

CORPORATE TAXATION AND MULTINATIONAL ACTIVITY

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Revised version

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Abstract

This paper assesses the impact of corporate taxation on multinational activity. A numerically solvable general equilibrium model of trade and multinational firms is used to incorporate the following components of corporate taxation: parent and host country statutory corporate tax rates, withholding tax rates, and parent and host country depreciation allowances. We account for their differential impact under alternative methods of double taxation relief (i.e., credit, exemption, and deduction). The hypotheses regarding the effects of changes in the tax parameters are investigated in a panel of bilateral outbound stocks of foreign direct investment (FDI) from 52 parent and 45 host countries for the years 1991 to 2004. For this, we compile annual information on taxation to construct the largest existing panel of tax parameters at the bilateral level based on national tax law and bilateral tax treaties. Our findings indicate that the parent country's statutory corporate tax rate tends to foster outward FDI, whereas the host country's statutory corporate and withholding tax rates are negatively associated with outward FDI. Depreciation allowances exert a significant impact on FDI, as hypothesized.

JEL classification: H25, H73, F21, F23, C33

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1 Introduction

The tariff-jumping argument has for long been one of the important rationales for the existence of horizontal multinational firms (MNEs) in international economics. Yet, in developed countries, where horizontal multinationals mainly arise, tariffs nowadays generate negligible revenues. In comparison, profit tax policy seems much more important in terms of the revenues generated by the respective instruments. Yet, a close look at the literature reveals that surprisingly little is known about the impact of profit taxation on MNE activity across a relatively large number of countries. It is well-understood that firms and, especially MNEs, care about effective tax rates, which are determined by a variety of tax instruments, the most important of which are four: statutory tax rates, depreciation allowances, withholding tax rates on foreign profits, and the mode of double taxation relief. With a variety of integration strategies any change in one or more of these parameters affects each possible margin of adjustment at the firm level potentially differently.¹ Hence, tax policy is faced with the problem that “the” effective tax rate cannot be altered in a specific way because it is an analytic tax burden measure based on the neoclassical investment model. What can be changed are the mentioned instruments that affect alternative margins of adjustment - and the corresponding effective tax rates - simultaneously and differently.

What are the expected effects of parent and host country parameters of taxation (statutory corporate and withholding tax rates, and the definition of the tax base) on bilateral multinational activity in general equilibrium under alternative methods of double taxation relief? How often and to which extent do countries alter these instruments empirically? And what is their impact on bilateral stocks of foreign direct investment (FDI)? These issues are of obvious importance to policy makers. Yet, existing research does not provide an encompassing answer to these questions, as will be illustrated in detail below.

We collect annual data from national tax codes and bilateral double tax treaties for 52 parent and 45 host countries over the period 1991 to 2004 to compile the largest existing data-set of corporate tax instruments – parent and host statutory country corporate tax rates, withholding tax

¹For instance, relevant extensive margins of adjustment are whether to enter any market at all, whether to enter a specific market, and how to enter it – e.g., as a national supplier, as an international producer via exports, or as a multinational firm via foreign affiliate sales (and the latter decision is to be made for all possible forms of multinational firm integration strategies). Relevant intensive margins of adjustment relate to the extent of investment, production, etc.

rates, (net present values of) parent and host country depreciation allowances, and information about the underlying method of double taxation relief (i.e., credit, exemption, and deduction). The tax instruments vary at the level of both parent-to-host country-pairs and time. Overall, we obtain more than about 23,000 data points for each tax component. Before using these data to assess hypotheses from a theoretical model about the impact of single corporate tax instruments on MNE activity, we provide an extensive discussion of the feature of the data.

We obtain several insights which inter alia are informative about possible methods for empirical analysis of the impact of taxes on FDI. For instance, it turns out that individual instruments change quite frequently for the average country so that it is virtually impossible to isolate corporate tax reforms which are surrounded by long enough spell lengths without any change in corporate taxation. Moreover, changes typically occur simultaneously – at least staggered over short periods of time – in several instruments. Also, changes are particularly frequent when considering not only national (or bilateral) changes in host countries but also their neighbors. Finally, changes in tax instruments are significantly different in country-pairs and years for which positive FDI data are reported in official statistics than for other observations. These features are important to consider when selecting empirical methods for the analysis of the impact of corporate taxation on FDI.

For the latter, we draw hypotheses from a general equilibrium model of trade and multinational firms cum taxation. The importance of relying on general equilibrium models to derive such hypotheses has been pointed out by Hines (1997, p. 418):

”In the absence of a complete general equilibrium model, it is impossible to predict with certainty the impact of tax changes on capital demand throughout a multinational firm.”

As a workhorse model, we apply a general equilibrium framework as developed by Markusen (1997, 2002) and Markusen and Venables (1998, 2000) and modify it to account for three (rather than two) countries and the role of corporate taxation. This framework seems especially suited for studying the impact of corporate taxation on FDI, since it proved empirically suitable in a number of recent empirical studies on the determinants of bilateral multinational activity (e.g., Carr, Markusen, and Maskus, 2001; Markusen and Maskus, 2002; Blonigen, Davies, and Head, 2003; Braconier, Norbäck, and Urban, 2005). The model allows to analyze the role of

parent and host country tax parameters under alternative methods of double taxation relief and provides hypotheses about the sign of the effect of an increase in each parameter of taxation on multinational activity, separately. In the model, taxation does not only affect the extent of multinational activity (as, e.g., in Devereux and Hubbard, 2003, and in Devereux and Lockwood, 2006), but also the configuration of plants and the integration strategies of firms in equilibrium.

Empirically, we find that the estimated effect of host country tax instruments is in line with the hypotheses about the (direct) impact of these variables on MNE activity in general equilibrium. The effect of the parent country tax variables often contradicts the hypotheses about their (indirect) effect in general equilibrium on MNE activity. With regard to the bilateral withholding tax rate we observe significantly negative impact on bilateral FDI, which is in accordance with theory. Overall, our findings support the use of individual corporate tax instruments in theoretical and empirical models of MNE activity. The results indicate that direct effects of host country and bilateral withholding tax parameters are particularly well identified.

The remainder of the paper is organized as follows. Section 2 describes the data and illustrates some of its mean features. Section 3 provides a brief review of the existing literature. Section 4 presents a Markusen-type knowledge-capital model of trade and multinational firms, which accounts for the mentioned parameters of taxation and the methods of double taxation relief. Section 5 discusses the major testable hypotheses relating to the parameters of taxation. Section 6 describes the empirical specification and presents the empirical findings and provides a sensitivity analysis. Section 7 concludes with a summary of the most important findings.

2 Corporate tax policy and FDI (1991-2004)

2.1 An anatomy of corporate tax policy

Before analyzing the role of alternative corporate tax parameters for bilateral foreign direct investment, we provide descriptive evidence about the time variation of the associated policy parameters among 52 parent and 45 host countries – forming altogether 2,295 country-pairs – over the period 1991-2004.² Such an exploration is informative about both the *frequency* and the *magnitude* of changes of the considered tax parameters. In particular, such an analysis may be

²In the sequel, we use the term *dyad* interchangeably with *country-pair* and consider, for instance, the pair with the U.S. as a parent and the U.K. as a host to be different from the one involving the U.K. as a parent and the U.S. as a host.

helpful when selecting the appropriate econometric framework for the empirical analysis below.

Let us start by focusing on the *frequency* of changes in various corporate tax instruments. There, we look at the proportion of *changers* among the 45 included host economies over the years. Table 1 summarizes the corresponding findings at the country-level for statutory corporate tax rates, depreciation allowances, and withholding tax rates.³

> Table 1 <

First, the table suggests that changes in tax policies occur quite frequently. For instance, about 30 percent of the host countries undertook some change in the statutory corporate tax rate between 1991 and 1992, according to the first entry in column [1]. Over the same time span, about 17 percent of the countries changed the tax base via altering the deductibility of investment costs (measured by the net present value of depreciation allowances);⁴ see the first row and column [2] of Table 1.

The average host country changed its withholding tax rate vis-à-vis one of its partner countries in about 11 percent between 1991 and 1992, according to column [3]. Quite remarkably, this high frequency of changes in tax parameters is not unusual. The bottom row of the table indicates that about 28 percent of the countries changed their statutory corporate tax rate in the average period. Similarly, the depreciation allowance parameter changed for more than 13 percent of the countries (and dyads) in the sample. The time pattern in the table suggests that countries tend to use depreciation allowances less frequently in recent years than they did a

³Note that our dataset is unbalanced, since the tax parameters of interest are not available for all dyads and years. For instance, with some of the observations, withholding tax rates are not available in a given year, while statutory tax rates and depreciation allowances are. In other cases, depreciation allowances are not available while statutory tax rates are. Information about the statutory tax rates would be available for 35,547 observations (2,652 dyads). Among those, we have data on depreciation allowances for 29,580 observations (2,652 dyads). Hence, by restricting the sample to those units where both statutory corporate tax rates and depreciation allowances are available, we lose time-series variation in tax rates, but the size of the cross-section remains unaffected. When taking the latter 29,529 observations and requiring bilateral withholding tax rates to be available as well, we obtain a sample of 23,358 observations (2,295 dyads). Hence, the limiting factor of our analysis is information about withholding tax rates.

⁴Following previous research, we measure depreciation allowances as the net present value of deductions from the tax base via depreciation (see Devereux and Griffith, 1999, 2003). Depreciation allowances are expressed as a fraction of the marginal investment. Hence, a value of one of the depreciation allowance parameter indicates immediate and full depreciation of investment costs. The corresponding parameter may be even larger than unity in case of extra allowances. On the contrary, a value of zero suggests that investment costs cannot be deducted at all. Empirically, the depreciation allowance parameter typically takes values between zero and unity. See the Appendix for further details on the calculation of this measure.

decade ago. Finally, the average economy's withholding tax rate changed for almost 8 percent of the partner countries in the average period.

Whilst the first three columns of Table 1 inform about the frequency of changes in a *single* dimension of tax law, columns [4]-[8] of the table shed light on combined changes in the three parameters. For instance, column [4] summarizes the frequencies at which both statutory corporate tax rates *and* depreciation allowances are changed (either increased or lowered).⁵ Such a combined change takes place at a frequency of more than 5 percent in the average period, according to the bottom row of column [4]. More than 4 percent of the dyads in the sample experienced such a combined change in the period 1992-1993.

Column [5] considers a change in *either* statutory tax rates *or* depreciation allowances. The table suggests that, within the average period and the average dyad in the sample, a change in either of these two parameters occurs at a frequency of 36 percent. As with the other columns in the table, there is a sizable variation in the corresponding frequencies across periods. For instance, the ones in column [5] take values between 26 percent in period 1996-1997 and almost 58 percent in periods 1992-1993 and 1993-1994.

In column [6] we look at combined changes in all three instruments together. Hence, any change in a singular measure of tax policy or combinations thereof with changes in only two instruments are classified as a zero change here. Consequently, this is the most restrictive measure of tax policy change considered in Table 1. According to the bottom row of the table, only 0.51 percent of the countries changed statutory tax rates, depreciation allowances and withholding tax rates with some partner country at the same time in the average period. However, in 1994-1995 such a simultaneous change occurred in almost 3 percent of the countries. Column [7] investigates how often changes in bilateral withholding tax rates *and either* unilateral statutory tax rates *or* depreciation allowances occur within a given period. As the bottom row of the table indicates, this happens quite frequently, namely for 29 percent of the countries and periods.

How frequently did tax policy change in at least one of the three dimensions of tax law considered? As can be seen from the bottom row of the table in Column [8], this was the case

⁵Obviously, these frequencies should be lower than those of the corresponding changes of statutory tax rates and depreciation allowances alone. Technically, it would be possible that the frequency is as high as the minimum of the frequencies of statutory tax rates and depreciation allowances for a given period, but this is not of empirical importance here.

for more than 40 percent of the countries in the average period considered. The corresponding frequency was as high as almost 60 percent in 1992-1993.

> Table 2 <

It should be noted that the frequency of tax changes does not only vary across periods but even more so across countries covered in our sample. This can be seen from the figures in Table 2. There, we report the average frequency in the respective tax parameter changes (and combinations thereof) as in Table 1 across the 45 partner countries and periods. Notice that, as in Table 1, the average percentage of changes reported at the bottom of Table 2 corresponds to simple averages of the rows. Hence, the bottom lines in Tables 1 and 2 are identical. Moreover, the maximum and minimum frequencies in columns [1], [5], [7], and [8] are more than 90 percent and 0 percent, respectively. Hence, the variation in the frequency of statutory corporate tax rate changes across economies is huge.⁶ The maximum and minimum frequencies of changes in depreciation allowances are 50 percent and 0 percent, respectively. Probably due to the cumbersome process of arranging negotiations about double-tax treaties at the country-pair level, the corresponding maximum frequency for withholding tax rates is about 27 percent.

Tables 1 and 2 summarize frequencies for all changes in tax instruments, irrespective of their magnitude. If we confine our investigation to those changes that were at least one or even as large as 5 percentage points in the respective tax policy instruments, the frequencies of change are reduced.⁷ But do the frequencies drop to (almost) zero? The answer to this question is clearly no, as can be seen from Table 3.

> Table 3 <

The block of frequencies at the top of the table refers to a minimum requirement of a unitary percentage point change in the corresponding tax parameters. The block at the bottom of the table relates to a minimum change of five percentage points in those parameters, respectively.

⁶The countries which did not change their tax policy in our sample were typically covered for a relatively short time period. The reason for the latter is lacking information about tax policy in these countries.

⁷Notice that in terms of the levels of statutory tax rates, depreciation allowances, and withholding tax rates a change of five percentage points should be considered as huge.

About 32 percent of the countries changed at least one of the tax policy parameters in the average period by one percentage point or more (see column [8] in the top panel). And about 15 percent of the country-pairs and periods are characterized by a minimum change of 5 percentage points in at least one of the considered tax instruments.

