The effect of EU member states’ asymmetric sizes on Personal Income Tax competition

Dirk Heine and Joé Rieff

11th August 2015

Abstract

This paper analyses the effect of asymmetries in country size on income tax competition. We construct two models explaining new mechanisms why tax havens must be small and why they set lower income tax rates despite the fact that labour is commonly considered immobile and thus hard to attract. Using the Maastricht Treaty as a natural experiment, where labour mobility increased without comparable changes to capital mobility, we are able to confirm that even small increases in labour mobility already generate large asymmetries in the development of large and small countries’ average effective income tax rates and income tax revenues. These results hold for both the original introduction of the Maastricht Treaty in 1994 and the extension of the treaty’s coverage to 10 new member states in 2004. These theoretical and empirical findings provide evidence of the existence of income tax competition between small and large countries in the European Union. In the light of current political proposals in the EU, inspired by the financial crisis, to finally harmonise European tax policy, this paper demonstrates new mechanisms how the fact that inner-EU tax competition is fundamentally asymmetric contributes to the current long-term downward trends in overall public revenues. And while the EU is focusing its attention on corporate taxation, we demonstrate the asymmetric tax competition is also powerful for personal income taxes, and that there is a fundamental problem in the working of the Maastricht Treaty, thus supporting current calls for re-opening the treaties.

*PhD students in the European Doctorate in Law and Economics at University of Bologna, University of Hamburg, and Erasmus University Rotterdam. Contact: dheine@posteo.de
1 Introduction

The British, French and German Parliaments were all recently concerned with the issue of income tax competition: Smaller countries, particularly in Europe, would set lower income taxes with the intention of inducing the influx of tax bases from large countries’ taxpayers, thus generating revenue losses for large jurisdictions.

This political allegation raises a theoretical puzzle. Classical models of tax competition assume that it is not in a small country’s interest to set lower income tax rates since labour is set immobile (Zodrow and Mieszkowski 1986; Bucovetsky and Wilson 1991; Baldwin and Krugman 2004). And as the EU even sees a need to subsidise labour mobility, the assumption of low income tax rates seems confirmed for the EU area.

We therefore face two puzzles: Why do these Parliaments all see themselves confronted with income tax competition if the economic literature on tax competition says labour is immobile? And why should the incentive for a country to undercut its neighbour’s income tax rates be negatively related to its own population’s size? In this paper we aim to resolve both puzzles.

For other forms of tax competition not to do with income taxes, we know that country size does matter. Small countries have an interest to set lower consumption taxes than their large neighbours (Kanbur and Keen 1993; Taugourdeau 2004; Ohsawa 1999). Assuming infinite capital mobility and zero labour mobility, small countries also have incentives to set no capital taxes and concentrate their tax burden on labour (Gordon 1986). Large countries, conversely, should share their tax burden more evenly between the two factors of production (Bucovetsky and Wilson 1991). This asymmetry was tested by Winner (2005) for OECD countries between 1965 and 2000. In line with the above models, he finds that small countries did diverge from large countries in putting lower taxes on capital. He also finds that the relative share of the total tax burden that falls on capital relative to labour is less in smaller countries. But contrary to Winner’s hypotheses and the above models, these differences in the relative share of tax burdens are not statistically significant. Additionally, he finds that small states undercut on both: capital and labour taxes. Both of these results suggest that income tax competition may

\[1\] For France: Cross-party “Rapport à l’Assemble Nationale” by Guigou and Garrigue (2009). For specific references to income-tax avoidance see, pp.41, 42, 53, 104, 211, For the UK: (Wright and Pelling 2005) debate on the “income tax avoidance industry”. Similarly, Prisk et al. (2008) and Tax Justice Network UK 2009 (presented in Parliament) also consider Brown (2009a, b) and its interpretation in press in line with income tax. For Germany, see Wissing et al. (2009), and more specifically on incomes and wealth tax see Binding (2008); Hall et al. (2008 p.2ff); Die Bundesregierung (2009, p.4ff.).

\[2\] Alongside with capital tax competition which remains the main concern. The novelty is that income tax competition is given some weight.

\[3\] (Guigou and Garrigue 2009, pp.50, 54)
exist. Undercutting in income taxes will not be as strong as capital tax competition but it is in the data, although unexplained by these authors.

A possible explanation comes from Alesina and Spolaore (1995). Their model of the determination of country size shows that tax rates could be lower in small countries, even without income tax competition, if country size is endogenous in fiscal policy. These authors assume that political leaders can choose which country they want to govern, and under this assumption Leviathans\(^4\) pick large jurisdictions. Benevolent politicians instead seek a homogeneous electorate (so that it is easier to agree on public goods), and are therefore attracted by small jurisdictions. This would explain Winner’s findings: Parliaments in large countries may contain an asymmetric proportion of Leviathans. In such a case, tax competition may be welfare-improving (Besley and Case 1995; Besley and Smart 2002, 2007; Brennan and Buchanan 1980; Wilson 2005; Rauscher 1997, Edwards and Keen 1996) particularly when it is a source of information about the true costs of providing public goods (Besley and Case 1995; Besley and Smart 2002, 2007).

The assumption in Alesina and Spolaore (1995), that Leviathans can choose which state they want to govern, appears realistic though. And if Leviathans instead were randomly distributed across states of different size, tax competition may not adequately address the problem of wasteful governance if it benefits small states relative to big states. Yes, tax competition would be able to discipline the Leviathans in big states, but the ones in small states would go unchecked. Hence, even authors who consider all governments to be private rents maximisers, asymmetric tax competition might still not be just all optimal.

This paper proceeds as follows: Sections 2 and 3 present models suggesting why income tax competition may arise despite low average labour mobility and that incentives for policy-makers to undercut another countries’ taxes are based on country size. Sections 4 and 5 test these models’ predictions using two policy that cause a small increase in labour mobility. Section 6 provides policy conclusions.

2 Model with smooth transaction costs

To explain the existence of income tax competition when labour is immobile on average, we need to assume that at least relevant subsections of society are mobile. Therefore it is assumed that labour is mobile on the margin and to generate large effects, the

\(^4\)Which are leaders whose aim is to maximize private rents from tax revenue.
relevant subsections are assumed to possess a higher propensity to avoid taxes. One common trait to such a subgroup could be cultural homogeneity in the border regions. One indication is empirical evidence on Europe, which suggests that labour mobility has risen in near-border regions (Brügger et al. 2009, p.18; Collier & Vickerman 2001, p.3). Another indication is that “cultural proximity” between the host and the origin country has empirically been identified as an important determinant of cross-border tax avoidance (Tsakumis et al. 2007), particularly in Europe (Torgler & Schneider 2004). We model the role of cultural proximity with a Hotelling-type model.\(^5\)

2.1 Assumptions

There is a disk-shaped country “Home” with an open border to another region “Rest of World”. Every point in this flat world is populated, including the borderlines. The size of the home country’s population is therefore equal to the area of the circle including the red-marked border region.

All agents earn the same income and the governments of both, Home and Rest of World, charge only resident income taxes. By means of simplification, it is assumed that there is no taxation at source. Furthermore, the agents only earn income in their country of residence. So in the following, taxation refers to income taxation on a residence principle. If tax rates differ between countries, agents can reduce their tax bill by moving work and tax residence abroad, but they incur the personal cost of cultural inhibitions and information costs for foreign job opportunities. We describe these costs as “cultural proximity” and assume that they are linearly increasing in the distance of an agent’s residence to the border.

