int_0^N \tilde{x}_i^{\frac{\sigma-1}{\sigma}} di + \int_N^{N+N^*} \tilde{x}_j^{\frac{\sigma-1}{\sigma}} dj \right)^{\frac{\sigma}{\sigma-1}} - 1 \right) \tag{22}$$

Which in has for $\forall i \in [0, N]$ and $\forall j \in (N, N + N^*]$ as first order conditions:

$$\begin{aligned} \partial\Gamma(C_X, C_A, \gamma)/\partial\tilde{x}_i &= P_i - \gamma \left(\int_0^N \tilde{x}_i^{\frac{\sigma-1}{\sigma}} di + \int_N^{N+N^*} \tilde{x}_j^{\frac{\sigma-1}{\sigma}} dj \right)^{\frac{1}{\sigma-1}} \tilde{x}_i^{-\frac{1}{\sigma}} = 0 \\ \partial\Gamma(C_X, C_A, \gamma)/\partial\tilde{x}_j &= \tau P_j - \gamma \left(\int_0^N \tilde{x}_i^{\frac{\sigma-1}{\sigma}} di + \int_N^{N+N^*} \tilde{x}_j^{\frac{\sigma-1}{\sigma}} dj \right)^{\frac{1}{\sigma-1}} \tilde{x}_j^{-\frac{1}{\sigma}} = 0 \\ \partial\Gamma(C_X, C_A, \gamma)/\partial\gamma &= 1 - \left(\int_0^N \tilde{x}_i^{\frac{\sigma-1}{\sigma}} di + \int_N^{N+N^*} \tilde{x}_j^{\frac{\sigma-1}{\sigma}} dj \right)^{\frac{\sigma}{\sigma-1}} = 0 \end{aligned} \tag{23}$$

Rearranging the first and second of the first order conditions and dividing them by the rearranged first order condition for $\tilde{x}_0$, which is produced in Home, gives us a general expression $\forall i \in [0, N]$ and $\forall j \in (N, N + N^*]$ of $\tilde{x}_i$ and $\tilde{x}_j$ in terms of $\tilde{x}_0$. In specific,

$$\tilde{x}_i = (P_0/P_i)^\sigma \tilde{x}_0, \text{ and } \tilde{x}_j = (P_0/\tau P_j)^\sigma \tilde{x}_0 \tag{24}$$

Substituting these definitions for $\tilde{x}_i$ and $\tilde{x}_j$ into the constraint which is given by the third of the first order conditions yields $\tilde{x}_0$:

$$\tilde{x}_0 = P_0^{-\sigma}\left(\int_0^N P_i^{1-\sigma}di + \int_N^{N+N^*}(\tau P_j)^{1-\sigma}dj\right)^{\frac{\sigma}{1-\sigma}} \tag{25}$$

Which gives the per unit of manufacturing good demand for variety i (j) by substituting $\tilde{x}_0$ back into the definition of $\tilde{x}_i$ ($\tilde{x}_j$) in terms of $\tilde{x}_0$.

$$\begin{aligned}\tilde{x}_i &= P_i^{-\sigma}\left(\int_0^N P_i^{1-\sigma}di + \int_N^{N+N^*}(\tau P_j)^{1-\sigma}dj\right)^{\frac{\sigma}{1-\sigma}}\\ \tilde{x}_j &= (\tau P_j)^{-\sigma}\left(\int_0^N P_i^{1-\sigma}di + \int_N^{N+N^*}(\tau P_j)^{1-\sigma}dj\right)^{\frac{\sigma}{1-\sigma}}\end{aligned} \tag{26}$$

As such the lowest achievable price index P per unit of the manufactured consumption good is obtained through substituting the definitions of $\tilde{x}_i$ and $\tilde{x}_j$ into the objective function:

$$P = \left(\int_0^N P_i^{1-\sigma}di + \int_N^{N+N^*}(\tau P_j)^{1-\sigma}dj\right)^{\frac{1}{1-\sigma}} \tag{27}$$

Having found the price index this allows for further simplification of the demand per unit of manufactured good of of the variety i (j), namely:

$$\tilde{x}_i = P_i^{-\sigma}P^{\sigma}, \text{ and } \tilde{x}_j = (\tau P_j)^{-\sigma}P^{\sigma} \tag{28}$$

Finally, using the fact that $x_i = \tilde{x}_i C_X$ and that $x_j = \tilde{x}_j C_X$ we then obtain the per household demand for variety i produced in Home and variety j produced in Foreign as:

$$x_i = \alpha P_i^{-\sigma}P^{\sigma-1}, \text{ and } x_j = \alpha(\tau P_j)^{-\sigma}P^{\sigma-1} \tag{29}$$

Which was to be shown. Note that x_i^* and x_j^* readily follow from doing the same but then for Foreign instead of for Home.