The above evidence summarizes the frequency of changes in corporate tax law, yet it does not provide details on the *magnitude* of changes in the corresponding tax parameters. This information can be found in Table 4, where we summarize the average magnitude of the annual change in any of the tax parameters in specific periods as well as the average period within our sample. Table 4 consists of two panels. The one on the left hand side reports average changes for those countries and years which actually faced a non-zero tax reform in the respective instrument (i.e., given that the tax reform indicator as in Table 1 took a value of one). The panel on the right hand side of the table does not condition on non-zero reform observations.

> Table 4 <

According to Table 4, the average annual conditional change in statutory corporate tax rates, depreciation allowance parameters, and country-pair-specific withholding tax rates amounted to -2.80 percentage points, -0.38 percentage points, and -4.84 percentage points, respectively. We should be careful with interpreting this evidence as being in favor of 'tax-cut-cum-base-broadening' in the sample.⁸ Own calculations indicate that only 1.97 percent of the countries undertake tax-cut-cum-base-broadening (the latter figure is not shown in Table 1). This is about one-third of the countries which changed both statutory corporate tax rates and depreciation allowances in the average period (according to column [4] of Table 1). With regard to withholding tax rates, column [3] in Table 1 together with column [3] in Table 4 suggest that withholding tax rates are changed rather infrequently but if so, the associated change in the tax rate is quite sizable. Since the panel on the right does not condition on non-zero reform observations, the average percentage point changes in the respective instruments is much smaller there than on the left hand side both in each period and on average.

⁸Tax-cut-cum-base-broadening is a combination of corporate tax rate reduction and a reduction of depreciation allowances within a certain period.

2.2 Changes in tax policy and FDI

The aim of this sub-section is to provide some tentative insights into the nexus between tax policy change and the magnitude of outward FDI. With regard to the latter, we use nominal stocks of bilateral outward FDI in U.S. dollars between 1991 and 2004 from UNCTAD's Major FDI Indicators (2007). We convert the corresponding figures to obtain real stocks of bilateral outward FDI by using GDP deflators of the parent country with base year 2000.

Let us start by reporting similar statistics as in Tables 1 and 4 about the frequency of tax policy changes, but focusing on their nexus with bilateral stocks of outward FDI. We will shed light on quantitative relationships later on and concentrate for now on the average frequencies for those pairs (and periods) where contemporaneous changes in log stocks of outward FDI were missing versus non-missing in our sample. The corresponding frequencies are summarized in Table 5.

> Table 5 <

According to Table 5, the frequency of tax policy reform is significantly different in country-pairs for which a log-change in FDI is non-missing as compared to other country-pairs. This indicates that one should probably pay attention to issues of selection into the sample in the empirical analysis to avoid a potential associated selection bias. Except for Columns [2], [3], and [6], a change in tax policy instruments occurs at higher frequency, if data on the log annual change in bilateral FDI are missing.

In a further step, we investigate the magnitude of a change in each of the tax instruments depending on a missing/non-missing contemporaneous log-change in stocks of outward FDI. As in Table 4 we report conditional (on a non-zero change) and unconditional changes in tax parameters.

> Table 6 <

Table 6 indicates that changes in the unilateral tax instruments such as statutory corporate tax rates and depreciation allowances tend to be significantly different between dyads where

the contemporaneous change in FDI is missing/non-missing. In contrast, there is no significant difference between those two categories with regard to withholding tax rates. We may conclude that unilateral tax law is more likely to matter for the extensive (country-pair coverage) margin than for bilateral tax law. If anything, the figures suggest that cuts in corporate tax rates are accompanied by contemporaneous tax base narrowing for observations with non-missing changes in FDI. In contrast, tax-cut-cum-base-broadening seems to happen more likely for observations where changes in FDI are missing.

In a final step of our descriptive analysis on the nexus between corporate taxation and FDI, let us distinguish among changes in the relevant five corporate tax policy instruments: parent and host country statutory corporate tax rates, parent and host country depreciation allowances, and withholding tax rates affecting profits that are repatriated from the host to the parent country. Furthermore, let us ignore for a moment the issue of missing data on changes in FDI and selection into the sample. Conditional on the availability of both an annual log change in FDI and data on a (zero or non-zero) change in any of the five tax instruments, we may decompose the variance in the log change in FDI into several components.

The first component is the variance – in terms of partial sum of squares – which is explained by the five indicator variables capturing any corporate tax policy change. The second and third component are the partial sums of squares contributed by fixed year and dyad effects, respectively.⁹ These three variance components together with the constant add up to the model sum of squares. The latter plus the residual sum of squares give the total sum of squares of the left-hand-side variable. The goal of this analysis is to see whether the five tax instruments together contribute to explaining the variation in the growth of FDI or not. Of course, we should bear in mind that we ignore here any influence of other covariates and account for tax policy changes by indicator variables rather than continuous changes. The latter will be the focus of a multivariate analysis of covariance in Section 6.

> Table 7 <

Table 7 contains three panels, which differ in terms of the timing of the left-hand-side variable.

⁹Notice that the left-hand-side of the model is a log-change. Accordingly, jointly significant fixed dyad effects would suggest that there is a significant difference in the annual growth of FDI across country-pairs.

The one at the top uses the once-lagged log change of outward stocks of FDI (i.e., the change between years $t - 2$ and $t - 1$). The center panel employs the contemporaneous change in FDI (between years $t - 1$ and t). The panel at the bottom uses the lead of FDI (i.e., the change between years t and $t + 1$). This analysis may shed some light on the timing of tax reform effects on FDI, a possible anticipation thereof and, eventually, the direction of causality.

The results in Table 7 support the following conclusions. First, fixed dyad effects can be safely ignored in the analysis of *growth* of bilateral FDI. Second, fixed annual effects are important and their omission would likely lead to biased parameter estimates. Third, corporate tax reform matters in a statistically significant way only for post-reform FDI growth but not for contemporaneous or once-lagged FDI.

2.3 Some tentative conclusions about the empirical analysis of the role of taxation for FDI

The descriptive exploration of changes in the three tax policy instruments suggests the following: (i) changes in at least one parameter occur very frequently for the average country-pair; (ii) there is a significant overlap in the changes across the tax instruments; (iii) changes do not occur in selected countries or years but they are all over the place regarding both countries and time.

These features of profit tax reform clearly call for a multivariate analysis. For instance, the pattern of changes precludes the application of tools suited for event-studies or natural experiments because of arguments (i)-(iii) above: feature (i) renders the time-wise isolation of tax policy changes impossible; feature (ii) does not allow for isolating the impact of single tax policy measures in a univariate analysis; and (iii) suggests that a suitable control group without any change in one or several tax instruments over a reasonably long contemporaneous time span is hard to find.

Obviously, the explorative data analysis is helpful in determining stylized facts about corporate tax policy in a large sample of country-pairs and years. Also, it assists the selection of appropriate empirical tools for analyzing the impact of corporate tax policy on FDI. However, the identification of the quantitative effects of corporate taxation of FDI calls for a less parsimonious empirical model whose specification needs to rest on economic theory. The subsequent two sections are therefore dedicated to a survey of previous empirical and theoretical work on the matter and the outline of a model to understand the role of the five mentioned parent

and host country tax instruments (as employed in Table 7) on multinational activity in general equilibrium.

The models to be used in an empirical analysis of the nexus between corporate tax policy and stocks of FDI should account for sample selection, involve levels (rather than changes) of log stocks of bilateral FDI as the dependent variable to avoid an excessive loss of observations, and include dyad as well as time fixed effects. Based on the previous insights, tax policy changes should be allowed to exert a once-lagged impact on FDI.

3 Previous research

Under which conditions and to what extent corporate taxes influence a firm's location and production decisions is lively debated, not only among policy makers but also among researchers (see Hines, 1997, 1999; Gresik, 2001; Devereux, 2007, for comprehensive surveys). If firms cannot arbitrarily shift their profits abroad, taxes reduce their after-tax profits and this, in turn, affects both the location and the volume of FDI. In that case, a high tax burden in a host country represents an impediment to its inbound FDI, even if its effect is partly offset to the extent that governments use tax revenues to reduce investment costs. In fact, this reasoning may explain why several industrialized countries have recently reduced their corporate tax rates.¹⁰ For instance, in the Western European economies corporate tax rates have been reduced in response to the much lower tax rates in Central and Eastern Europe.

Empirical evidence tends to confirm the presumption that taxation is decisive for production and location decisions of MNEs. The bulk of results is available for the U.S. (see Hines, 1997, for an excellent overview). Three strands of the literature can be distinguished here. One of them analyzes the impact of U.S. corporate tax rates on inbound FDI (see, e.g., Hartman, 1984; Bartik, 1985; Coughlin, Terza, and Arromdee, 1991; Head, Ries, and Swenson, 1999). A second line of research studies the effects of host country taxes on U.S. outbound FDI (see Grubert and Mutti, 1991, 2000; Hines and Rice, 1994; Devereux and Griffith, 1998; Grubert and

¹⁰Within the OECD, the statutory corporate tax rate (excluding local corporate income taxes) fell by 15 percent between 2000 and 2005, where the strongest reductions took place in Austria (2005, from 34 to 25 percent), Belgium (2005, from 39 to 33 percent), Canada (several reductions 2000-2005, from 28 to 21 percent), Germany (2001, from 40 to 25 percent), Iceland (2002, from 30 to 18 percent), Ireland (several reductions 2000-2005, from 24 to 12.5 percent) and Luxembourg (2002, from 30 to 22 percent). Among the Eastern European members, the lowest levels of corporate tax rates amount to 16 percent (Hungary, since 2004) and 19 percent (Poland and the Slovak Republic, since 2004), respectively.

Slemrod, 1998; Altshuler, Grubert, and Newlon, 2001; Mutti and Grubert, 2004; Desai, Foley, and Hines, 2005). A third strand of work considers both parent and host country taxation by additionally accounting for the role of the underlying method of double taxation relief, i.e., whether (repatriated) profits of foreign affiliates are taxed on a territorial or a worldwide basis in the country where the headquarters are located (see Slemrod, 1990; Shah and Slemrod, 1991; Cummins and Hubbard, 1995; Swenson, 1994, 2001; Hines, 1996). In general, the U.S. evidence reveals that inbound FDI is negatively affected by the U.S. tax burden,¹¹ and U.S. outbound FDI is positively (negatively) associated with domestic (host country) tax rates. Although one would expect that the impact of tax rates differs between countries applying the credit and exemption method (see, e.g., Slemrod, 1990),¹² there is no clear-cut empirical support for this view.

Only a few studies consider a broader set of country-pairs. Devereux and Freeman (1995), using bilateral FDI flows between seven countries (including the U.S.) from 1984 to 1989 and referring to a cost-of-capital concept of taxation, find that a firm's choice between domestic and foreign investment as such is not influenced by taxation. However, given that a firm has decided to invest abroad, taxation is decisive for where the investment takes place. The results of Bénassy-Quéré, Fontagné, and Lahrière-Révil (2005), relying on bilateral FDI flows among 11 OECD countries over the period 1984-2000 and using statutory corporate tax rates as well as (forward-looking) effective marginal (*EMTR*) and average tax rates (*EATR*) as published in Devereux, Griffith, and Klemm (2002), indicate a significant role of tax differentials for foreign plant location. Similar evidence is provided by Egger, Loretz, Pfaffermayr and Winner (2009), who focus on unilateral and bilateral *EMTR* and *EATR* of 22 OECD countries between 1991 and 2002. Razin, Rubinstein, and Sadka (2005) point out that statutory tax rates affect FDI flows in two ways. First, they determine whether it is profitable for any firm to invest in a particular host country at all (sample selection). Second, given that some investment takes place, they affect the magnitude of these investments. Razin, Rubinstein, and Sadka (2005) find

¹¹One notable exception is Swenson (1994), who finds that the increased after-tax cost of capital after the Tax Reform Act 1986 induced an increase in U.S. inbound FDI. The underlying reason is that the broadening of the tax base raised the attractiveness of U.S. assets for foreign investors whose parent countries allowed a tax credit against taxes abroad (see Scholes and Wolfson, 1990, for a theoretical foundation of this argument).

¹²Under the credit method, foreign-earned profits are taxed both in the parent and the host country, but the foreign taxes are deductible from the domestic tax liability. Under the exemption method, by way of contrast, foreign-earned profits are only taxed abroad.

supportive evidence for these hypotheses in a panel of bilateral OECD FDI flows. Regarding investment flows to Central and Eastern European countries, Carstensen and Toubal (2004) observe a significant negative impact of the difference in host and parent country statutory corporate tax rates on inward FDI.¹³

Overall, previous empirical research is characterized by two features. First, most of the existing literature considers the parent and/or host country tax rate or composite measures of tax burden (e.g., forward- or backward-looking effective tax rates). The former approach ignores important tax-related determinants of FDI, such as depreciation allowances or host country withholding taxes (see Clark, 2000; OECD, 2001). The problem with the latter approach is that it is difficult to draw strong conclusions about the 'composite' impact of the tax components through effective tax rates on MNE activity.¹⁴ In particular, our theoretical hypotheses shed light on the fact that some of the components of effective tax rates exert a non-monotonic effect on FDI, where the sign of the impact depends on the relative prevalence of multinational versus national firms.

Second, many of the existing applications tend to rely on an eclectic approach to specifying empirical FDI equations. In this regard, Hines (1999, p. 311) emphasizes that

"[O]ne of the difficulties facing all cross-sectional studies of FDI location is the inevitable omission of many important determinants of FDI that may be correlated with tax rates and therefore bias estimation of tax elasticities."