\(^5\)The idea to analyse tax competition through a Hotelling model is from Kanbur & Keen (1993). The original contribution in this section is the geometry argument that follows.
2.2 Mechanisms

Consider the case where the home country’s government would like to raise its income tax above the rate charged by Rest of World, whose government is assumed to be passive. People living in “Home” now have an interest to look for work abroad. Those living inside the circle will then compare their potential savings from paying less taxes to their cost of moving abroad, as given by their distance to the border. There will hence be some positive tax differences that they would accept and stay at Home. For those agents living directly on the boundary of the circle, however, the costs of going abroad are infinitesimally low, as they are so close. These individuals are culturally so familiar with Rest of World that their costs of moving tend to zero. It follows that, for the home government, the ability to tax depends on the relation between the area of the circle compared to its circumference. Ideally, the government would want to have a large area (many people who accept paying some extra tax to incurring the cost of moving) but a small circumference (few people from who it is impossible to raise a higher tax rate than the one prevalent in the Rest of the World).

From geometry, we know that the ratio between the area of a circle and its circumference decreases as the circle becomes bigger. Interpreting this result in the above context, the larger the home country is, the smaller is the proportion of citizens it loses for a small increase in taxes in relation to its total population. Using the above diagram, the home country finds increasing taxes more efficient in Case 2 compared to the situation in Case 1.

Conversely, assume now that the region Rest of World increases its income taxes slightly above the rate charged by Home. Home can now benefit from foreigners moving in. Similarly to before, the foreigners living just around the circle have an infinitesimally low cost of coming onto the red border region. Importantly, the proportion of those foreigners to Home’s own population is larger in Case 1 compared to Case 2, again due to the ratio of circle circumference to circle area being larger the small is the circle.

This simple geometry suggests that in tax competition, smaller countries will set lower taxes, since the smaller one’s country, the larger is the quantity of foreign inflows that can be attracted in relation to the size of the loss from equally needing to apply the lower tax rate to one’s own tax base.

And culture arises as just one transmission channel mapping the willingness to avoid taxes spatially. Instead of “cultural proximity”, the above model’s results could also work with other smooth transaction costs of tax avoidance. For example, if the trans-
action costs of agents depends on their knowledge about tax loopholes, then we could similarly model this scenario using the simple distance model, with tax lawyers as the ones with zero transaction costs on the circle’s circumference and people without any knowledge of such evasion opportunities towards the middle of the circle. What this model would not capture, however, is a situation in which the transaction cost of avoiding taxes involves a fixed cost, rather than a smoothly increasing cost. We turn to this case with our second model and show that again the size of a country determines its likelihood of setting low income taxes.

3 Model with fixed transaction costs

3.1 Assumptions

Consider two countries of asymmetric size, each with revenue maximising governments.\footnote{Revenue maximisation works through proportional income taxes, which governments set non-cooperatively and simultaneously. Labour income is the only source of tax revenue as households earn the total output as incomes. Labour is supplied inelastically, so there are no labour-leisure trade-offs. In this game, there is a tax loophole: there is a way for citizens of each country to shift their income to the other country.\footnote{Citizens all know these loopholes exist, but to actually shift their income abroad they need to incur a fixed cost (e.g., legal, search and psychological costs).} While the fixed cost is constant across individuals,\footnote{The assumption that it is possible to buy information about loopholes is not an arbitrary description of the mechanics of tax competition. As Giegold describes there is a clear market for tax avoidance with clearly identified facilitators selling these services (Giegold 2005, p.176). The assumption of clear prices is hence not far-fetched.} the actual incentive to exploit the loophole will be shown to vary with the incomes across and between both countries’ populations.}

The model assumes that one country undercuts the other one’s taxes. Without loss of generality and in line with common notation (Kanbur & Keen 1993), we refer to the undercutting country as the “home country” and denote home variables in lowercase letters, while variables associated with the other country, “the foreign country”,

\footnote{The reader may choose to interpret these governments as Leviathans or as Pigouvian-type welfare maximizers for the case of a society that values tax-financed public goods higher than private goods.}
appear in upper case. In the remainder of this section, we show that for undercutting to be optimal, the home country must be smaller than the foreign country, either in population or in output per capita.

It is developed below that only the upper part of a country’s income distribution is relevant for income tax haven strategies. In Europe, income distributions all have a single hump, so the number of rich individuals generally falls in higher income brackets. And as only the rich will matter in equilibrium, our modelling of the income distribution does not need to consider the lower end of the hump but we can instead approximate the top-end of the usual log-normal distribution function with a reciprocal function.

\[
f(Y_i) = \frac{S}{Y_i} \quad \forall (Y_{\text{richmin}} < Y_i < Y_{\text{max}})
\]

Above a threshold \(Y_{\text{richmin}}\), incomes are assumed to be continuously distributed up to a best-earning individual with income \(Y_{\text{max}}\). The frequency of observing persons earning any income high \(Y_i\) decreases in that income. \(S\) is a scaling variable; the fatter is the top-end of the income distribution, the the larger is the proportion of rich individuals in society. A higher \(S\) for a given GNP is a measure of inequality.

### 3.2 Mechanisms

Given proportional income taxes \((t \text{ and } T\) respectively), the home country’s tax revenue \(r\) for the benchmark case of closed borders equals the product of homes’ population size \(h\) and its mean income \(\mu\).

\[
r_{\text{closed}} = th\mu
\]

Similarly, for the foreign country:

\[
R_{\text{closed}} = THM
\]

From the objective of government and the lack of labour leisure trade-offs, the tax rates under autarky are simply \(t_{\text{closed}} = T_{\text{closed}} = 1\), so governments earn their country’s gross product.

Now imagine that country borders are opened, and the loopholes for cross-border tax avoidance now exist. We momentarily constrain the government of Home to adjust its fiscal stance by undercutting the taxes of Foreign \((t < T)\), and later check under what condition this strategy is optimal.
Given \( t < T \), foreigners compare in which country they would attain higher utility. We assume utility functions in Foreign take the form \( U_i = C_i \) with \( C_i = Y_i(1 - T) \), \(^{10}\) and equivalent in Home.\(^{11}\)

For Foreigner \( i \), the utility derived if staying in Foreign is then \( U_i = Y_i(1 - T) \) and the utility derived if moving to Home — considering the need to incur a fixed cost \( K \) for relocation — is \( u_i = Y_i(1 - t) - K \). The Foreigner shifts her income if the tax savings exceed the cost \( K \) of using the loophole,\(^{12}\) so if

\[
  u_i - U_i > K
\]

\[\Rightarrow Y_i(T - t) > K\] (5)

Under this condition, the income of a Foreigner who is just indifferent between relocating to Home and staying in Foreign is \( Y_s \):

\[
  Y_s = \frac{K}{T - t}
\] (6)

Of all persons who shift their income, the indifferent person must be the one with the lowest income, since above \( Y_s \), there is an incentive to move. The home country can therefore attract only rich foreigners. If the home country undercuts the taxes of Foreign by only infinitesimally little, the existence of a fixed cost for income-shifting implies that \( \lim_{T \to t} Y_s \to \infty \). So if Home undercut by too little, equation 5 would not

\(^{10}\) Sinn (2002, 2003) suggests this utility set-up would be inappropriate for modelling tax competition, as we would simultaneously need to model cross-country differences in public goods provision. Below it will become apparent, however, that using a wider utility function of the type \( U_i = (1 - T)Y_i + B(G) \) with the traditional assumption of \( \frac{\partial B}{\partial G} > 0 \) and \( \frac{\partial^2 B}{\partial G^2} < 0 \) would not change results. We will show that with fixed costs for using loopholes, tax avoidance is only lucrative with high incomes. And as the proportion of utility derived from public goods decreases as \( Y_i \) rises, differences in public good provisions may not be decisive in determining the location of high-income tax avoiders. Furthermore, Palan, in his analysis of the global history of tax havens, argues that persons shifting income abroad typically do not genuinely move to the country of their new legal address (Palan 2003, p.163). Then the host country’s public goods provision would presumably be even less relevant. We therefore leave public goods out of our model’s utility function.