□

A.3 Prices per Unit of a Variety [Eq (8)]

To be shown is that $P_i = \frac{c\sigma}{\sigma-1}$ *and that* $P_i^* = \frac{c\sigma}{\sigma-1}$.

Proof. Starting for the variety that is produced in Home, these firms maximize their profit function in equation (5):

$$\max_{\{x_i,x_i^*\}} \Pi_i(x_i,x_i^*) = \max_{\{x_i,x_i^*\}} ((P_i(x_i)-c)X_i(x_i) + (P_i^*(x_i^*)-c)X_i^*(x_i^*) - R) \tag{30}$$

Which yields the following first order conditions:

$$\begin{aligned}\partial\Pi_i(x_i,x_i^*)/\partial x_i &= \frac{\partial P_i(x_i)}{\partial x_i}X_i(x_i) + (P_i(x_i)-c)\frac{\partial X_i}{\partial x_i} = 0\\ \partial\Pi_i(x_i,x_i^*)/\partial x_i^* &= \frac{\partial P_i^*(x_i^*)}{\partial x_i^*}X_i^*(x_i^*) + (P_i^*(x_i^*)-c)\frac{\partial X_i^*}{\partial x_i^*} = 0\end{aligned} \tag{31}$$

Using equation (4) it can then be verified that $\frac{\partial P_i(x_i)}{\partial x_i} = -\frac{1}{\sigma}P_i/x_i$ and $\frac{\partial P_i^*(x_i)}{\partial x_i^*} = -\frac{1}{\sigma}P_i^*/x_i^*$. In addition, since $X_i = (L+K)x_i$ and $X_i^* = (L^*+K^*)\tau x_i^*$ it is readily verified that $\frac{\partial X_i}{\partial x_i} = L+K$ and that $\frac{\partial X_i^*}{\partial x_i^*} = (L^*+K^*)\tau$. Substituting this into the first order conditions gives:

$$
\begin{aligned}
\partial\Pi_i(x_i, x_i^*)/\partial x_i = & -\frac{1}{\sigma}P_i(x_i)(L+K) + (P_i(x_i) - c)(L+K) = 0 \\
\partial\Pi_i(x_i, x_i^*)/\partial x_i^* = & -\frac{1}{\sigma}P_i^*(x_i^*)(L^*+K^*)\tau + (P_i^*(x_i^*) - c)(L^*+K^*)\tau = 0
\end{aligned} \tag{32}
$$

Solving for P_i and P_i^* then yields what had to be shown, which is that:

$$
P_i = \frac{c\sigma}{\sigma - 1} \text{ and } P_i^* = \frac{c\sigma}{\sigma - 1} \tag{33}
$$

Applying symmetry then also confirms that $P_j = P_j^* = \frac{c\sigma}{\sigma-1}$.

□

A.4 Aggregate Price Level [implication Eq (8)]

To be shown is that $P = \frac{c\sigma}{\sigma-1} \cdot (N + \tau^{1-\sigma}N^*)^{\frac{1}{1-\sigma}}$.

Proof. From the definition of the price index for the manufactured good at Home, derived for equation (4), we know that it is given in optimum by:

$$
P = \left(\int_0^N P_i^{1-\sigma} di + \int_N^{N+N^*} (\tau P_j)^{1-\sigma} dj\right)^{\frac{1}{1-\sigma}} \tag{34}
$$

Since the price levels are set by the firms we can now substitute the price levels for each individual variety given by equation (6) into the price index to obtain:

$$
P = \left(\int_0^N \left(\frac{c\sigma}{\sigma - 1}\right)^{1-\sigma} di + \int_N^{N+N^*} \left(\tau\frac{c\sigma}{\sigma - 1}\right)^{1-\sigma} dj\right)^{\frac{1}{1-\sigma}} \tag{35}
$$

Which is equivalent to:

$$
P = \frac{c\sigma}{\sigma - 1}\left(\int_0^N di + \tau^{1-\sigma}\int_N^{N+N^*} dj\right)^{\frac{1}{1-\sigma}} \tag{36}
$$

