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# Taxes, Mobile Capital, and Economic Dynamics in a Globalising World

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## **Abstract**

This contribution provides evidence for the hypothesis that trade increases growth through its curbing effect on capital taxes. The analysed trade-growth channel includes a negative impact of openness on corporate taxes and a negative effect of taxes on growth. The paper explores the two steps both theoretically and empirically, taking into account the different theories and estimation problems involved. Simultaneous estimations with panel data for a sample of 12 OECD countries in the period 1965-1999 confirm a significant and robust impact of trade on growth through corporate tax rates.

*Keywords:* Trade and Growth, Tax Competition, Capital Taxes and Mobility, OECD Countries

*JEL Classification:* F43, O40, H71

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# 1 Introduction

Capital is internationally mobile and, at the same time, crucial for economic dynamics. More mobility does not necessarily result in more growth, however. The growth rate depends on accumulation incentives, which can increase or decrease with globalisation, see Grossman and Helpman (1991). But goods and factor trade may entail additional mechanisms which unambiguously enhance the accumulation of new capital. According to theory, productivity, competition, market size, and resource reallocation mechanisms can be considered. Various additional channels like government policies and technology diffusion have been tested empirically by Wacziarg (2001). This paper argues that one of the prominent but still neglected channels is the effect operating through capital taxes. Tax competition theory predicts that increasing globalisation forces governments to reduce taxes on more mobile assets, which - under fairly general conditions - increases growth. Thus the connection is readily given: the pressure on exactly those taxes that seem to be crucial for the growth rate is able to provide a direct link between trade and growth.

The underlying model for the capital tax mechanism can be derived from first principles. Tax competition theory argues that, in an open economy, any increase in the tax rate of capital causes a capital outflow to other economies, which is a fiscal externality. Costs for capital holders to shift capital abroad fall with lower capital trade restrictions and/or with increasing openness of the economy, see Bucovetsky (1991) and Wilson (1991). Thus rising openness increases the externality and decreases capital tax rates. The impact from capital taxes on growth is given by the effect on the private return on investment. Easterly and Rebelo (1993) point out that “it is hard to think of an influence on the private rate of return and on the growth rate that is more direct than that of income taxes. If these do not affect the rate of growth, what does?”

The two relationships of the tax channel mechanism appear to be very intuitive. However, there are additional and possibly conflicting effects in reality, which pose an additional challenge for the present study. Regarding globalisation, Rodrik (1998) argues that more open economies need a larger stabilising role for governments to cope with the increased uncertainty due to international shocks. Accordingly, early empirical studies such as Garrett (1995), Quinn (1997) and Swank (1998) do not find that increasing globalisation decreases the tax rates. On the theoretical level, Uhlig and Yanagawa (1996) show that, in an overlapping generations economy, lower capital taxes may decrease the growth rate. This can happen because taxing capital relieves the tax burden on the young generation which enables it to save more. Wacziarg (2001) concludes that openness increases government efficiency and, finally, Barro (1990) derives that the relationship be-

tween tax rates and growth is non-monotonic but hump-shaped, assuming the government provides productive services.

In the present paper, we incorporate all these different effects to build a simple model of tax competition and economic dynamics. The relevant model impacts of openness and government behaviour are derived from the theory and directly used in the subsequent empirical estimations. By using a general model and appropriate data we will find that, for developed countries, the hypothesis of capital taxes as a link between trade and growth can be confirmed. We take into account that the interpretation of growth regressions with purposeful policies as explanatory variables is problematic, see Rodrik (2005). In our approach, tax competition does not assume purposeful tax changes, but policy changes that are enforced by globalisation i.e. outside forces, which cannot be influenced by the government.

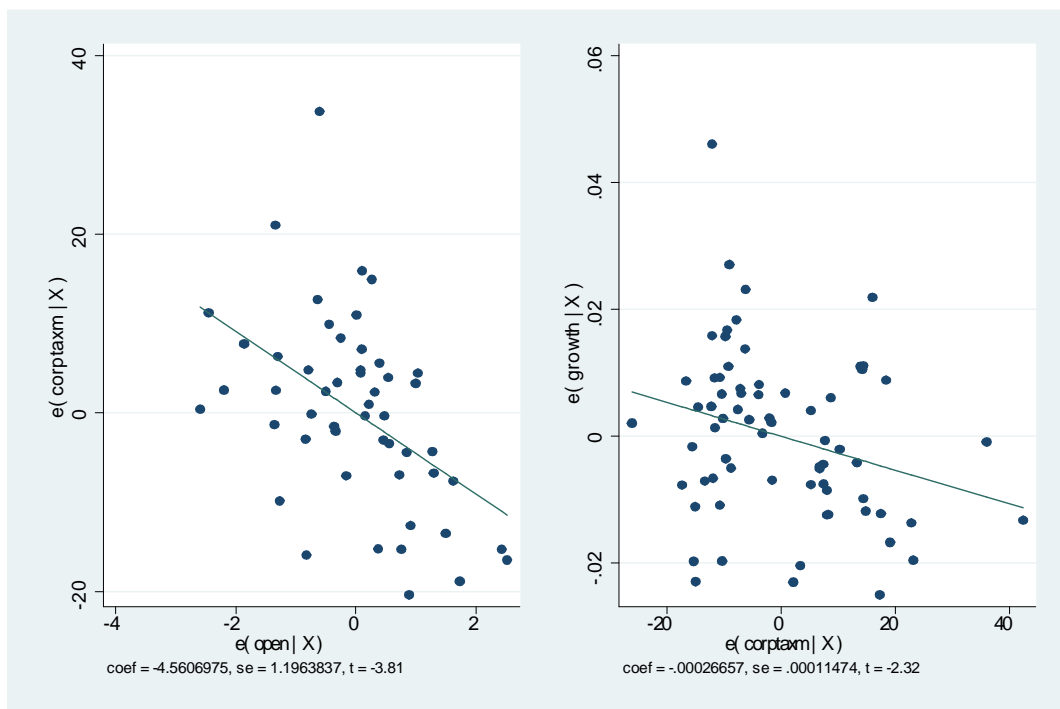


Figure 1: The effect of openness on corporate tax rates (left) and of corporate taxes on growth (right).