Of course, this argument does not advocate an empirical analysis that uses all available explanatory variables, disregarding their theoretical relevance. But rather, it makes the case for a specification of FDI capturing the most important empirical determinants consistent with theory. Following this advice, we employ an empirical specification based on a variant of the knowledge-capital model of multinational firms.

¹³De Mooij and Ederveen (2003), performing a meta-analysis based on 25 empirical studies on FDI and taxation, estimate a (median) tax rate elasticity of -3.3. Focusing on U.S. studies, Hines (1997) reports a tax rate elasticity of approximately -0.6.

¹⁴Basically, effective tax rates are an aggregate measure of company tax burden, i.e., the same level of the effective tax rate may be a result of different combinations of its components. Hence, an increase of effective tax rates may be due to entirely different changes in the underlying components. More importantly, it can be shown that in a general equilibrium model of trade and multinationals as the one applied below, effective (marginal and average) tax rates change across endowment configurations, even if the tax parameters themselves remain unchanged. Put differently, each margin of adjustment faces its own effective tax rate. Hence, aggregate effective tax rates are endogenous even for given tax instruments.

4 A numerically solvable three-country general equilibrium model of multinational activity and taxation

With three countries, *complex* (i.e., mixed horizontal and vertical) integration strategies of multinational firms become possible (see Yeaple, 2003). In particular, we consider the possibility of *export-platform* multinational activity (see, e.g., Ekholm, Forslid, and Markusen, 2007), where firms decide to set up two production facilities – one at home and one abroad – while serving the third country (which may be a conglomerate of economies) through exports from the foreign subsidiary. Along with export platform multinationals, the standard firm types may arise: national firms which serve domestic consumers locally and foreign ones through exports; horizontal multinationals which run one production facility in each foreign market to serve consumers locally in general; and vertical multinationals which run a single production facility in only one of the foreign markets and serve consumers worldwide from there.¹⁵

The model consists of three countries indexed $\{i, j, k\} = \{1, 2, 3\}$. Each of them hosts a single representative consumer who derives utility from the consumption of two goods, X and Z . Z is a homogeneous (agricultural) good produced at constant returns to scale. There is a large number of varieties of (manufactures) X that are imperfect substitutes as in Dixit and Stiglitz (1977) based upon Cobb-Douglas preferences with constant income shares of γ and $(1 - \gamma)$, respectively.

X can be produced by four principal types of firms. National enterprises (NEs) serve domestic consumers locally and foreign ones via exports. The corresponding number of NEs in country i is denoted by n_i . Horizontal MNEs (HMNEs) headquartered in country i run a plant each at home and one in each foreign market. Hence, they serve consumers in all three countries through local production and do not engage in trade. The central motives to enter as an HMNE are the avoidance of trade costs and the exploitation of multi-plant economies of scale. h_i indicates the number of HMNEs headquartered in i . Vertical MNEs (VMNEs) unbundle their headquarters' activities from the production process. They produce headquarters' services in the skilled labor abundant economy and locate production in an unskilled labor abundant country. VMNEs serve

¹⁵Depending on which market the production facility is located, each parent country may run two different types of vertical MNEs in a three-country model. Similarly, depending on which market the export-platform is located in, there will be two possible types of export-platform MNEs in such a model. We will use parent and foreign subsidiary location indices in the sequel to distinguish among these types of firms.

foreign consumers in the host country locally and consumers in both the domestic and the other foreign market via exports from their foreign subsidiary. Since the foreign subsidiary of a VMNE headquartered in i may either be located in j or k , we need to distinguish these two types of VMNEs. We do so by using two subscripts, where the first one refers to the parent and the second one to the host country. Accordingly v_{ij} denotes the number of i 's VMNEs with a foreign subsidiary in j and v_{ik} denotes this country's VMNEs with a foreign subsidiary in k .

Finally, there are export-platform MNEs (EMNEs) which are horizontal to the extent that they serve parent country consumers and host country consumers through local production (like an HMNE), and they are vertical in nature since they deliver products to the third market by exports from the foreign platform. Similar to VMNEs, the number of foreign markets to locate an export-platform in is larger than the number of foreign subsidiaries EMNEs actually set up. Therefore, we need to distinguish between i 's EMNEs with a platform in j from those with a platform in k . The number of the former is e_{ij} while the number of the latter is e_{ik} .

Quantities of X are indexed as follows. The superscript indicates the firm type, the first subscript refers to the country where the firm is headquartered, the second one denotes the country where the variety is produced, and the third subscript labels the economy where the variety is consumed. For instance, X_{ij}^n is the production of manufactures produced by a single NE of i in i for consumers in j . Consider an HMNE with headquarters in country i . Then, X_{ijj}^h indicates this firm's production in country j for consumers there. Now, focus on a VMNE with headquarters in i . Such a firm's production in country j for consumers in i is denoted by X_{iji}^v . Similarly, production of an EMNE which is headquartered in i in its platform in j for consumers in k is referred to by X_{ijk}^e . The use of subscripts for the homogeneous good Z is analogous to X .

Preferences are assumed to be a Cobb-Douglas nest of the homogeneous Z -good and the differentiated X -good. The price of Z serves as the numéraire. U_i describes the utility function of a representative household in country i , where μ denotes the fixed expenditure share for differentiated products and $\sigma > 1$ is the elasticity of substitution between differentiated product

varieties:

$$\begin{aligned}
U_i &= X_{ic}^\mu \left(\sum_{j=1}^3 Z_{jji} \right)^{1-\mu}, \\
X_{ic} &\equiv \left\{ \sum_{j=1}^3 \left[n_j \left(\frac{X_{jji}^n}{1+\tau_{ji}} \right)^{\frac{\sigma-1}{\sigma}} + h_j \left(X_{jii}^h \right)^{\frac{\sigma-1}{\sigma}} \right] + \sum_{k \neq j} \left[v_{kj} \left(\frac{X_{kji}^{v_{kj}}}{1+\tau_{ji}} \right)^{\frac{\sigma-1}{\sigma}} \right] \right\}^{\frac{\sigma}{\sigma-1}} \\
&\quad + \left\{ \sum_{j \neq i} \left[e_{ij} \left(X_{iii}^{e_{ij}} \right)^{\frac{\sigma-1}{\sigma}} \right] + \sum_{k \neq j, j \neq i} \left[e_{kj} \left(\frac{X_{kji}^{e_{kj}}}{1+\tau_{ji}} \right)^{\frac{\sigma-1}{\sigma}} \right] \right\}. \tag{1}
\end{aligned}$$

Cross-border trade of the differentiated X -good, say, from i to j is subject to iceberg transport costs (τ_{ij}) for the shipment of each unit. For intra-national transportation, we use the conventional assumption in related research that trade costs are zero ($\tau_{ii} = 0$). Homogeneous Z -goods are tradeable at zero costs.

For each firm type and location, the utility maximization of consumers yields demand for a single variety of manufactures

$$\begin{aligned}
X_{iii}^\ell &= \left(p_{iii}^\ell \right)^{-\sigma} P_i^{\sigma-1} \mu E_i \quad \forall \quad i \in \{1, 2, 3\} \quad \wedge \quad \forall \quad \ell \in \{n, h, e_{ij}, e_{ik}\} \\
X_{jii}^\ell &= \left(p_{jii}^\ell \right)^{-\sigma} P_i^{\sigma-1} \mu E_i \quad \forall \quad i \neq j \in \{1, 2, 3\} \quad \wedge \quad \forall \quad \ell \in \{h, v_{ji}, e_{ji}\} \\
X_{ijk}^{v_{ij}} &= \left(p_{ijk}^v \right)^{-\sigma} P_k^{\sigma-1} \mu E_k \quad \forall \quad i \neq j, k \in \{1, 2, 3\} \\
X_{ijk}^{e_{ij}} &= \left(p_{ijk}^e \right)^{-\sigma} P_k^{\sigma-1} \mu E_k \quad \forall \quad i \neq j, i \neq k \in \{1, 2, 3\} \\
X_{jji}^n &= \left(p_{jji}^n \right)^{-\sigma} P_i^{\sigma-1} \mu E_i \quad \forall \quad i \neq j \in \{1, 2, 3\}. \tag{2}
\end{aligned}$$

E_i represents the total expenditures of consumers in country i . The price index P_i of differentiated goods *consumed* in country i can be written as

$$\begin{aligned}
P_i &= \left\{ \sum_{j=1}^3 \left[n_j \left(p_{jji}^n \right)^{1-\sigma} + h_j \left(p_{jii}^h \right)^{1-\sigma} \right] + \sum_{k \neq j} \left[v_{kj} \left(p_{kji}^{v_{kj}} \right)^{1-\sigma} \right] \right. \\
&\quad \left. + \sum_{j \neq i} \left[e_{ij} \left(p_{iii}^{e_{ij}} \right)^{1-\sigma} \right] + \sum_{k \neq j, j \neq i} \left[e_{kj} \left(p_{kji}^{e_{kj}} \right)^{1-\sigma} \right] \right\}^{\frac{1}{1-\sigma}}. \tag{3}
\end{aligned}$$

Expenditures for X and Z are allocated as follows:

$$X_{ic} = \frac{\mu E_i}{P_i}, \quad \sum_{j=1}^3 Z_{jji} = (1 - \mu)E_i. \quad (4)$$

4.1 Production and labor markets

The production function for Z is a CES technology which is identical in all three economies. It uses skilled labor (S) and unskilled labor (L) at a technical rate of substitution of $1/(1 - \rho)$:

$$\sum_{j=1}^3 Z_{ijj} = [aS_i^\rho + (1 - a)L_i^\rho]^{\frac{1}{\rho}}, \quad (5)$$

where a is a weighting parameter. Since all firms within a country face the same homothetic technology and identical factor prices, Z -sector input coefficients are identical across firms. Let w_{Si} and w_{Li} denote the factor rewards for skilled and unskilled labor in country i . Skipping the arguments, these input coefficients are determined as

$$a_{LZi} = \left(\frac{w_{Li}}{1 - a} \right)^{\frac{1}{\rho-1}} \left[\left(\frac{w_{Si}^\rho}{a} \right)^{\frac{1}{\rho-1}} + \left(\frac{w_{Li}^\rho}{1 - a} \right)^{\frac{1}{\rho-1}} \right]^{-\frac{1}{\rho}} \quad (6)$$

$$a_{SZi} = \left(\frac{w_{Si}}{a} \right)^{\frac{1}{\rho-1}} \left[\left(\frac{w_{Si}^\rho}{a} \right)^{\frac{1}{\rho-1}} + \left(\frac{w_{Li}^\rho}{1 - a} \right)^{\frac{1}{\rho-1}} \right]^{-\frac{1}{\rho}}. \quad (7)$$

Perfect competition among the producers of Z ensures zero profits so that unit costs satisfy

$$a_{LZi}w_{Li} + a_{SZi}w_{Si} \geq 1 \quad \perp \quad Z_{iii} \geq 0, \quad Z_{ijj} \geq 0 \quad \forall \quad i \neq j \in \{1, 2, 3\}, \quad (8)$$

where \perp indicates that at least one of the adjacent conditions has to hold with equality. Zero trade costs lead to an equalization of marginal costs across countries.

The production of manufactures X uses both factors in fixed proportions (see Markusen, 2002), where a_{LX} and a_{SX} are the corresponding input coefficients for production. The set-up of firms in the X -sector requires skilled labor in order to produce firm-specific assets and blueprints as well as unskilled labor to set up plant-specific assets (production facilities). In line with the knowledge-capital model literature, we assume that fixed input requirements are highest for horizontal MNEs, lower for vertical MNEs, and lowest for NEs. Specifically, national

firms need 2 units of skilled labor, while (horizontal and vertical) MNEs employ $2 + \theta$ units with $\theta \geq 0$. This accounts for the possibly higher firm-specific fixed costs of running a multinational network. For NEs and for domestic plants of horizontal MNEs the plant-specific fixed input requirements are equal to 1 unit of unskilled labor. Setting up a plant abroad requires $1 + \gamma$ units of unskilled labor with $\gamma \geq 0$, reflecting the associated possible fixed cost disadvantages of MNEs.

Under full employment, the factor market clearing conditions for unskilled and skilled labor in country i require

$$\begin{aligned}
L_i &\geq a_{LX} \left[\sum_{j=1}^3 \left(n_i X_{ij}^n + h_j X_{ji}^h \right) + \sum_{j \neq i} \left(v_{ji} \sum_{k=1}^3 X_{jik}^v \right) + \sum_{j \neq i} \left(e_{ij} X_{iii}^e \right) + \sum_{k \neq j, j \neq i} \left(e_{ki} X_{kij}^e \right) \right] \\
&\quad + \left[a_{LZi} \sum_{j=1}^3 Z_{ij} \right] + n_i + h_i + \sum_{j \neq i} e_{ij} + (1 + \gamma) \sum_{j \neq i} (h_j + v_{ji} + e_{ji}) \quad \perp \quad w_{Li} \geq 0, \\
S_i &\geq a_{SX} \left[\sum_{j=1}^3 \left(n_i X_{ij}^n + h_j X_{ji}^h \right) + \sum_{j \neq i} \left(v_{ji} \sum_{k=1}^3 X_{jik}^v \right) + \sum_{j \neq i} \left(e_{ij} X_{iii}^e \right) + \sum_{k \neq j, j \neq i} \left(e_{ki} X_{kij}^e \right) \right] \\
&\quad + \left[a_{SZi} \sum_{j=1}^3 Z_{ij} \right] + 2n_i + (2 + \theta) \left[h_i + \sum_{j \neq i} (v_{ij} + e_{ij}) \right] \quad \perp \quad w_{Si} \geq 0. \tag{9}
\end{aligned}$$

Variable unit costs for the production of an X -variety are given by $c_{Xi} = a_{SX} w_{Si} + a_{LX} w_{Li}$. Fixed costs are financed by operating profits. There is a fixed markup over variable costs, which is determined by the elasticity of substitution between varieties. Identical technologies and price elasticities of demand ensure that the domestic price of a locally produced good (the mill price) is identical in equilibrium across all firms producing there. Therefore, it is sufficient to use a single subscript for the producer prices, indicating the country of production: $p_i \equiv p_{iii}^n = p_{iii}^h = p_{iii}^{e_{ij}} = p_{jii}^{v_{ji}} \quad (\forall \quad j \neq i)$.

