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Empirical evidence on fiscal interdependence

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Abstract

In this paper we investigate whether there is empirical evidence to support the idea that countries set their taxes interdependently. To test this idea we estimate countries' reaction functions using a panel of data across countries, years and tax classes. We find that they are interdependent, and in a way that is consistent with the tax competition literature. Taxes on mobile factors react more than those on less mobile factors. This reaction is larger between countries where we think these factors are more mobile.

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1 Introduction

The possibility that tax setting behaviour is interdependent between countries is the cornerstone of recent policy debate focussing on tax competition. Casual observation supports the hypothesis that countries compete. Statutory tax rates have fallen in most industrialised countries over the past few decades (see Figure 1). In OECD countries average tax rates on retained income fell form 51.1% in 1985 to 38.1% in 1999. This paper considers whether there is any stronger empirical evidence to suggest a process of tax competition, and if so what form it takes.

A large body of theoretical literature has build up around the presence of tax setting externalities. While there is a growing empirical literature at the level of local governments or between local and national government within a country,[1] there is much less empirical validation of the importance of such externalities in tax setting between different countries. The aim of this paper is to explore the empirical evidence by estimating tax reaction functions for a the main types of taxes using data on OECD countries over the period 1980-2003.

The theoretical literature on tax competition between countries has generated many alternative propositions.[2] A central result of the theoretical literature is that in small, open economies there should be no source-based

[1] See Brueckner (2001) for a survey.

[2] See Devereux (1996) for a survey of these predictions and Wilson (1999) for a survey of the theoretical literature.

capital taxation, only residence-based. However, most countries operate a combination of the two, although in practice they tend to be more source than residence-based, as the enforcement of residence -based corporate inocm system is difficult, largely because of problems in gathering information about the activities of companies located in other jurisdictions. Thus many theoretical models assume that countries can only use source-based taxes.

Where capital is assumed to be perfectly mobile, and if the country is a price-taker in the world capital market, then the owners of capital will not bear the incidence of a corporate income tax.[3] An increase in capital taxes will lead to an outflow of capital which will drive up the pre-tax rate of return until the post-tax rate of return is again equal to that in other locations. This means that the incidence of the tax is not on the owners of mobile capital. Instead, as capital flows out of the country, the income of immobile factors of production declines, implying that the burden of capital taxation falls on these immobile factors. A dead-weight loss arises as a result of the lower level of investment in capital, which would be avoided if the immobile factors were taxed directly.

This logic has led many papers to conclude that capital taxes should be zero,[4] or that small countries should choose lower source based capital income

[3]See, inter alia, Gordon (1986), Razin and Sadka (1991) and Bucovetsky and Wilson (1991). Other important references in this literature include Oates (1982) and Zodrow and Mieszkowski (1986) who showed that competition between countries created an incentive to hold tax rates on capital income down.

[4]See, inter alia, including Bucovetsky and Wilson (1991), Razin and Sadka (1991).

tax rates than large countries[5] and that any revenue that the government required should be raised from a tax on immobile factors, such as labour. Empirically it is clear that taxes levied on corporate income are not in fact zero. This, and other, observations have led to numerous models explaining why they might not be zero.

One obvious empirical explanation is that, while capital may be increasingly mobile, it is not perfectly so. It could be that capital taxes are tending towards zero, but have not reached it yet. This is possible, but one needs to be clear about what is changing that makes capital more mobile. In our empirical investigation below we look at this in two ways. First, we look across several tax bases that we believe to have differential levels of mobility. Secondly, we look at how joining the European Union has affected the interdependence in countries' tax rates. An explicit aim of EU integration was to encourage the free movement of capital across national boundaries.

The basic theory presented above assumes that capital is perfectly mobile between countries. But if it is not mobile, or at least not perfectly so, what does this imply for the ability of governments to tax it? Janeba (1994) suggests that if capital is immobile then domestic firms should be subsidised. One possibility is that there are both mobile and immobile forms of capital, that governments are limited to the broad instrument of a universal corporate income tax and are prepared to accept the inefficient dead weight loss associated with taxing mobile capital, in order to collect revenue from

[5] See, inter alia, Bucovetsky (1991), Wilson (1991)

the immobile form of capital. We would still expect that, where possible, governments would seek to levy higher taxes on capital that was less mobile.

