Bilateral Effective Tax Rates and Foreign Direct Investment

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March 2006

Abstract

This paper computes effective (marginal and average) tax rates that account for bilateral aspects of taxation and, therefore, vary across country-pairs and years. These tax rates serve to estimate the impact of corporate taxation on outbound stocks of bilateral foreign direct investment (FDI) among OECD countries between 1991 and 2002. The findings indicate that outbound FDI is positively related to the parent and host country tax burden and negatively associated with bilateral effective tax rates. Relying only on unilateral (country and time variant) rather than on both unilateral and bilateral (country-pair and time variant) effective tax rates leads to biased estimates of the impact of corporate taxation on FDI.

JEL classification: H25, H73, F21, F23, C33
Keywords: Corporate taxation; Foreign direct investment; Panel econometrics

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1 Introduction

It is now widely accepted among public economists that empirical work on the role of corporate taxation for the production and investment decisions of multinational firms should rely on a broader set of tax components rather than only on statutory corporate tax rates.[1] In this vein, an important strand of the literature recommends forward-looking effective (marginal and average) tax rates (henceforth, $EMTR$ and $EATR$) as suitable measures of the corporate tax burden (see Devereux and Griffith, 2002, 2003).

Based on this literature, this paper uses $EMTR$ and $EATR$ to estimate the impact of corporate taxes on outbound foreign direct investment (FDI) within the OECD. In contrast to previous research, we argue that it is decisive to account for both the *unilateral* (parent and host country-specific) and the *bilateral* (country-pair-specific) components of effective tax rates. This is motivated by the observation that bilateral tax treaties among the OECD countries are the rule rather than the exception. Also, bilateral tax rates account for additional financing opportunities of a multinational enterprise which are not available for a national firm.[2] Then, the question arises whether the omission the country-pair-(time)-specific variation in effective tax rates leads to biased estimates of the impact of corporate taxation on FDI.

We follow the conceptual framework of Devereux and Griffith (1999, 2003) in computing bilateral forward-looking $EMTR$ and $EATR$ for the OECD economies at the annual level between 1991 and 2002. This entails screening all national and supranational tax codes (most importantly the tax law of the European Union) and bilateral tax treaties in place. Overall, the sample includes about 8000 bilateral effective tax rates.[3] The large number of economies and years covered enables us to apply panel econometric methods to control for country-pair specific heterogeneity in FDI relations. Specifically, we compare the impact of unilateral as well as bilateral $EMTR$ and $EATR$ in our empirical analysis. One major finding is that an omission of the country-pair variation in effective tax rates leads to an underestimation of the role of taxation for FDI.

The remainder of the paper is organized as follows. The next section pro-

[1] For instance, Devereux, Griffith and Klemm (2002: p. 452) note: *"Typically, corporate income taxes ... act as a disincentive to invest. The two aspects of these [rate-cutting and base-broadening] reforms have offsetting effects on this disincentive: the lower tax rate increases the incentive to invest, while the lower allowance increases it."*

[2] For instance, foreign affiliates may finance an investment project at the foreign market and/or via equity from the parent.

[3] Up to now, the most comprehensive comparable studies are Yoo (2003), computing bilateral effective tax rates for the OECD countries and three selected years (1991, 1996 and 2001), and the Commission of the European Communities (2001), calculating bilateral effective tax rates for the EU15 and from Canada and the US into the EU15 in the year 1999.

vides a brief overview of the related empirical literature. Section 3 describes the data and dissects the variation in bilateral effective tax rates into its major components. Section 4 introduces the empirical specification and lays out the estimation framework. Section 5 presents the results, and the last section summarizes the most important findings.

2 A brief overview on previous empirical research

Most of the previous empirical work on corporate taxation and FDI employs statutory corporate tax rates or backward-looking average effective tax rates (as contained in firm-level balance-sheet data), mainly for reasons of data availability (see Hines, 1997, 1999, for comprehensive surveys of this literature).[4] While the former ignore a possible influence of the tax base on FDI (e.g., via depreciation allowances or first-year investment incentives), the latter do not account for the forward-looking nature of a firm's investment decisions and, perhaps more importantly, the endogeneity of backward-looking tax rates from an empirical perspective (see Devereux and Griffith, 2002, p. 91).

Only a small number of studies employs forward-looking tax burden measures. These studies tend to support a significant impact of corporate tax rates on FDI. Early examples are Slemrod (1990), Papke (1991), Shah and Slemrod (1991), Cummins and Hubbard (1995) and Devereux and Freeman (1995). More recently, Devereux and Griffith (1998) analyze U.S. FDI outflows to three host economies using host country $EATR$. Gorter and Parikh (2003) rely on host country $EMTR$ to assess the role of corporate taxation for FDI flows from 8 EU parent countries into 14 EU host countries. Bénassy-Quéré, Fontagné, and Lahrèche-Révil (2005) consider $EMTR$ and $EATR$ as published in Devereux, Griffith, and Klemm (2002) to investigate bilateral FDI flows among 11 OECD countries between 1984 and 2000.

The majority of these studies incorporates country-specific (i.e., host and/or parent) effective tax rates rather than their country-pair-specific counterparts. Only Devereux and Freeman (1995) form an exception using bilateral cost of capital data as defined in Devereux and Pearson (1995). From the remaining papers, one group uses host country effective tax rates only (Papke, 1991; Gorter and Parikh, 2003; Devereux and Griffith, 1998). A second group includes the parent and host country rates (Shah and Slemrod, 1991; Cummins and Hubbard, 1995), some of them by additionally accounting for the methods

[4] For example, Mutti and Grubert (2004: p. 343) note that "*[A]lthough marginal effective tax rates [...] are a preferable measure to indicate a firm's incentive to expand output in a given location, such rates are not available for [...] many [..] countries ...*"

of international double taxation relief via separate regressions for credit and exemption countries (Slemrod, 1990; Bénassy-Quéré, Fontagné, and Lahrèche-Révil, 2005).[5] Although the latter approach introduces bilateral aspects in the relationship of interest, there remain some significant differences to Devereux and Freeman (1995). Most importantly, the bilateral tax burden is not only determined by the method of double taxation relief but also by other bilaterally negotiated (rather than unilaterally applied) rules of international taxation, such as the agreed level of withholding taxes on repatriated profits, and by the additional financing opportunities of multinationals as compared to national firms. In contrast to Devereux and Freeman (1995), we include the parent and host country effective tax rates in addition to the bilateral tax rates. This enables a distinction between the direct impact of bilateral tax rates and the indirect one of unilateral tax rates (affecting mainly national firms) on the investment decisions of multinational firms.