\(^{11}\) So for home: \( u_i = c_i \), \( c_i = y_i(1 - t) \)

\(^{12}\) This condition for the tax avoidance decision follows the Optimal Tax literature in assuming that agents are tax bill minimisers. Stiglitz (1988) criticises that assumption. Yet, wider concerns of taxpayers, such as patriotism, can be incorporated into our utility system without it changing the model’s conclusions. If the degree of patriotism of an agent is captured by \( \omega \), then equation 5 becomes \( Y_i(T - t)\omega > K \). If individual \( i \) is a patriot, \( \omega > 1 \). For the patriot to decide in favour of shifting income to the other country, the tax savings must exceed \( K \) significantly (given that for tax rates the denominator is necessarily below 1 and \( T > t \)). Conversely, if individual \( i \) feels patriotically for the other country, \( \omega < 1 \), and income shifting occurs even when tax savings are somewhat less than \( K \). In any case, making this incorporation of patriotism will not change our model’s later conclusions and is hence left out in the interest of simplicity.
hold anymore for any foreigner \( Y_s > Y_{max} \). Setting \( Y_s = Y_{max} \), we can find a maximum tax rate \( t_{max} \) for the home country that is compatible with attracting at least the richest foreigner:

\[
Y_{max} = \frac{K}{T-t_{max}} \Rightarrow t_{max} = T - \frac{K}{Y_{max}}
\]  

(7)

We guess, and later check, that the equilibrium tax rate of Home, \( t^* \), is below \( t_{max} \).

Using conditions 2 and 6, the home country’s revenue after attracting foreigners through undercutting is

\[
r = th\mu + t \int_{Y_s}^{Y_{max}} Y \times f(Y) dY
\]  

(8)

The domestic tax base is extended by those foreigners with \( Y_s > Y_s \). The integral hence represents the uppermost part of the wealthy tail of Foreign’s income distribution. From equations 1, 6 and 8, we have

\[
r = th\mu + t S (Y_{max} - Y_s)
\]  

(9)

The Home government maximises its revenue subject to \( t \) in reaction to \( T \) such that

\[
\frac{\partial r}{\partial t} = (h\mu + SY_{max}) - \left( SY_s + t \frac{\partial Y_s}{\partial t} \right)
\]  

(10)

\[
= (h\mu + SY_{max}) - \left( SK \frac{T}{(T-t)^2} \right)
\]

Home’s marginal benefit of an increase in \( t \), represented by the first bracket, is the extra revenue earned on the own tax base and on the best-earning foreigners. The marginal cost is the loss of the foreigners on the margin and the increase in \( Y_s \) that results from the tax change. The second derivative is negative, so this is indeed an optimal response to \( T \) given \( t < T \). Reforming equation 10, Home’s reaction function is

\[
t(T) = T - \sqrt{\frac{SK}{h\mu + SY_{max}}} - T
\]  

(11)

This function’s properties \( \frac{\partial t(T)}{\partial h} > 0 \) and \( \frac{\partial t(T)}{\partial \mu} > 0 \) imply that the smaller the home country’s population is and the lower its own population’s average income is, the more aggressively it undercut the foreign country.
We switch to the perspective of Foreign. Using equations 1, 3 and 6, the foreign government’s objective function, given open borders and our temporary restriction $T > t$, is

$$R = THM - T \int_{Y_=}^{Y_{max}} Y \times f(Y) dY $$

$$= T (HM - SY_{max}) + T (SY_*)$$

By increasing $T$, Foreign can attempt to extract more from its total tax base $HM$ but it loses its richest citizens and decreases the income of the marginal tax avoider, thus increasing the number of avoiders.

$$\frac{\partial R}{\partial T} = (HM - SY_{max}) - SK \frac{t}{(T-t)^2} > 0$$

The second derivative of $R$ being positive, this problem has no interior maximum, but two corner solutions presented graphically in the following illustration.
The two illustrations visualise the left and right brackets of equation 12, respectively. Based on equation 6, there is a kink of the tax rates schedule at $T_{\text{min}}$. At this point, the foreign country’s tax rate is so close to $t$ that $Y^* = Y_{\text{max}}$. Tax rates below $T_{\text{min}}$ cannot be optimal for Foreign, since in the red area revenue can be increased without any tax avoidance.

Increasing $T$ to 1 causes losses from the decline in the income of the indifferent person but the rate of change for these losses is diminishing. Comparing the linear gain in the first illustration with the diminishing loss in the second illustration, $T = 1$ emerges as a candidate equilibrium.

We compare the potential equilibria $T = T_{\text{min}}$ and $T = 1$.

**Candidate Equilibrium for $T > t$ with $T = T_{\text{min}}$**

Using equation 6 to set $Y_s = Y_{\text{max}}$, and solving for $T$, we get the reaction function

$$T_{\text{min}}(t) = t + \frac{K}{Y_{\text{max}}}$$  \hspace{1cm} (14)

Combining (14) with (11), we get the candidate equilibrium tax rates

$$T^{**} = \frac{K(bu + SY_{\text{max}})}{SY_{\text{max}}^2}$$

$$t^{**} = \frac{K^2h}{SY_{\text{max}}^2}$$
These taxes are larger than 1 and hence impossible.\footnote{If used to calculate the equilibrium revenues, those are larger than the countries’ gross products.} We conclude that $T = T_{\min}$ is not an equilibrium. Given that $T > t$, it must then be that $T^* = 1$.

**Equilibrium for $T > t$ with $T = 1$**

The home country’s equilibrium tax using equation 11 and $T^* = 1$ is

$$t^* = 1 - \sqrt{\frac{SK}{h\mu + SY_{\max}}}$$

(15)

This equation has the following properties:

**Tax Base Effect**

The smaller and poorer the home country’s population, the lower is its tax rate ($\frac{\partial t^*}{\partial h} > 0$, $\frac{\partial t^*}{\partial \mu} > 0$). This is because, for a small domestic tax base $\mu \times h$, any decrease of the proportional domestic tax rate (to induce foreigners to shift their income into the home country) only gives up on taxing that small domestic base, but induces a relatively big sum of foreign income to flow in.

**High-Value-Individuals Effect**

The wealthier the foreign top-earners, the less aggressive the home country undercuts ($\frac{\partial t^*}{\partial Y_{\max}} > 0$). As long as the top-rich come at all ($t < t_{\max}$), if they earn more, it is lucrative to tax them more, even though that implies losing some less rich foreigners on the margin.

**Transaction Cost Effect**

A higher $K$ requires the undercutting home country to undercut more to keep foreigners’ incentives to still shift their income ($\frac{\partial t^*}{\partial K} < 0$).

**Inequality Effect**

Recall from equation 1 that increasing $S$ while holding $HM$ constant raises the foreign country’s income inequality. Such an increase means that there are more foreigners with incomes above $Y_{\text{richmin}}$ that can be attracted, i.e. the whole undercutting game is
more lucrative, and hence the home country lowers its tax rate \( \frac{\partial t^*}{\partial S} < 0 \). So higher foreign inequality incentivises more aggressive tax haven strategies.

**Equilibrium Revenues for \( T > t \)**

Using equations 12, 15 and \( T^* = 1 \), the foreign country’s revenue is

\[
R^* = HM - SY_{max} + \sqrt{SK(h\mu + SY_{max})}
\]  

(16)

The smaller the home country, the lower is the foreign country’s revenue \( \frac{\partial R^*}{\partial h} > 0 \). This is because the home country undercuts harder the smaller it is, as shown in equation 15.