This form of immobility means that there are location specific economic rents to be earned. Each government can, in principle, capture the economic rent that is specific to their location. Taxes on natural resource, such as petroleum, are a classic example of a tax of this form. One interpretation of the variation we see in tax rates shown is that countries have different levels of location specific attributes, allowing them to collect tax on some forms of corporate income.

This literature generally does not predict actual reactions functions, but rather simply explains why there may be a downward pressure in taxes as economic integration proceeds. Nevertheless, we can take two empirical predictions and look for support in the data. These are (1) taxes on mobile factors should have steeper reaction functions than less mobile factors, and (2) reactions functions between countries where factors flow more freely should be steeper than between countries where there are barriers to the free flow of factors.

This paper focuses on direct empirical evidence for tax competition.

Before turning to that discussion it is worth noting that alternatively we could look for indirect evidence. For example, if we found that firms' location decision were very sensitive to changes in tax regimes, then this would suggest that rational welfare-maximising governments would either engage in tax competition, or set taxes co-operatively. There are several

recent surveys of this sort of indirect evidence. Hines (1999) reviews this literature and concludes that the allocation of real resources is highly sensitive to tax policies. de Mooij, R.A. and S. Ederveen (2001) similarly conclude that foreign capital is very sensitive to tax (using meta analysis). Devereux and Griffith (2001) discuss these findings and the literature on which they are based. They conclude that, while there is some evidence that taxes affect firms' location and investment decisions, it isn't clear how big is this affect and they note that the literature has provided little by way of insight into the key questions for policy interest. Linking the (reduced form) estimates from this literature to the (structural parameters in a) model of tax competition is very difficult, and has not been done satisfactorily. Thus we are left unable to say very much from the empirical literature about important policy questions.

A number of papers have looked at competition between local governments (mainly US States). Brueckner (2001) provides an excellent survey of this literature. These studies suggest support for all three forms of tax competition. Case, Rosen and Hines (1993) find evidence of interdependence between US States due to public expenditure spillovers while Fredriksson and Millimet (2001) find evidence to suggest that there are spillovers due to pollution abatement. Murdoch, Sandler and Sargent (1997) reach a similar conclusion looking across European countries.

A number of papers also find evidence of yardstick competition - Besley and Case (1995) for US States and Bivand and Szymanski (1997, 2000) and Revelli (2001) for UK regions.

The resource flows model is the one of most interest to us here. Empirical papers that consider such a model include: Brueckner and Saavedra (2001) for property taxes in cities in the Boston metropolitan area, Brett and Pinske (1997,2000) for local property taxes in Canada, Buettner (2001) for local business tax in Germany and Hayashi and Boadway (2000) for provincial corporate taxes in Canada.

Only very recently has empirical work turned to international tax competition. Chennells and Griffith (1997) consider specific predictions from the tax competition literature and looks at whether the empirical evidence supports them. They calculate effective and implicit tax rates for ten countries over the period 1979-1994. They then consider whether small countries have lower taxes than larger countries, whether this depends on the degree of openness, and whether capital importing countries set their tax rates at, or below, a dominant capital exporter. Neither of these hypotheses are supported by the data.

Devereux, Griffith and Klemm (2002) present evidence on the development of taxes on the income from capital since the mid 1960s. They compare alternative measures and show that effective tax rates on mobile capital have declined but that revenue has remained static or even increased. These two trends may be reconciled by an increase in corporate income; in turn this may be due at least partly to a reclassification of activities as corporate, or possibly just a reclassification of income as corporate profit.

Devereux, Lockwood and Redoano (2001) use an updated version of the

data in Chennells and Griffith and estimate countries' reaction functions. The strength of this paper is that the authors pay careful attention to measuring forward-looking effective tax rates. The weakness is that, in order to do this, they limit themselves to ten countries over a relatively short time period, and can only look at taxes on specific types of corporate investment. They find evidence to suggest that there is interdependence in the statutory and average tax rates, but not in marginal tax rates. They interpret this as evidence in favour of tax competition. The authors are not able to provide any supporting evidence to distinguish between the various models (resource flows, yardstick, spillovers or other common factors).