The consumer price for varieties exported from country i to j is then $p_i(1 + \tau) \equiv p_{iij}^n = p_{kij}^{v_{ki}} \quad (\forall \quad j \neq i) = p_{kij}^{e_{ki}} \quad (\forall \quad k \neq j, j \neq i)$. Given that the demand for all varieties is positive due to our assumptions, the mill price of a variety of X in i is determined by

$$p_i = c_{Xi} \frac{\sigma}{\sigma - 1}. \tag{10}$$

Free entry of firms implies that after-tax profits are zero. Therefore, the corresponding zero-

profit conditions determine the number of firms. NEs in i face fixed costs of $FC_i^n = 2w_{Si} + w_{Li}$. After subtracting depreciation allowances, these fixed costs have to be covered by after-tax operating profits. Operating profits of NEs are subject to the domestic statutory corporate tax rate (t_i). We denote the share of fixed costs which is deductible from the tax base by δ_i .¹⁶ NEs in country i exist if their fixed costs are equal to after tax profits including depreciation allowances (D_i^n)

$$FC_i^n \geq \frac{p_i \left(\sum_{j=1}^3 X_{ij}^n \right)}{\sigma} (1 - t_i) + \underbrace{\delta_i t_i (2w_{Si} + w_{Li})}_{D_i^n} \perp n_i \geq 0. \quad (11)$$

The fixed costs of MNEs are $FC_i^h = (2 + \theta)w_{Si} + w_{Li} + \sum_{j \neq i} (1 + \gamma)w_{Lj}$ for an HMNE, $FC_i^{vij} = (2 + \theta)w_{Si} + (1 + \gamma)w_{Lj}$ for a v_{ij} -type VMNE, and $FC_i^{eij} = (2 + \theta)w_{Si} + w_{Li} + (1 + \gamma)w_{Lj}$ for a v_{ij} -type VMNE respectively. The corresponding zero profit conditions are given by

$$\begin{aligned} FC_i^h &\geq \sum_{j=1}^3 \left[\frac{p_j X_{ij}^h}{\sigma} (1 - t_j)(1 - t_{ji}^M) \right] + \underbrace{\delta_i t_i (2w_{Si} + w_{Li}) + \sum_{j \neq i} \left[\delta_j t_j (t_{ji}^M - t_j^w)(1 + \gamma)w_{Lj} \right]}_{D_{ii}^h} \\ &+ \sum_{j \neq i} \left[\underbrace{\delta_j t_j (1 + t_j^w)(1 + \gamma)w_{Lj}}_{D_{ij}^h} \right] \perp h_i \geq 0 \end{aligned} \quad (12)$$

$$\begin{aligned} FC_i^{vij} &\geq \frac{p_j \left(\sum_{k=1}^3 X_{ijk}^{vij} \right)}{\sigma} (1 - t_j)(1 - t_{ji}^M) + \underbrace{\delta_j t_j (t_{ji}^M - t_j^w)(1 + \gamma)w_{Lj}}_{D_{ii}^{vij}} \\ &+ \underbrace{\delta_j t_j (1 + t_j^w)(1 + \gamma)w_{Lj}}_{D_{ij}^{vij}} \perp v_{ij} \geq 0 \end{aligned} \quad (13)$$

$$\begin{aligned} FC_i^{eij} &\geq \sum_{j \neq k} \left[\frac{p_j \left(\sum_{k \neq i} X_{ijk}^{eij} \right)}{\sigma} (1 - t_j)(1 - t_{ji}^M) \right] + \underbrace{\delta_i t_i (2w_{Si} + w_{Li}) + \delta_j t_j (t_{ji}^M - t_j^w)(1 + \gamma)w_{Lj}}_{D_{ii}^{eij}} \\ &+ \underbrace{\delta_j t_j (1 + t_j^w)(1 + \gamma)w_{Lj}}_{D_{ij}^{eij}} \perp e_{ij} \geq 0, \end{aligned} \quad (14)$$

¹⁶An alternative would be to apply depreciation allowances for variable costs additionally. However, since variable costs are not deductible at the same rate as fixed costs, we do not rely on this variant in the main text but relegate it to a sensitivity analysis. We briefly discuss the outcome of this model variant in Footnote 26, below.

where D_{ij}^h indicates the depreciation allowances of a horizontal MNE with headquarters in country i at market j , and similarly for the other depreciation allowances. Our setting implicitly assumes that fixed costs are deductible only in the country where the investment takes place. We further assume that MNEs fully repatriate the profits of foreign subsidiaries to the domestic headquarters (see Hartman, 1985; and Sinn, 1993, for a discussion). In this case, operating profits of foreign affiliate firms are subject to corporate taxation in the host country (t_j). Under repatriation, foreign-earned profits are additionally subject to withholding taxes (t_j^w) and taxation at home (t_{ji}^M), where the first subscript in t_{ji}^M denotes the origin and the latter the destination of the dividend flow. Hence, if double taxation is not alleviated unilaterally or bilaterally (via tax treaties), foreign affiliate income is exposed to double taxation. The extent to which double taxation occurs depends on the method of double taxation relief (Alworth, 1988, provides a detailed discussion).¹⁷ In general, $t_{ii}^M = 0$ but t_{ji}^M will be different from zero:

$$\begin{aligned}
t_{ji}^M &= t_j^w && \text{(exemption)} \\
&= \max \left[\frac{t_i - t_j}{1 - t_j}, t_j^w \right] && \text{(credit)} \\
&= t_i(1 - t_j^w) + t_j^w && \text{(deduction)}
\end{aligned} \tag{15}$$

All production factors are owned by the households, so that consumer income is determined by the sum of factor rewards in country i ($w_{S_i}S_i + w_{L_i}L_i$) plus the eventual transfers of tax revenues to them. Below, we discuss two modes of public spending of tax revenues, where only one of them involves such transfers.

4.2 Public sector

The only source of tax revenues are taxes on operating profits of firms. Hence, tax revenues for country i can be summarized as

¹⁷See Bond and Samuleson (1989), Janeba (1995), and Davies (2003) for a theoretical analysis on the effects of the methods of double taxation relief on the volume of foreign investment. Davies (2004) provides a survey.

$$\begin{aligned}
G_i &= n_i \left[\left(\sum_{j=1}^3 X_{ij}^n \right) \frac{p_i}{\sigma} t_i - D_i^n \right] + h_i \left\{ X_{iii}^h \frac{p_i}{\sigma} t_i + \sum_{j \neq i} \left[X_{ijj}^h \frac{p_j}{\sigma} (1 - t_j) (t_{ji}^M - t_j^w) \right] - D_{ii}^h \right\} \\
&+ \sum_{j \neq i} v_{ij} \left[\left(\sum_{k=1}^3 X_{ijk}^{v_{ij}} \right) \frac{p_j}{\sigma} (1 - t_j) (t_{ji}^M - t_j^w) - D_{ii}^{v_{ij}} \right] \\
&+ \sum_{j \neq i} e_{ij} \left\{ X_{iii}^{e_{ij}} \frac{p_i}{\sigma} t_i + \left[\left(\sum_{k \neq i} X_{ijk}^{e_{ij}} \right) \frac{p_j}{\sigma} (1 - t_j) (t_{ji}^M - t_j^w) \right] - D_{ii}^{e_{ij}} \right\} \\
&+ \sum_{j \neq i} h_j \left[X_{jii}^h \frac{p_i}{\sigma} (t_i - t_i t_i^w + t_i^w) - D_{ji}^h \right] + \sum_{j \neq i} v_{ji} \left[\left(\sum_{k=1}^3 X_{jik}^{v_{ji}} \right) \frac{p_i}{\sigma} (t_i - t_i t_i^w + t_i^w) - D_{ji}^{v_{ji}} \right] \\
&+ \sum_{j \neq i} e_{ji} \left[\left(\sum_{k \neq i} X_{jik}^{e_{ji}} \right) \frac{p_i}{\sigma} (t_i - t_i t_i^w + t_i^w) - D_{ji}^{e_{ji}} \right]. \tag{16}
\end{aligned}$$

Tax revenues are either used to finance a lump-sum transfer to consumers or to provide public infrastructure to the firms to lower their fixed input requirements (see Kellenberg, 2003, for a treatment of infrastructure in a model with MNEs). In case of lump-sum transfers, gross national income of country i (E_i) includes the tax revenues collected by its government. In case of public infrastructure provision, no such transfers occur and gross national income equals total factor income in i . We assume that one unit of public infrastructure needs one unit of skilled labor and one unit of unskilled labor.¹⁸ Accordingly, public infrastructure (I_i) in country i equals

$$I_i = \frac{G_i}{w_{Si} + w_{Li}}. \tag{17}$$

Under the assumption that public infrastructure reduces the fixed factor requirement of firms headquartered in a given country, the fixed costs of setting up a national firm in country i are

$$FC_i^n = \frac{2w_{Si} + w_{Li}}{(I_i + 1)^\beta}, \tag{18}$$

where $\beta > 0$ is a scaling parameter. Similarly, the fixed costs for HMNEs, VMNEs, and EMNEs are then reduced by the public infrastructure in the relevant country

¹⁸This guarantees that the production of public infrastructure as such only induces minor effects on relative factor prices of skilled and unskilled labor.

$$FC_i^h = \frac{(2 + \theta)w_{Si} + w_{Li}}{(I_i + 1)^\beta} + \sum_{j \neq i} \left[\frac{(1 + \gamma)w_{Lj}}{(I_j + 1)^\beta} \right], \quad (19)$$

$$FC_i^{v_{ij}} = \frac{(2 + \theta)w_{Si}}{(I_i + 1)^\beta} + \frac{(1 + \gamma)w_{Lj}}{(I_j + 1)^\beta}, \quad (20)$$

$$FC_i^{e_{ij}} = \frac{(2 + \theta)w_{Si} + w_{Li}}{(I_i + 1)^\beta} + \frac{(1 + \gamma)w_{Lj}}{(I_j + 1)^\beta}. \quad (21)$$

4.3 Model parameterization

Due to the non-linearities and the numerous possible corner solutions, an analytical solution of the model is infeasible (see Markusen and Venables, 1998, 2000; Markusen, 2002). Therefore, we derive the empirically testable hypotheses of interest by means of numerical simulation, using the following parameter values. World factor endowments are set at $L = 300$ and $K = 75$. $a = 0.9$ for the skilled labor coefficient in the CES technology of Z . The production of the differentiated X -good is relatively more skilled labor intensive with fixed input coefficient of $a_{LX} = 0.75$ and $a_{SX} = 0.25$ (see Markusen, 2002). We parameterize the additional effort of transferring knowledge abroad with $\theta = 0.1$ and the additional resources required for setting up a plant abroad with $\gamma = 0.1$. According to the United Nation's World Trade Database, the share of manufacturing goods trade in the 1990s is about 70 to 80 percent of total trade. Therefore, we assume an expenditure share for manufactures of $\mu = 0.8$. We consider $\sigma = 4$ as value for the elasticity of substitution, which is close to the one usually applied in the knowledge-capital literature (see Markusen, 2002). Trade costs are assumed identical between the different country pairs, and high with $\tau = 0.25$ being in line with Carr, Markusen, and Maskus (2001). Finally, the elasticity of substitution in the production of the homogeneous good is $(1/(1 - \rho)) = 3$.

Concerning the public sector, we initially set the corporate tax rates symmetrically at $t_i = t_j = t_k = 0.3$, which roughly resembles the average corporate tax rate in the OECD countries in 2004. We account for the fact that bilateral tax treaties prevail among the countries of interest and set the withholding tax rate at a low level, $t_i^w = t_j^w = t_k^w = 0.05$. We assume that about 20 percent of fixed costs are tax deductible so that $\delta_i = \delta_j = \delta_k = 0.2$.¹⁹ In the case where

¹⁹In our empirical analysis below, we measure tax base reducing allowances by depreciation rates including first-

tax revenues are used to finance public infrastructure, the scaling parameter determining the relative importance of public infrastructure is set at $\beta = 0.1$.

5 Simulation results and hypotheses

To facilitate the comparison with the existing literature we hold the size of the third country fixed at one third of the world endowment, and run simulations for different configurations in factor endowments in country i and j . Similarly we are only interested in the bilateral outbound FDI of country i . Hence, we measure foreign affiliate activity as the share of outbound affiliate production of country i (defined as $h_i X_{ijj}^h + v_{ij}(X_{iji}^v + X_{ijj}^v + X_{ijk}^v) + e_{ij}(X_{ijj}^e + X_{ijk}^e)$) in the combined production of X in country i and j by firms headquartered in these countries. Without corporate taxation (i.e., setting all parameters of taxation to zero) the chosen calibration of the model leads to a pattern of affiliate production which is virtually identical to the one in Carr, Markusen, and Maskus (2001) and in Markusen and Maskus (2002). Horizontal multinational firms prevail, if country size and relative factor endowments are not too different. Vertical multinationals and export platforms come into existence only, if relative factor endowment differences (i.e., production cost differences) are large enough. Higher trade costs (foreign plant set-up costs) discourage NEs and EMNEs (MNEs).