The openness-tax-growth relationship is inherently multidimensional. Accordingly, single observations and case studies are not necessarily helpful to gain intuition. To motivate the study we thus present some first empirical evidence. Figure 1 shows, on the left hand side, the combination of openness of the economies across time (within 5 years subperiods) and the residuals resulting from a basic regression for corporate tax determination, as explained in section 4, see specifically table 3, for 12 OECD countries. The negative slope of the fitted regression line between

openness and corporate taxes is statistically significant across a large set of empirical specifications. On the right hand side, the figure shows the relationship between corporate taxes and the growth residuals, resulting from a basic growth regression. Again, the negative slope of the fitted regression line between corporate taxes and growth is significant across a large set of empirical specifications. This piece of evidence points to the fact that the specific tax mechanism through which openness fosters economic growth is present in developed countries.

The search for robust channels in the trade-growth relationship makes a contribution to a central but controversial issue in the current macroeconomic debate. Michaely (1977), Dollar (1992), Sachs and Warner (1995) and Edwards (1992) find a positive impact of trade and open trade policies on the growth rate, while recent papers do not come to unanimous conclusions. Edwards (1998) confirms the earlier results but Rodriguez and Rodrik (2001) remain very skeptical regarding the general validity of the positive connection. Levine and Renelt (1992) and Temple (1999) emphasise that various traditional cross-country studies suffer from methodological problems. Wacziarg and Welch (2003) confirm the low robustness of the nexus for cross-sectional studies but find new evidence when focusing on within-country growth. Frankel and Romer (1999) comment that, in their opinion, trade is a "very noisy proxy for income-promoting interactions". Reconsidering several important studies, Rodriguez and Rodrik (2001) conclude that open trade policies are not significantly associated with economic growth, once other relevant country characteristics are controlled for. They suspect that the relationship between trade and growth depends on additional characteristics and argue that "scrutinizing the channels through which trade policies influence economic performance is likely to be more productive" before they conclude that "the challenge of identifying the connections between trade policy and economic growth" is crucial for any further research in this field.

This paper adds to both the trade-growth and the tax competition literature in several respects. First, taking the critique of Rodriguez and Rodrik (2001) seriously, it identifies and explores a specific trade-growth channel which operates through taxes. Second, it develops a novel approach to construct a simple dynamic tax competition model. Theory is used to derive the main hypotheses. Third, the model is tested empirically with OECD data to check the accuracy and robustness of the predictions. Fourth, the empirical estimations take recently discussed econometric problems into account. By concentrating on OECD countries the contribution avoids estimation problems of large cross-country samples. The 12 leading OECD countries considered are quite similar, e.g. regarding factor endowments, market structures, and institutions, so that the aim of identifying and separating the tax effects seems to be feasible. The time period under study covers a sufficiently long horizon and the use of five-year intervals helps to minimise

business cycle effects. Fifth, the paper sheds a light specifically on the relationship between institutions and growth, with the tax-setting government in a globalising world as an institutional actor. In particular, it provides results on developed countries, while many other studies concentrate on less developed economies or mixed samples. The characteristics of richer countries will also lead to a particular view on the different channels under debate. Finally, for the empirical estimation of the tax channel, the paper applies the method of Tavares and Wacziarg (2001) and Wacziarg (2001) to the tax competition literature. We estimate the equations jointly using three-stage least squares, so that consistency is achieved by instrumentation and efficiency is reached by appropriate weighting using the covariance matrix from the second stage of the procedure.

Of course, the specific channel between trade and growth in this paper has to be seen as a complement to other possible links like scale, accumulation and productivity effects, treated in Rivera-Batiz and Romer (1991), Eaton and Kortum (2001), Keller (2002), Baldwin (2003), Lee, Ricci, and Rigobon (2004), and Alcalá and Ciccone (2004); for the effects of globalisation on the tax-mix and labour taxation see Bretschger and Hettich (2002), Winner (2005), Hauffer, Klemm and Schjelderup (2006) and Adam and Kammas (2007); tax competition in a spatial framework is treated in Borcka and Pflüger (2006) while related policy and institutional issues are dealt with in Kneller, Bleany and Gemmell (1999), Tavares and Wacziarg (2001), Devereux, Griffith, and Klemm (2002), Dollar and Kraay (2003), Yanikkaya (2003), Dalgaard, Hansen, and Tarp (2004), and Winters (2004). We will relate the importance of our findings to the other channels of the literature at the end of the paper.

The remainder of the paper is organised as follows. Section 2 presents a simple model which is the basis for empirical estimations. In Section 3, the estimation method and the data are discussed. Section 4 provides empirical evidence for the capital tax channel in OECD countries. Finally, section 5 concludes.

## **2 Theoretical framework**

### **2.1 The model**

Following the causal chain from trade to capital taxes to growth, the theoretical approach presented here necessarily includes the formulation of two relationships: the first is the impact of trade and trade policy on capital taxes, the second the effect of capital taxes on growth. Let us present a simple approach to formalise the basic idea. Assume  $n$  identical model economies. In each of them, output per capita is determined by the production function:

$$y = f(B, k, q, E) = Bk^\alpha q^{1-\alpha} E^\beta \quad (1)$$

with  $y$  denoting per capita output,  $B$  a parameter,  $k$  private capital per capita,  $q$  government services per capita, and  $E$  a (pure) public good provided by the government. We assume  $0 < \alpha, \beta < 1$ . Contrary to  $E$ ,  $q$  is rival in production, as in Barro (1990), so that the return to the two rival inputs  $k$  and  $q$  together is constant. Assume the government levies a proportional tax on income with a rate  $\tau$  to finance  $q$ , i.e. we have at each point in time:

$$q = \tau \cdot y. \quad (2)$$

As we are interested in growth we focus on the impact of  $\tau$  as a capital income tax; labour and labour taxation have no explicit role in the model. With given  $B$  and  $E$ , which are treated below, and with  $q$  being outside of the scope of the single firm, we obtain the private marginal product of capital  $MPK_p$  by taking the derivative of (1) with respect to  $k$  and using (2) according to:

$$MPK_p = (1 - \tau)\alpha B^{\frac{1}{\alpha}} E^{\frac{\beta}{\alpha}} \tau^{\frac{1-\alpha}{\alpha}}. \quad (3)$$

Postulating perfect domestic capital markets and with  $r$  denoting the interest rate, we get  $MPK_p = r$ . According to (3), the relationship between  $\tau$  and  $r$  is hump-shaped (and thus single-peaked). By taking the derivative of  $MPK_p$  with respect to  $\tau$  and setting equal to zero it can easily be checked that  $r = r^*$  ( $r$  reaches the maximum value) when  $\tau = 1 - \alpha$ , see also Barro (1990). The solid line in figure 2 shows (3) graphically.