The remainder of this paper is structured as follows: ...

2 Empirical specification

One possible approach to testing for intedependent tax setting would be to consider a specific model of tax competition and empirically test the predictions from that model. This could be either against a null of no interdependence in tax setting, or against some alternative model of tax setting behaviour. A rejection of the model tested would thus not be a rejection of interdependence intax setting per se.

In this paper we do not follow this approach. Instead we attempt to estimate countries' reaction functions directly, imposing only a basic structure, which is necessary to allow us to estimate these functions with the limited available data. The results obtained will help us answer both the question

of wether there is any interdependence and whether or not this consistent with the broad predictions from the theoretical literature described in the Introduction.

We develop a simple empirical specification based on an underlying theory which views governments as setting taxes to achieve well defined ends. Suppose that a government in jurisdiction s at time t must raise taxes to meet an expenditure requirement G. It has a variety of tax instruments denoted by a vector $(t_{1st}, ..., t_{Mst})$ to achieve its ends. The possibility of mobility of tax bases implies that consumers care about the taxes set on the goods in other jurisdictions. We denote the vector of all other relevant taxes by T_{st}. The government's objective can be modeled in terms of a set of weights on N groups of heterogeneous consumers with payoff functions $v_{jst}(t,T) + \phi_{jst}(G)$ $(j = 1, ..., N)$. The weights are denoted $(\omega_{1st}, ..., \omega_{Nst})$. The demand for good i by group j is $X_{ijst}(t,T)$. Then government revenue is

$$R_{st}(t,T) = \sum_j \sum_i t_i X_{ijst}(t,T). \tag{1}$$

The government's objective is

$$W_{st}(t,T,\omega_{st}) = \sum_j \omega_{jst} v_{jst}(t,T). \tag{2}$$

This is a standard maximization problem holding T as fixed. The first order condition can be written as

$$X_{kst} - X^*_{kst} = \lambda_{st} \sum_i t_{ist} \frac{\partial X_{ist}}{\partial t_{kst}} \qquad k = 1, ..., N \tag{3}$$

where $X^*_{ist} = \sum_j \left(\frac{\omega_{jst}}{\lambda_{st}}\right) X_{jist}$ and for optimal public spending

$$\lambda_{st} = \sum_j \omega_{jst} \phi'_{jst} \left(G_{st}\right). \tag{4}$$

To generate an empirical specification, we begin by taking λ as given. In general, we can solve (3) to generate equations of the form:

$$t^*_{ist} = g\left(\lambda_{st}, \omega_{st}, T_{st}\right).$$

Thus, the exogenous variables are the shadow price of public funds, the vector of "welfare weights" and the taxes set in the other competing jurisdictions. Under this general specification, it is quite possible for taxes on all goods to affect tax setting on good i. This is empirically demanding. Under the simplifying assumption that X_i depends only on (t_{ist}, T_{ist}), this becomes

$$t^*_{ist} = g\left(\lambda_{st}, \omega_{st}, T_{ist}\right)$$

where T_{ist} is the tax rate on good i in the other jurisdiction. This will be the main specification that we study empirically. In fact, we work with the advalorem tax rate in jurisdiction s at time t denoted τ_{ist}.

It is clear that we do not observe λ_{st} directly in the data. However, as we noted above, this will depend on the level of public spending in the economy under the hypothesis that preferences for taxes and spending are separable.[6] Thus, we write

$$\lambda_{st} = h\left(G^*\left(\omega_{st}, T_{st}\right), \omega, T_{st}\right).$$

[6]Besley and Jewitt (1991) discuss in more detail the conditions under which tax setting and public spending is optimally separable.