Figure 1 displays foreign affiliate production in an Edgeworth box with relative factor endowments on the axes for the benchmark case without corporate taxation. First, consider factor endowments along the main diagonal indicating that country i and j have identical relative factor endowments. Here, NEs and horizontal MNEs prevail, and foreign affiliate production is higher the more similar the countries are in size. At the center of the Edgeworth box both countries are identical to the third country, which implies a market structure of symmetrical horizontal MNEs. Moving from the center towards the North-Western corner implies larger differences in relative factor endowments, inducing an increase in foreign affiliate production by vertical MNEs, all else equal.

year extra depreciations (see Devereux and Griffith, 1999, 2003). The net present value of depreciation allowances for tax purposes is about 30 percent higher than the assumed depreciation rate in the model simulation. The means of the periodical depreciation rates in the sample are about 22 percent (machinery) and 5 percent (buildings), respectively.

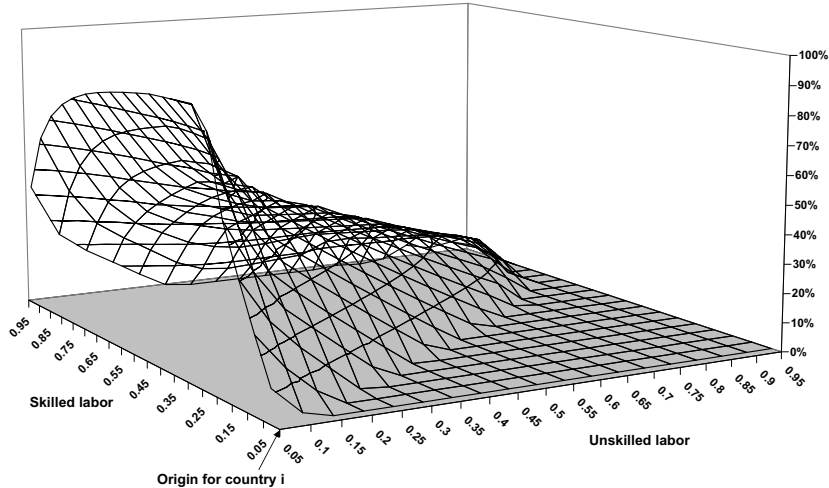


Figure 1: Share of affiliate production without corporate taxation

5.1 Effects of bilateral tax rate changes on FDI

In the subsequent analysis we introduce corporate taxation and primarily focus on the case where tax revenues are used to finance public infrastructure. However, in qualitative terms the effects are similar for lump-sum transfers. The reason is that corporate taxation affects the equilibrium plant configuration even if tax revenues are redistributed in a lump-sum fashion.²⁰

Figure 2 displays the share of foreign affiliate production under the exemption or credit method. We further assume that both countries have an exemption/credit system with the third country.²¹ In this case, multinational activity is affected only to a minor extent by corporate taxation (see the small differences between Figures 1 and 2). Only for small countries near the main diagonal we observe less foreign affiliate activity of horizontal MNEs, resulting from the additional tax burden for MNEs due to withholding taxes. The foreign affiliate activities of vertical MNEs located in the North-Western corner of the Edgeworth box remain more or less unaffected by profit taxation.

Compared to tax credit and exemption methods the deduction method is associated with a higher tax burden on MNEs. Again, we maintain the assumption that both countries apply an exemption system with the third country. Accordingly, the distortion of multinational activity

²⁰Figures and other results for the lump-sum transfer case are available from the authors upon request but are left out here for the sake of brevity.

²¹Note that under the assumption of symmetric tax rates in the initial equilibrium the exemption and the credit methods lead to identical results with regard to the relationship between corporate taxation and MNE activity.

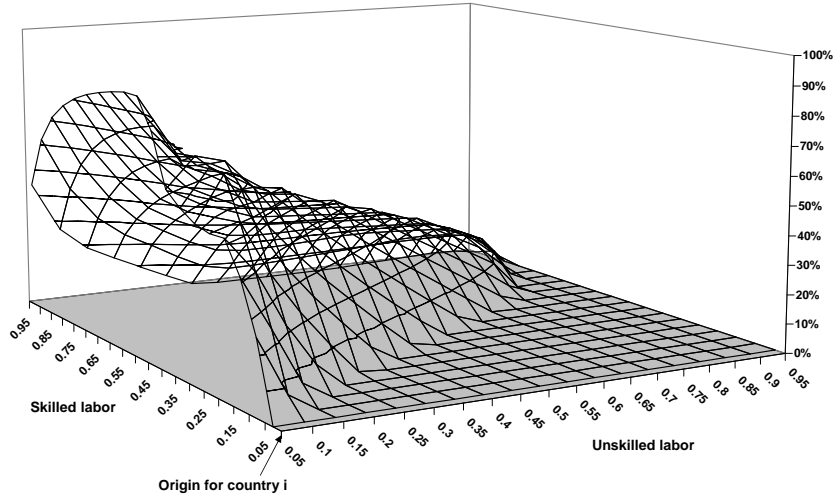


Figure 2: Share of affiliate production with exemption system

induced by corporate taxation becomes more evident under deduction. Figure 3 illustrates that the foreign activity of horizontal MNEs is significantly reduced as compared to the case of the exemption and the credit method, especially for small countries. In small economies, firms choose serving the foreign markets via exports since double taxation reduces foreign affiliate profits required to cover the fixed costs abroad. Further, firms from the third country have a tax advantage as they are under an exemption system. The other explanation for the absence of bilateral direct investment from country i to j is the relative attractiveness of the third country, as there is an exemption system there. As a consequence, export platforms in country k emerge. However, if country j is large enough and tax revenue is used to finance public infrastructure, horizontal MNEs come into existence even under deduction. In this case, tax revenues are high enough to finance public infrastructure, reducing fixed plant setup costs to compensate the disadvantages of double taxation. Again, the production decisions of vertical MNEs are nearly unaffected by double taxation.

In the following, we focus on four factor endowment configurations within the Edgeworth box to derive the effects of the considered tax parameters on MNE activity.²² For each of these endowment points and each method of double taxation relief (credit, exemption, and deduction), we compare the foreign affiliate production in the reference case as described in Section 4.3 with

²²We do not consider any impact of taxation on outbound MNE activity of an unskilled labor abundant economy, since such an economy does not run foreign affiliates.

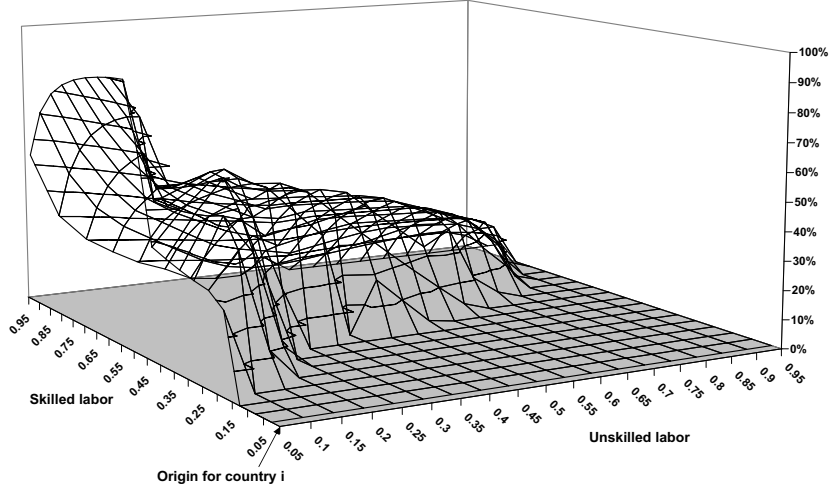


Figure 3: Share of affiliate production with deduction system

a counterfactual where the taxation parameters of interest are increased by one percentage point, one at a time. Our parameterization (symmetric tax rates) is not suitable for illustrating the differential effects of taxation under the credit method as compared to exemption. Therefore, we allow initial tax rate differentials between domestic and foreign countries in alternative scenarios. The results are summarized in Table 8.

We consider the following endowment configurations. First, one where country i is small compared to j but the relative factor endowments are identical across the two countries at $L_i/(L_i + L_j) = S_i/(S_i + S_j) = 0.15$. There, country i 's foreign affiliate production is small, amounting to only 5.86 percent of the combined production of X under tax credit or exemption (there is no MNE activity under deduction at this endowment configuration). Second, still at zero relative factor endowment differences, $L_i/(L_i + L_j) = S_i/(S_i + S_j) = 0.85$, country i is large relative to j . Still, its MNE activity is relatively small. Country i 's foreign affiliate production amounts to 14.12 percent of the world production of X under tax credit or exemption and to 10.89 percent under deduction, respectively. Third, in the center of the Edgeworth box the two countries are identical in size and relative factor endowments with $L_i/(L_i + L_j) = L_j/(L_i + L_j) = S_i/(S_i + S_j) = S_j/(S_i + S_j) = 0.5$. Therefore, the production of horizontal MNEs is evenly distributed and vertical MNEs do not exist. The foreign affiliate production of country i accounts for 25 percent of the overall production of X by NEs and MNEs in both countries, irrespective of the applied method of double taxation relief. Finally, consider an

endowment allocation where country i is skilled labor abundant with $L_i/(L_i + L_j) = 0.15$ and $S_i/(S_i + S_j) = 0.85$. At this configuration, it headquarters mainly vertical MNEs that exploit comparative advantages, and 41.14 (39.63) percent of the combined production of X are due to country i 's foreign subsidiary activity under credit or exemption (deduction). Table 8 also provides a summary of the effects of a one percent increase in each of the parameters of taxation on country i 's MNE activity, separately.

> Table 8 <

The impact of statutory corporate tax rates on MNE activity: Under the *exemption method*, any increase in the parent country tax rate stimulates foreign affiliate production.²³ The reason for the positive nexus of parent country tax rates and outbound MNE activity is that the change in its tax rate only affects domestic production. For similar reasons, a higher tax rate in the host country reduces affiliate production there. Hence, the predicted effect of an increase in parent (host) country corporate tax rates on a country's outbound MNE activity is positive (negative) under exemption.

With the *credit method*, the effects of corporate tax rates are ambiguous if horizontal MNE activity prevails (i.e., the factor endowment differences are not important; see the first three endowment configurations under tax credits in Table 8). As becomes apparent from Equation (15), the impact of a tax increase depends on the differential between domestic and foreign corporate tax rates. If the parent country is in an excess credit position (i.e., its corporate tax rate is lower than the host country tax burden; see footnote *c* in Table 8) the effect of the parent country's tax increase is the same as under the exemption method. An increase in the statutory tax rate of the parent country fosters its foreign affiliate production. The tax increase, by contrast, applies to operating profits of foreign affiliates if the parent tax rate is equal to or higher than the host country tax burden. This reduces foreign affiliate activities

²³Slemrod (1990) was the first who has pointed to a positive relationship between the parent country tax rate and outbound FDI, especially under the exemption system. In this regard, Hartman (1990, p. 121) criticized that "... the sign of the home country taxation parameter is indeterminate from economic theory." According to the insights from our model, Slemrod rightfully suggested using parent country corporate tax rates as a determinant of outbound FDI.

of horizontal MNEs, but increases the domestic production of host country owned firms.²⁴ For similar reasons, an increase in the host country's corporate tax rate induces the opposite effect.

With a *deduction system*, an increase in the corporate tax rate reduces MNE activities in both countries,²⁵ with one exception. If both countries are identical in endowment and size, an increase in the host country corporate tax rate fosters foreign affiliate activity there, as long as the tax burden becomes not prohibitively high. Although the tax burden is increased for all (domestic and foreign) MNEs, the host country firms are even more exposed to the increased tax rate.

The impact of withholding tax rates on MNE activity: The effects of a change in the withholding tax rate are unambiguous and straight-forward. An increase in the host country's withholding tax rate raises the tax burden of the parent country's MNEs only, irrespective of the method of double taxation relief. Consequently, MNE activity is reduced there.

The impact of depreciation allowances on MNE activity: If the parent country provides more generous depreciation allowances (reflected in a higher level of δ_i), the model predicts an increase of the parent's horizontal outbound MNE activity. The reason for this result lies in the assumption that fixed costs are deductible in the country where they are actually paid (firm-specific and domestic plant-specific fixed costs in the parent country and foreign plant-specific fixed costs abroad). Hence, domestically headquartered MNEs gain the most, as they face the highest fixed costs. However, this effect exists only under cross-hauling, i.e., the coexistence of outbound and inbound horizontal MNE activity at small (zero) relative factor endowment differences. The effects of depreciation allowances are reversed if large relative factor endowment differences exist and vertical MNEs prevail.²⁶ Since vertical MNEs do not operate a production facility at the headquarters location, they only can deduct fixed plant set-up costs (in contrast to domestic NEs or horizontal MNEs). Accordingly, an increase in domestic depreciation allowances

²⁴In the case of identical factor endowments, the impact of a parent country's tax increase on foreign affiliate activity is only positive if both countries are in an excess credit position, i.e., $(t_j - t_i^w(1-t_i)) < t_i < (t_j + t_j^w(1-t_j))$, obtaining the same result as with the exemption method.

²⁵As discussed above, the deduction method leads to zero MNE activity for a small country. For such a situation, we are not able to identify a change in MNE activity due to an increase in the tax parameters. However, to illustrate the impact of tax changes we re-parameterize the model such that MNE activity arises in the initial equilibrium (see footnote *b* in Table 8).

²⁶The effects of δ_i and δ_j are also reversed if depreciation allowances are not only applied to fixed costs but also to variable costs, as indicated in Footnote 16.

leads to a distortion in favor of domestic NEs and vertical outbound MNE activity is crowded out. An increase in the depreciation allowances in an unskilled labor abundant host country attracts even more affiliate production there and fosters the parent country's vertical outbound MNE activity. In the remaining factor configurations, we obtain the opposite sign to a change in depreciation allowances in the parent country.