Evaluating the integrals then yields what has to be shown:

$$
P = \frac{c\sigma}{\sigma - 1}\left(N + \tau^{1-\sigma}N^*\right)^{\frac{1}{1-\sigma}} \tag{37}
$$

Again applying symmetry one obtains the price index in Foreign as:

$$
P^* = \frac{c\sigma}{\sigma - 1}\left(\tau^{1-\sigma}N + N^*\right)^{\frac{1}{1-\sigma}} \tag{38}
$$

□

A.5 Gross Income Capitalist [Eq (9)]

To be shown is that $R = \frac{\alpha(L+K)}{\sigma(K+\tau^{1-\sigma}K^*)} + \tau^{1-\sigma}\frac{\alpha(L^*+K^*)}{\sigma(\tau^{1-\sigma}K+K^*)}$.

Proof. To find the return to Capitalists in Home I follow Pflüger (2004) in setting R such that the firm obtains zero profit. To that end we have that:

$$\Pi_i(x_i, x_i^*) = \ (P_i(x_i) - c)X_i(x_i) + (P_i^*(x_i^*) - c)X_i^*(x_i^*) - R = 0 \tag{39}$$

Using the fact that in optimum $P_i^{(*)}(x_i^{(*)}) - c = c/(\sigma - 1)$ and since by substituting equations (6) and (7) into (4) we have that $x_i = \alpha\frac{\sigma-1}{c\sigma}\left(N + \tau^{1-\sigma}N^*\right)^{\sigma-1}$ and $x_i^* = \alpha\frac{\sigma-1}{c\sigma}\left(\tau^{1-\sigma}N + N^*\right)^{\sigma-1}$, the zero profit condition can be rewritten as:

$$R = \frac{\alpha(L+K)}{\sigma(N + \tau^{1-\sigma}N^*)} + \tau^{1-\sigma}\frac{\alpha(L^* + K^*)}{\sigma(\tau^{1-\sigma}N + N^*)} \tag{40}$$

Lastly, realizing that each variety requires exactly one unit of Capital relates the previous equilibrium condition for R to the one in equation (8):

$$R = \frac{\alpha(L+K)}{\sigma(K + \tau^{1-\sigma}K^*)} + \tau^{1-\sigma}\frac{\alpha(L^* + K^*)}{\sigma(\tau^{1-\sigma}K + K^*)} \tag{41}$$

R^* is then obtained analogously but through setting the profit function of a variety j producer equal to zero which is:

$$R^* = \tau^{1-\sigma}\frac{\alpha(L+K)}{\sigma(\tau^{1-\sigma}K + K^*)} + \frac{\alpha(L^* + K^*)}{\sigma(K + \tau^{1-\sigma}K^*)} \tag{42}$$

□

A.6 Gravity Expression

To be shown is that $\tau_{ij} \equiv (x_{ii}x_{jj}/x_{ij}x_{ji})^{1/2\sigma}$.

Proof. Let τ_{ij} be the trade costs when a good is transported from region i to j. In addition let $x_j = x_{ji}$, $x_{ii} = x_i$, $x_j^* = x_{jj}$ and $x_i^* = x_{ij}$. Then:

$$(x_{ii}x_{jj}/x_{ij}x_{ji}) = (\alpha(\tau_{ii}P_i)^{-\sigma}P^{\sigma-1}\alpha(\tau_{jj}P_j^*)^{-\sigma}P^{*\sigma-1})/(\alpha(\tau_{ij}P_i^*)^{-\sigma}P^{*\sigma-1}\alpha(\tau_{ji}P_j)^{-\sigma}P^{\sigma-1}) \tag{43}$$

Let us furthermore impose that there exist no internal trade frictions, i.e. $\tau_{ii} = \tau_{jj} = 1$, and that trade costs are symmetric, i.e. $\tau_{ji} = \tau_{ij}$. Using the expressions obtained above we then also know that $P_i = P_i^*$ and that $P_j = P_j^*$. Further simplification of the above expression then yields:

$$(x_{ii}x_{jj}/x_{ij}x_{ji}) = \tau_{ij}^{2\sigma} \iff \tau_{ij} = (x_{ii}x_{jj}/x_{ij}x_{ji})^{1/2\sigma} \tag{44}$$