To proxy for the vector ω_{st} we will use characteristics of the government in power. Putting this together, we propose the following estimation method. Let τ_{ist} be the tax on category i in country s at time t then

$$\tau^*_{ist} = \mu_i R_{st} + Z'_{st}\gamma + \beta_i T_{ist} + \eta_{is} + \zeta_t + \varepsilon_{ist} \tag{5}$$

where R_{st} is the ratio of total tax revenue to GDP, Z_{st} is a vector of other controls η_{is} captures country-good fixed effects, ζ_t captures common macro trends and ε_{ist} is an idiosyncratic shock. Note that we have allowed the coefficients on total tax revenue (μ) and the slope of the reaction function (β) to vary by tax class. The vector of coefficients on the other control variables (γ) is, however, restricted to be constant across tax classes. We discuss this identifying assumption in the next section. To implement this empirically, we model T_{ist} as the weighted average value of other countries' tax rates, specifically:

$$T_{ist} = \frac{\sum_{k \neq s} w_{st}\tau_{kit}}{\sum_{k \neq s} w_{st}}. \tag{6}$$

where w is the weight, which is GDP in US Dollars, converted using a purchasing power parity exchange rate.

3 Data and measurement

The most readily available measures of tax rates are ratios based on macro–economic data such as tax revenues as a share of GDP or an approximation of the tax base. While such measures have the advantage of being available for a large number of countries, taxes and years, there are great doubts as

to whether the can be useful when analysing the tax-setting behaviour of countries.

Theoretically, this is because such measures are backward looking, and include the effects of past investment decisions, unrelieved losses etc. In any given year, the measure will therefore depend on the history of investment in a given country, rather than on the current investment climate or current policy.

Devereux and Klemm (2004) show that this concern is not purely theoretical, but that such measures will in practice lead to very different description of tax rates than measures based on the tax laws. To some extent one can try to control for the factors that affect such measures, but this is unlikely to be completely satisfactory.

To make this point more obvious, consider Figure 1, which shows the UK's statutory tax rate against two measures based on macrodata. It can be noted that the macro-data measures are both volatile, and exhibit different trends from the statutory tax sytem. There are reasons to believe that this is not just due to the economic cycle and other other unrelated events, but that this creates a direct bias of the measure. To give just one example, consider that a tax cut leads to an inflow of profits into a country. The tax ratios will rise and indicate a higher tax burden, even though the opposite is true.

Concerning corporate taxes, we therfore focus on measures based on the tax law, mainly on the stautory tax rate. A case could be made for using effective tax rates as suggested by Devereux and Griffith (2003). This is

because location decisions will not only depend on the statutory tax rate, but also on other tax provisions, such as the definition of the tax base, which is to a large extent determined by the generosity of investment allowances. We have experimented with such tax rates and generally obtain similar results. Our main measures will however be statutory tax rates, because they are the main component determining the value of effective average tax rates, provided the profitability is sufficiently large. Effective marginal tax rates can be very different, but they depend so strongly on assumptions that it is doubtful how valid the comparison across countries and time periods may be. Furthermore, to the extent that countries may compete for paper profits rather than real activity (e.g. as in Haufler and Schjelderup, 2000), the statutory tax rate is the more relevant measure. We use data collected at the IFS for previous projects. They are available from the IFS website.

When considering labour taxes, the choice is less obvious. We could for similar reasons as above consider the maximum statutory tax rates. In the case of labour taxes though, it is questionable how relevant this rate is. In many countries and time periods, the top tax bracket affected only a minority of incomes and may therefore have had direct effects on a small part of the population only (which in turn may have had acces to tax avoidance). When considering a tax rate that is relevant for economic activity, there is then a case for considering the average tax rate, defined as taxes paid by an average worker as a share of gross income. Note that we include any taxes on labour income, be they labelled income taxes, payroll taxes or social security

contributions. These data are from the OECD's Taxing Wages data base. For a few of the earlier years, we needed to interpolate the data, as the data base was biannual until 19xx.

While, as argued above, the top tax rate may be confusing when considering the economic incentives faced by most individuals in the economy, it is still interesting in its own right. First, as the best-paid individuals are likely to have important economic influence and second, because of the signal sent out to worldwide investors. We therefore also consider this measure at times. Unfortunately though, data limitations make it impossible to include payroll and social security taxes in that case. In the case of social security contributions that may not be a major drawback, as these are capped in many countries so that the top marginal rate is in fact 0 per cent. These date were obtained from the World Tax Database, maintained at the University of Michigan. We have checked the data manually, and removed some obvious mistakes.