3 Computing and dissecting bilateral effective tax rates

The framework to compute (unilateral) $EMTR$ has been developed by King and Fullerton (1984), and was subsequently applied by the OECD (1991) and the Commission of the European Community (1992, 2001), among others. The main idea behind these rates is to calculate the *tax wedge* between the rate of return of hypothetical investment projects and a given rate of return on savings.[6] The tax wedge is determined by statutory tax rates (on retained and repatriated profits) and the definition of the tax base (e.g., depreciation allowances, first-year extra allowances or deductability of interest on debt). Further, it depends on the assumptions about the economic environment in which investment takes place (e.g., inflation rates or economic depreciation).

To illustrate the method, consider a marginal investment whose after-tax rate of return is just equal to the after-tax rate of return on an alternative asset. For such an investment, it is possible to calculate the corresponding before-tax rate of return, known as the *cost of capital* (see Auerbach, 1979). The tax wedge is defined as the difference between the cost of capital and the after-tax

[5] Bénassy-Quéré, Fontagné, and Lahrèche-Révil (2005) use the difference between the host and the parent country effective tax rates and introduce dummy variables for exemption and credit countries.

[6] Typically, $EMTR$ are calculated for each of several investment projects (e.g., plant, machinery, or inventory) under different sources of finance (retained earnings by the subsidiary or the parent, equity by the subsidiary or the parent, and debt from the parent company; see Alworth, 1988, for a detailed discussion). The overall $EMTR$ is a weighted average of these combinations, where the weights are usually taken from the OECD (1991).

rate of return. The $EMTR$ is equal to the ratio of the tax wedge and the cost of capital. In contrast to the $EMTR$, the $EATR$ informs about the tax burden on *average* (infra-marginal) investment projects, which yield a higher rate of return than the marginal investment discussed above (see Devereux and Griffith 1999, 2003). The underlying reasoning is that the decisions to go multinational (i.e., locating production abroad versus exporting) and where to locate are discrete in the sense that firms choose those alternatives with the highest after-tax profits. Hence, the net present value of an investment project with a given economic rent before taxes is compared with the net present value of the associated costs. This difference, related to the net present value of the income stream in the absence of taxation, defines the $EATR$. The $EATR$ is equal to the $EMTR$ for a marginal investment project, and identical to the statutory tax rate for investment projects with infinite economic rents. Hence, the $EATR$ can be expressed as a weighted average between the $EMTR$ and the statutory tax rate (see Devereux and Griffith, 2003; Devereux, Griffith and Klemm, 2002). Since FDI figures comprise both marginal (i.e., changing the existing capital stock abroad) and average investment (i.e., installing new plants abroad), we use $EMTR$ and $EATR$ alternatively in our empirical analysis.

In contrast to the unilateral $EMTR$ and $EATR$, their bilateral counterparts include information contained in bilateral tax treaties, such as the method of double taxation relief (i.e., credit, exemption, and deduction) or bilateral withholding tax rates on repatriated foreign-earned profits. We follow the conceptual framework laid out in Devereux and Griffith (1999, 2003) to compute bilateral, time-variant tax rates (see the Appendix for details on the tax legislation of the countries and years considered).

We start with a descriptive analysis of the bilateral effective tax rates as compared to their unilateral counterparts. The unilateral $EATR$ and $EMTR$ are illustrated in Figures 1 and 2.[7] For instance, such unilateral, time-variant, forward-looking effective tax rates have been computed by Devereux, Griffith, and Klemm (2002) for a panel of economies. To describe the distribution of these rates we use box plots. The bold lines within the boxes represent the median, whereas the boundaries of the boxes indicate the two quartiles at the center of the distribution (i.e., the interquartile range). The whiskers in the plots have a length of 1.5 times the interquartile range. Entries outside the whiskers refer to observations in the upper or lower tails of the distribution.

[7]To save space, we only display $EATR$ and $EMTR$ for host countries. As long as the panel is balanced we obtain the same figures for parent countries. In our case, the panel is unbalanced and therefore the averages of the $EATR$ and $EMTR$ for the parent countries slightly deviate from their host country counterparts.

According to Figures 1 and 2, we observe a downward trend in effective tax rates. The medians of the $EATR$ are in the range of 25 to 32 percent, whereas the ones of the $EMTR$ are lower, as expected. In the case of the $EMTR$, we obtain even negative entries in the first three years of the sample period.[8]

> Figures 1 and 2 <

The bilateral effective tax rates are displayed in Figures 3 and 4. Similar to the unilateral rates, they tend to decrease over the sample period. The medians of the bilateral effective tax rates are higher and their spread is wider as for the unilateral rates, especially for the $EMTR$. Apart from domestic tax law, the bilateral effective tax rates depend on various details of taxation as laid out in bilateral tax treaties (such as double taxation relief and withholding taxes) and on the financing opportunities of multinational firms. Further, the time variation seems to be small but sufficient for fixed country-pair effects estimation (to see this, consider the fluctuations in the upper and lower bounds of the whiskers).[9]

> Figures 3 and 4 <

To illustrate the importance of bilateral tax rates, Figures 5 and 6 focus on the difference between the bilateral effective tax rates and the unilateral ones. Roughly, this difference can be interpreted as the additional tax burden for profits of foreign affiliates as compared to the ones of national firms. Put differently, it represents the change in the effective tax rate if a domestically owned country-j firm becomes an affiliate of a country-i based multinational. It is obvious from the figures that foreign affiliates pay higher taxes (in terms of $EATR$ and $EMTR$) than their domestic counterparts, reflecting an additional tax burden for multinational firms (e.g., due to withholding taxes on repatriated profits). The median of the additional tax burden of a multinational firm is

[8] The negative outliers are Austria (1991, 1992, 1993), Belgium (1991) and Ireland (1991). In Austria, a 20 percent extra first-year allowance is responsible for the negative values in 1991, 1992 and 1993. In the case of Belgium, the negative $EMTR$ is due to a 1 percent plus inflation extra first-year allowance in combination with generous declining balance deprecation allowances and a high statutory corporate tax rate. The negative entry in Ireland is due to a 50 percent immediate depreciation allowance (abolished in 1992).