□

B Observations w.r.t. the Allocation Equilibrium

B.1 The Relative Prices function as a Centripetal Force

To be shown is that $\partial\left(\alpha \ln(P^*/P)\right)/\partial\lambda > 0$, $\forall\lambda \in [0,1]$

Proof. In section 3.1 I assert that if λ rises this increases the incentive to relocate to Home through a fall in the price differential. This is equivalent to showing that $\alpha \ln(P^*/P)$ increases in λ, where:

$$\alpha \ln(P^*/P) = \frac{\alpha}{1-\sigma} \ln\left(\frac{\phi\lambda + (1-\lambda)}{\lambda + \phi(1-\lambda)}\right) \tag{45}$$

Taking the derivative and rearranging yields that:

$$\partial\left(\alpha \ln(P^*/P)\right)/\partial\lambda = \underbrace{\frac{\alpha(1-\phi)}{\sigma-1}}_{>0 \text{ for } \sigma>1 \text{ and } \phi\in(0,1)} \underbrace{\left(\frac{1}{\phi\lambda + (1-\lambda)} + \frac{1}{\lambda + \phi(1-\lambda)}\right)}_{>0 \text{ for } \lambda\in[0,1] \text{ and } \phi\in(0,1)} > 0 \tag{46}$$

Hence, if the share of Capitalists in Home increases this increases $\Omega(\lambda)$ which in turn increases $V_K - V_K^*$ causing the net-of-relocation-cost benefit of relocating bigger for Capitalists located in Foreign. □

B.2 The Centripetal Force exerted by the Relative Prices increases with Trade Costs

To be shown is that $\partial\left(\alpha \ln(P^*/P)\right)/\partial\phi < 0$, $\forall\lambda \in (\frac{1}{2},1]$ *and the converse* $\forall\lambda \in [0,\frac{1}{2})$

Proof. In section 3.1 I furthermore assert that the larger the trade costs, τ, are (or the lower openness to trade, ϕ, is) the larger the cost savings will be of agglomerating. For $\lambda > \frac{1}{2}$, i.e. price level is lower in Home than in Foreign, then $V_K - V_K^*$ must increase and more so the larger trade costs are as capitalists must be more willing to start relocating to Home. For $\lambda < \frac{1}{2}$, i.e. price level is higher in Home than in Foreign, then $V_K^* - V_K$ must increase and more so the larger trade costs are as capitalists must be more willing to start relocating to Foreign. This is equivalent to saying that $\partial\left(\alpha \ln(P^*/P)\right)/\partial\phi < 0$, $\forall\lambda \in (\frac{1}{2},1]$, where:

$$\alpha \ln(P^*/P) = \frac{\alpha}{1-\sigma} \ln\left(\frac{\phi\lambda + (1-\lambda)}{\lambda + \phi(1-\lambda)}\right) \tag{47}$$

Taking the derivative and rearranging then gives

$$\partial\left(\alpha \ln(P^*/P)\right)/\partial\phi = \underbrace{\frac{\alpha}{1-\sigma}}_{<0 \text{ for } \sigma>1} \underbrace{\left(\frac{\lambda^2 - (1-\lambda)^2}{(\phi\lambda + (1-\lambda))(\lambda + \phi(1-\lambda))}\right)}_{\substack{>0 \text{ for } \lambda\in(\frac{1}{2},1] \\ <0 \text{ for } \lambda\in[0,\frac{1}{2})}} \tag{48}$$

As such, for any share of Capitalists larger than 50% more trade openness decreases $\Omega(\lambda)$ and thus lowers incentive to move to Home. Conversely, higher openness to trade increases $\Omega(\lambda)$ if the share of Capitalists in Home falls short of 50% and thus reduces the incentive to relocate to Foreign. This effect is stronger the more Capitalists have already located together as the benefit of relocating is larger as there are more cost savings being realized already. □

B.3 The Return Differential acts as a Centrifugal Force if Trade costs are High and as a Centripetal Force if Trade Costs are Low

To be shown is that $\partial(R - R^*)/\partial\lambda < 0$ if $\phi < \phi'$ and the converse if $\phi > \phi'$