Capital cannot be transferred between the economies without cost. Assume the cost of having one unit of capital in one of the other  $n - 1$  economies is given by  $\xi$  per period (with  $0 < \xi < r$ ), so that the private return for domestic capital installed abroad becomes  $r - \xi$ . Two effects have now to be observed. First,  $\xi$  is a function of globalisation, i.e. the lower trade cost, the lower becomes  $\xi$ . Second, the government has no control over  $\xi$  but obtains room to determine the tax rate. By increasing  $\tau$  it can raise the share of public services, which increases its impact on the economy. According to the theory of bureaucracy, administrations seek to maximise their budget and impact, see Niskanen (1971), so that we assume that the maximum feasible  $\tau$  is chosen.

With  $\xi = 0$ , the only feasible outcome would be  $\tau = 1 - \alpha$  because a different  $\tau$  would induce capital to move completely to any country where the return is maximum. This would lead to  $y = 0$  by (1), obviously not a desired outcome. But given  $\xi > 0$ , the government can choose  $\tau > 1 - \alpha$ , thus lowering the capital return, as long as the condition  $r > r^* - \xi$  is fulfilled, see figure 2. The limit is given by  $\bar{r} = r^* - \xi$  which corresponds to point C in the figure. Up to this

point, it is not favourable for capital to move. If we set  $r < r^* - \xi$  in country  $j$ , however, every other government can credibly threat to set its  $\tau$  such that all capital of country  $j$  would immediately be shifted abroad. This is not a stable equilibrium. With symmetry, the equilibrium outcome is that every government sets  $\bar{r} = r^* - \xi$ , which is the maximum feasible tax rate yielding capital return  $\bar{r}$ ; considering (3) it is:

$$\bar{r} = \alpha^2 B^{\frac{1}{\alpha}} E^{\frac{\beta}{\alpha}} (1 - \alpha)^{\frac{1-\alpha}{\alpha}} - \xi \quad (4)$$

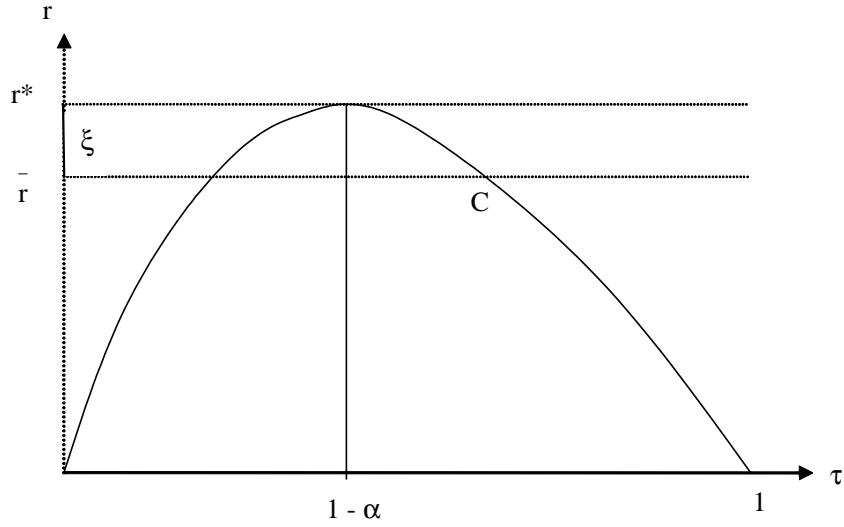


Figure 2: Tax rate  $\tau$  and capital return  $r$

We conclude that an increase of the openness of an economy (a shrinking  $\xi$ ) raises  $\bar{r}$  because the government has to lower  $\tau$  in order to avoid a complete capital exit.

Observing (4) the impact of the non-rival variables  $B$  and  $E$  on the capital return becomes evident.  $B$  may not only reflect the choice of units but also other inputs such as environmental services like clean air, clean water etc. If so, it is conceivable to argue that (at least some of) these services are diminished by capital use through negative externalities. This would suggest to write  $B = \bar{B} \cdot k^{-\psi}$  with  $0 < \psi < 1$ ,  $\bar{B} > 0$ . As a consequence, the (social) return to the two rival inputs  $k$  and  $q$  together becomes decreasing over time and output converges to a constant value in the long run, see below. To distinguish the different government activities most clearly we assume the public good  $E$  is financed by a lump-sum tax where the tax rate per capita is denoted by  $\mu$  so that



$$E = \mu L \quad (5)$$

with  $L$  denoting population. As becomes evident from the examples of Scandinavian or Anglo-Saxon countries,  $E$  is largely determined by the preferences of the electorate (i.e. the political orientation of the voters) which leads to a country-specific  $\mu_j = v_j/L_j$  with  $v_j$  denoting preferences for the public good in country  $j$ . In addition, large (and probably more efficient) countries like the U.S. might have a higher  $E$  because it can be provided with a lower cost per capita. Together with (4) we can see that  $E$  has an impact on  $\bar{r}$  and, by this, on the tax rate  $\tau$  chosen by the government. Put differently, a government can impose a higher  $\tau$  with higher  $E$ . The reason lies in the positive impact of the public good on capital productivity. In the figure, an increase in  $E$  shifts the curve upward while the endpoints at  $\tau = 0$  and  $\tau = 1$  remain unchanged. Note that in a non-symmetric equilibrium with country-specific  $v_j$ , tax competition requires the government of country  $j$  to set  $\bar{r}_j = r_{v_{\max}}^* - \xi$  where  $r_{v_{\max}}^*$  is the maximum capital return in the country with the highest public good provision, which is exogenous for country  $j$  (except it is the "leading" country in which case  $r_{v_{\max}}^* = r^*$ ).