When calculating leave-out averages, we take care to calcualte them on a balanced panel of countries, so that changes in the average, reflect tax reforms rather than changes in the availability of data. We nevertheless run the regressions on all countries, including those for which data are not present in all years. Results on a perferctly balanced panel were similare though.

We also use some general economic and political variables as controls. They are from the follwoing data sets...

Table 1 provides some descriptive statistics of all the data used.

4 Identification

The aim of this paper is to find out whether, and to what extent, tax setting behaviour in one country reacts to other countries' tax systems. But estimating a reaction function such as (5) does not in itself present a test of competitive behaviour, as there may be observational equivalence between different processes. It could be the case, for example, that countries reduce tax rates at similar points in time because of a cooperative tax setting process, or a common intellectual trend rather than because of a direct reaction to other countries' behaviour.

Manski (1993) addressed the question of identification such a context. In particular he asks whether endogeneous social effects can be identified from other (exogenous) social effects. Manski identifies three effects which can lead the observation that members of a group, such as the tax-setting jurisdicitons in our case, behave similarly. These are:

1. *Endogenous effects:* The behaviour of an individual varies with the group behaviour;

2. *Exogenous effects:* The behaviour of an individual varies with some exogenous characteristics of the group;

3. *Correlated effects*: The behaviour of an individual varies with some individual characteristic which are similar across members of the group.

Another issue is the inclusion of year dummies and which relationship is

estimated.In an appendix we show that β is only identified if we constrain the time dummies in equation (5) to be equal across tax classes. In practice this also means that it is important that we constrain γ (the parameter on exogenous observable characteristics) to be constant across tax classes, since much of the variation in the X variables is capturing time series effects.

5 Estimation and results

Table 2 give some results of different approaches to estimating equation (). In all specification we condition on year and country-class dummies. This means that we are allowing for a different mean level of each type of tax in each country and for common movements in tax rates, so we are identifying the reaction from the relative deviations across countries. Our aim is to see whether there is empirical support for the prediction that reaction functions are steeper on more mobile factors.

All regressions allow for heteroskedasticity and serial correlation within country-classses. [Note: without allowing for serial correlation, results are even nicer]

In regresssion (1) we just regress tax rates on the leave-out averages, including all dummies mentioned, but no further variables. We find that the coefficient on corporate income tax leave-out average is positive and significant, but that the one for labour income taxes is insignificant. In regression (2) we add the government's revenue requirement, measures as the share of government consumption in GDP. We allow the coefficient to vary

across tax classes. While it is insignificant for both tax classes at conventional levels, it is closer to significance for labour income taxes.

These first regressions are biased, because the leave-out average is necessarily endogenous, if there is indeed fiscal interdependence. We deal with this in two ways. First in regression (3) we exclude the G3 countries from the regression. This makes the leave-out average more exogenous, although not perfectly so, as the G3 countries will have been the main factors determining its value, because of the weighting by GDP. Clearly this is not a perfect solution. The results are similare to the previous regresssion.

Then we consider estimation using instrumental variables. Here we first use a simplistic approach of assuming that lagged values of tax rates are good instruments of current ones. The results on tax rates are again very similar, although now the coefficient on the revenue requirement has become significant for labour taxes. In regresssion (5) then we consider political variables as instruments for tax rates. Our methodology is to first obtain predicted values of tax rates based on the instruments and then to calculate the leave-out avareages of these. Using this approach we again obtain similar results for the tax rates, although coefficients on the reveuneu requirements are now insignificant again.

More results, using top PIT rate. [finding is that top PIT rate also seems to be interpdependent. Hence all of this may well be yardstick competition]

6 Summary and conclusions

In this paper we have investigated whether there is empirical evidence to support the idea that countries set their taxes interdependently. We find that they do, and that they do so in a way that is consistent with the tax competition literature. Taxes on mobile factors react more than taxes on less mobile factors. However, we cannot rule out alternative explanations such as yardstick competition.

7 Appendix: Identification

The following chart shows a plot of the 21 countries' tax rates agains the leave-out means for labour taxes. The downward sloping lines characterise the relationship between the tax rate and the leave-out average within a given year. The more interesting realationship for our purposes is the one for each country over time. Depending on the tax rate this may downward or upward sloping.