Using (8), (15) and \( T^* = 1 \), Home’s revenue is

\[
r^* = \left( \sqrt{h\mu + SY_{max}} - \sqrt{SC} \right)^2
\]  

(17)

**Testing previous assumptions**

We assumed that \( t < T \). This was optimal for Home if \( r^* > r^{closed} \), which (comparing equations 17 and 2) is the case if

\[
\left( \sqrt{h\mu + SY_{max}} - \sqrt{SK} \right)^2 > h\mu
\]  

(18)

Confirming our previous assumption, undercutting is more likely to be optimal for small countries.

\[
\frac{\partial r^*}{\partial h} < \frac{\partial r^{closed}}{\partial h}
\]  

(19)

We confirm the guess we made before that \( t^* \leq t^{max} \). From equations 7 and 15, the home country sets its tax rate sufficiently low to attract at least the foreigners earning \( Y_{max} \) iff

\[
1 - \sqrt{\frac{SK}{h\mu + SY_{max}}} \leq 1 - \frac{K}{Y_{max}}
\]  

(20)

This equals

\[
\sqrt{K(h\mu + Y_{max})} < Y_{max}\sqrt{S}
\]  

(21)
The smaller the home country’s population \((h)\), the more likely this condition holds. So given that the home country is the smaller one of the two, our previous assumption on tax rate setting matches incentives.

We confirm under what conditions \(T > t\) is optimal for the foreign country. Given our results (19) and (21), the home country would only have undercut if the foreign country is larger (and/or richer) than itself either in terms of \(H\) or \(M\) or in terms of the wealth in the top tail of its income distribution. So being undercut necessitates asymmetry. Given this asymmetry, Foreign’s reaction is intuitive: if the own tax base is large, reducing the tax rate to prevent undercutting incurs a large opportunity cost of lost revenue.

A second condition for \(T > t\) to be true, is that the foreign country does not respond to being undercut by itself undercutting the home country. If the foreign country did undercut in retaliation, this would trigger a Race to the Bottom (RTB). We check that a large country would prefer being undercut to the RTB result.

The objective functions in an RTB version of our game would be

\[
 r = th\mu + t \int_{y_i}^{y_{\max}} Y \times f(Y) \, dY \\
 R = THM + T \int_{y_i}^{y_{\max}} y \times f(y) \, dy
\]

The income distribution and the indifferent person of the home country are defined in symmetry to the definition in (6).

\[
f(y_i) = \frac{s}{y_i} \forall (y_{\text{richmin}} < y_i < y_{\max})
\]

We assume that the cost for using the loophole is the same from both sides of the border \((k = K)\).

Home’s reaction function is as in equation 11 and Foreign now behaves the same, so its reaction function is

\[
 T(t) = t - \sqrt{\frac{sk}{HM + s y_{\max}}}t
\]

Combining reaction functions 11 and 25,\(^{15}\) we get the following four candidate tax rates:

\(^{15}\)To solve this, we define as an intermediate step \(t \equiv a^2\), \(T \equiv A^2\) and subsequently substitute back.
To set the tax rates equal to zero is incompatible with revenue maximisation, hence we drop these results. Analysing the remaining two options, we find that also in the equilibrium reached with a Race to the Bottom, the smaller country will set its tax rate again below that one of the larger country since \( \frac{\partial T^*_{RTB}}{\partial H} > 0 \) and \( \frac{\partial T^*_{RTB}}{\partial h} < 0 \), as well as \( \frac{\partial t^*_{RTB}}{\partial h} > 0 \) and \( \frac{\partial t^*_{RTB}}{\partial H} < 0 \). This confirms our previous assumptions about the behaviour of Foreign.

4 Empirical Analysis

4.1 Exposition of the natural experiment

In both sections 2 and 3, we developed that the following two hypotheses hold jointly

“H1” A newly created ability for countries to compete in income taxes will lead small countries to undercut the taxes of larger countries.

“H2” As a result of this undercutting, the tax revenue accruing to small countries from income taxes rises relative to that of large countries.

To test these theoretical hypotheses empirically, we use a differences-in-differences approach. As a policy event we use the ratification of the “Treaty of European Union” signed in 1992 in Maastricht, Netherlands. We use this treaty to identify the effect of an increase in labour mobility without a competing treatment in capital mobility on countries’ income tax rates and income tax revenues. We decompose these effects for countries of asymmetric size.

\[ t^*_{RTB} = \begin{cases} 0 \\ \frac{shSHK^2}{([HM+sy_{max}]SHK-[h\mu+SY_{max}][shK])^2} \end{cases} \]

\[ T^*_{RTB} = \begin{cases} 0 \\ \frac{shSHK^2}{([h\mu+SY_{max}][shK]-[HM+sy_{max}][SHK])^2} \end{cases} \]

\[ \frac{\partial t^*_{RTB}}{\partial h} > 0 \] and \( \frac{\partial t^*_{RTB}}{\partial H} < 0 \), and symmetrically for \( \frac{\partial T^*_{RTB}}{\partial h} < 0 \) and \( \frac{\partial T^*_{RTB}}{\partial H} > 0 \).
Theoretically speaking, the ratification of the Maastricht Treaty has increased labour mobility in the European Union (e.g. Close 1995, p.246). Some economists predicted already then that the treaty rules could be used to legally avoid taxes (Kanbur & Keen 1993b, p.1; Sinn 1991, p.15) and with respect to income taxes, their assessment was confirmed by legal analysts (Weber 2005, p.258). Maastricht hence caused exactly the type of loophole that we considered in our model, which qualifies it as a test on our theory.

At the same time, the Maastricht Treaty did not cause massive changes in the average population’s mobility and abilities to shift income, only in the abilities of a mobile subsection of Europeans. That makes the Maastricht treaty an even better test, because our model predicted that we would get a change in tax policy even if only a subgroup of the population (the border region in section 2 and the rich in section 3) are actually mobile.

4.2 Scrutiny of the validity of our natural experiment

A concern to using the use of the Maastricht Treaty as a policy event for a differences-in-differences estimation is that the variation of country size might not be large enough, since many small European countries are not EU members. Simultaneous with the ratification of the Maastricht Treaty, however, the following small European states adopted the Maastricht Freedoms through other ways: Åland; Andorra; Iceland, Liechtenstein and Norway; Monaco and Switzerland. The treatment was hence applied to countries of asymmetric size.

A challenge to the internal validity of using the Maastricht Treaty as a natural experiment arises from the Treaty containing also the agreement on creating a European Monetary Union. To join the planned common currency, countries had to achieve certain fiscal stability targets (Euro Convergence Criteria); so it stimulated candidates for the Eurozone to increase revenue by raising taxes and cutting spending. Problematically, those countries which joined the EMU tended to be the larger ones, and microstates who did adopt the Euro (Åland, Andorra, Monaco) did not have to join the EMU, and did not have to meet the targets. This is problematic for internal validity

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17In 1995, simultaneous with Finland’s accession to the EU. The treaty came into force on 1 January 1994, so Åland and Finland entered it about at the same time as the other states.
18Unilaterally. No information on the timing was available.
19On 1 January 1994, through membership in the Treaty of the European Economic Association
20Through an open-border agreement with France (1994).
21In 1994, through bilateral agreement with the EU in the course of EEA negotiations.
22These states were allowed to circulate and mint the Euro without being part of EMU, at the cost of foregoing a formal representation at the European Central Bank.
because some countries of different size then received somewhat different treatments. Specifically, EMU-countries received two treatments.

1. The increase in labour mobility created incentives to lower income taxes because of tax competition.

2. The application for EMU, conversely, created incentives to raise tax revenue. This incentive does not need to require raising tax rates, if a tax haven strategy of attracting foreigners works well, but it changes the trend of tax policy in any case, and the stability of trends is an identification assumption for differences-in-differences regression.

Due to these overlapping incentives for EMU-countries, it is possible that our experiment testing the reaction of large states to income tax competition with small states finds no net effects, just because the two forces might cancel. For non-EMU microstates, there are only the incentives for tax competition. Hence asymmetries in the setting of income taxes could arise independently of the asymmetries in incentives that we uncovered above.