[9] The cross-country dimension of the sample changes over the years (notably in 1996) with new countries entering the OECD. In our empirical analysis below, we exploit only variation within country-pairs. Hence, an increase in the number of country-pairs as such is irrelevant.

around 7 percent ($EATR$) or 9 percent ($EMTR$), although decreasing over the course of the years.

> Figures 5 and 6 <

The quantitative importance of the different dimensions of variation in bilateral effective tax rates is best seen in terms of an analysis of variance. In this regard, the following questions seem to be interesting. First, how important is the country-pair-specific variation as compared to the parent and host country-specific ones. Second, for fixed effects (within) estimation it is relevant how important the country-pair variation in the tax rates is as compared to the time-specific variance in the data. Third, how important are the combined idiosyncratic (country-pair-time-specific) and country-pair-specific variations as a measure of the difference in variation between the bilateral tax rates and the unilateral ones. Table 1 summarizes the corresponding findings for both the $EATR_{ijt}$ and the $EMTR_{ijt}$, covering exactly the same number of observations that will be used to estimate the effect of corporate taxation on FDI, below. The three subscripts with bilateral effective tax rates (FDI parent country i; FDI host country j; time period, t) are associated with a three-dimensional space of variation.

> Table 1 <

In Table 1, the total variance in the effective tax rates is split into two major components: the one explained by a set of dummy variables (i.e., the 'model') and the rest (the 'residual'). Here, we are only interested in dissecting the two bilateral effective tax rates. Accordingly, there are no covariates included so that the model and residual variances sum up to the total variance of the tax rates. The model variance is made up of three 'main' effects (parent country, host country, and time) and a comprehensive set of three pairwise interaction effects (parent country×host country, parent country×time, and host country×time). It is important to emphasize that the main effects are nested in the interaction effects. Hence, the space of the three main effects is included in the one spanned by the interaction effects. This implies that there are restrictions on the parameters. The main effects sum up to zero, but also the sum over all interaction effects is restricted to zero.[10] In less formal accounts:

[10] This guarantees that the mean of the model is equal to the overall mean.

after dropping the main effects, the inclusion of the interactive effects would still lead to the same model and residual variances. However, for our purpose it is preferable to distinguish between the variance in tax rates that is accounted for by the main effects and the additional one that is spanned by the interaction effects.

The first two columns of Table 1 reflect the variance in absolute and in relative terms. The latter is the variance due to each effect in percent of the total variance. The overall set of dummy variables (including the constant, which is not reported) accounts for 98.13 (97.56) percent of the variation in the $EATR_{ijt}$ ($EMTR_{ijt}$). The third column of results summarizes the degrees of freedom corresponding to each effect (the number of dummy variables reflecting parent countries, host countries, years, or interactions thereof in the sample). The last column reports the mean squared errors.

The second column of the table indicates which dimension of the panel actually accounts for the lion's share in the variation of tax rates. Obviously, this is the host country dimension for both $EATR_{ijt}$ and $EMTR_{ijt}$. Hence, a major component of bilateral tax rates is due to time-invariant, host-country-specific differences in the tax law. However, almost 12 percent of the variance is country-pair-specific and time-invariant. Altogether, the time-invariant variance components (constant, parent country, host country, and country-pair) account for about 90 percent of the total variation in effective tax rates (of this, about 70 percentage points are contributed by the time-invariant deviations from the mean rather than the constant). Hence, a panel econometric analysis with fixed country-pair effects as ours exploits about 10 percent (=2.37+0.91+4.47+1.87) of the variation in the $EATR$. In the case of $EMTR$, about 16 percent of the variation is left. If fixed time effects are included as well, another 2 percentage points of the variation are wiped out. However, in a large data-set as ours the tax rate effects on FDI should be easily identifiable.

4 Empirical analysis

Specification and econometric issues: In the subsequent analysis, we focus on the impact of effective corporate tax burden on outbound FDI. Apart from forward-looking effective tax rates ($EMTR$ and $EATR$), we employ a gravity model specification of bilateral outbound FDI. Such a model typically includes parent and host country GDP as well as GDP per capita (see Blonigen and Davies, 2004; Mutti and Grubert, 2004; Bénassy-Quéré, Fontagné, and Lahrèche-Révil, 2005, for the use of gravity models in the analysis of corporate

tax issues on FDI).[11] Note that our empirical models rely on fixed country-pair effects estimation throughout. Hence, all potentially important time-invariant determinants such as bilateral distance, common language, adjacency, but also time-invariant political and institutional factors are comprehensively captured by the fixed effects. We use real GDP and GDP per capita in U.S. dollars with 2000 as the base year from the World Bank's World Development Indicators 2005. The estimated specifications based on unilateral forward looking effective tax rates are

$$\begin{aligned} FDI_{ijt} &= \alpha_1 \tau_{i,t-1} + \alpha_2 \tau_{j,t-1} + \beta_1 GDP_{it} + \beta_2 GDP_{jt} \\ &+ \beta_3 GDPPC_{it} + \beta_4 GDPPC_{jt} + \mu_{ij} + \lambda_t + \nu_{ijt}, \end{aligned} \tag{1}$$

where $\tau \ \epsilon \ \{EATR, EMTR\}$. FDI_{ijt} denotes the logarithm of bilateral outbound stocks of FDI of parent country i in host country j and year t.[12] $EATR_{i,t-1}$ and $EATR_{j,t-1}$ ($EMTR_{i,t-1}$ and $EMTR_{j,t-1}$) are effective tax rates of the parent and the host country, respectively. We treat these variables as predetermined and use their lagged values to avoid a possible endogeneity bias. GDP_{it} and $GDPPC_{it}$ denote parent country log real GDP and log real GDP per capita. A similar indexation applies for the corresponding host country variables. μ_{ij} are fixed country-pair effects capturing all unobserved time-invariant influences on outward FDI. λ_t denote fixed time effects reflecting time-specific shocks common to all country-pairs in the sample. ν_{ijt} is a remainder error term. The latter may be autocorrelated and/or heteroskedastic.