Taking the total differential of (3) for  $r = \bar{r}_j$  yields the partial impact of trade cost  $\xi$  and (preferences for) the public good  $E$  on the tax rate  $\tau$ , which read *ceteris paribus*:

$$\frac{d\tau}{d\xi} = -\frac{1}{\bar{r}_j} \frac{\alpha\tau(1-\tau)}{(1-\alpha-\tau)} > 0 \quad \text{for } \tau > 1-\alpha. \quad (6)$$

and

$$\frac{d\tau}{dE} = -\frac{\beta}{\alpha E} \frac{\alpha\tau(1-\tau)}{(1-\alpha-\tau)} > 0 \quad \text{for } \tau > 1-\alpha. \quad (7)$$

The two expressions (6) and (7) contain two hypotheses which can be tested in the first estimation equation below. They express that the tax rate  $\tau$  decreases with increasing globalisation (decreasing trade cost  $\xi$ ) and increases with rising preferences for public goods  $E$  (denoted by  $v$ ).

To derive the growth equation we use individual utility  $u$  given by:

$$u = \int_0^{\infty} e^{-\rho t} \log c(t) dt \quad (8)$$

where  $\rho$ ,  $t$ , and  $c$  are the discount rate, the time index, and individual consumption.  $u$  is maximised by each agent under the restriction for individual wealth  $z$  reading  $\partial z/\partial t = rk - c$ . Maximising the current-value Hamiltonian yields the usual Keynes-Ramsey rule for intertemporal optimisation:

$$g = r - \rho \quad (9)$$

where  $g$  is the per capita consumption growth rate. Inserting (3) yields:

$$g = (1 - \tau)\alpha B^{\frac{1}{\alpha}} E^{\frac{\beta}{\alpha}} \tau^{\frac{1-\alpha}{\alpha}} - \rho \quad (10)$$

which exhibits the next hypothesis to be tested, which will be done in the second estimation equation. (10) means that we predict  $\partial g / \partial \tau < 0$  for the relevant case  $\tau > 1 - \alpha$ . Furthermore, we have seen for  $r = \bar{r}_j$  that the tax rate offsets the effects of  $E$  on  $MPK_p$  so that we get  $\partial g / \partial E = 0$ , meaning there is no impact of the public good on the growth rate. The development of  $B$  has an effect on  $r_{v_{\max}}^*$  and thus the growth rate of the "leading" economy. Taking  $B = \bar{B} \cdot k^{-\psi}$  ( $1 - \psi > 0$ ) we have  $r_{v_{\max}}^*$  decreasing over time so that capital and output converge to constant values in steady state, just as in the neoclassical growth model. In country  $j$  we still apply  $\bar{r}_j = r_{v_{\max}}^* - \xi$  so that the convergence property is transmitted to all the economies, which is also tested in the second estimation equation.

## 2.2 Estimation equations

The simultaneous empirical system contains two key equations in the first variant; it is extended to three and four equations in alternative specifications which include additional channel effects. The endogenous variables are the tax rate and the per capita growth rate in the former case and, additionally, government spending and investment in the latter. We have obtained in (6) and (7) that the tax rate  $\tau$  in country  $j$  ( $j = 1, 2, \dots, n$ ) depends positively on trade cost  $\xi$  and preferences for public goods  $v$ , so that the first estimation equation reads:

$$\tau_j = a_0 + a_1 \xi_j + a_2 v_j + a_3 Z'_j + \epsilon_\tau \quad (11)$$

In (11)  $Z'_j$  denotes a vector of further control variables (used to check the robustness of the theory) and  $\epsilon_\tau$  an error term. From the theoretical derivation, we expect  $a_1 > 0$  and  $a_2 > 0$  when using  $\xi_j$  and  $v_j$ . Note, however, that the empirical results below will show reversed signs, which is due to the (usual) measurement of the variables. First, according to the literature, we express internationalisation in terms of openness and not trade cost  $\xi$ , so that the impact of openness on  $\tau$  will be expected to be negative. Second,  $v$  measures the ideology of the government and the electorate on a left-right scale, increasing from far left to far right. If we realistically postulate more conservative voters and governments to have a preference for lower taxes and public goods, the impact of the ideology variable will be negative in the estimations. For  $Z'_j$  we consider two effects. First, trade and political unions might make a difference, which is especially obvious in the

case of the European Union. We thus test for EU i.e. non-EU membership with a separate variable. Second, there might be a common trend across countries in the variables, so that a time trend is included as well.

The growth rate has been shown to depend negatively on the tax rate. Income convergence (due to the decreasing  $B$  in the leading economy and international transmission) is tested by inserting  $\ln y_0$  in the growth equation, a well-known procedure in growth empirics. Thus the second estimation equation for country  $j$  becomes :

$$g_j = b_0 + b_1\tau_j + b_2 \ln y_{j0} + b_3X'_j + \epsilon_g \quad (12)$$

In (12)  $X'_j$  denotes a vector of further control variables and  $\epsilon_g$  an error term. In  $X'_j$  we include a time trend, initial human capital, which is often used as a further determinant of productivity, and population size  $L$  to check for scale effects. From the theoretical derivation we expect  $b_1 < 0$  and  $b_2 < 0$ .

In a second variant of the model we extend equation (5), i.e.  $E = \mu L$ , and consider the possibility for the government to redistribute some revenues, denoted by  $D$ , so that  $E + D = \mu L$ . Provided that redistribution required by voters increases with globalisation we get a second channel through which the openness has an impact on the economy. If the increase in  $D$  does not go entirely at the expense of  $E$  the prediction would be that government expenditures increase with globalisation. Again, however, we do not predict an impact of government expenditures on growth. By adding the government expenditure channel to the empirical system, this is also tested with the data below.

In a final variant of the model we furthermore add an investment channel to the empirical system. Specifically, we include the separate impact of globalisation on domestic capital investment and the effect of investment on growth. Importantly, this allows us to discuss the nature and the importance of the tax channel compared to other transmission mechanisms.

