# Corporate Taxation and Multinational Activity

Peter Egger,[†] Simon Loretz,[‡]
Michael Pfaffermayr[§] and Hannes Winner[¶]

December 2005

**Abstract**

This paper assesses the influence of corporate taxation on the production and investment decisions of multinational firms. The theoretical hypotheses are derived in a numerically solvable general equilibrium model of trade and multinational firms, where we incorporate the following tax components: parent and host country 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 marginal effects of changes in the parameters of taxation are investigated in a panel of bilateral OECD outbound foreign direct investment (FDI) from 1991 to 2002. Thereby, we use annual information on domestic and international taxation as laid out in the tax codes and tax treaties. Our findings indicate that the parent country tax rate tends to foster outward FDI, whereas the host country's corporate and withholding tax rates are negatively associated with outward FDI. Further, we observe a considerable influence of depreciation allowances on FDI.

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

**Keywords:** Corporate taxation; Foreign direct investment; Panel econometrics

---

[†]Ifo Institute and University of Munich, Poschingerstraße 5, D-81679 Munich, Germany, e-mail: egger@ifo.de

[‡]Department of Economics and Statistics, University of Innsbruck; Universitaetsstrasse 15, A-6020 Innsbruck, Austria, e-mail: Simon.Loretz@uibk.ac.at

[§]Department of Economics and Statistics, University of Innsbruck; Universitaetsstrasse 15, A-6020 Innsbruck, Austria, e-mail: Michael.Pfaffermayr@uibk.ac.at

[¶]Department of Economics and Statistics, University of Innsbruck; Universitaetsstrasse 15, A-6020 Innsbruck, Austria, e-mail: Hannes.Winner@uibk.ac.at.

# 1 Introduction

What are the expected effects of parent and host country parameters of taxation (corporate and withholding tax rates, definition of tax base) on bilateral multinational activity in general equilibrium under alternative methods of double taxation relief? What is their impact on bilateral foreign direct investment (FDI) in an empirical application? These questions are of an obvious interest to policy makers. Yet, existing research does not provide an encompassing answer on these questions, as we will lay out in detail below.

The importance of relying on general equilibrium models to derive the hypotheses of taxation on FDI 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."*

This paper analyzes the relationship between taxation and FDI in a general equilibrium knowledge-capital model of multinational enterprises (MNEs; see Markusen, 1997, 2002). This model seems especially suited for studying the role of corporate taxation on FDI, since it has become the workhorse model of numerous 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). Controlling for the most important endowment-related and trade and investment impediment-related determinants of FDI, we analyze the role of parent and host country parameters of taxation under alternative methods of double taxation relief. The model enables us to predict the sign of the marginal effect of an increase in each parameter of taxation on multinational activity, separately.

Empirically, we use parent and host country corporate tax rates, withholding tax rates, (net 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 required data are collected from (domestic) tax codes and bilateral double tax treaties for 26 OECD countries over the period 1991 to 2002. The time-variant tax components vary at the parent-to-host country-pair rather than the host country (unilateral) level. We assess their impact on bilateral outbound FDI stocks. The majority of the empirically identified parameter signs of the taxation variables is in accordance with the theoretical hypotheses.

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

# 2 Previous evidence and motivation

Under which conditions and to which 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, 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. Then, a high tax burden in a host country represents an impediment to its inbound FDI, even if this effect is partly offset if tax revenues are used to reduce the investment costs there. In fact, this reasoning may explain why several industrialized countries have recently reduced their corporate tax rates.[1] For instance, in the Western European economies corporate tax rates were 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 literature can be distinguished here. One line of research 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; Shah and Slemrod, 1991; Hines and Rice, 1994; Devereux and Griffith, 1998a; Grubert and Slemrod,

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

1998; Altshuler, Grubert and Newlon, 2001; Mutti and Grubert, 2004; Desai, Foley and Hines, 2005). A third group of papers 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 affiliated firms are taxed on a territorial or worldwide basis in the country where the headquarters are located (see Slemrod, 1990; Swenson, 1994, 2001; Hines, 1996). In general, the U.S. evidence reveals that inbound FDI is negatively affected by the U.S. tax burden,[2] and U.S. outbound FDI is positively (negatively) associated with domestic (host country) tax rates. Although it would be expected that the impact of tax rates differs between credit and exemption countries (see, e.g., Slemrod, 1990), there is no clear-cut empirical support for this.