There are two further problems, and it appears that they actually mitigate the first. Firstly, we know that the Maastricht Freedoms were applied to EEA- and EU-member countries in the same manner, so we can assume that there is no variation in treatment intensity. For Andorra and Monaco, however, the treatment only comes from bilateral agreements with neighbour countries and so the uniformity of treatment intensity is uncertain. This suggests excluding Andorra and Monaco from the difference-in-differences analysis.

Secondly, microstates are commonly not part of data collection by international institutions. We therefore contacted the Statistics and/or Treasury Departments of all those microstates that received the treatment, asking for the missing data. All responded but the data provision was, unfortunately, insufficient. We can therefore analyse only countries that report data to OECD.

When considering this reduced set of 18 countries, EMU membership is more evenly distributed between countries of different size. If we categorise countries as “small” based on their population size and check how many of these countries are EMU members, they are \( \frac{4}{9} \) when the cut-off value for “small” is set at 10 million; \( \frac{4}{7} \) when “small” is meant to mean a population size no larger than 7.5 million, and \( \frac{2}{5} \) when it is set at \( \leq 5 \) million. With this cleansed dataset, the asymmetries of EMU membership between large and small countries are hence not too likely going to bias our estimate of the effect of tax competition.
Instead, there is sample selection bias now. The countries that we just removed from the analysis due to data issues (Åland, Andorra, Monaco, Liechtenstein) are the smallest, and in popular debate all four are frequently characterised as “tax havens”. Excluding precisely those of all countries will bias our estimate of small countries’ tax rates upwards. We are therefore more likely to make a type 1 error by incorrectly finding that country size does not matter. Conversely, a finding that country size matters even when excluding these jurisdictions would indicate robustness of our results.

Despite adjustments, some EMU bias remains since EMU membership is still more prevalent in large economies. This bias could imply that H1 is confirmed while H2 is rejected. A scenario where both are confirmed, however, could not be explained with EMU and would indicate that asymmetries of country size must be significant.

4.3 Estimation Strategy

In the first regression, we test H1 using the data on tax rates from the literature. Assuming common trends between large and small countries’ tax setting, the difference in the changes in the mean tax rates of small countries relative to those of large countries, \( \triangle_i \), must be negative and significant.

\[
\triangle_i = \{ E \left[ Tax \mid (Country = Large) \cap (Time = Before) \right] \\
- E \left[ Tax \mid (Country = Large) \cap (Time = After) \right] \\
- \{ E \left[ Tax \mid (Country = Small) \cap (Time = Before) \right] \\
- E \left[ Tax \mid (Country = Small) \cap (Time = After) \right] \} \\
\]

In regression format, \( \triangle_i \) equals \( \beta_3 \) in equation 29, where \( small_i \) and \( aftermaas_i \) are indicator variables. \( small_i \) takes the value 1 if the population of the respective country is below a defined threshold and \( aftermaas_i \) is 1 for all years from the ratification of the Maastricht Treaty in 1994 onwards.

\[
tax_i = \beta_1aftermaas_i + \beta_2small_i + \beta_3(aftermaas_i \times small_i) + \nu_i \quad (29)
\]

We use the same strategy to test hypothesis H2. The basic model is
\[
\left( \frac{\text{revenue}}{\text{capita}} \right)_t = \beta_1 \text{aftermaas}_t + \beta_2 \text{small}_i + \beta_3 (\text{aftermaas}_t \times \text{small}_i) + \nu_t
\]  

(30)

4.4 Justification of control variables

Since the mid-1980s, many countries made changes to their tax base (Griffith & Klemm 2004, p.6). Our model is about tax rates, but changes to the base affect effective tax rates. Effective tax rates are what citizens actually pay, as opposed to statutory tax rates, which ignore deductions, exemptions and tax credits. In our model, we assumed that there are no such variations. It is therefore important to control for them in the real world. We do this by using Average Effective Income Tax Rates (AEITR) as the independent variable in equation 29.

Using AEITR necessitates controlling for unemployment. Effective income tax rates are based on actual tax payments. Variations in AEITR can therefore occur even if the statutory rate remains constant, because if labour market conditions alter, unemployment can change the eligibility for tax credits. Such changes threaten the assumption that \( \text{tax}_t \) follows the same trend for large and small countries. The structure of labour markets in small states varies systematically compared to those of large states (Armstrong & Read 2002), for example in the role of tourism versus that of manufacturing. A different trend in unemployment (say due to long-term increases in European tourism, but a gradual decay of its manufacturing due to increased competition with Asia) would cause a diversion of trends. \( \beta_3 \) would then be a (upwards) biased estimate of strategic tax setting in small countries relative to large countries in the period after Maastricht. Similarly, such differences in labour market trends would impact income tax revenue.

With this justification, we control for unemployment in both regressions, and interact this control with \( \text{small}_i \). We lag unemployment by one period and treat it as predetermined.

We furthermore control for the political ideology of the executive. Persson and Tabellini (2002) observed a rise in the number of left-leaning governments in Europe during the 1990s. Our cross-checks did not confirm this finding for small countries. If conservative governments set lower taxes, and Europe overall leaned more to the left over the course of the 1990s but small European countries did not, then these diverging political trends must be accounted for. We do this by constructing an indicator variable \( \text{conservative}_t \) which takes the value 1 if the executive in power on 30 June
of any particular year belonged to a party that either called itself “Conservative” or “Christian Democratic” or that was a member of the conservative meta-party association “European People’s Party”.

We furthermore control for time effects to avoid biasing $\beta_1$ and $\beta_3$. For this, we include year dummies in all regressions, removing period-specific fixed effects.

Section 3 showed that a determinant of the tax rate is $\mu$, the average real income of each country’s own citizens, excluding foreigners. We would therefore like to control for real GNP per home citizen. Unfortunately, this data is unavailable (both in nominal and real terms), as we only have data on GNP including foreign tax avoiders. We cannot use the latter, as this would lead our testing of H1 ad absurdum; it would change the research question. The same holds for the second regression on $(\text{revenue capita})_{it}$. We must therefore assume that incomes of local populations in small and large countries follow common trends.

Our regressions therefore are:

$$
tax_{it} = \alpha_i + \lambda_t + \beta_1 \text{aftermaas}_{it} + \beta_2 \text{small}_{i} + \beta_3 (\text{aftermaas}_{it} \times \text{small}_{i}) + \beta_4 \text{unemp}_{it-1} + \beta_5 (\text{unemp}_{it-1} \times \text{small}_{i}) + \beta_6 \text{conservative}_{it} + \beta_7 (\text{conservative}_{it} \times \text{small}_{i}) + \nu''_{it}
$$

We use the same strategy to test hypothesis H2.

$$
(\text{revenue capita})_{it} = \alpha_i + \lambda_t + \beta_1 \text{aftermaas}_{it} + \beta_2 \text{small}_{i} + \beta_3 (\text{aftermaas}_{it} \times \text{small}_{i}) + \beta_4 \text{unemp}_{it-1} + \beta_5 (\text{unemp}_{it-1} \times \text{small}_{i}) + \beta_6 \text{conservative}_{it} + \beta_7 (\text{conservative}_{it} \times \text{small}_{i}) + \nu'''_{it}
$$

Differences-in-differences regressions often suffer from serial correlation problems (Bertrand et al. 2004), causing over-estimation of $t$-statistics. For both regressions we therefore compute Newey-West HAC standard errors (Newey & West 1987). These are robust to “arbitrary” autocorrelation and (also) heteroskedasticity (Baum 2006, p.140).