## 3 Estimation Method and Data

### 3.1 Econometric issues

In cross-country studies on trade and growth, econometric problems such as simultaneity, parameter heterogeneity and missing variables have to be especially considered, see Temple (1999). Simultaneity arises because “countries whose incomes are high for reasons other than trade may trade more” (Frankel and Romer 1999, p. 379). These authors use geographical variables as instruments to correct for this bias. We will proceed similarly by introducing the average distance to trade partners and the land area as instruments.

A second econometric problem is the possible parameter heterogeneity, which especially arises from the use of large samples including very different countries. Problems of data quality and outliers are well known and can be addressed with appropriate sensitivity tests. But there are good reasons to believe that the mechanisms transmitting the impact of trade on growth vary when we compare different countries, notably LDCs and leading economies. Whereas for developing countries, the strengthening of market forces might be a main channel in the trade-growth nexus, this effect seems to be less important for industrialised countries. In addition, the growth effects of trade depend on comparative advantage, see Grossman and Helpman (1991), which varies strongly between very different countries. If theory is richer than is expressed in the current empirical studies, the problem of omitted variables is also a serious obstacle for good estimation results.

By restricting our analysis to 12 highly developed OECD economies with similar factor endowments and institutional background, using appropriate instruments, and adopting a simultaneous estimation approach, we aim to reduce the problems of simultaneity, parameter heterogeneity and omitted variables as far as possible.

### **3.2 Estimation procedure**

In the present paper, the core system consisting of equations (11) and (12) is estimated jointly using three-stage least squares. The same applies to the enlarged system in the final part of the paper. The procedure follows Tavares and Wacziarg (2001) and Wacziarg (2001). The advantage of this estimation method (e.g. compared to a dynamic GMM) is its ability to take care of the various cross-equation restrictions which appear to be highly important in the context of trade and growth. The procedure exploits the information inherent in the fact that error terms may not be independent across structural relationships. In the first step, for each of the two equations, a reduced-form coefficient matrix is estimated using OLS. In the second step, 2SLS is adopted to estimate the structural model. Finally, in the third step, the estimated covariance matrix from step 2 and the fitted values of the endogenous variables of step 1 are used for an IV-GLS estimation applied to the stacked structural model. By applying this estimation procedure, consistency is achieved by instrumentation while efficiency is reached by appropriate weighting when using the covariance matrix from the second stage. As in Tavares and Wacziarg (2001), time lags are disregarded. An additional restriction is that the covariance matrix does not depend on country effects which rules out heteroskedasticity and spatial autocorrelation.

By using a sufficient number of exogenous variables and instruments, we aim at reducing the scope for omitted variable bias. As instruments we use a variety

of predetermined demographic and geographic variables. Specifically, we introduce in all equations the logarithm of population, the average distance to trade partners, the land area, the age dependency ratio, the share of arable land, and life expectancy; distance to trade partners and land area are, as noticed, good instruments for openness.

### 3.3 The data

To measure capital mobility and openness we combine two types of information. We follow Dreher and Siemers (2005) by using binary data from the International Monetary Fund's annual report including (i) restrictions on payments for capital account transactions, (ii) separate exchange rate(s) for some or all capital transactions and/or some or all invisibles, (iii) surrender requirements for proceeds from exports and/or invisible transactions and (iv) restrictions for payments on current transactions, see also Gruben and McLeod (2001) and Bai and Wei (2001). While (i)-(iii) represent different forms of capital control, (iv) is included because current transactions can be used to circumvent restrictions on the capital account, see Milesi-Ferretti (1998). The subindex aggregating (i) - (iv) takes the value 4 for fully restricted capital accounts and 0 if no restrictions are in place. It needs to be supplemented for two reasons. First, capital markets were almost fully liberalised in Europe in the 1990s so that the variation becomes comparatively low in that period, although perceived capital mobility still changed (i.e. increased). Moreover, countries like the US, Canada and Germany have no variation in openness although it is conceivable that capital trade has been further liberalised. Second, qualitative measures can be rendered more precisely when adding information on quantitative trade flows. This holds true because policy indicators suffer from several drawbacks. A common variable used in empirical studies is the sum of imports and exports as a percentage of GDP, which we use as second subindex. We normalise both subindices by dividing the data values by the mean and the standard deviation of the series to give them equal weight. We then use the sum of the (negative) value of the first subindex and the second subindex for our capital openness index *open* so that a higher value of the index means a more open economy.

The effective tax burden of firms is determined not only by the statutory tax rate but also by the determination of the legal tax base, which differs due to complex national differences in tax credits, tax exemptions and tax deductions for identical operating surpluses. Capital tax revenue as a share of GDP was used by Garrett (1995), Quinn (1997) and Swank (1998). But since capital tax revenue as percent of GDP equals capital tax rates times the capital base divided by total income, the observed relationship is not necessarily incompatible with

greater openness reducing the tax rate. If, at the same time, openness raises the capital/output ratio and, especially, if it does so by means of lower tax rates, a positive impact of globalisation on tax revenue can be expected, according to theory. Therefore, effective tax rates are used for the estimations below. These rates are calculated by dividing total tax revenues from corporate taxation by the operating surplus of corporate enterprises, according to the methodology proposed in Mendoza, Razin and Tesar (1994). As effective capital tax rates incorporate taxes on immovable properties with a very inelastic tax base, corporate taxes are better suited for testing the theoretical predictions of the tax competition model. A large share of corporate capital belongs to multinational firms and is thus especially mobile. Qualitatively, the tax competition results in this paper is compatible with the outcome in Rodrik (1997) and Bretschger and Hettich (2002), where, however, annual data are used for single equation estimations, which does not allow the channel and the endogenous growth perspective taken here.