The corresponding empirical models employing bilateral effective tax rates are

$$\begin{aligned} FDI_{ijt} &= \alpha_1 \tau_{i,t-1} + \alpha_2 \tau_{j,t-1} + \alpha_3 \tau_{ij,t-1} + \beta_1 GDP_{it} \\ &+ \beta_2 GDP_{jt} + \beta_3 GDPPC_{it} + \beta_4 GDPPC_{jt} + \mu_{ij} + \lambda_t + \nu_{ijt} \end{aligned} \tag{2}$$

where $EATR_{ij,t-1}$ ($EMTR_{ij,t-1}$) is included to take into account that parent country i's multinationals are directly affected by the bilateral tax rate rather than by the unilateral host and parent country tax rates only. In accordance

[11] Other representative studies employing gravity equations of FDI are Hufbauer, Lakdawalla, and Malani (1994), Eaton and Tamura (1994), Wei (1998), Levy Yeyati, Stein and Daude (2003), and Braga Nonnenberg and Cardoso de Mendonca (2004). If FDI is mostly market-seeking, we would expect host country market size to exert a positive impact. If it is mostly low-cost seeking, we would expect a country's outbound FDI to decrease in a host country's per-capita income (as a measure of factor costs).

[12] Recently, Mutti and Grubert (2004) indicate that a specification of FDI in logs is preferable over one in levels.

with Devereux and Freeman (1995), we expect a negative coefficient of the bilateral tax rate for multinationals of country i operating in j. A higher bilateral tax rate discourages country i's FDI in j and creates an incentive to serve this market via exports, for example. However, in contrast to Devereux and Freeman (1995) the unilateral parent and host country tax rates $EATR_{i,t-1}$ and $EATR_{j,t-1}$ ($EMTR_{i,t-1}$ and $EMTR_{j,t-1}$) are additionally included in the model. The parent's unilateral tax rate accounts for the corporate tax environment of national firms (exporters) at the domestic market. Intuitively, a higher effective tax rate in country i increases the tax burden of national firms. Then, it is more attractive for these firms to shift (parts of) their production abroad and go multinational. Hence, we predict a positive relationship between the domestic effective tax rates and outbound FDI. Similarly, the host's unilateral effective tax rate captures the tax environment for national firms there. We would expect this variable to enter positively, exerting an indirect impact on multinational firms headquartered in i and investing in j. The higher the effective tax rate of national firms in j – holding constant the bilateral tax rate of foreign affiliates in j – the more FDI we would expect firms from i to conduct in this country.[13]

The FDI data contain numerous missing values (accordingly, our sample reduces from about 8000 bilateral effective tax rate data points to 2361 observations in Table 2). These could be randomly missing but there could also be systematic variation, resulting in a sample selection bias (see Razin, Rubinstein, and Sadka, 2005, for an application of a cross-sectional sample selection model in international taxation). We apply a test on sample selection with a fixed effects panel data estimator (Wooldridge, 1995). This entails estimating a (binary choice; in our case, a probit) sample selection model for each year separately. The dependent variable in this model is an indicator taking the value 0 whenever bilateral FDI is missing in a given year and 1 else. We employ a gravity model using parent and host country GDP, GDP per capita,

[13] While there is some correlation between the bilateral and the unilateral host country tax rate, the two rates are sufficiently independent to identify their impact separately. In our sample, the correlation coefficient between $EMTR_{ij}$ and $EMTR_j$ ($EATR_{ij}$ and $EATR_j$) is estimated at 0.77 (0.80) in the average year (see Table A2). This is sufficient for identification, given the large number of observations. The following intuition supports an imperfect correlation between bilateral and unilateral host country tax rates. Consider two countries that apply the credit system, where the host country's statutory corporate tax rate is lower than in the parent country. Then, an increase in the host country's statutory tax rate exerts a direct impact only on national firms there, whereas the bilateral effective tax rate remains unchanged (see Bond and Samuelson, 1989, for a theoretical analysis). This is the case for about 17 percent of the country-pairs in our database (the credit method applies for about 35 percent of the 2361 observations; for about 48 percent of those, the tax differential between the parent and host countries is positive).

and their bilateral distance in the selection equation.[14] Based on the vector of estimated model predictions in the selection equation, we can compute the Mills' ratio for all years to control for the selection bias in the FDI model. The coefficient of the Mills' ratio in Table 2 is significant in all models, indicating that there is systematic selection into the sample. Ignoring this endogenous selection could lead to biased parameter estimates. Consequently, we follow Wooldridge (1995) in applying the selection correction with panel data. This is based on a Mundlak-type approach which includes the group means of all explanatory variables as additional regressors instead of the country-pair dummy variables. In this way, one obtains the same within parameters as with the least-squares dummy variable estimator. For the sake of brevity, we do not report the parameters of the group means of the explanatory variables. A test on their joint significance indicates whether a simple pooled OLS model is rejected against the Wooldridge-type fixed effects estimator (the test statistic is given at the bottom of Table 2 being significant throughout). The estimation of the standard errors of the parameters has to take into account that the Mills' ratio itself is estimated in the first stage.

Estimation results: The regression results for specifications (1) and (2) are summarized in Table 2. (1) is represented by "Model 1" and "Model 3", and (2) is labelled "Model 2" and "Model 4".