5.2 Third country tax effects on bilateral FDI

The setup of our model also allows us to calculate effects of a tax change in the third country on the bilateral investment activities. We start with the same four endowment scenarios as in the previous simulations, but now change the tax parameters of the third country. As the method of double taxation between the third country and the two other countries also influences the sign and strength of the third-country effect we run the simulations for all three forms. The results summarized in Table 9 suggest that the factor endowments scenarios tend to drive the third country effects. This intuitively makes sense, since the sign and magnitude of third country effects depends on the prevailing plant configuration.²⁷

> Table 9 <

If countries i and j are identical in the relative factor endowments and therefore horizontal MNEs prevail, the third country effects differ substantially between small and large countries. The underlying reasoning is that the tax changes in country k increase (decrease) the outbound FDI from country k into the large (small) country j . This, in turn, reduces (increases) the market shares of both domestic NEs and the HMNEs of country i in country j . If the host country j is relatively large compared to country i , the loss in market shares will be less pronounced. Hence, the share of bilateral FDI from i to j will decline. In contrast, a small domestic sector in country j will lose relatively more and, therefore, the share of bilateral affiliate production of HMNEs of country i in j will increase. In case of identical countries, firms will lose equally and their share of affiliate production remains unaffected. To predict the sign of the third country effects for country pairs only differing in size, all that needs to be determined is the effect of

²⁷The extent of the tax rate change we are considering is too small to change the plant configuration. In consequence, a multitude of different and strong third country effects are possible, but the determination of these is beyond the scope of this paper.

the tax change on the outbound FDI from country k . For the exemption and credit system this is intuitive, as it is a reverse case of the situation described in the previous subsection. If countries i and j apply the deduction method but the exemption method with country k , the sign for the bilateral withholding tax rate changes to the positive with the exception of the small country case. This is due to the fact that both countries i and j are exposed to the increase in the withholding tax rate, so that the tax burden on both inbound and outbound investment increases. This results in a reduction of output by all firms, which is larger for the firms with relatively more multinational activity.

With strong differences in relative factor endowments between countries i and j (i.e., cases where VMNEs emerge), the model clearly predicts positive third country effects of tax rate changes. Again, the reason can be found in the plant configuration in country j . In this setting, of foreign affiliate production originates solely from VMNEs. These are not directly affected by tax changes in country k . In contrast, firms headquartered in j are horizontal MNEs and, therefore, are exposed to a tax change in k . As a consequence, an increase in either the corporate tax rate or the withholding tax rate reduces the profits and market shares of the HMNEs, implying an increase of the share of affiliate production in country j . The increase of depreciation allowances in country k reduces the tax burden of the HMNEs and, therefore, increases their market share. This leads to a reduction in the share of affiliate production in country j by country i based VMNEs.

6 Empirical analysis

To confront the theoretical predictions of the model with the data, we estimate a specification of log stocks of bilateral outward foreign direct investment of parent country i in host country j and year t (LFDI_{ijt}) in a parsimonious specification including parent and host country statutory corporate tax rates, depreciation allowances, bilateral withholding tax rates and parent and host country GDP. The model in Section 4 suggests that comparative static effects are nonmonotonic in two regards. First, depreciation allowances affect MNE activity of relatively rich (skilled labor or capital abundant) parent countries differently than that of poorer ones. To capture this effect, we include an interaction term for both parent and host country depreciation allowances with GDP variables, separately. Second, the comparative static effects are different across the

applied methods of double taxation relief. To allow for the latter, we estimate the model not only for the pooled sample but also for credit countries and exemption countries, separately. Otherwise, we focus on a linear approximation of the nexus between tax parameters and log foreign direct investment:

$$\begin{aligned}
LFDI_{ijt} = & \beta_1 t_{i,t-1} + \beta_2 t_{j,t-1} + \beta_3 t_{ij,t-1}^w + \beta_4 \delta_{i,t-1} + \beta_5 \delta_{j,t-1} \\
& + \beta_6 \delta_{i,t-1} \times D_{SK_{it}/SK_{jt} > \text{median}(SK_{it}/SK_{jt})} + \beta_7 \delta_{j,t-1} \times D_{SK_{it}/SK_{jt} > \text{median}(SK_{it}/SK_{jt})} \\
& + \beta_8 \text{LGDP}_{i,t-1} + \beta_9 \text{LGDP}_{j,t-1} + \mu_{ij} + \lambda_t + \varepsilon_{ijt}.
\end{aligned} \tag{22}$$

The variables $t_{i,t-1}$ and $t_{j,t-1}$ are the once-lagged statutory corporate tax rates of the parent and the host country, respectively. $t_{ij,t-1}^w$ is the once-lagged withholding tax rate MNEs of i face in country j . $\delta_{i,t-1}$ and $\delta_{j,t-1}$ are the once lagged depreciation allowances of i and j , respectively. $D_{SK_{it}/SK_{jt} > \text{median}(SK_{it}/SK_{jt})}$ is an indicator variable which is one if country i 's GDP per capita relative to j is larger than the median. This variable indicates large differences in skilled labor and capital endowments between parent and host countries. $\text{LGDP}_{i,t-1}$ and $\text{LGDP}_{j,t-1}$ are once lagged log GDPs of the parent and the host country, respectively. β_1 - β_9 are unknown slope parameters, μ_{ij} and λ_t are specific constants for country-pair ij and year t , respectively. Finally, ε_{ijt} is a remainder error term.

Fixed country-pair effects control for the impact of relatively time-invariant variables such as relative factor endowments, while fixed time effects capture the impact of variables that have little variance across country-pairs such as third-country tax variables (see the sensitivity analysis for an explicit impact of third-country variables). We estimate sample selection models for panel data (see Wooldridge, 1995) to control for possible systematic selection effects.²⁸ The most important results are summarized in Table 10.

> Table 10 <

The table includes three sets of results. The one on the left-hand side represents parameter

²⁸We follow Wooldridge (1995) to model the constants μ_{ij} as functions of time-averaged explanatory variables. The sample selection equation includes all corporate tax variables and GDP as in the outcome equation. The inverse Mills' ratios are calculated for each year separately from annual probit models.

estimates and test statistics for the full sample (covering credit, exemption, and deduction countries). The results in the center are obtained when focusing on exemption countries exclusively. And the figures on the right-hand side of Table 10 are obtained with the sub-sample of credit countries only. We indicate whether the sign of the point estimate of a parameter is in line with the theoretical model in Section 4 (Y) or not (N). In some cases, the theoretical model does not provide unambiguous predictions of tax parameter changes, which we indicate by ? in Table 10.

The findings of our regression analysis can be summarized as follows. In line with previous empirical evidence, parent and host country size are positively related to bilateral stocks of outward FDI. While sample selection is significant in the full sample, there is no significant selection bias in the estimated model parameters for the exemption or credit countries alone.

As for the tax effects, broadly speaking, the impact of host country tax parameters ($t_{j,t-1}$, $\delta_{j,t-1}$, and $t_{ij,t-1}^w$) tends to be in line with the theoretical hypotheses.²⁹ Parent country tax parameters ($t_{i,t-1}$ and $\delta_{i,t-1}$) exert an indirect impact on bilateral MNE activity in the theoretical model. Their empirical effects tend to contradict the theoretical hypotheses significantly for exemption countries. While the magnitude of the tax effects differs significantly across the considered samples in Table 10, the signs of the point estimates are identical for all variables included. Overall, it seems easier to identify the expected direct effects of host country corporate taxation as compared to the indirect ones of parent country corporate taxation.

The results in Table 10 are based on the notion that third-country effects are relatively homogeneous across dyads and are captured by the country-pair and time fixed effects. In a sensitivity analysis, we relax this assumption and include inverse-distance-weighted³⁰ third-country effects of GDP (to be interpreted as market potential), the statutory tax rate, the withholding tax rate, and the depreciation allowance parameter.

> Table 11 <

²⁹There is no clear-cut hypothesis about the impact of statutory corporate taxes ($t_{i,t-1}$ and $t_{j,t-1}$) on bilateral FDI neither in the full sample nor for credit countries.

³⁰In particular, we consider host countries to be “neighbors” if their capitals are located within a radius of 600 kilometers. Then, we divide the respective variables by the great circle distance between the respective capitals. We experimented with alternative cut-offs. It turns out that third-country effects of countries within a larger radius of, say, 900 kilometers are significantly smaller, indicating that the impact of tax policy variables and even market potential drops off dramatically with a distance of more than 600 kilometers. Also, after controlling for market potential, using GDP-over-distance-based weights does not lead to much different results from the ones we report here.

Notice that we do not report predicted signs of the third-country variables for various reasons. As discussed above, the results of Table 9 do not suggest clear effects of third-country tax parameters on bilateral MNE activity. The findings are more suggestive of whether changes in third-country tax parameters and GDP exert some time-variant impact on bilateral FDI.

Table 11 summarizes the parameters and test statistics of interest. First of all, the consideration of third-country variables in the econometric models does not alter the coefficients of the parent and host country tax policy variables dramatically. For instance, none of the parameters in Table 11 exhibits a sign which is different from its counterpart in Table 10. Even the magnitude of the coefficients is similar between the two tables. The third-country variables – including corporate tax policy instruments as well as market potential – are jointly significant in all samples. As before, there is evidence of a significant sample selection bias only in the full sample of country-pairs.

The results in Tables 10 and 11 suggest some policy conclusions from a host country’s perspective. For convenience, let us focus on the findings in Table 10 and especially on the nexus between the host country statutory tax rate ($t_{j,t-1}$) and the corresponding depreciation allowance parameter ($\delta_{j,t-1}$). Unlike the withholding tax rate, these tax parameters can be changed unilaterally. Suppose that policy makers were interested in the inward-FDI-neutral $t_{j,t-1}/\delta_{j,t-1}$ -trajectory at any given set of bilateral withholding tax rates. Then, results suggest that the trajectory is negatively sloped for the average host country. An economy would have to reduce its statutory corporate tax rate by 0.64 percentage points to neutralize the effect of a one-percentage-point increase in the depreciation allowance parameter on inward FDI. The slope of the $t_{j,t-1}/\delta_{j,t-1}$ -trajectory is similar for exemption countries. On the contrary, a country applying the credit method would have to raise its statutory corporate tax rate by about 0.25 percentage points to neutralize the impact of a one-percentage-point increase in its depreciation allowance parameter on inward FDI.

7 Conclusions

In this paper, we provide insights into the frequency and extent of changes in three corporate tax instruments – statutory corporate tax rates, the deductibility of fixed cost from the tax base, and withholding tax rates on dividend payments such as repatriated profits – and their role for

multinational (MNE) activity such as bilateral foreign direct investment (FDI).

The paper delivers interesting insights that are generally relevant for hypothesis testing and the specification of empirical models for the nexus between profit taxes and multinational firm activity. For instance, we find that changes in tax instruments are relatively frequent in a sample of 52 parent and 45 host countries over the period 1991-2004: for more than 40 percent of the host countries at least one of the considered profit tax instruments changes in the average year. Moreover, a change in one instrument is frequently combined with a change in at least one other profit tax instrument. This suggests that the impact of corporate profit taxation on FDI may hardly be analyzed by means of micro-econometric tools for binary treatments or natural experiments. Rather, empirical stylized facts support methods suitable for panel data with fixed dyadic and time effects.

Moreover, a general equilibrium model of national and multinational firms puts forward hypotheses about the impact of the three tax instruments separately on multinational activity. The tax policy instruments exhibit non-monotonic effects on MNE activity. In fact, each tax instrument exerts an impact on each and every margin of adjustment at the firm level. There are direct effects on MNE profits as well as indirect effects through profits on non-MNEs or foreign MNEs. It turns out that “the” effective tax rate becomes an artifact with a manifold of margins of adjustment across different integration strategies at the firm level. Different combinations of corporate profit tax instruments may lead to an identical level or change of the effective tax rate for the average MNE, yet the resulting impact on FDI or other modes of MNE activity may differ due to heterogeneous indirect effects on other firms. Hence, we propose to focus on instrument-specific parameter estimates rather than ones of effective tax rates.

A large-scale panel data analysis suggests that empirical estimates of the impact of host country tax instruments are mostly in line with the theoretical hypotheses. The estimates indicate that the average country has to reduce its statutory corporate tax rate by about 0.64 percentage points to neutralize the impact of a one-percentage-point increase in depreciation allowances. According to the theoretical model, host country profit tax variables exert a direct effect on bilateral MNE activity, while parent country tax rates mainly affect it indirectly (through effects on national firms and foreign MNEs). Empirically, we find support of negative direct effects of parent country profit tax instruments rather than of positive total effects which are dominated by indirect effects on other firms.

The findings certainly point to omitted variables problems with empirical specifications, where corporate profit taxation is captured by the inclusion of statutory corporate tax rates only. However, also the use of publicly available effective tax rates cannot be recommended and is not supported by general equilibrium models, where firms can choose their integration strategy from a portfolio of choices. For future work on the impact of profit taxation on FDI it seems more fruitful to capture the relevant tax instruments separately and allow for their non-monotonic impact on firm activity – multinational or national in scope.

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Appendix: Data sources and variable description

1. **Data on foreign direct investment:** We use bilateral outward FDI in U.S. dollars between 1991 and 2004 from UNCTAD's Major FDI Indicators (2007).

Parent country coverage: The sample contains a total of 52 parent economies: Albania, Australia, Austria, Belgium, Bulgaria, Brazil, Canada, Chile, China, Colombia, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, Malta, Netherlands, New Zealand, Norway, Pakistan, Peru, Poland, Portugal, Romania, Russia, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Thailand, Turkey, Ukraine, United Kingdom, United States.

Host country coverage: There are 45 host countries in the sample: Albania, Australia, Austria, Belgium, Bulgaria, Brazil, Canada, Colombia, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, Malta, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russia, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom, United States.