Proof. In section 3.1 it is asserted that if trade openness is sufficiently low, that is $\phi < \phi'$, that the returns tend to disperse Capital. This is the case if $R - R^*$ decreases with λ as it structurally lowers $V_K - V_K^*$ if λ is small enough, $\lambda < \frac{1}{2}$, and it should also decrease with λ as $R - R^*$ becomes negative for $\lambda > \frac{1}{2}$ and as such decreases $V_K^* - V_K$ for high concentrations of Capitalists in Home. Here we have that $R - R^*$ is given by:

$$R - R^* = \frac{\alpha(1-\phi)}{\sigma}\left(\frac{\rho+\lambda}{\lambda+\phi(1-\lambda)} - \frac{\rho^*+(1-\lambda)}{\phi\lambda+(1-\lambda)}\right) \tag{49}$$

Taking the derivative with respect to λ gives after simplification:

$$\partial(R - R^*)/\partial\lambda = \underbrace{\frac{\alpha(1-\phi)}{\sigma}}_{>0 \text{ for } \phi\in(0,1)} \underbrace{\left(\frac{\phi-\rho(1-\phi)}{(\lambda+\phi(1-\lambda))^2} - \frac{\rho^*(1-\phi)-\phi}{(\phi\lambda+(1-\lambda))^2}\right)}_{\text{Could be }<0\text{ or }>0} \tag{50}$$

Hence, whether $R-R^*$ is strictly decreasing or not hinges on the sign on the second term. Imposing $\rho = \rho^*$ as per section 2.6, further rewriting gives us that $\partial(R-R^*)/\partial\lambda < 0$ whenever $\phi < \rho/(1+\rho) \equiv \phi'$ and $\partial(R - R^*)/\partial\lambda > 0$ whenever $\phi > \rho/(1 + \rho) \equiv \phi'$. Hence, the difference in returns is a centrifugal force if trade costs are high enough while it is a centripetal force if trade costs are low enough. □

B.4 The centrifugal force exerted by the return differential decreases with trade costs and becomes a centripetal force thereafter. If trade costs increase even further, the centripetal force of the return differential weakens

To be shown is that $\partial(R - R^*)/\partial\phi < 0$ if $\lambda < \frac{1}{2}$ and $\partial(R - R^*)/\partial\phi > 0$ if $\lambda > \frac{1}{2}$ whenever $\phi < \phi''$ and the opposite if $\phi > \phi''$, where $\phi'' > \phi'$.

Proof. To show that further economic integration increases the the incentive to agglomerate as it causes competition to go up by less (i.e. less isolated markets thus increase in competition becomes less) I have to show that $\partial(R - R^*)/\partial\phi < 0$ if $\lambda < \frac{1}{2}$ and $\partial(R - R^*)/\partial\phi > 0$ if $\lambda > \frac{1}{2}$ so long as trade openness does not increase above ϕ''. The definition of $R - R^*$ as:

$$R - R^* = \frac{\alpha(1-\phi)}{\sigma}\left(\frac{\rho+\lambda}{\lambda+\phi(1-\lambda)} - \frac{\rho^*+(1-\lambda)}{\phi\lambda+(1-\lambda)}\right) \tag{51}$$

Then taking the derivative of the difference in returns and simplifying yields:

$$\partial(R - R^*)/\partial\phi = \underbrace{\frac{\alpha}{\sigma}}_{>0} \underbrace{\left(\frac{\rho^*+(1-\lambda)}{(\phi\lambda+(1-\lambda))^2} - \frac{\rho+\lambda}{(\lambda+\phi(1-\lambda))^2}\right)}_{\text{Could be }<0\text{ or }>0} \tag{52}$$

The sign of $\partial(R-R^*)/\partial\phi$ thus depends on the second term. Setting this term equal to zero yields however a third order polynomial in λ and as such involves tedious rewriting to find the conditions.

Using the parameters as described in section 2.6 I show that this is the case numerically (note that numerical evidence for any case can be provided upon request).