> Table 2 <

In all models, we account for the parent and host country unilateral tax rates ($EATR_{i,t-1}$, $EATR_{j,t-1}$, and $EMTR_{i,t-1}$, $EMTR_{j,t-1}$, respectively). When excluding bilateral effective tax rates from the specification, a higher parent country unilateral tax rate stimulates outbound FDI, whereas a higher host country unilateral tax rate impedes it (see Models 1 and 3 in Table 2). This result is in line with recent research focusing on the impact of unilateral effective tax rates on bilateral FDI.[15] However, this model maintains that all domestic and multinational firms in the host country pay the same tax rate and ignores

[14] Hence, we assume that FDI data are more likely missing if parent and host countries are small, exhibit a low GDP per capita, and are distant from each other. This is strongly confirmed by the estimation results of the selection models (detailed model output is available from the authors upon request but suppressed here for the sake of brevity).

[15] For instance, Bénassy-Quéré, Fontagné, and Lahrèche-Révil (2005) investigate the impact of the tax rate differential between host and parent countries on FDI inflows. They find a significantly negative impact of this tax difference. This is consistent with the finding of a negative (positive) impact of the host (parent) country tax rate.

bilateral variation in the tax burden. This is at odds with the intuition that higher effective tax rates for national firms in the host country should increase outbound FDI into this economy.

The host country unilateral tax rate parameter changes substantially, if we include the bilateral tax rate as well (see Models 2 and 4 in Table 2). As said before, the impact of the host country unilateral tax rate then captures the taxation environment there, given the bilateral tax rate for multinationals of parent i. In accordance with our expectation discussed above, the sign of the parameter estimate is now positive. Hence, there are two dimensions of host country taxation. We should distinguish an increase in the tax rate affecting national firms only, exhibiting an indirect positive effect on bilateral FDI, from an increase of a parent country's bilateral tax rate with the same host, exerting a direct negative effect on bilateral FDI. Omitting the bilateral tax rate from the specification results in a bias of the absolute impact of corporate taxation on bilateral FDI. In particular, the relevance of the bilateral dimension of taxation is not acknowledged appropriately in this case. To sum up, for the OECD countries, there is a positive impact of unilateral tax rates *given bilateral taxes* and a direct negative impact of bilateral taxes *given taxes for national firms*. The latter effect is consistent with Devereux and Freeman (1995), who find that bilateral costs of capital are negatively related to flows of outbound FDI.

Robustness: We assess the sensitivity of these results in various ways. The results corresponding to five alternative specifications are summarized in Table 3. In order to facilitate the comparison of the estimation results, we use the same Probit specification for sample selection throughout. For the sake of brevity, we only report the parameters of the tax variables of interest. The model numbers indicate which baseline specification in Table 2 the parameters should be compared to.

> Table 3 <

The letters 'a' to 'e' refer to the corresponding robustness experiment. 'a' indicates models that – apart from the tax parameters – rely on a knowledge-capital model specification as in Carr, Markusen, and Maskus (2001), Markusen and Maskus (2002) and Markusen (2002). This specification is derived from a general equilibrium model with two countries where three types of firms may endogenously arise: national exporting ones, horizontal market-seeking and trade-cost-jumping multinationals, and vertical low-production-cost-seeking multina-

tionals. Besides total bilateral country size and the difference in parent-to-host country size, skilled labor endowments (tertiary school enrolment figures from the World development data base) are a key determinant of multinational activity. See Markusen and Maskus (2002) for the details on the specification. Since our left-hand-side variable is in logs, all right-hand-side variables are expressed in logs, too. However, a comparison of Model 1a with 2a and Model 3a with 4a, respectively, indicates that the difference between the unilateral-only and the bilateral tax rate specifications is qualitatively similar to the original gravity-model-based results in Table 2.

'b' relies on the original gravity model, but it excludes the (low-tax) transition countries from the estimation (Czech Republic, Hungary, and Poland). This is motivated by the conjecture that our previous results could be driven by the low tax rates in Central and Eastern Europe. Again, the pattern of changes from a unilateral specification to a bilateral one is qualitatively similar to the results in Table 2.

'c' labels a specification that excludes all non-European economies from the sample (both as parent and as host countries). This leads to a dramatic decline in the number of observations from originally 2361 to 1489. The reason is that especially the U.S. and also Japan are among the most important parent and host countries in the world but they are now excluded from the sample. Therefore, the tax parameters of interest cannot be estimated at the same level of significance as before. The bilateral $EATR$ still enters significantly at 5 percent. But the bilateral $EMTR$ is insignificant at conventional levels, and the corresponding t-statistic drops to about 1.5. However, the qualitative change in the parameter point estimates is similar to the original outcome.

'd' refers to a specification that includes the host country's market potential in the original specifications, all else equal. The market potential of a host country is the inverse-distance-weighted market size of all other countries in the sample. It should be important, if vertical multinationals or export-platform multinationals are prevalent (these firms serve third markets from production platforms in the host country).[16] The market potential enters positively and significantly, as expected from a theoretical point of view. However, it turns out that this does not change the parameters of the tax variables of interest.

Finally, in all models with label 'e' we apply a dynamic model instead of the static ones in Table 2. This specification can be justified by the presumption that firms might be unable to adjust their location decisions immediately (see

[16] See Blonigen, Davies, Waddell, and Naughton (2004) and Bénassy-Quéré, Fontagné, and Lahrèche-Révil (2005) for specifications including the market potential as an explanatory variable of bilateral FDI.

Devereux and Freeman, 1995, for a discussion). To avoid an endogeneity bias inherently present in dynamic panels with fixed effects (see, e.g., Baltagi, 2005, p. 136), we use a GMM-estimator as proposed by Arellano and Bond (1991). The estimates of the lagged dependent variable are rather low and only weakly significant (see the notes in Table 3). The results concerning the signs of the tax variables of interest are unchanged. However, the Wooldridge-type sample selection correction is not applicable here.[17] Therefore, the results should be interpreted with care and are not directly comparable to the original ones in Table 2.

Overall, we conclude that our finding of the importance of the bilateral dimension in tax rates for bilateral FDI is robust. Empirical work should infer the role of corporate taxation for FDI based on unilateral and bilateral tax rates together for the sake of consistent inference.