Only a few studies are focusing on 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. But 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 Lahrèche-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), point to a significant role of tax differentials for foreign plant location. De Mooij and Ederveen (2005), performing a meta-analysis based on 25 empirical studies on FDI and taxation, estimate a (median) tax rate elasticity of -3.3.[3]

In general, 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 average 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 their composite

[2] One 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).

[3] Focusing on U.S. studies, Hines (1997) reports a tax rate elasticity of approximately -0.6.

impact on MNE activity.[4] Our theoretical hypotheses shed light on the fact that different components of effective tax rates partly exert a non-monotonic impact on FDI.

Second, many of the existing applications tend to rely on an eclectic approach to specifying the estimated 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 is not in favor of an empirical analysis that uses all available explanatory variables, disregarding their relevance. But rather, it makes the case for a specification of FDI capturing the most important empirical determinants consistent with theory.

This paper extends the previous literature on taxation and FDI in two ways. First, it derives the hypotheses about the marginal impact of the most important parameters of taxation from a knowledge-capital model of multinational firms. Thereby, we consider the parent and host country corporate tax rates, the withholding tax rate, the parent and host country (net present value of) depreciation allowances, and the method of double taxation relief as the relevant parameters of taxation. Second, it assesses the theoretical hypotheses in a panel of OECD country-pairs by estimating the impact of each of the relevant tax components on FDI.

# 3 A numerically solvable general equilibrium model of trade and multinational firms under corporate taxation

There are two economies, indexed $\{i, j\} = \{1, 2\}$, and two sectors, $Z$ and $X$. $Z$ is a homogeneous (agricultural) good produced at constant returns to scale.

[4] Basically, effective tax rates are an aggregate measure of company tax burden, i.e., one and the same level of the effective tax rate may be made up by 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. Hence, effective tax rates are endogenous even for given tax rates.

There is a large number of varieties of (manufactures) $X$ that are imperfect substitutes as in Dixit and Stiglitz (1977). $X$ can be produced by various firm types.

National enterprises (NEs) serve domestic consumers locally and foreign ones through exports. The corresponding number of NEs in country $i$ is denoted by $n_i$. Horizontal MNEs headquartered in country $i$ run a subsidiary each at home and abroad. Hence, they serve consumers in both countries through local production. They produce one and the same good at home and abroad and do not engage in trade. The central motive to enter as a horizontal MNE is to avoid trade costs and to exploit multi-plant economies of scale at the level of firm-specific assets. $h_i$ indicates the number of horizontal MNEs headquartered in $i$. Vertical MNEs completely unbundle their headquarters' activities from the production process. They produce headquarters' services in the skilled labor abundant economy and locate production of one variety of $X$ in the unskilled labor abundant country. They serve foreign consumers locally and domestic ones via exports from their foreign subsidiary. $v_i$ denotes the number of vertical MNEs headquartered in $i$.

Quantities 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, $X^n_{iij}$ is the production of manufactures produced by a single NE of $i$ in $i$ for consumers in $j$. $X^h_{ijj}$ indicates the production of such a variety by a horizontal MNE headquartered in country $i$ in $j$ for consumers there. $X^v_{iji}$ denotes the production of a vertical MNE headquartered in $i$ in country $j$ for consumers in $i$. Subscripts are used in the same way with the homogeneous good ($Z$).

### 3.1 Households

Preferences are assumed to be a Cobb-Douglas nest of the homogenous $Z$-good and the differentiated $X$-good. Note that the price of $Z$ serves as the numéraire (since the trade of $Z$ is not impeded, its equilibrium price will be unity in either country). $U_i$ describes the utility function of a representative household in country $i$, where $\mu$ denotes the fixed expenditure share for differentiated products and $\sigma > 1$ is the elasticity of substitution between differentiated product varieties.

$$
\begin{aligned}
U_i &= X_{ic}^{\mu}\left(Z_{iii}+Z_{jji}\right)^{1-\mu}, \\
X_{ic} &\equiv \Bigg[ n_i\left(X_{iii}^{n}\right)^{\frac{\sigma-1}{\sigma}} + n_j\left(\frac{X_{jji}^{n}}{1+\tau}\right)^{\frac{\sigma-1}{\sigma}} + h_i\left(X_{iii}^{h}\right)^{\frac{\sigma-1}{\sigma}} \\
&\quad + h_j\left(X_{jii}^{h}\right)^{\frac{\sigma-1}{\sigma}} + v_i\left(\frac{X_{iji}^{v}}{1+\tau}\right)^{\frac{\sigma-1}{\sigma}} + v_j\left(X_{jii}^{v}\right)^{\frac{\sigma-1}{\sigma}} \Bigg]^{\frac{\sigma}{\sigma-1}} \qquad (1)
\end{aligned}
$$

The transport of the differentiated $X$-good is subject to iceberg transport costs ($\tau$) for the shipment of each unit. $Z$-goods, in contrast, are costlessly tradeable.