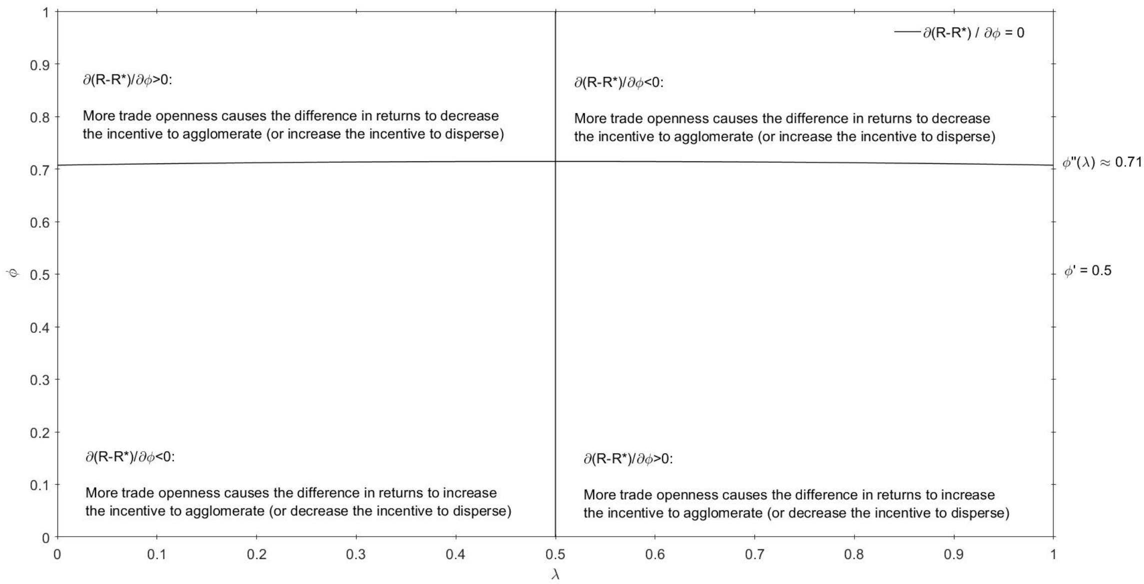

Figure A: Contour plot of $\frac{\partial(R-R^*)}{\partial\phi} = 0$. The value of $\frac{\partial(R-R^*)}{\partial\phi}$ and its implication is described in each region. Note that strict technically ϕ'' depends on λ, albeit the case that ϕ'' is not influenced much by λ.

□

C Proof of Proposition 1

Proof. Proposition 1 requires us to prove that $\lambda_M = \text{argmax}_{\lambda\in(0.5,1]}(\Omega(\lambda)$ is a continuous function that is decreasing in τ on the interval $\tau \in (f^{-1}(1)^{\frac{1}{1-\sigma}}, \tau_b)$. To show this λ_M needs to be obtained first through setting:

$$\begin{aligned}\frac{\partial\Omega(\lambda)}{\partial\lambda} =& \frac{\sigma}{\sigma-1}\left(\frac{(1+\phi)(\lambda+\phi(1-\lambda))(\phi\lambda+(1-\lambda))}{(\lambda+\phi(1-\lambda))^2(\phi\lambda+(1-\lambda))^2}\right)+\\ &\left(\frac{(\phi+\phi\rho-\rho)(\phi\lambda+(1-\lambda))^2}{(\lambda+\phi(1-\lambda))^2(\phi\lambda+(1-\lambda))^2}+\frac{(\phi+\phi\rho^*-\rho^*)(\lambda+\phi(1-\lambda))^2}{(\lambda+\phi(1-\lambda))^2(\phi\lambda+(1-\lambda))^2}\right) = 0\end{aligned} \tag{53}$$

Rearranging terms to rewrite (A.1) as a second order polynomial in λ and imposing for simplicity $\rho = \rho^*$[47], (A.1) implies that:

$$\begin{aligned}\lambda^2\left(2(\phi+\phi\rho-\rho)-\frac{\sigma(1+\phi)}{\sigma-1}\right)+&\lambda\left(\frac{\sigma(1+\phi)}{\sigma-1}-2(\phi+\phi\rho-\rho)\right)+\\ &\left(\frac{\sigma(1+\phi)\phi}{(\sigma-1)(1-\phi)^2}+(\phi+\phi\rho-\rho)\frac{1+\phi^2}{(1-\phi)^2}\right)=0\end{aligned} \tag{54}$$

[47]This is not necessary but does make things analytically slightly simpler and is consistent with the analysis throughout sections III and IV. In specific, equation (A.2) would then have that $2(\psi+\psi\rho-\rho)$ need be replaced with $(\psi+\psi\rho-\rho)+(\psi+\psi\rho^*-\rho^*)$