5 Conclusions

This paper suggests using bilateral effective tax rates in addition to unilateral ones when assessing the impact of corporate taxation on foreign direct investment. We follow Devereux and Griffith (1999, 2003) in computing effective (average and marginal) tax rates at the bilateral level. Screening national tax codes and all tax treaties in place among the OECD economies, we construct a panel of unilateral and bilateral effective tax rates among the OECD economies for a time span reaching from 1991 to 2002.

Our findings suggest that corporate taxes significantly affect the production and location decisions of multinational firms. This result is in line with most of the previous empirical studies. However, our specific focus on the country-pair-specific tax burden motivates some additional conclusions. The parameter of bilateral tax rates captures the direct impact on bilateral FDI, given the tax rates for national firms. The parameters of the unilateral parent and host country tax rates reflect the role for the tax rates that national firms face in a given parent and host country, respectively. Relying on unilateral effective tax rates only may result in misleading conclusions about the impact of a change in bilateral tax instruments (e.g., through bilateral tax treaties) on bilateral FDI. In particular, an increase in host country unilateral tax rates that affect national firms is erroneously associated with a decline in FDI there with our data at hand. When controlling for unilateral and bilateral effective tax rates simultaneously, we find a robustly negative coefficient of the bilateral tax burden

[17] To the best of our knowledge, such a correction is generally not available for panel data with more than two time periods as ours.

and a robustly positive one of both the unilateral parent and the unilateral host country tax burden.

Acknowledgements

Financial support from the Austrian Fond zur Förderung der wissenschaflichen Forschung (FWF, grant no. P 17028-G05) is gratefully acknowledged.

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Appendix: Data and descriptive statistics

1. **Data on foreign direct investment:** We use bilateral outbound FDI stock data as published by UNCTAD (FDI Country profiles), covering the period 1991-2002.

   Parent country coverage: The sample includes 22 OECD parent economies: Australia, Austria, Canada, Czech Republic, Denmark, Finland, France, Germany, Hungary, Iceland, Italy, Japan, Luxembourg, Netherlands, Norway, New Zealand, Poland, Portugal, Sweden, Switzerland, United Kingdom, United States.

   Host country coverage: We have 26 host countries in the sample: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, Netherlands, Norway, New Zealand, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States.

2. **GDP and GDP per capita:** Data on real GDP and GDP per capita at constant U.S. dollars (base year is 2000) are collected from the World Bank's World Development Indicators 2005.

3. **Tax rates, depreciation allowances, tax treaties:** Information on tax codes (i.e., statutory corporate tax rates including local business taxes, withholding taxes on repatriated profits, depreciation allowances, first-year extra allowances) and bilateral tax treaties (i.e., methods of double taxation relief, withholding taxes) are primarily taken from the following online databases of the International Bureau of Fiscal Documentation (IBFD):

   - *Central/Eastern Europe - Taxation & Investment*
   - *Corporate Taxation in Europe*
   - *Tax News Service*
   - *Tax Treaties Database*

   Further, we exploit information of tax legislation from the following publications:

   - Baker&McKenzie, 1999. *Survey of the effective tax burden in the European Union*, Amsterdam.
   - Commission of the European Communities, 1992. *Report of the committee of independent experts on company taxation*, Brussels and Luxembourg.
   - Commission of the European Communities, 2001. *Towards an internal market without tax obstacles. A strategy for providing companies with a consolidated corporate tax base for their EU-wide activities*, COM (2001) 582 final, Brussels.
   - Ernst&Young, 2003. *Company taxation in the new EU Member states survey of the tax regimes and effective tax burdens for multinational investors*, Frankfurt am Main.
   - OECD, 1991. *Taxing Profits in a Global Economy: Domestic and International Issues*, Paris: Organisation for Economic Co-operation and Development.
   - PriceWaterhouseCoopers, 1999. *Spectre: Study of potential of effective corporate tax rates in Europe*, Report commissioned by the Ministry of Finance in the Netherlands, Amsterdam.
   - Yoo, K.-Y., 2003. Corporate taxation of foreign direct investment income 1991-2001, *OECD Economics Department Working Paper* No. 365, Paris: Organisation for Economic Co-operation and Development.

   To calculate $EMTR$ and $EATR$ we closely follow Devereux and Griffith (1999, 2003) and Yoo (2003). Personal income taxes (i.e., taxation at the shareholder level) are not considered. Hence, the issue of corporate tax integration does not arise here (see Alworth, 1988, for a discussion; Devereux and Freeman, 1995, for an empirical application).

4. **Descriptive statistics:** Table A1, Table A2

Table 1: Analysis of Variance of Effective Tax Rates

Source	Bilateral effective average tax rate: $EATR_{ijt}$				Bilateral effective marginal tax rate: $EMTR_{ijt}$			
	Absolute	in %	Degrees of freedom	Mean squared error	Absolute	in %	Degrees of freedom	Mean squared error
Model	17.737	98.13	756	0.023	14.038	97.56	756	0.019
Parent country effect	1.172	6.48	21	0.056	1.391	9.66	21	0.066
Host country effect	9.388	51.94	25	0.376	6.657	46.27	25	0.266
Time effect	0.428	2.37	11	0.039	0.313	2.18	11	0.028
Bilateral interaction	2.156	11.93	342	0.006	1.721	11.96	342	0.005
Parent country effect * Time effect	0.165	0.91	160	0.001	0.228	1.59	160	0.001
Host country effect * Time effect	0.808	4.47	197	0.004	1.368	9.51	197	0.007
Residual	0.337	1.87	2040	0.000	0.351	2.44	2040	0.000
Total	18.075	100.00	2796	0.006	14.389	100.00	2796	0.005