2. **Tax rates, depreciation allowances, tax treaties:** Information on tax codes and bilateral tax treaties are primarily taken from the following online databases of the International Bureau of Fiscal Documentation (IBFD):

- *Africa - Taxation & Investment*
- *Asia-Pacific - Taxation & Investment*
- *Central/Eastern Europe - Taxation & Investment*

- *Latin America - Taxation & Investment*
- *Corporate Taxation in Europe*
- *Global Tax Surveys*
- *Tax News Service*
- *Tax Treaties Database*

Additionally, we exploit information of tax law from the following printed publications:

- Arthur Anderson, 1992-1996. *A tax guide to Europe*, London: Arthur Andersen
- 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.
- Coopers & Lybrand, 1991-1998. *International tax summaries : a guide for planning and decisions*, Chichester: John Wiley & Sons.
- 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.
- Ernst&Young, 1998-2003. *Worldwide Corporate Tax Guide*, Frankfurt am Main.
- IBFD, 1994-1999. *Central and East European Tax Directory*, Amsterdam.
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- Matthew Bender, 1990-2003. *Foreign tax and trade briefs : international withholding tax treaty guide*, New York: LexisNexis.
- Nexia International, 1992-2003. *The international Handbook of Corporate and Personal Taxation*, London: LexisNexis.
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- PriceWaterhouseCoopers, 1999. *Spectre: Study of potential of effective corporate tax rates in Europe*, Report commissioned by the Ministry of Finance in the Netherlands, Amsterdam.
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The computation of the net present value of depreciation allowances is derived in King and Fullerton (1984) and described in more detail in Devereux and Griffith (1999) and Yoo (2003). The corresponding information on the number of years for which depreciations can be claimed ('depreciation rate'), the depreciation system (i.e., straight line or declining balance schedule) and on (general) investment incentives (e.g., extra first-year allowances in Australia, Poland or Spain) are taken from the above mentioned sources. In cases where a firm has several opportunities to choose from, we use in line with the literature the most generous one.

Table 1: Frequency of period-specific change in tax parameters for 2,295 dyads (45 host countries) in percent

Period	Corporate tax rate (1)	Depreciation allowances (2)	Withholding tax rate (3)	Change of (1) and (2) (4)	Change of (1) or (2) (5)	Change of (1) and (2) and (3) (6)	Change of (1) or (2) and (3) (7)	Change of (1) or (2) or (3) (8)
1991-1992	30.43	17.39	10.83	4.35	43.48	0.17	31.63	51.07
1992-1993	42.31	30.77	4.00	15.38	57.69	0.83	42.38	59.65
1993-1994	38.46	30.77	10.86	11.54	57.69	0.15	42.53	58.82
1994-1995	23.33	16.67	11.31	10.00	30.00	2.75	24.25	33.46
1995-1996	15.63	15.63	7.35	3.13	28.13	0.49	16.05	33.76
1996-1997	21.05	7.89	4.08	2.63	26.32	0.15	21.21	28.84
1997-1998	27.50	7.50	8.14	5.00	30.00	0.00	27.50	36.81
1998-1999	25.00	17.50	10.20	5.00	37.50	0.05	27.75	44.41
1999-2000	30.77	17.95	8.45	5.13	43.59	0.60	33.79	46.71
2000-2001	38.46	10.26	5.58	2.56	46.15	0.05	38.56	48.32
2001-2002	29.27	7.32	7.56	7.32	29.27	1.72	29.27	33.33
2002-2003	19.51	7.32	3.11	2.44	24.39	0.05	19.89	26.64
2003-2004	32.56	2.33	9.39	2.33	32.56	0.05	32.56	39.17
<i>Average</i>	<i>28.38</i>	<i>13.32</i>	<i>7.61</i>	<i>5.46</i>	<i>36.24</i>	<i>0.51</i>	<i>29.32</i>	<i>40.47</i>

Table 2: Frequency of period-specific change in tax parameters by host country in percent

Country	Corporate tax rate (1)	Depreciation allowances (2)	Withholding tax rate (3)	Change of (1) and (2) (4)	Change of (1) or (2) (5)	Change of (1) and (2) and (3) (6)	Change of (1) or (2) and (3) (7)	Change of (1) or (2) or (3) (8)
Albania	10.00	10.00	18.63	0.00	20.00	0.00	20.00	28.04
Australia	30.77	23.08	1.96	15.38	38.46	0.60	30.92	39.52
Austria	7.69	38.46	8.14	7.69	38.46	0.00	10.11	44.19
Azerbaijan	15.38	15.38	6.33	0.00	30.77	0.00	17.35	33.18
Brazil	60.00	0.00	3.53	0.00	60.00	0.00	60.00	61.57
Bulgaria	37.50	0.00	0.00	0.00	37.50	0.00	37.50	37.50
Canada	50.00	0.00	5.15	0.00	50.00	0.00	50.00	52.94
Chile	53.85	0.00	3.02	0.00	53.85	0.00	53.85	55.20
Croatia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cyprus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Czech Republic	53.85	30.77	5.58	23.08	61.54	1.21	53.85	64.10
Denmark	92.31	15.38	8.75	15.38	92.31	0.15	92.31	93.06
Estonia	23.08	7.69	8.14	7.69	23.08	0.00	23.08	31.22
Finland	15.38	7.69	6.33	0.00	23.08	0.00	15.38	27.15
France	0.00	10.00	21.76	0.00	10.00	0.00	0.39	31.37
Germany	30.77	15.38	5.28	7.69	38.46	1.21	31.07	41.33
Greece	53.85	7.69	3.32	7.69	53.85	0.15	53.85	55.20
Hungary	23.08	0.00	0.00	0.00	23.08	0.00	23.08	23.08
Iceland	15.38	15.38	7.54	0.00	30.77	0.00	15.38	38.31
India	14.29	14.29	15.97	0.00	28.57	0.00	14.29	30.25
Indonesia	23.08	7.69	11.16	0.00	30.77	0.00	23.08	34.24
Italy	8.33	8.33	10.29	8.33	8.33	0.16	8.33	18.46
Japan	25.00	33.33	7.84	8.33	50.00	5.56	25.49	51.47
Korea, Rep.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Latvia	46.15	0.00	4.98	0.00	46.15	0.00	46.15	47.66
Lithuania	25.00	25.00	0.98	12.50	37.50	0.00	25.00	38.24
Luxembourg	37.50	0.00	2.70	0.00	37.50	0.00	37.50	39.71
Malta	25.00	25.00	26.72	25.00	25.00	1.23	25.00	50.49
Mexico	46.15	0.00	9.20	0.00	46.15	0.00	46.15	47.51
Netherlands	37.50	12.50	3.19	0.00	50.00	0.00	37.99	51.23
New Zealand	33.33	0.00	27.02	0.00	33.33	0.00	33.33	60.35
Norway	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pakistan	7.69	0.00	3.02	0.00	7.69	0.00	7.69	10.56
Peru	7.69	15.38	2.26	7.69	15.38	0.30	7.84	17.19
Poland	0.00	15.38	0.45	0.00	15.38	0.00	0.00	15.84
Russian Federation	58.33	50.00	5.23	33.33	75.00	2.12	59.64	76.31
Slovak Republic	30.77	0.00	7.54	0.00	30.77	0.00	30.77	34.99
Slovenia	20.00	0.00	1.96	0.00	20.00	0.00	20.00	21.57
Spain	0.00	0.00	3.92	0.00	0.00	0.00	0.00	3.92
Sweden	38.46	23.08	14.78	7.69	53.85	0.45	38.91	55.35
Switzerland	0.00	33.33	3.27	0.00	33.33	0.00	1.53	35.08
Thailand	7.69	0.00	3.02	0.00	7.69	0.00	7.69	10.26
Ukraine	23.08	30.77	24.74	7.69	46.15	5.58	35.14	52.94
United Kingdom	14.29	42.86	18.49	14.29	42.86	0.28	22.69	52.66
United States	38.46	7.69	2.87	7.69	38.46	0.30	38.46	39.97
<i>Average</i>	<i>28.38</i>	<i>13.32</i>	<i>7.61</i>	<i>5.46</i>	<i>36.24</i>	<i>0.51</i>	<i>29.32</i>	<i>40.47</i>

Table 3: Frequency of period-specific change in tax parameters for 2,295 dyads (45 host countries) at specific minimum change requirements in percent

Period	Corporate tax rate	Depreciation allowances	Withholding tax rate	Change of (1) and (2)	Change of (1) or (2)	Change of (1) and (2) and (3)	Change of (1) or (2) and (3)	Change of (1) or (2) or (3)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Fraction of dyads with a change of at least 1 percentage point								
1991-1992	8.70	13.04	10.83	4.35	17.39	0.17	8.78	27.96
1992-1993	30.77	30.77	4.00	15.38	46.15	0.83	30.84	48.42
1993-1994	30.77	30.77	10.86	11.54	50.00	0.15	34.84	53.39
1994-1995	16.67	13.33	8.95	10.00	26.67	0.07	17.65	30.39
1995-1996	6.25	15.63	7.35	3.13	18.75	0.49	6.68	24.82
1996-1997	13.16	7.89	4.08	2.63	18.42	0.15	13.31	21.88
1997-1998	17.50	7.50	7.89	5.00	22.50	0.00	17.50	29.56
1998-1999	20.00	15.00	10.00	5.00	30.00	0.05	20.25	39.46
1999-2000	20.51	17.95	6.49	5.13	33.33	0.60	23.53	35.04
2000-2001	30.77	5.13	5.58	2.56	35.90	0.00	30.87	38.26
2001-2002	19.51	7.32	7.56	7.32	21.95	1.72	19.51	26.26
2002-2003	12.20	7.32	3.11	2.44	17.07	0.05	12.58	19.56
2003-2004	23.26	2.33	9.39	2.33	23.26	0.05	23.26	30.05
<i>Average</i>	<i>19.21</i>	<i>12.23</i>	<i>7.25</i>	<i>4.37</i>	<i>27.07</i>	<i>0.33</i>	<i>19.88</i>	<i>31.92</i>
Fraction of dyads with a change of at least 5 percentage point								
1991-1992	4.35	13.04	10.66	4.35	13.04	0.09	4.43	23.53
1992-1993	19.23	7.69	2.79	15.38	23.08	0.23	19.23	25.11
1993-1994	3.85	11.54	10.86	11.54	15.38	0.00	7.92	22.17
1994-1995	6.67	3.33	8.50	3.33	10.00	0.00	6.73	15.10
1995-1996	0.00	6.25	6.13	3.13	6.25	0.00	0.12	12.25
1996-1997	0.00	0.00	3.30	2.63	0.00	0.00	0.00	3.30
1997-1998	2.50	0.00	7.84	2.50	2.50	0.00	2.50	9.95
1998-1999	5.00	5.00	10.00	5.00	10.00	0.00	5.15	19.71
1999-2000	2.56	15.38	5.83	5.13	17.95	0.00	5.68	20.56
2000-2001	7.69	5.13	4.83	0.00	12.82	0.00	7.79	14.78
2001-2002	7.32	2.44	4.54	4.88	9.76	0.00	7.32	14.06
2002-2003	2.44	2.44	3.11	2.44	4.88	0.00	2.73	7.65
2003-2004	9.30	2.33	9.39	2.33	9.30	0.05	9.30	16.32
<i>Average</i>	<i>5.24</i>	<i>5.24</i>	<i>6.60</i>	<i>0.66</i>	<i>9.83</i>	<i>0.02</i>	<i>5.80</i>	<i>15.06</i>

Table 4: Magnitude of period-specific non-zero change in tax parameters across 2,295 dyads (45 host countries) in percentage points

Period	Conditional (non-zero) change			Unconditional change		
	Corporate tax rate (1)	Depreciation allowances (2)	Withholding tax rate (3)	Corporate tax rate (4)	Depreciation allowances (5)	Withholding tax rate (6)
1991-1992	-4.02	2.16	-23.29	-1.22	0.38	-2.52
1992-1993	-5.31	0.12	-11.75	-2.25	0.04	-0.47
1993-1994	-2.83	2.83	2.32	-1.09	0.87	0.25
1994-1995	-2.27	-1.53	-1.28	-0.53	-0.25	-0.15
1995-1996	0.40	2.29	-14.82	0.06	0.36	-1.09
1996-1997	-0.49	0.46	-7.34	-0.10	0.04	-0.30
1997-1998	-2.68	-2.67	2.42	-0.74	-0.20	0.20
1998-1999	-2.09	-5.98	10.48	-0.52	-1.05	1.07
1999-2000	-2.28	2.00	-8.31	-0.70	0.36	-0.70
2000-2001	-3.74	-4.02	0.36	-1.44	-0.41	0.02
2001-2002	-3.90	-0.77	-6.99	-1.14	-0.06	-0.53
2002-2003	-1.20	-5.02	-11.12	-0.23	-0.37	-0.35
2003-2004	-2.98	8.66	-10.54	-0.97	0.20	-0.99
<i>Average</i>	<i>-2.80</i>	<i>-0.38</i>	<i>-4.84</i>	<i>-0.80</i>	<i>-0.05</i>	<i>-0.37</i>

Table 5: Frequency of change in tax parameters in percent for missing and non-missing changes of real stocks of bilateral outward FDI

$\log FDI_{i,j,t} - \log FDI_{i,j,t-1}$ category	Corporate tax rate		Depreciation allowances	Withholding tax rate	Change of (1) and (2)		Change of (1) and (2) and (3)		Change of (1) or (2) and (3)		Change of (1) or (2) or (3)	
	(1)	(2)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Missing	32.41	12.06	12.06	5.70	6.30	38.17	0.22	32.85	41.51			
Non-missing	26.18	14.01	14.01	8.66	5.00	35.19	0.68	27.39	39.89			
Difference is significant at 10%	YES	YES	YES	YES	YES	YES	YES	YES	YES			
<i>Average</i>	<i>28.98</i>	<i>13.92</i>	<i>13.92</i>	<i>7.61</i>	<i>5.46</i>	<i>36.24</i>	<i>0.51</i>	<i>29.32</i>	<i>40.47</i>			

Notes: The log change of FDI is missing for 59.91 percent of the 21,432 observations, for which tax policy instruments are available.