The maximization problem of the consumers obtains demand for a single variety of manufactures of

$$
\begin{aligned}
X_{iii}^{k} &= \left(p_{iii}^{k}\right)^{-\sigma} P_i^{\sigma-1}\mu E_i \quad \forall \quad i\in\{1,2\} \quad \wedge \quad \forall \quad k\in\{n,h\} \\
X_{jii}^{k} &= \left(p_{jii}^{k}\right)^{-\sigma} P_i^{\sigma-1}\mu E_i \quad \forall \quad i\neq j\in\{1,2\} \quad \wedge \quad \forall \quad k\in\{h,v\} \\
X_{iji}^{v} &= \left(p_{iji}^{v}\right)^{-\sigma} P_i^{\sigma-1}\mu E_i \quad \forall \quad i\neq j\in\{1,2\} \\
X_{jji}^{n} &= \left(p_{jji}^{n}\right)^{-\sigma} P_i^{\sigma-1}\mu E_i \quad \forall \quad i\neq j\in\{1,2\}, \qquad (2)
\end{aligned}
$$

where $E_i$ 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

$$
\begin{aligned}
P_i &= \Bigg[ n_i\left(p_{iii}^{n}\right)^{1-\sigma} + n_j\left(p_{jji}^{n}\right)^{1-\sigma} + h_i\left(p_{iii}^{h}\right)^{1-\sigma} \\
&\quad + h_j\left(p_{jii}^{h}\right)^{1-\sigma} + v_i\left(p_{iji}^{v}\right)^{1-\sigma} + v_j\left(p_{jii}^{v}\right)^{1-\sigma} \Bigg]^{\frac{1}{1-\sigma}}. \qquad (3)
\end{aligned}
$$

The division of expenditures across the two sectors is as follows.

$$X_{ic} = \frac{\mu E_i}{P_i} \qquad (4)$$

$$Z_{iii} + Z_{jji} = (1-\mu)E_i \qquad (5)$$

## 3.2 Production and labor market

The production function for the $Z$-good is a CES technology being identical in both countries. It uses skilled labor ($S$) and unskilled labor ($L$), (where '$a$' is the coefficient for $S$ and '$1-a$' that for $L$). The technical rate of substitution is $1/(1-\rho)$.

$$Z_{iii} + Z_{iij} = [aS_i^\rho + (1-a)L_i^\rho]^{\frac{1}{\rho}} \tag{6}$$

Since all firms within a country face the same homothetic technology and identical factor prices, the $Z$-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 given by

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

$$a_{SZi} = \left(\frac{w_{Si}}{a}\right)^{\frac{1}{\rho-1}} \left[\left(\frac{w_{Si}^\rho}{a}\right)^{\frac{1}{\rho-1}} + \left(\frac{w_{Li}^\rho}{1-a}\right)^{\frac{1}{\rho-1}}\right]^{-\frac{1}{\rho}} \tag{8}$$

Perfect competition in the production of the homogeneous $Z$-good ensures zero profits so that the unit costs satisfy

$$a_{LZi}w_{Li} + a_{Szi}w_{Si} \geq 1 \quad \perp \quad Z_{iii} \geq 0, Z_{iij} \geq 0 \quad \forall \quad i,j \in \{1,2\} \tag{9}$$

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

The production of manufactures $X$ uses both factors in fixed proportions (see Markusen, 2002), where $a_{LXi}$ and $a_{SXi}$ are the corresponding input coefficients for production in country $i$. The set-up of firms in the $X$-sector requires skilled labor $(a_{Sni}, a_{Shi}, a_{Svi})$ in order to produce firm-specific assets and blueprints and unskilled labor $(a_{Lni}, a_{Lhii}, a_{Lhij}, a_{Lvi})$ to set up plant-specific assets (production facilities). In line with the literature, we assume that fixed input requirements are highest for horizontal MNEs, lower for vertical MNEs and lowest for NEs. Specifically, we set $a_{Sni} = 2 < a_{Shi} = a_{Svi} = 2 + \theta$ to account for the fixed firm cost disadvantages of running a multinational network. The plant-specific fixed input requirements are $a_{Lni} = a_{Lhii} = 1$ and $a_{Lhij} = a_{Lvi} = 1+\gamma$, reflecting the difficulties that may arise in setting up a plant abroad.