Through completing the square and by using the fact that $\Omega(\lambda)$ is a odd function about $\lambda = \frac{1}{2}$ and that $\partial^2\Omega(\lambda)/\partial\lambda^2 < 0$ for $\lambda \in (\frac{1}{2}, 1]$, λ_M can then be defined for $\phi \in \{\phi | \lambda_M \in \mathbb{R}$ and $\lambda_M \in (\frac{1}{2}, 1]\}$ as:

$$\lambda_M \equiv \min\left(\frac{1}{2} + \frac{\sqrt{\left(\frac{\sigma(1+\phi)}{\sigma-1} - 2(\phi+\phi\rho-\rho)\right) + 4\left(\frac{\sigma(1+\phi)\phi}{(\sigma-1)(1-\phi)^2} + (\phi+\phi\rho-\rho)\frac{1+\phi^2}{(1-\phi)^2}\right)}}{2\sqrt{\left(\frac{\sigma(1+\phi)}{\sigma-1} - 2(\phi+\phi\rho-\rho)\right)}}, 1\right) \quad (55)$$

Subsequent rearrangements of equation (A.3) permit us to rewrite λ_M as function of the ratio of two cubic equations, $g(\phi)/h(\phi)$, in ϕ namely:

$$\lambda_M \equiv \min\left(\frac{1}{2} + \frac{1}{2}\sqrt{1 + 4\frac{g(\phi)}{h(\phi)}}, 1\right) \quad (56)$$

Where these third order polynomials can be written as:

$$\begin{aligned} g(\phi) &\equiv \phi^3(\sigma-1)(1+\rho) - \phi^2((\sigma-1)\rho-\sigma) + \phi(\sigma+(\sigma-1)(1+\rho)) - (\sigma-1)\rho \\ h(\phi) &\equiv \phi^3(2-\sigma-2\rho(\sigma-1)) + \phi^2(3\sigma-4+6\rho(\sigma-1)) + \phi(2-3\sigma-6\rho(\sigma-1)) + \sigma + 2\rho(\sigma-1) \end{aligned} \quad (57)$$

After cumbersome rewriting it is found that for any ρ and $\sigma/(\sigma-1) < 2\rho$ the ratio of the two cubic equations is strictly increasing in ϕ. As such, this proves for $\phi \in \{\phi | \lambda_M \in \mathbb{R}$ and $\lambda_M \in (\frac{1}{2}, 1)\}$ that $\frac{\partial\lambda_M}{\partial g(\phi)/h(\phi)}\frac{\partial g(\phi)/h(\phi)}{\partial(\phi)} > 0$ since both $\frac{\partial\lambda_M}{\partial g(\phi)/h(\phi)} > 0$ and $\frac{\partial g(\phi)/h(\phi)}{\partial\phi} > 0$. This proves the main point of this exercise, namely that:

$$\frac{\partial\lambda_M}{\partial\tau} = \frac{\partial\lambda_M}{\partial g(\phi)/h(\phi)}\frac{\partial g(\phi)/h(\phi)}{\partial\phi}\frac{\partial\phi}{\partial\tau} < 0 \quad (58)$$

Since $\frac{\partial\phi}{\partial\tau} < 0$. From equation (A.5) it then follows that equation (A.4) is injective if the domain is restricted to exclude ϕ such that $\frac{1}{2} + \frac{1}{2}\sqrt{1 + 4\frac{g(\phi)}{h(\phi)}} > 1$. Defining the inverse of $\lambda_M \equiv f(\phi)$ as $f^{-1}(\lambda_M)$, we can rewrite the conditions on ϕ in terms of the trade cost parameter. In fact, the restriction on ϕ is identical to restricting $f^{-1}(1)^{\frac{1}{1-\sigma}} < \tau < \tau_b$ as the lower bound restrains λ_M to lie between a half and unity[48], whereas the upper bound controls for the fact that $\frac{\partial\Omega(\lambda)}{\partial\lambda} = 0$ for $\tau = \tau_b$ representing an inflection point rather than a maximum and above it λ_M would no longer be real[49]. Using the findings in section 4, the delocation tax differential is equal to $\Omega(\lambda_M) + \mu_1$ if $\lambda_M \geq 1 - \eta$ and to $\Omega(\lambda_M) + \mu_2$ whenever $\lambda_M < 1 - \eta$. Therefore, letting $\tilde{\tau} \equiv f^{-1}(1-\eta)^{\frac{1}{1-\sigma}}$ we know that $\lambda_M < 1 - \eta \iff \tilde{\tau} < \tau < \tau_b$ and that $\lambda_M \geq 1 - \eta \iff f^{-1}(1)^{\frac{1}{1-\sigma}} < \tau \leq \tilde{\tau}$ which affirms the second assertion stated in Proposition 1. I show this graphically in the Figure B below as well. The first assertion - that the delocation tax differential drops by $\mu_2 - \mu_1$ at the unique level $\tilde{\tau}$ - is now readily verified as the fall in the delocation tax at $\tilde{\tau}$ equals:

[48] Moreover, in all simulations with parameters as per section 2.6, then $f^{-1}(1)^{\frac{1}{1-\sigma}} = 1.279$ as for any smaller trade costs $\Omega(\lambda)$ would be strictly increasing and thus have no interior extrema.