Table 2: Estimation results - impact of corporate income taxation on FDI

Explanatory variables	Model 1	Model 2	Model 3	Model 4
Parent country effective average tax rate: $EATR_{i,t-1}$	4.194 ***	5.502 ***	–	–
	(0.896)	(0.923)		
Host country effective average tax rate: $EATR_{j,t-1}$	-1.604 *	3.961 ***	–	–
	(0.878)	(1.192)		
Bilateral effective average tax rate: $EATR_{ij,t-1}$	–	-6.113 ***	–	–
		(0.927)		
Parent country effective marginal tax rate: $EMTR_{i,t-1}$	–	–	4.093 ***	4.410 ***
			(0.947)	(0.901)
Host country effective marginal tax rate: $EMTR_{j,t-1}$	–	–	-0.602	3.051 ***
			(0.630)	(0.930)
Bilateral effective marginal tax rate: $EMTR_{ij,t-1}$	–	–	–	-4.607 ***
				(0.913)
$Log(GDP_{it})$	-0.721	-1.497	-3.707	-1.029
	(2.525)	(2.441)	(2.401)	(2.284)
$Log(GDP_{jt})$	-8.201 ***	-10.940 ***	-11.723 ***	-9.581 ***
	(2.016)	(2.875)	(3.105)	(3.068)
$Log(GDP_{it}$ per $capita_{it})$	2.016	2.748	5.182 **	1.754
	(2.774)	(2.718)	(2.565)	(2.507)
$Log(GDP_{jt}$ per $capita_{jt})$	7.932 **	10.582 ***	11.653 ***	9.432 ***
	(3.525)	(3.183)	(3.426)	(3.345)
Observations	2361	2361	2361	2361
R^2	0.967	0.969	0.966	0.969
Fixed time effects, χ^2-test (9)	60.74	63.37	53.80	51.08
p-value	0.000	0.000	0.000	0.000
Sample selection (Mills' ratio), t-test	-0.665	-0.641	-0.608	-0.570
p-value	0.001	0.002	0.003	0.006
Test on between transformed variables, χ^2-test	2259.127 (70)	2226.906 (80)	2246.584 (70)	2898.592 (80)
p-value	0.000	0.000	0.000	0.000

Notes: Standard errors in parentheses according to Wooldridge (1995), Procedure 4.2. The test for samlpe selection is calculated according to Wooldridge (1995), Procedure 3.2 using serial correlation and heteroskedasticity robust standard errors according to Newey and West (1987).
*** significant at 1%; ** significant at 5%; * significant at 10%. $EATR_i$, $EATR_j$, $EMTR_i$ and $EMTR_j$ are unilateral effective tax rates as defined in Devereux, Griffith and Klemm (2002). The bilateral effective tax rates $EATR_{ij}$ and $EMTR_{ij}$ are defined in Devereux and Griffith (1998, 2003).

Table 3: Robustness

	Model 1a	Model 2a	Model 1b	Model 2b	Model 1c	Model 2c	Model 1d	Model 2d	Model 1e	Model 2e
Effective average tax rate										
$EATR_{i,t-1}$	7.225 ***	7.894 ***	3.128 ***	4.823 ***	2.634 ***	3.519 ***	4.128 ***	5.101 ***	0.825	1.319 **
	(1.169)	(1.129)	(0.784)	(0.875)	(0.959)	(1.005)	(0.891)	(0.927)	(0.634)	(0.637)
$EATR_{j,t-1}$	0.482	6.581 **	-0.470	5.646 ***	-1.592 *	2.842 **	-0.215	4.152 ***	-1.168	0.526
	(1.045)	(1.311)	(0.896)	(1.196)	(0.957)	(1.274)	(0.883)	(1.176)	(0.817)	(1.051)
$EATR_{ij,t-1}$	–	-7.224 ***	–	-7.493 ***	–	-4.912 ***	–	-5.133 ***	–	-1.891 **
		(0.955)		(0.940)		(1.005)		(0.855)		(0.915)
	Model 3a	**Model 4a[a)]**	**Model 3b**	**Model 4b**	**Model 3c**	**Model 4c**	**Model 3d**	**Model 4d**	**Model 3e**	**Model 4e**
Effective marginal tax rate										
$EMTR_{i,t-1}$	6.281 ***	5.868 ***	3.112 ***	4.126 ***	2.530 **	2.779 ***	4.074 ***	4.230 ***	2.104 ***	2.557 ***
	(0.894)	(0.875)	(0.950)	(1.020)	(1.060)	(1.045)	(0.899)	(0.863)	(0.729)	(0.754)
$EMTR_{j,t-1}$	-0.163	2.969 ***	-0.069	3.905 ***	-1.233 *	0.921	-0.079	2.737 ***	-0.909	1.138
	(0.645)	(0.818)	(0.686)	(0.961)	(0.687)	(0.919)	(0.616)	(0.878)	(0.581)	(0.862)
$EMTR_{ij,t-1}$	–	-4.384 ***	–	-5.384 ***	–	-2.797 ***	–	-3.641 ***	–	-2.577 ***
		(0.876)		(0.919)		(0.919)		(0.840)		(0.953)

Notes: Standard errors in parentheses according to Wooldridge (1995), Procedure 4.2. The test for samlpe selection is calculated according to Wooldridge (1995).
All Models indicated with "a" (1104 observations): Knowledge-capital model instead of gravity model. Skill measure as proposed by Markusen (2002: p. 228).
All Models indicated with "b" (2147 observations): Excluding transition economies (Czech Republic, Hungary and Poland).
All Models indicated with "c" (1489 observations): Excluding non-European economies (Australia, Canada, Japan, USA, New Zealand).
All Models indicated with "d" (2361 observations): Distance weighted market potential as additional control variable.
All Models indicated with "e" (1792 observations): Dynamic model as proposed by Arellano and Bond (1991). Sample selection is not accounted for in the regressions. Lagged dependent variable amounts to 0.200 (s.e. = 0.109) in Model 1e, 0.206 (s.e. = 0.108) in Model 2e, 0.172 (s.e. = 0.110) in Model 3e, 0.183 (s.e. = 0.110) in Model 4e.