Table 1: Data

Used variables and sources

Variable	Description	Source
corptax	effective corporate tax rate	OECD (1998a,b), (2005)
open	index of capcontrol and opentrade	IMF, PWT 6.1
capcontrol	index of restrictions for capital mobility	IMF
opentrade	(exports+imports)/GDP	PWT 6.1
growth	real per capita GDP growth, const. prices, chain series	PWT 6.1
gov	center of political gravity: government, cabinet, and electorate	Cusack (1997), Cusack and Engelhardt (2002)
logincome	log of initial GDP per capita	PWT 6.1
human	initial years of average schooling	Barro/Lee (2000)
invest	average investment share	PWT 6.1
pop	population size	PWT 6.1
popgrowth	population growth	PWT 6.1
logpop	log of population	PWT 6.1
dist	average distance to trading partners	Barro/Lee (1994)
agriland	share of land area that is arable	WDI (2005)
lifeexp	life expectancy at birth	WDI (2005)
agedep	ratio of dependents; people (<15 + >64)/others	WDI (2005)
area	land area	WDI (2005)
govspend	government final consumption expenditure (% of GDP)	WDI (2005)

Effective corporate tax rates are calculated with OECD tax data as the sum of tax revenues of corporate taxation plus tax revenues on companies' assets, both

taken from the revenue statistics (OECD 1998b), divided by net operating surplus of corporations, taken from the national accounts (OECD 1998a). Data for 1997-99 are calculated by using OECD (2005). The other data sources are described in table 1. PWT 6.1 refers to the Penn World Table, see Heston, Summers and Aten (2002).

The sample covers the 12 OECD countries with adequate tax data (Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Norway, Sweden, Switzerland, UK and USA) and ranges from 1965 to 1999, divided into five year periods as follows: 1965-69, 1970-74, 1975-79, 1980-84, 1985-1989, 1990-94 and 1995-99. For some countries, tax data are not available from the beginning, so that the panel is unbalanced. The summarising description of the series is given in table 2.

Table 2: Description of variables

Variable	Obs.	Mean	Std.dev.	Min	Max
corptax	70	36.88	14.02	13.20	78.19
gov	84	9.28	1.06	7.14	11.09
open	84	1.12	1.39	-2.42	4.62
opentrade	83	57.84	30.15	10.11	141.73
capcontrol	77	0.87	1.09	0	4
pop	84	54580	62533	3724	263073
popgrowth	83	0.005	0.004	-0.002	0.017
logpop	84	4.45	0.53	3.57	5.42
invest	83	26.05	5.01	16.99	37.87
growth	83	0.0243	0.0161	-0.0161	0.1044
logincome	84	9.71	0.28	8.83	10.25
area	84	1830	3535	31	9976
dist	84	3.19	2.14	1.27	8.79
human	84	8.43	1.82	3.31	11.89
agriland	84	19.90	11.50	2.59	42.58
lifeexp	80	74.75	2.29	70.17	79.54
agedep	84	0.53	0.05	0.44	0.69
govspend	82	18.79	4.55	8.34	29.81

## 4 Empirical Evidence for OECD Countries

The equations derived from theory are now used for the simultaneous empirical estimation of the tax channel mechanism. The results are presented in several steps. We start with the core model for the tax and the growth equation given by (11) and (12). The first equation gives the impact of trade on the channel variable *corptax*, which appears in the second equation as an explanatory variable of the growth rate of the economy. To show the whole variety of results, we vary the control variables and the estimation method and then also include additional channels for the trade-growth nexus in the simultaneous system. In the 3SLS and 2SLS estimations, the instruments used in all equations are *logpop*, *dist*, *area*, *agedep*, *agriland*, and *lifeexp*. The results of the first-stage estimations are available from the author upon request.

Table 3 first presents the result for (11) and (12) without including further exogenous variables in column (1). Stepwise, the control variables are added to the trade-tax and the tax-growth relationships under (2)-(5). This provides information about the robustness of the central trade-tax-growth nexus under various specifications. Different alternative estimation methods are tested in table 4. In particular, we use 2SLS, SURE, and PCSE estimates to check the sensitivity of the main results with regard to the estimation method. Finally, table 5 reports the results of the full system including all regarded channels, i.e. the simultaneous estimation of three and four equations, introducing the additional channels of government spending and investment. The additional channels are first added individually, then, in the final results, all the channels are jointly estimated.

In table 3, we see that the variable *open* is significant at the 5 % level in all the specifications; it shows the predicted negative impact on the corporate tax rate throughout. The estimated parameter values vary relatively little between the different equations. The impact of the political variable *gov* has the predicted negative sign, confirming that more right-wing governments and voters have strong preferences for lower capital taxes. Its significance, however, is not given in all the different specifications, mainly because the estimated coefficients vary. The impact of the non-EU variable *nonEU* (value of 1 for non-EU countries) is negative, that is countries which are not members of the European Union tend to have lower corporate taxes; the significance is only given in (3), however. To test for common trends across countries the trend variable *time* is included in (3). It turns out that the time trend has no explanatory power in the case of the tax equation.

Regarding the determination of growth, the log of initial income *logincome* is highly significant and negative, showing the conditional convergence property for income. The variable for corporate taxation *corptax* is negative throughout and



highly significant. In four out of five specifications it is significant at the 1%-level. The estimated parameter values do not vary much between the different equations. In the growth equation, the trend variable *time* is positive and significant. The impact of initial human capital *human* is positive as expected but only significant in one of the two tested specifications. The size of the economy measured by population size *pop* has a positive and strongly significant effect on growth, as seen in specification (5). The results confirm the hypotheses of the theoretical model. They reveal a specific trade-growth mechanism for leading OECD countries.

Table 4 presents results similar to table 3 in column (5), but using the alternative estimation techniques of two-stage least squares (2SLS), seemingly unrelated regressions (SURE) and panel corrected standard errors (PCSE). In the former two cases, the specification of equation (5) is estimated without and with the time trend. When using the alternative instrumenting procedure of 2SLS, similar results to 3SLS are obtained. Openness *open* has a negative and significant impact on taxes as before, while the impact of *gov* is again negative but of higher significance than with 3SLS. The non-EU dummy and the trend have no impact on taxes. In the growth equation, the highly significant impact of initial income, tax rates and size are confirmed. The time trend is again positive in (7). When running the model without instrumenting for the endogenous variables, inconsistent estimates might be the result. Nevertheless, it is useful to see whether large differences in results are observed when adopting the SURE procedure. By inspecting (8) and (9) one can easily check that this is not the case here. The general quality of the regressions remain unchanged and the signs and the significance of the key variables remain the same. The impact of openness on the tax rate is of the same size, the effect of the tax on growth is a bit lower than in the 3SLS estimations but still shows high significance. Corrected standard errors are used in the PCSE procedure. Results reported in (10) reveal that the effect of openness on taxes is like with the other procedures, but now the non-EU dummy appears as significant. The characteristics of the results in the growth equation also emerge when using the PCSE method, see column (10). We conclude that the main results hold under different estimation methods, but 3SLS seems to be most accurate, especially when including two additional transmission mechanisms as done in the following.