[49] In specific, equation (A.3) is only defined on $\mathbb{R}$ if and only if:

$$\psi \geq \frac{2\rho - \frac{\sigma}{\sigma-1}}{2\rho + \frac{\sigma}{\sigma-1} + 2} = \tau_b^{1-\sigma}$$

$$\lim_{\tau \to \tilde{\tau}^+} \Omega(\lambda_M(\tau)) + \mu_2 - \Omega(\lambda_M(\tilde{\tau})) - \mu_1 = \Omega(1-\eta) + \mu_2 - \Omega(1-\eta) - \mu_1 = \mu_2 - \mu_1 \tag{59}$$

The last two assertions are then readily verified by verifying that for $\tau \leq f^{-1}(1)^{\frac{1}{1-\sigma}}$ the net-of-taxes utility differential is strictly increasing (see Figure 1). Thus delocation occurs when just one Capitalist moves out. Given that this will always be a type 1 Capitalist (assuming $\eta > 0$, we have that if the tax differential should exceed $\Omega(1) + \mu_1$ all Capitalists would relocate to Foreign and Home would not have any Capitalists remaining. Ergo, $\Omega(1) + \mu_1$ becomes the delocation tax differential. For $\tau \geq \tau_b$ it can be readily verified that the net-of-taxes utility differential is strictly decreasing in λ (see Figure 1) as such any change in $t - t^*$ brings about only gradual changes in the share of Capitalists that are located in Home.

□

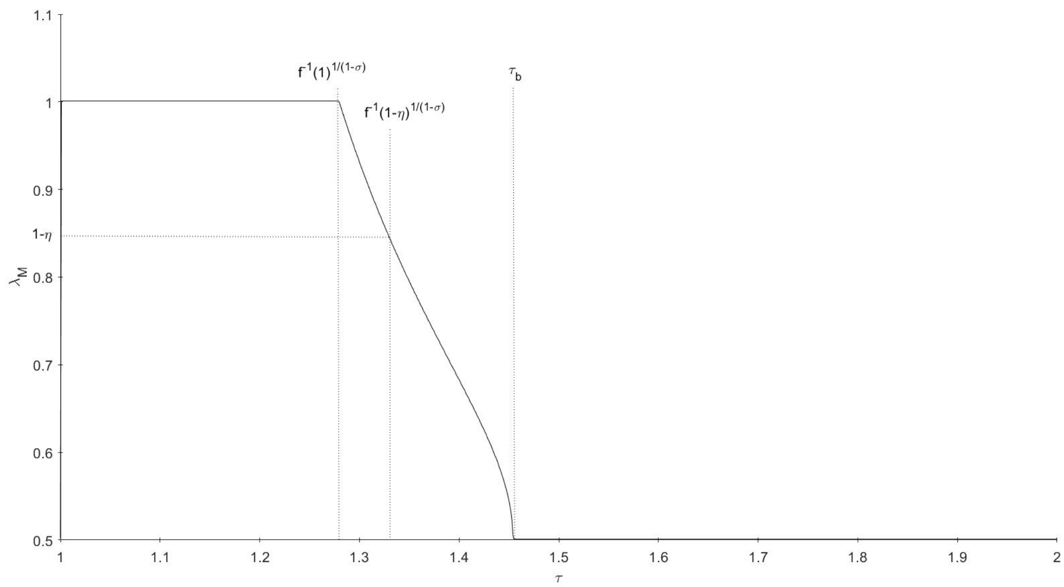

Figure B: λ_M plotted for different levels of trade costs using parameter values as per section 2.6. Note that I restrict $f(\phi) : (f^{-1}(1), \tau_b^{1-\sigma}) \to (\frac{1}{2}, 1)$ to preserve bijectivity. Formally this graph thus depicts: $\text{argmax}_{\lambda \in [\frac{1}{2}, 1]} \Omega(\lambda)$.