Table 6: Magnitude of change in parent and host country tax instruments in percent for missing and non-missing changes of real stocks of bilateral outward FDI

$\log FDI_{i,j,t} - \log FDI_{i,j,t-1}$ category	Conditional (non-zero) change				Withholding tax rate for repatriated profits from host to parent
	Parent	Host	Parent	Host	
Missing	-2.11	-2.29	-1.62	-1.92	-5.28
Non-missing	-2.87	-3.15	-0.29	0.35	-4.68
Difference is significant at 10%	YES	YES	YES	YES	NO
<i>Average</i> ^a	-2.58	-2.80	-0.79	-0.38	-4.84
	Unconditional change				
Missing	-0.64	-0.74	-0.16	-0.23	-0.30
Non-missing	-0.78	-0.83	-0.03	0.05	0.40
Difference is significant at 10%	YES	YES	YES	YES	YES
<i>Average</i> ^a	-0.73	-0.80	-0.09	-0.05	-0.37

Notes: Changes in tax parameters are from t-1 to t (as with FDI). - ^a Parent and host country average changes are not symmetric because of the unbalancedness of the panel due to unavailable withholding tax rate data.

Table 7: Analysis of variance of log change in FDI (in real U.S. dollars; base year is 2000)

		Dependent variable: $\log FDI_{i,j,t-1} - \log FDI_{i,j,t-2}$			
Categories (indicator variables)	Partial sum of squares	Degrees of freedom	F-statistic	p-value	
Contemp. change in 5 tax instruments ^a	3.94	5	0.93	0.458	
Year effects	59.27	11	6.38	0.000	
Country-pair (dyad) effects	981.69	1,083	1.07	0.060	
Model (all categories together)	1,051.69	1,099	1.13	0.003	
Residual	4,884.33	5,788			
Total	5,936.02	6,887			
Model characteristics	No. of observations	R ²	Root mean-squared error		
	6,888	0.177	0.919		

		Dependent variable: $\log FDI_{i,j,t} - \log FDI_{i,j,t-1}$			
Categories (indicator variables)	Partial sum of squares	Degrees of freedom	F-statistic	p-value	
Contemp. change in 5 tax instruments ^a	5.70	5	1.29	0.266	
Year effects	70.12	12	6.61	0.000	
Country-pair (dyad) effects	1,136.17	1,231	1.04	0.164	
Model (all categories together)	1,218.86	1,248	1.10	0.011	
Residual	5,662.09	6,401			
Total	6,880.95	7,649			
Model characteristics	No. of observations	R ²	Root mean-squared error		
	7,650	0.177	0.941		

		Dependent variable: $\log FDI_{i,j,t+1} - \log FDI_{i,j,t}$			
Categories (indicator variables)	Partial sum of squares	Degrees of freedom	F-statistic	p-value	
Contemp. change in 5 tax instruments ^a	25.26	5	5.53	0.000	
Year effects	66.38	11	6.60	0.000	
Country-pair (dyad) effects	1,075.59	1,174	1.00	0.477	
Model (all categories together)	1,159.87	1,190	1.07	0.074	
Residual	5,401.36	5,908			
Total	6,561.23	7,098			
Model characteristics	No. of observations	R ²	Root mean-squared error		
	7,099	0.177	0.956		

Notes: ^a We construct 5 indicator variables for tax policy change. They take a value of one whenever a change in the corresponding instrument occurred from period $t - 1$ to period t and zero else. The five instruments are: parent and host country corporate tax rates, parent and host country depreciation allowances and the bilateral withholding tax rate affecting repatriated profits from the host to the parent.

Table 8: The impact of corporate taxation on foreign affiliate production^a

	Country i corporations affiliate production in country j if country i (in relation to j) is:											
	small			large			identical			skilled labor abundant		
	EX	C	DED	EX	C	DED	EX	C	DED	EX	C	DED
Affiliate production	5.86%	5.86%	5.11% ^b	14.12%	14.12%	10.89%	25.00%	25.00%	25.00%	41.14%	41.14%	39.63%
Δt_i	+	+/- ^c	-	+	+/- ^c	-	+	+/- ^c	-	+	+	-
Δt_j	-	-/+ ^d	-	-	-/+ ^d	-	-	-/+ ^f	+ ^g	-	-	-
Δt_{ji}^w	-	-	-	-	-	-	-	-	-	-	-	-
$\Delta \delta_i$	+	+	+	+	+	+	+	+	+	-	-	+
$\Delta \delta_j$	-	-	-	-	-	-	-	-	-	+	+	+

Notes: Third country (k) assumptions: $L_k/(L_i + L_j + L_k) = S_k/(S_i + S_j + S_k) = 1/3$, Exemption method, $t_k = 0.3$, $t_{jk}^w = t_{ki}^w = t_{kj}^w = 0.05$, $\delta_k = 0.2$.

The assumptions about relative factor endowments in country i are as following: **small:** $L_i/(L_i + L_j) = S_i/(S_i + S_j) = 0.15$.

large: $L_i/(L_i + L_j) = S_i/(S_i + S_j) = 0.85$. **identical:** $L_i/(L_i + L_j) = S_i/(S_i + S_j) = 0.5$. **skilled labor abundant:** $L_i/(L_i + L_j) = 0.15$, $S_i/(S_i + S_j) = 0.85$.

Δt_i (Δt_j) indicates an increase of one percentage point in the corporate tax rate in country i (j).

Δt_{ji}^w indicates an increase of one percentage point in the withholding taxes for repatriation from country j country i .

$\Delta \delta_i$ (δ_j) indicates an increase of one percentage point in the depreciation allowances in country i (j).

^a Affiliate production is measured in percent of the total production of the X-good in countries i and j by corporation headquartered in countries i or j .

^b The base case scenario of 30% corporate taxes would rule out affiliate production, hence we evaluate the impact of a change in tax parameter, at $t_i = t_j = t_k = 0.1$

^c Positive, if country i is in excess credit position, i.e. if $t_i < (t_j + t_j^w(1 - t_j))$ holds, otherwise negative.

^d Negative, if country i is not in excess credit position, i.e. if $t_j < (t_i - t_j^w(1 - t_j))$ holds, otherwise positive.

^e Positive, if both country are in excess credit position, i.e. within the range $(t_j - t_j^w(1 - t_i)) < t_i < (t_j + t_j^w(1 - t_j))$, otherwise negative.

^f Negative, if both country are in excess credit position, i.e. within the range $(t_i - t_j^w(1 - t_j)) < t_j < (t_i + t_i^w(1 - t_i))$, otherwise positive.

^g Positive, for a reasonably large tax increase, otherwise negative.

Table 9: The third country effects on foreign affiliate production^a

Country i corporations affiliate production in country j if country i (in relation to j) is:												
small				large				identical				skilled labor abundant
	EX	C	DED	EX	C	DED	EX	C	DED	EX	C	DED
Affiliate production	5.86%	5.86%	5.11% ^b	14.12%	14.12%	10.89%	25.00%	25.00%	25.00%	41.14%	41.14%	39.63%
Exemption method with country k												
Δt_k	-	-	-	+	+	+	0	0	0	+	+	+
Δt_k^w	+	+	-	-	-	+	0	0	0	+	+	+
$\Delta \delta_w$	-	-	-	+	+	+	0	0	0	-	-	-
Credit method with country k												
Δt_k	-	-	-	+	+	+	0	0	0	+	+	+
Δt_k^w	+	+	-	-	-	+	0	0	0	+	+	+
$\Delta \delta_w$	-	-	-	+	+	+	0	0	0	-	-	-
Deduction method with country k												
Δt_k	-	-	+	+	+	-	0	0	0	+	+	+
Δt_k^w	-	-	+	+	+	-	0	0	0	+	+	+
$\Delta \delta_w$	-	-	-	+	+	+	0	0	0	-	-	-

Notes: The assumptions about relative factor endowments in country i are as following: **small:** $L_i/(L_i + L_j) = S_i/(S_i + S_j) = 0.15$.

large: $L_i/(L_i + L_j) = S_i/(S_i + S_j) = 0.85$. **identical:** $L_i/(L_i + L_j) = S_i/(S_i + S_j) = 0.5$. **skilled labor abundant:** $L_i/(L_i + L_j) = 0.15, S_i/(S_i + S_j) = 0.85$.

Δt_k indicates an increase of one percentage point in the corporate tax rate in country k .

Δt_k^w indicates an increase of one percentage point in the withholding taxes for repatriation from or to country k .

$\Delta \delta_k$ indicates an increase of one percentage point in the depreciation allowances in country k .

^a Affiliate production is measured in percent of the total production of the X-good in countries i and j by corporation headquartered in countries i or j .

^b The base case scenario of 30% corporate taxes would rule out affiliate production, hence we evaluate the impact of a change in tax parameter, at $t_i = t_j = t_k = 0.1$

Table 10: Estimation results - Dissecting the impact of corporate income taxation on FDI

Explanatory variables	Full Sample			Exemption Countries			Credit Countries		
	Coef.	t-statistic	Est. as predicted	Coef.	t-statistic	Est. as predicted	Coef.	t-statistic	Est. as predicted
Parent country corporate tax rate: t_{it}	-0.897	-2.870	?	-0.846	-2.410	N	-1.925	-1.070	?
Host country corporate tax rate: t_{jt}	-1.544	-5.280	?	-1.870	-5.870	Y	2.180	1.120	?
Withholding tax rate on repatriated profits (host country): t_{jtw}	-1.206	-4.150	Y	-0.731	-2.460	Y	-1.481	-0.760	Y
Parent country depreciation allowances: δ_{it}	-0.579	-1.310	N	-1.265	-2.310	N	-9.392	-2.520	N
Host country depreciation allowances: δ_{jt}	-2.415	-3.610	Y	-2.991	-2.750	Y	-8.688	-1.360	Y
$\delta_{it} \times D_{SK_i/SK_j > median(SK_i/SK_j)}$	0.460	0.850	N	1.292	1.910	N	8.282	1.800	N
$\delta_{jt} \times D_{SK_i/SK_j > median(SK_i/SK_j)}$	2.291	3.280	Y	2.795	2.500	Y	9.941	1.520	Y
$\text{Log}(GDP_{it})$	1.618	6.090	Y	1.744	5.510	Y	2.276	1.580	Y
$\text{Log}(GDP_{jt})$	1.513	6.390	Y	1.572	6.190	Y	0.422	0.740	Y
Observations	8,319			6,416			906		
R ²	0.358			0.402			0.295		
Sample selection (joint significance of Mills' ratios): Wald-test	27.82			17.54			6.15		
degrees of freedom	13			13			13		
p-value	0.010			0.176			0.941		

Notes: All models include time fixed effects and country-pair fixed effects as in Wooldridge (1995).

Reported t-statistics are bootstrapped with 1,000 replications to account for estimated Mills' ratios in the regressions.

Table 11: Estimation results cum third-country effects

Explanatory variables	Full Sample			Exemption Countries			Credit Countries		
	Coef.	t-statistic	Est. as predicted	Coef.	t-statistic	Est. as predicted	Coef.	t-statistic	Est. as predicted
Parent country corporate tax rate: t_{it}	-0.937	-2.910	?	-0.929	-2.670	N	-1.925	-1.340	?
Host country corporate tax rate: t_{jt}	-1.702	-5.610	?	-1.994	-5.820	Y	2.180	0.980	?
Withholding tax rate on repatriated profits (host country): t_{jtw}	-1.058	-3.510	Y	-0.658	-2.280	Y	-1.481	-0.110	Y
Parent country depreciation allowances: δ_{it}	-0.616	-1.410	N	-1.224	-2.160	N	-9.392	-2.340	N
Host country depreciation allowances: δ_{jt}	-2.464	-3.840	Y	-2.969	-2.750	Y	-8.688	-0.990	Y
$\delta_{it} \times D_{SKi/SKj > median(SK_i/SK_j)}$	0.419	0.790	N	1.052	1.520	N	8.282	1.630	N
$\delta_{jt} \times D_{SKi/SKj > median(SK_i/SK_j)}$	2.099	3.190	Y	2.682	2.430	Y	9.941	1.070	Y
$\text{Log}(GDP_{it})$	1.449	5.510	Y	1.626	5.000	Y	2.276	2.200	Y
$\text{Log}(GDP_{jt})$	1.402	5.970	Y	1.479	5.540	Y	0.422	0.640	Y
				Weighted third country effects					
Host country corporate tax rate: t_{jt}	-4.450	-2.330	?	-4.291	-2.180	?	-7.680	-0.970	?
Withholding tax rate on repatriated profits (host country): t_{jtw}	-2.467	-1.680	?	-0.688	-0.410	?	17.951	2.460	?
Host country depreciation allowances: δ_{jt}	-1.443	-0.950	?	-1.100	-0.590	?	-2.936	-0.470	?
$\delta_{jt} \times D_{SKi/SKj > median(SK_i/SK_j)}$	-2.231	-2.330	?	-2.405	-1.830	?	-4.737	-1.340	?
$\text{Log}(GDP_{jt})$	-0.019	-0.120	?	-0.159	-0.820	?	-1.266	-1.520	?
Observations	8,319			6,416			906		
R ²	0.361			0.405			0.292		
Third country effects (joint significance): Wald-test	23.58			23.18			14.43		
degrees of freedom	5			5			5		
p-value	0.000			0.000			0.013		
Sample selection (joint significance of Mills' ratios): Wald-test	30.97			17.12			1.24		
degrees of freedom	13			13			13		
p-value	0.003			0.194			1.000		

Notes: All models include time fixed effects and country-pair fixed effects as in Wooldridge (1995). Reported t-statistics are bootstrapped with 1,000 replications to account for estimated Mills' ratios in the regressions.

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