Table 5 introduces two additional channels for the impact of globalisation on growth. The results of the simultaneous system including both the capital tax and the government spending channel are presented in under (11). As becomes evident, the impact of openness on corporate taxes remains basically unchanged. The impact of openness on government spending is found to be positive (and highly significant), as suggested in the literature. The impact is robust when varying the specification and remains significant at the 1% level throughout. Interestingly, the

impacts of *gov* and *nonEU* on government spending are negative and significant, as could be expected. In the growth part of (11) we see an interesting pattern. Corporate taxes still have a negative impact on growth; the significance remains at the 1% level. However, government spending turns out to have no significant effect on growth, so that the second part of this channel effect is non-existent in our sample. This is according to our theoretical model. With regard to growth, quantity and quality of government spending seem to work in different directions. We thus conclude that only the channel working through corporate taxes adds to the explanation of the globalisation-growth nexus in this country sample.

We finally aim at evaluating the overall importance of the tax channel by additionally including a transmission from globalisation on investment which is separate from taxes. (12) reports the results when adding the investment channel to the core model. Somewhat surprisingly, we find *ceteris paribus* a negative impact of openness on the investment share *invest* in this sample. The signs of *gov* and *nonEU* are more according to the expectations. The important conclusion for this study is that the tax channel remains basically unchanged, also with regard to the growth relation. There, *invest* has the expected positive impact on the growth rate. Taken (11) and (12) together, only the tax channel survives as a positive trade-growth mechanism, whereas *govspend* has no impact on growth and openness has not the desired effect on the investment share *invest*. These conclusions are confirmed in specifications (13) and (14), where the whole system of four equations is estimated simultaneously. All the findings of the previous estimations carry over to the full system, providing another piece of evidence for the robustness of the general results. To further investigate the sensitivity of our findings, we also used different measures of openness and found similar support for our predictions. In particular, we tested the index of capital and current account restrictions and trade openness which also yielded a robust and significant impact of globalisation on taxes and of taxes on growth. These additional results are available from the author upon request.

Specification (13) can be seen as quite successful regarding the explanatory power. Calculating the elasticities related to the mean for the estimated parameter values, we obtain an elasticity of -0.09 for the impact of trade openness on the corporate tax rate and -1.28 for the effect of the corporate tax rate on growth. Although highly significant according to the estimations, the overall effect of the tax channel can be seen as not exorbitantly high in terms of the elasticities. It might be that, in the longer run, the quantitative effect is stronger, as investors need a certain time to adjust to an altered tax environment.

Table 3: Estimation results I  
Endogenous variables corptax and growth; 3SLS (IV-GLS)  
Tax channel estimations

Variable	(1)	(2)	(3)	(4)	(5)
<hr/>					
corptax					
open	-2.175** (1.095)	-2.274** (1.082)	-2.422** (1.206)	-2.981** (1.256)	-3.071** (1.243)
gov	-4.135*** (1.306)	-2.846* (1.528)	-2.555* (1.481)	-3.091** (1.545)	-2.419 (1.531)
nonEU		-5.912 (3.732)	-7.259** (3.604)	-5.423 (3.757)	-5.936 (3.717)
time			0.836 (0.914)	1.087 (0.925)	1.109 (0.922)
Constant	77.51*** (12.57)	67.59*** (13.92)	61.79*** (13.45)	65.71*** (13.98)	59.63*** (13.88)
<hr/>					
growth					
logincome	-0.0417*** (0.00605)	-0.0421*** (0.00602)	-0.0675*** (0.0120)	-0.0798*** (0.0133)	-0.0916*** (0.0125)
corptax	-0.000560*** (0.000182)	-0.000553*** (0.000181)	-0.000814*** (0.000187)	-0.000435** (0.000169)	-0.000600*** (0.000153)
time			0.00396** (0.00162)	0.00418*** (0.00154)	0.00617*** (0.00149)
human				0.00294** (0.00128)	0.00186 (0.00118)
pop					8.28e-08*** (2.16e-08)
Constant	0.450*** (0.0603)	0.454*** (0.0600)	0.693*** (0.114)	0.773*** (0.119)	0.889*** (0.112)
<hr/>					
Observations	69	69	69	69	69
$R^2$ corptax	0.14	0.16	0.17	0.18	0.18
$R^2$ growth	0.34	0.35	0.26	0.46	0.50
$\chi^2$ corptax	11.98	14.86	16.69	16.01	14.59
$\chi^2$ growth	51.79	53.09	60.93	69.13	102.37

Standard errors in parentheses\*\*\*  
p<0.01, \*\* p<0.05, \* p<0.1

Instruments used in all equations: logpop, dist, area, agedep, agriland, lifeexp

Table 4: Estimation results II  
 Endogenous variables corptax and growth  
 2SLS, SURE and PCSE estimations