Bertrand et al’s Monte Carlo simulations show that a procedure which they classify as

\footnote{Even though we hence exclude GDP from the later later regressions for conceptual reasons, the results do not actually change if we include it. $\beta_3$ stays significant and of the same sign as in the results shown below. I tested this using GDP\_capita in PPP-terms (to make the variable real).}
“analogous” to Newey-West performs better than parametric alternatives (Bertrand et al. 2004, pp.23-25) also in small samples. The version of Newey-West that we use is adjusted for panel data (Roodman 2009).

4.5 Data

Data on population sizes is from United Nations Statistics Division; the unemployment rates from OECD. For income tax revenue, we use the OECD data in constant US$, which includes tax revenue on self-employed individual’s profit income but excludes capital and corporate earnings. For Average Effective Income Tax Rates, we use Winner’s (2005) data.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs.</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEITR</td>
<td>532</td>
<td>14.53</td>
<td>10.51</td>
<td>0.09</td>
<td>65.1</td>
</tr>
<tr>
<td>Conservative</td>
<td>792</td>
<td>0.5</td>
<td>0.5</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Conservative for states with Population &lt;5M</td>
<td>793</td>
<td>0.12</td>
<td>0.23</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Conservative for states with Population &lt;7.5M</td>
<td>794</td>
<td>0.18</td>
<td>0.39</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Conservative for states with Population &lt;10M</td>
<td>793</td>
<td>0.21</td>
<td>0.41</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Dummy Population &lt;5M</td>
<td>795</td>
<td>0.22</td>
<td>0.42</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Dummy Population &lt;7.5M</td>
<td>797</td>
<td>0.39</td>
<td>0.49</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Dummy Population &lt;10M</td>
<td>798</td>
<td>0.63</td>
<td>0.52</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Population</td>
<td>821</td>
<td>2.07e-07</td>
<td>2.41e-07</td>
<td>192288</td>
<td>8.25e7</td>
</tr>
<tr>
<td>Revenue per capita</td>
<td>752</td>
<td>4984.43</td>
<td>1054</td>
<td>15778.55</td>
<td></td>
</tr>
<tr>
<td>Unemployment rate</td>
<td>785</td>
<td>5.66</td>
<td>4.24</td>
<td>0.002</td>
<td>24.17</td>
</tr>
<tr>
<td>Unemployment for states with Population &lt;5M</td>
<td>784</td>
<td>0.85</td>
<td>2.48</td>
<td>0</td>
<td>17.35</td>
</tr>
<tr>
<td>Unemployment for states with Population &lt;7.5M</td>
<td>785</td>
<td>1.63</td>
<td>3.2</td>
<td>0</td>
<td>17.15</td>
</tr>
<tr>
<td>Unemployment for states with Population &lt;10M</td>
<td>786</td>
<td>3.28</td>
<td>3.28</td>
<td>0</td>
<td>17.15</td>
</tr>
</tbody>
</table>

24 OECD revenue category 1110
4.6 Test on H1

Test of model prediction of asymmetric undercutting

<table>
<thead>
<tr>
<th></th>
<th>Small=1 if the population size in all years</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤5 million(^a)</td>
<td>≤7.5 million(^b)</td>
<td>≤10 million(^c)</td>
<td></td>
</tr>
<tr>
<td>AfterMaastricht</td>
<td>8.25*** (1.66)</td>
<td>14.14*** (1.46)</td>
<td>14.86*** (1.91)</td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>-0.65 (0.79)</td>
<td>-1.74 (1.94)</td>
<td>17.11*** (2.92)</td>
<td></td>
</tr>
<tr>
<td>Small × AfterMaastricht</td>
<td>-5.54*** (1.88)</td>
<td>-4.11*** (1.89)</td>
<td>-2.15 (2.09)</td>
<td></td>
</tr>
<tr>
<td>Conservative</td>
<td>-1.48* (0.76)</td>
<td>-1.95** (0.89)</td>
<td>-2.61*** (0.94)</td>
<td></td>
</tr>
<tr>
<td>Small × Conservative</td>
<td>0.90 (1.19)</td>
<td>1.75 (1.12)</td>
<td>2.81** (1.12)</td>
<td></td>
</tr>
<tr>
<td>Unemployment t-1</td>
<td>0.40*** (0.16)</td>
<td>0.39*** (0.13)</td>
<td>0.40*** (0.13)</td>
<td></td>
</tr>
<tr>
<td>Small × Unemployment t-1</td>
<td>0.05 (0.16)</td>
<td>0.18 (0.17)</td>
<td>0.12 (0.17)</td>
<td></td>
</tr>
</tbody>
</table>

| Observations              | 631 | 631 | 631 |
| Countries                 | 18  | 18  | 18  |
| Country fixed effects: F(16, 573) | 36.33*** | 41.33*** | 78.48*** |
| Period fixed effects: F(33, 573) | 7.72*** | 19.97*** | 5.34*** |
| Serial correlation\(^d\) F(1, 17) | 198.35*** | 202.02*** | 212.01*** |

**NOTES:**
Newey-West standard errors (HAC) are given in parentheses. They have been calculated using five lags, according to the formula provided by Baum (2006, p.140) using Roodman’s (2009) procedure of HAC for panel data analysis.

\(a\): The indicator variable “Small” is 1 if the country’s population is less than 5 million for all years. This holds for 4 countries and they are geographically balanced (Iceland, Ireland, Luxembourg, Norway).

\(b\): Seven of the countries have a population below 7.5 million for all years.

\(c\): Nine countries’ population is below 10 million for all years.


In all definitions of “small countries”, we find that the average effective income tax rate was cut relative to large countries. \(\beta_3\) is significant at the 1% level despite the exclusion of the known small tax havens Åland, Andorra, Monaco and Liechtenstein.
The intensity of this undercutting decreases in its economic and statistical significance as we extent our definition of “small”. For microstates with populations below 5 million, we see a cut of income tax rates by a whole 5.54 percentage points relative to larger countries, and this cut is significant at the 1% level. When including also those countries with populations between 5 and 7.5 million inhabitants in “small”, the economic significance of the tax cutting falls to 4.11pp, which is still statistically significant at the 5% level. For column 3, where also Sweden and Austria are classified as “small”, this group’s tax rates are actually higher. But even when including these two —known “social market economies”—, the incentive for small countries after Maastricht was to cut taxes: β3 remains negative.

H1 is supported by the undercutting itself (second row), the fact that this undercutting increased after mobility was eased through Maastricht (third row) and the fact that the intensity of both effects decrease with country size (second and third column).

Before the Maastricht Treaty eased labour mobility, small countries did not set their taxes significantly below those of large countries; confirming our assumption in equations 2 and 3.

Overall, countries increased their income tax rates after Maastricht. This is in line with the literature’s finding that the main competition was still in capital taxes, so that countries increasingly substitute into labour taxes (Winner 2005). The point here is that despite the shifting of tax burden from capital onto labour, there was also income tax competition going on and it took the form of asymmetric undercutting by small countries as displayed above.
4.7 Test on H2

Test of model prediction of asymmetric changes in income tax revenue

Dependent variable: general government income tax revenue per capita in constant US$