Table A1: Descriptive statistics

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
Real outward FDI stock (in Tsd. 2000 US$)	2361	83.56	227.42	0.00	3013.13
Bilateral EATR	2361	0.34	0.08	0.09	0.56
Bilateral EMTR	2361	0.23	0.07	0.03	0.51
Host country domestic EATR	2361	0.28	0.07	0.08	0.44
Host country domestic EMTR	2361	0.15	0.06	-0.05	0.36
Parent country domestic EATR	2361	0.29	0.06	0.16	0.44
Parent country domestic EMTR	2361	0.16	0.05	-0.05	0.36
Host country real GDP (in Billions 2000 US$)	2361	1180.00	2200.00	12.70	9820.00
Parent country real GDP (in Billions 2000 US$)	2361	1320.00	2410.00	7.25	9820.00
Host country real GDP per capita	2361	22040.90	8632.52	3799.71	45205.65
Parent country real GDP per capita	2361	23516.24	8659.63	3799.71	45205.65

Table A2: Correlation matrix

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Real outward FDI stock	(1)	1										
Bilateral EATR	(2)	-0.040	1									
Bilateral EMTR	(3)	-0.030	0.815	1								
Host country domestic EATR	(4)	-0.065	0.766	0.705	1							
Host country domestic EMTR	(5)	-0.024	0.490	0.799	0.742	1						
Parent country domestic EATR	(6)	-0.066	0.310	0.311	0.174	0.081	1					
Parent country domestic EMTR	(7)	-0.016	0.105	0.115	0.044	0.017	0.708	1				
Host country real GDP	(8)	0.427	-0.092	-0.075	-0.066	-0.024	-0.147	-0.005	1			
Parent country real GDP	(9)	0.289	-0.136	-0.068	-0.148	-0.032	-0.042	-0.002	0.090	1		
Host country real GDP per capita	(10)	0.319	-0.272	-0.157	-0.184	-0.014	-0.290	-0.048	0.409	0.402	1	
Parent country real GDP per capita	(11)	0.263	-0.356	-0.221	-0.311	-0.092	-0.184	0.030	0.367	0.487	0.741	1

Figure 1: Unilateral (host) EATR

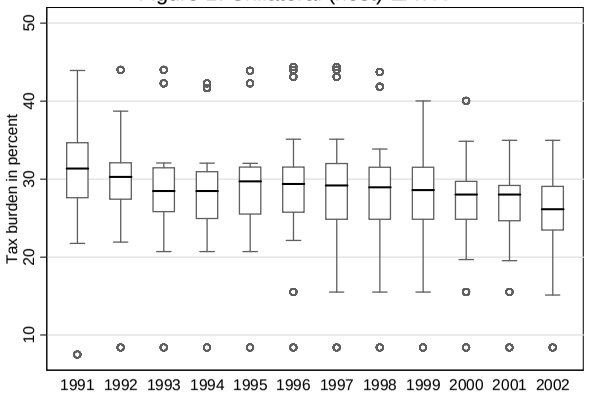

Figure 2: Unilateral (host) EMTR

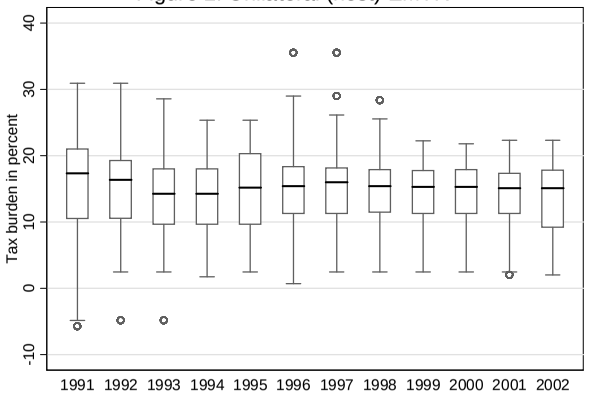

Figure 3: Bilateral EATR

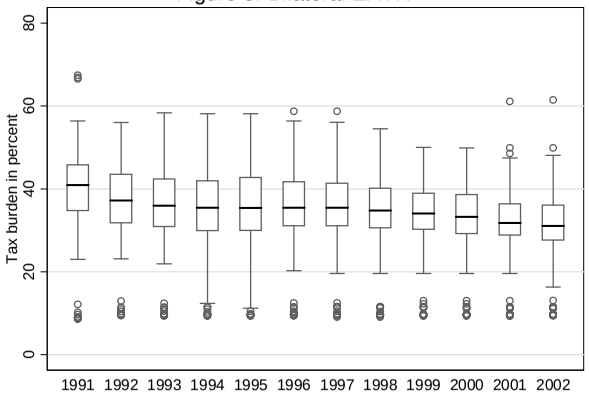

Figure 4: Bilateral EMTR

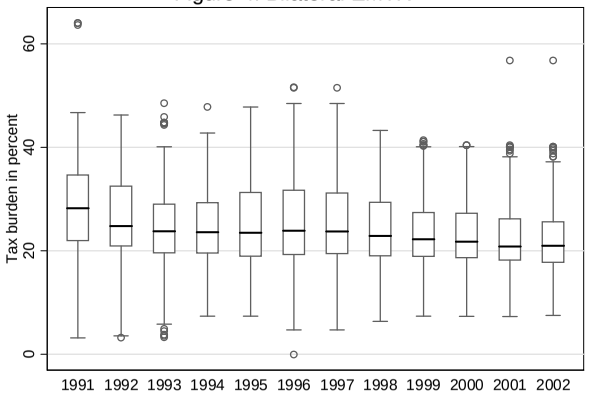

Figure 5: Bilateral minus unilateral (host) EATR

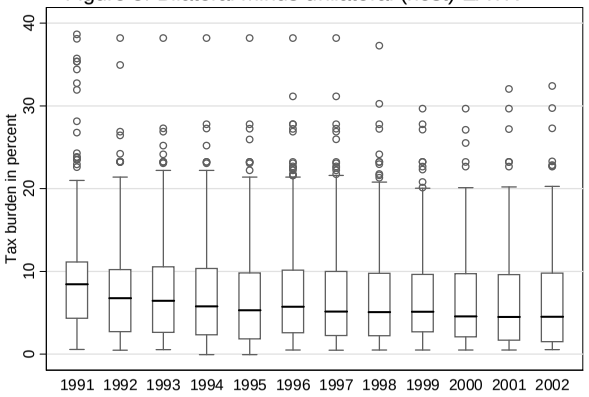

Figure 6: Bilateral minus unilateral (host) EMTR