To see the identification problem first consider our model for only one individual tax class, τ_{st} with no other control variables

$$\tau_{st} = \beta\tau_{-st} + \eta_s + \zeta_t + \varepsilon_{st} \tag{7}$$

where

$$\tau_{-st} = \frac{1}{N-1}\sum_{j\neq s}\tau_{jt} = \frac{N}{N-1}\overline{\tau_t} - \frac{1}{N-1}\tau_{st}.$$

Our main coefficient of interest is β which is not identified in this model. To see this rewrite (5) as

$$\left(\tau_{st} - \overline{\tau_s} - \overline{\tau_t} + \overline{\overline{\tau}}\right) = \beta\left(\tau_{-st} - \overline{\tau_{-s}} - \overline{\tau_{-t}} + \overline{\overline{\tau_-}}\right) + \varepsilon_{st} \tag{8}$$

where

$$\begin{aligned}\overline{\tau_s} &= \frac{1}{T}\sum_{t=1}^{T}\tau_{st} \\ \overline{\tau_t} &= \frac{1}{N}\sum_{s=1}^{N}\tau_{st} \\ \overline{\overline{\tau}} &= \frac{1}{NT}\sum_{t=1}^{T}\sum_{s=1}^{N}\tau_{st}\end{aligned}$$

$$\begin{aligned}\overline{\tau_{-s}} &= \frac{1}{T}\sum_{t=1}^{T}\tau_{-st} = \frac{N}{N-1}\overline{\overline{\tau}} - \frac{1}{N-1}\overline{\tau_s} \\ \overline{\tau_{-t}} &= \frac{1}{N}\sum_{s=1}^{N}\tau_{-st} = \overline{\tau_t} \\ \overline{\overline{\tau_-}} &= \frac{1}{NT}\sum_{t=1}^{T}\sum_{s=1}^{N}\tau_{-st} = \overline{\overline{\tau}}\end{aligned}$$

substitute in to (**??**) gives

$$\left(\tau_{st} - \overline{\tau_s} - \overline{\tau_t} - \overline{\overline{\tau}}\right) = \beta\left(-\frac{1}{N-1}\right)\left(\tau_{st} - \overline{\tau_s} - \overline{\tau_t} + \overline{\overline{\tau}}\right) + \varepsilon_{st}. \tag{9}$$

Hence, the OLS estimator will be:

$$\begin{aligned}\widehat{\beta} &= \frac{\frac{-1}{N-1}\sum\left(\tau_{st} - \overline{\tau_s} - \overline{\tau_t} + \overline{\overline{\tau}}\right)^2}{(\frac{-1}{N-1})^2\sum\left(\tau_{st} - \overline{\tau_s} - \overline{\tau_t} + \overline{\overline{\tau}}\right)^2} \\ &= -(N-1)\end{aligned} \tag{10}$$

Identification with more than one tax class

We add different classes $i = 1...M$, with leave out mean taken only across your own class (so cross class effects ruled out)

$$\tau_{sit} = \beta\tau_{-sit} + \eta_{si} + \zeta_t + \varepsilon_{sit} \tag{11}$$

in deviation form

$$(\tau_{sit} - \overline{\tau_{si}} - \overline{\tau_t} + \overline{\tau}) = \beta\left(\tau_{-sit} - \overline{\tau_{-si}} - \overline{\tau_{-t}} + \overline{\tau_{-}}\right) + \varepsilon_{sit} \tag{12}$$

where

$$\begin{aligned} \overline{\tau_{-si}} &= \frac{N}{N-1}\overline{\tau_i} - \frac{1}{N-1}\overline{\tau_{si}} \\ \overline{\tau_{-t}} &= \overline{\tau_t} \end{aligned}$$

substitution gives

$$(\tau_{sit} - \overline{\tau_{st}} - \overline{\tau_i} + \overline{\tau}) = \beta\left(\frac{-1}{N+1}\tau_{sit} + \frac{1}{N+1}\overline{\tau_{si}} + \frac{N}{N+1}\overline{\tau_{it}} - \frac{N}{N+1}\overline{\tau_i} - \overline{\tau_t} + \overline{\tau}\right) + \varepsilon_{sit} \tag{13}$$

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