Years: 1965 through 2008

<table>
<thead>
<tr>
<th></th>
<th>Small=1 if the population size in all years</th>
<th>≤5 million$</th>
<th>≤7.5 million$</th>
<th>≤10 million$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AfterMaastricht</td>
<td>3107.00***</td>
<td>1990.34***</td>
<td>2182.37***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(488.73)</td>
<td>(566.37)</td>
<td>(293.34)</td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>1959.85***</td>
<td>1668.18</td>
<td>1676.33***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(474.42)</td>
<td>(537.32)</td>
<td>(494.77)</td>
<td></td>
</tr>
<tr>
<td>Small × AfterMaastricht</td>
<td>750.41***</td>
<td>1748.85***</td>
<td>1746.33***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(345.06)</td>
<td>(298.50)</td>
<td>(297.02)</td>
<td></td>
</tr>
<tr>
<td>Conservative</td>
<td>282.94</td>
<td>10.50</td>
<td>10.25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(187.32)</td>
<td>(108.36)</td>
<td>(108.29)</td>
<td></td>
</tr>
<tr>
<td>Small × Conservative</td>
<td>-88.32</td>
<td>279.52</td>
<td>280.50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(244.58)</td>
<td>(264.62)</td>
<td>(264.81)</td>
<td></td>
</tr>
<tr>
<td>Unemployment t-1</td>
<td>-68.69***</td>
<td>-70.00***</td>
<td>-69.76***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(29.07)</td>
<td>(20.94)</td>
<td>(20.85)</td>
<td></td>
</tr>
<tr>
<td>Small × Unemployment t-1</td>
<td>16.30</td>
<td>9.72</td>
<td>10.26</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(37.65)</td>
<td>(45.49)</td>
<td>(45.10)</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>741</td>
<td>741</td>
<td>741</td>
<td></td>
</tr>
<tr>
<td>Countries</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Country fixed effects: F(16, 675)</td>
<td>24.90***</td>
<td>24.90***</td>
<td>19.28***</td>
<td></td>
</tr>
<tr>
<td>Period fixed effects: F(41, 675)</td>
<td>8.43***</td>
<td>8.43***</td>
<td>8.09***</td>
<td></td>
</tr>
<tr>
<td>Serial correlation$^d$ F(1, 17)</td>
<td>41.41***</td>
<td>39.61***</td>
<td>41.42***</td>
<td></td>
</tr>
</tbody>
</table>

NOTES:
Newey-West standard errors (HAC) are given in parantheses. They have been calculated using five lags, according to the formula provided by Baum (2006, p.140) using Roodman’s (2009) procedure of HAC for panel data analysis.
a: The indicator variable “Small” is 1 if the country’s population is less than 5 million for all years. This holds for 4 countries and they are geographically balanced (Iceland, Ireland, Luxembourg, Norway). b: Seven of the countries have a population below 7.5 million for all years. c: Nine countries’ population is below 10 million for all years. d: Wooldridge test for first-order autocorrelation in the uncorrected fixed-effects regression (Wooldridge 2002, p.282f.).

We find that small states were able to significantly increase their revenue after the ratification of the Maastricht Treaty by more than large countries.

Assuming the zero conditional means assumption holds, we draw the following con-
clusion: A small increase in labour mobility induced by the Maastricht Freedoms caused small countries to significantly decrease their effective average income taxes (H1) which lead to a significant increase of their tax revenue (H2). Small countries benefited from fiscal externalities from large countries.

Doubts to these conclusions come from the increase in row 3, as we go from countries below 5 million citizens to countries below 10 million. Our models suggest that the smallest countries should benefit the most from tax competition. The finding, that the group of small countries made more revenue when including those with populations $\leq 10$ million, speaks against the common trends assumption underlying the differences-in-differences approach. Also the country and period fixed effects are significant in all regressions, suggesting that much is not captured by our regressions.

5 Robustness Checks

To test for the robustness of our results, we repeat the whole analysis with a different dataset, a different econometric approach, and with a further policy event.

5.1 Second introduction of the Maastricht Treaty

In 1994, the Maastricht Treaty took effect for the old set of EU member states, and in 2004 its reach was extended to 10 new member states. In both cases labour mobility increased, and we therefore expect to see similar results for both policy events. In both cases, the labour mobility was increased a little and small member states should therefore react to an incentive to set lower tax rates and attract foreigners.

Our robustness check uses the that these two policy events took place 10 years apart from each other. Maybe in 1994 something else was happening in European politics or the world economy that divided the fortunes of large and small countries, and this could be driving our results. In 2004, however, any random shocks to large and small countries may be different, so if we can confirm our hypotheses again, the chance that our results for the first policy event were just endogenous will be smaller.

This is our motivation for testing a second policy event, but there is also a problem with that strategy. We would not expect the two introductions of the Maastricht Treaty to yield effects of equal strengths. This is because in 1994, when the Maastricht Treaty was introduced for the first time, the large countries tended to be rich countries, whereas in the set of countries that joined in 2004, the larger ones were comparatively poor (the formerly Communist states) and the smaller ones (Malta, Cyprus) were comparatively
rich. Hence, the incentive for small countries to attract the taxpayers of their larger neighbours would be smaller in the second event compared to the first event. We therefore expect to validate our hypotheses in both cases, but to a larger extent in the first event compared to the second event.

5.2 Estimation Strategy

In the first estimation, we used a classical differences-in-differences design. For our robustness test, we use a more advanced design from the trade theory literature. Here our explanatory variable is not a country’s tax rate but its tax rate relative to each other country individually. Through this set-up, we are able to control not only for the fixed effects of each country’s own tax policy, but also for the fixed effects of each country’s interaction with each other country. These 'bilateral resistance terms' take into account that some countries may react to particular countries’ tax policy more than to others. This may be important because our model with smooth transaction costs showed that countries that are far away from each other may be less affected by each other if the transaction costs for tax avoidance rise in the distance. Besides physical distance, the tax policy of countries may also be affected by cultural differences: Scandinavian countries might, for example, just have a more high-tax tradition than a Commonwealth country such as Malta, independent of their population sizes. When labour mobility changes, these cultural differences may then affect some pairs of countries more than others.

The difference between the tax rate of country $i$ relative to the tax rate of country $j$ is regressed on the relative population sizes before and after the introduction of the Maastricht Treaty, now controlling for the fixed effect of each country pair $ij$ interacting. We define a dummy variable that is equal to 1 when the counterparty that country $i$ is facing, country $j$, is smaller than country $i$. We repeat this regression for both introductions of the Maastricht Treaty and for their joint effect. Calling the original introduction of the treaty in 1994 “maas1” and its extension into new member states in 2004 “maas2”, we then have the regressions

$$tax_i - tax_j = \epsilon_{ij} + \beta_1 \times l_i + \beta_2 aftermaas1_i + \beta_3 small_i + \beta_4 (aftermaas1_i \times small_i) + \epsilon_{ij}$$

(33)
\[ \text{tax}_it - \text{tax}_jt = c_{ij} + \beta_1 \times \text{small}_i + \beta_1 \text{aftermaas}2_t + \beta_2 \text{small}_i + \beta_3 (\text{aftermaas}2_t \times \text{small}_i) + \epsilon_{ijt} \]  

(34)

and

\[ \text{tax}_it - \text{tax}_jt = c_{ij} + \beta_1 \times \text{small}_i + \beta_1 \text{aftermaas}1_t + \beta_1 \text{aftermaas}2_t + (\text{aftermaas}2_t \times \text{small}_i) + \epsilon_{ijt} \]  

(35)

Following Bertrand, Duflo and Mullainathan’s (2004) warning about serial correlation issues in Differences-in-Differences estimations, we use cluster-robust standard errors. In our setting, the treatment level is a pair of states, not individual states (since our explanatory variable in this regression is the bilateral difference in tax rates of two states, not an individual state’s tax rate). Therefore we cluster the standard errors at the level of the country pairs.

5.3 Data

The previous regressions relied on an estimate of effective average tax rates from Winner (2005). There is no consensus in the literature about the methodology through which effective average tax rates should be estimated. We therefore test for the stability of the results using a different methodology which has received praise in the theoretical literature but which has not been applied to recent European data yet (Carey 2000). This methodology takes into account all types of income that a person receives and all kinds of forced payments (taxes and social security contributions) that a person makes. Since this calculation is very data-intensive and the data is not available for all European countries, we only have this detailed estimate for 17 countries, for the period of 1985 to 2013.