Variable	(6)	(7)	(8)	(9)	(10)
corptax	2SLS	2SLS	SURE	SURE	PCSE
open	-2.456** (1.134)	-3.338** (1.319)	-2.474** (1.100)	-3.336*** (1.270)	-2.692** (1.217)
gov	-2.808* (1.612)	-3.105* (1.621)	-2.822* (1.564)	-3.066** (1.560)	-2.364 (1.631)
nonEU	-4.846 (3.940)	-4.428 (3.934)	-4.888 (3.823)	-4.589 (3.788)	-6.143** (2.777)
time		1.243 (0.963)		1.239 (0.927)	
Constant	67.09*** (14.67)	65.24*** (14.66)	67.26*** (14.23)	64.95*** (14.12)	64.05*** (15.40)
growth					
logincome	-0.0474*** (0.00808)	-0.0910*** (0.0135)	-0.0498*** (0.00746)	-0.0907*** (0.0125)	-0.0496*** (0.0104)
corptax	-0.000413** (0.000178)	-0.000447*** (0.000164)	-0.000227** (0.000110)	-0.000258*** (9.99e-05)	-0.000196*** (7.35e-05)
human	0.00108 (0.00138)	0.00196 (0.00127)	0.00183 (0.00121)	0.00262** (0.00112)	0.00185*** (0.000681)
pop	5.84e-08** (2.38e-08)	8.62e-08*** (2.30e-08)	5.66e-08** (2.23e-08)	8.32e-08*** (2.12e-08)	5.73e-08*** (1.43e-08)
time		0.00605*** (0.00159)		0.00573*** (0.00146)	
Constant	0.488*** (0.0706)	0.877*** (0.120)	0.497*** (0.0660)	0.863*** (0.111)	0.494*** (0.0993)
Observations	69	69	69	69	69
$R^2$ corptax	0.16	0.18	0.16	0.18	0.161
$R^2$ growth	0.46	0.56	0.49	0.58	0.488
F/ $\chi^2$ corptax	4.10	3.53	13.26	15.30	73.71
F/ $\chi^2$ growth	15.11	16.97	67.56	96.72	62.51

Standard errors in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Instruments used in 2SLS estimations: logpop, dist, area, agedep, agriland, lifeexp

Table 5: Estimations results III  
 Endogenous variables corptax, govspend, invest, growth  
 Additional channel estimations; 3SLS (IV-GLS)

Variable	(11)	(12)	(13)	(14)
<hr/>				
corptax				
open	-3.155** (1.246)	-3.108** (1.220)	-3.006** (1.206)	-2.313** (1.059)
gov	-2.434 (1.533)	-2.311 (1.505)	-2.365 (1.492)	-2.129 (1.498)
nonEU	-5.579 (3.743)	-5.432 (3.697)	-5.637 (3.675)	-6.013 (3.710)
time	1.148 (0.923)	1.133 (0.918)	1.090 (0.915)	
Constant	59.58*** (13.90)	58.40*** (13.66)	59.04*** (13.56)	60.99*** (13.64)
<hr/>				
govspend				
open	1.080*** (0.290)		1.075*** (0.291)	0.971*** (0.249)
gov	-0.840** (0.357)		-0.858** (0.357)	-0.894** (0.354)
nonEU	-3.508*** (0.866)		-3.476*** (0.866)	-3.426*** (0.866)
time	-0.149 (0.212)		-0.147 (0.212)	
Constant	28.31*** (3.228)		28.46*** (3.228)	28.25*** (3.224)
<hr/>				
invest				
open		-0.868** (0.442)	-0.896** (0.438)	-0.978*** (0.378)
gov		-0.929* (0.543)	-0.934* (0.540)	-0.962* (0.536)
nonEU		2.537* (1.324)	2.606** (1.318)	2.654** (1.316)
time		-0.153 (0.325)	-0.141 (0.325)	
Constant		34.50*** (4.920)	34.51*** (4.893)	34.22*** (4.875)

*cont. next page*

Table 5: Estimations results III (cont.)  
Endogenous variables corptax, govspend, invest, growth  
Additional channel estimations; 3SLS (IV-GLS)

	(11)	(12)	(13)	(14)
growth				
logincome	-0.0902*** (0.0126)	-0.0905*** (0.0124)	-0.0924*** (0.0127)	-0.0924*** (0.0127)
corptax	-0.000581*** (0.000152)	-0.000735*** (0.000158)	-0.000842*** (0.000173)	-0.000847*** (0.000173)
govspend	-0.000436 (0.000438)		0.000813 (0.000719)	0.000808 (0.000720)
human	0.00193 (0.00118)	0.00175 (0.00117)	0.00155 (0.00120)	0.00155 (0.00120)
pop	6.87e-08** (2.69e-08)	8.26e-08*** (2.18e-08)	1.10e-07*** (3.61e-08)	1.08e-07*** (3.62e-08)
time	0.00609*** (0.00150)	0.00660*** (0.00149)	0.00705*** (0.00157)	0.00667*** (0.00155)
invest		0.000947** (0.000406)	0.00160** (0.000659)	0.00156** (0.000661)
Constant	0.884*** (0.112)	0.859*** (0.113)	0.847*** (0.114)	0.850*** (0.115)
Observations	69	69	69	69
$R^2$ corptax	0.18	0.18	0.18	0.16
$R^2$ govspend	0.52		0.52	0.52
$R^2$ invest		0.13	0.13	0.12
$R^2$ growth	0.51	0.39	0.26	0.25
$\chi^2$ corptax	14.21	13.87	14.26	12.60
$\chi^2$ govspend	75.45		75.47	74.47
$\chi^2$ invest		11.46	11.99	11.54
$\chi^2$ growth	106.15	111.03	110.26	120.55

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1  
Standard errors in parentheses

Instruments used in all estimation equations: logpop, dist, area,  
agedep, agriland, lifeexp

## 5 Conclusions

According to our empirical results, trade fosters growth through its moderating impact on corporate taxes. The concurrence of two crucial attributes, mobility and accumulation capability of one single input factor - capital - drives the main

result. The outcome is in line with earlier studies finding a positive relationship between an increasingly globalised environment and the development of a single country. The paper adds to our understanding by identifying one significant channel transmitting the impulses from trade to growth. Other channels have not become evident in the regression analysis of this paper.

Of course, the analysed impact on growth is only effective when trade volumes are increasing and/or trade restrictions are decreasing. That means the phenomenon vanishes in the (very) long run, assuming that international integration gradually continues and then comes to an end in the future. But this is not a special attribute of capital taxes; it corresponds to all potential mechanisms like international knowledge transmission, competition and institutional effects.

A topic for further research would be the dynamic impact of skilled labour mobility, which is still quite low but will most probably increase in the time to come. It would also be interesting to know whether globalisation has similar effects on the behaviour of governments in areas where the government affects the levels (not the growth) of activities or income distribution. This could be analysed with a similar methodology as used here and is left for future research.

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