5.4 Test on H1

In the following Figure, the first column shows the regression 33. The dependent variable is the difference between the tax rates of country \( i \) and country \( j \) such that \( \text{tax}_{ij} = \text{tax}_i - \text{tax}_j \). The significant negative coefficient for “After Maas 1” (in the first row in the first column) indicates that across the whole sample of large and small countries, the period after the Maastricht Treaty was characterised by a convergence of average effective tax rates. The difference between tax rates between the countries became
smaller. This result indicates that the European Union did have some success in harmonising tax policy after Maastricht.

The second row indicates that when country $j$ is larger than country $i$ that did not always mean that country $j$ would undercut each other. Instead, the difference in the tax rates of countries of unequal size tended to be smaller for unequal pairs. But this result does not hold for the period after the introduction of the Maastricht Treaty, which brings us to the third row, our focus of interest, the interaction terms.

That positive and significant coefficient in the third row suggests that country $j$ was smaller than country $i$, the difference in the effective tax rates between the two countries increased after the introduction of the Maastricht Treaty. This finding supports our theory that an increase in the mobility of the relevant section of the labour market, as brought about by the Maastricht Treaty, raises the incentives for small countries to undercut the tax rates of larger countries.

In the second column we test for these effects using the policy event when the reach of the Maastricht Treaty got extended through the accession of 10 new member states to the European Union (variable $AfterMaas2$). The results of this second regression broadly confirm the first; again there was a convergence of tax rates across the Union, and again the interaction term is positive and significant. This finding suggests that again the increase in labour mobility brought about by the extension of the Maastricht Treaty caused smaller countries to undercut the taxes of larger ones. As our measurements are for effective tax rates, this cut of taxes might have come from cuts to the nominal rate or reductions in the tax base (e.g. through the granting of tax deductions or other tax exemptions).

Moving on to the third column we see that these results continue to hold also when we regress on both policy events jointly. The joint finding of the two significant interaction terms has two meanings. Firstly, the extension of the Maastricht Treaty in 2004 appears to have further intensified an already existing tax competition in which small countries undercut larger ones such that the difference of tax rates of bilateral country pairs widened. The second interaction term is smaller than the first, however. This smaller size suggests that although the extension of the Maastricht Treaty did further intensify the tax competition, it did not make as much of a difference as the first original introduction of the treaty in the old members of the EU.

We next confirm that our results do not stem from different growth performances of large and small countries. As mentioned above, there is a literature documenting that
Test of model prediction of asymmetric undercutting

Dependent variable: Difference between tax rates of country \( i \) and \( j \); Years: 1985 through 2013

<table>
<thead>
<tr>
<th></th>
<th>After Maas 1</th>
<th>After Maas 2</th>
<th>((\text{Population } j &lt; \text{Population } i) \times \text{After Maas } 1)</th>
<th>((\text{Population } j &lt; \text{Population } i) \times \text{After Maas } 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.45***</td>
<td>-0.016***</td>
<td>-0.0025</td>
<td>-0.0025</td>
</tr>
<tr>
<td></td>
<td>(-3.74)</td>
<td>(-3.48)</td>
<td>(0.79)</td>
<td>(0.79)</td>
</tr>
<tr>
<td>Population ( j &lt; ) Population ( i )</td>
<td>-0.74***</td>
<td>-0.008***</td>
<td>-0.074***</td>
<td>-0.074***</td>
</tr>
<tr>
<td></td>
<td>(-5.54)</td>
<td>(-4.85)</td>
<td>(-5.54)</td>
<td>(-5.54)</td>
</tr>
<tr>
<td>((\text{Population } j &lt; \text{Population } i) \times \text{After Maas } 1)</td>
<td>0.096***</td>
<td>0.093***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(5.37)</td>
<td>(5.21)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>((\text{Population } j &lt; \text{Population } i) \times \text{After Maas } 2)</td>
<td>0.039</td>
<td>0.0059**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(5.93)</td>
<td>(2.36)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>7623</td>
<td>7623</td>
<td>7623</td>
<td>7623</td>
</tr>
<tr>
<td>Countries</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>17</td>
</tr>
</tbody>
</table>

Note: The parentheses show \( t \)-values. Other tables in this study report standard errors in the parentheses. This presentation will be corrected to standard errors for the version presented at the conference. In all cases, the standard errors have been estimated correcting for heteroskedasticity and cluster-level serial correlation.
small and large countries tend to have significantly different economic structures, so if there happened to be a shock that caused a divergence in the growth performance of small and large countries, the tax rates might have nothing to do with country size per se. Instead, suppose there was a negative shock to the incomes of small countries and we have not controlled for it. Then it might be that poorly performing countries wanted to undercut richer countries to win over some of the rich taxpayers or they cut their taxed to engage in fiscal stimulus. In part, we are already safeguarding against such hidden divergences, because we estimate the parameters for two policy events that are 10 years apart. If there was an asymmetric shock in 1994 that explained the variation in the tax rates, that asymmetric shock should have phased out until 2004. To be even more certain, however, we re-run the regression and control for such asymmetric shocks.
We see that the signs of coefficients continue to hold also with the controls, and the effect of the original introduction of the Maastricht Treaty remains highly significant, but the estimate for the effect of the extension of the reach of Maastricht in 2004 is not anymore significant.

<table>
<thead>
<tr>
<th>Test of model prediction of asymmetric undercutting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variable: Difference between the effective tax rates of country i and j (tax_i - tax_j); Years: 1985 through 2013</td>
</tr>
<tr>
<td>After Maas 1</td>
</tr>
<tr>
<td>After Maas 2</td>
</tr>
<tr>
<td>Population j &lt; Population i</td>
</tr>
<tr>
<td>(Population j &lt; Population i) × After Maas 1</td>
</tr>
<tr>
<td>(Population j &lt; Population i) × After Maas 2</td>
</tr>
<tr>
<td>(GDP/cap j &lt; GDP/cap i) × After Maas 1</td>
</tr>
<tr>
<td>(GDP/cap j &lt; GDP/cap i) × After Maas 2</td>
</tr>
<tr>
<td>Observations</td>
</tr>
<tr>
<td>Countries</td>
</tr>
</tbody>
</table>

Notes: The standard errors reported in parentheses are robust to heteroskedasticity. They are clustered at the country pair level to correct for serial correlation.
5.5 Test on H2

<Note to EALE reviewers: We have not yet integrated revenue data until 2013 and will run the regressions on the revenue data in the next version of this paper, and integrate this test before the conference.>

6 Conclusion

We analysed if small countries have incentives to undercut larger countries’ income tax rates despite the literature’s common assumption that labour is not sufficiently mobile to bring about income tax competition. We keep this labour immobility assumption for the average citizen but not for the citizen on the margin that is decisive for tax rate setting. Taking into account constant costs of tax avoidance, we show that those persons at the margin are the top earners. We showed theoretically and empirically that—in income tax competition—small countries undercut larger one’s tax rates. This is because for a small country the loss from collecting less taxes from the own tax base is small in relation to the amount of foreign income that can be attracted.

In response to recent demands for European tax harmonisation, our models suggest that harmonisation policies are unlikely Pareto optimal as small countries systematically benefit from the non-cooperative status quo. As a result, large countries might need to either compensate smaller ones for harmonisation (e.g., through the European Structural Funds) or press the change through even against resistance (e.g., through threatening to unilaterally limit labour mobility of small EEA members, as done by the German government towards Switzerland and Liechtenstein [Steinbrück 2008]). Large countries furthermore have an incentive to limit the current increase in their pre-tax income inequalities (Palma 2009) such that a smaller proportion of their populations reaches the threshold incomes from which income shifting becomes incentive-compatible.

7 Bibliography

ASTG. Außensteuergesetz 8/9/1972 in the last version from 19/12/2008, §2 Abs. 1.