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

$$\begin{aligned} L_i \geq\ & a_{LXi}\Big[n_i\left(X_{iii}^n + X_{iij}^n\right) + h_i X_{iii}^h + h_j X_{jii}^h + v_j\left(X_{jii}^v + X_{jij}^v\right)\Big] \\ & + a_{LZi}\left(Z_{iii} + Z_{iij}\right) \\ & + n_i + h_i + (1+\gamma)(h_j + v_j) \quad \perp \quad w_{Li} \geq 0, \end{aligned} \tag{10}$$

$$
\begin{aligned}
S_i \quad \geq \quad & a_{SXi}\left[n_i\left(X^n_{iii}+X^n_{iij}\right)+h_iX^h_{iii}+h_jX^h_{jii}+v_j\left(X^v_{jii}+X^v_{jij}\right)\right] \\
& + a_{SZi}\left(Z_{iii}+Z_{iij}\right)+2n_i+(2+\theta)(h_i+v_i) \quad \perp \quad w_{Si}\geq 0. \quad (11)
\end{aligned}
$$

Variable unit costs for the production of an $X$-variety are given by $c_{Xi} = a_{SXi}w_{Si} + a_{LXi}w_{Li}$. 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 within a country ensure that the domestic price of a locally produced good (the mill price) in equilibrium is identical across all firms producing there. Therefore, it is sufficient to use a single subscript with prices, indicating the country of production. Accordingly, we may write $p_i \equiv p^n_{iii} = p^h_{iii} = p^h_{jii} = p^v_{jii}$. The consumer price for exported varieties of country $i$ is then $p_i(1+\tau) \equiv p^n_{iij} = p^v_{jij}$. 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

$$p_i = c_{Xi}\frac{\sigma}{\sigma-1}. \quad (12)$$

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 $FC^n_i = 2w_{Si}+w_{Li}$. 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 deductable from the tax base by $\delta_i$. The number of national firms in country $i$ is then determined by fixed costs before subtracting (i.e., gross of) depreciation allowances for NEs in $i$ ($D^n_i$)

$$FC^n_i \geq \frac{p_i\left(X^n_{iii}+X^n_{iij}\right)}{\sigma}(1-t_i) + \underbrace{\delta_i t_i(2w_{Si}+w_{Li})}_{D^n_i} \quad \perp \quad n_i \geq 0. \quad (13)$$

The fixed costs of MNEs are $FC^h_i = (2+\theta)w_{Si} + w_{Li} + (1+\gamma)w_{Lj}$ for a horizontal MNE and $FC^v_i = (2+\theta)w_{Si} + (1+\gamma)w_{Lj}$ for a vertical MNE, respectively. Zero profits imply that fixed costs gross of depreciation allowances for MNEs ($D^h_{ii}$, $D^h_{ij}$,$D^v_{ii}$,$D^v_{ij}$) are

$$\begin{aligned} FC^h_i &\geq \frac{p_i X^h_{iii}}{\sigma}(1-t_i) + \frac{p_j X^h_{ijj}}{\sigma}(1-t_j)(1-t^M_{ji}) \\ &+ \underbrace{\delta_i t_i(2w_{Si} + w_{Li}) + \delta_j t_j (t^M_{ji} - t^w_j)(1+\gamma) w_{Lj}}_{D^h_{ii}} \\ &+ \underbrace{\delta_j t_j (1 + t^w_j)(1+\gamma) w_{Lj}}_{D^h_{ij}} \perp h_i \geq 0 \end{aligned} \tag{14}$$

$$\begin{aligned} FC^v_i &\geq \frac{p_j \left( X^v_{iji} + X^v_{ijj} \right)}{\sigma}(1-t_j)(1-t^M_{ji}) \\ &+ \underbrace{\delta_j t_j (t^M_{ji} - t^w_j)(1+\gamma) w_{Lj}}_{D^v_{ii}} \\ &+ \underbrace{\delta_j t_j (1 + t^w_j)(1+\gamma) w_{Lj}}_{D^v_{ij}} \perp \ v_i \geq 0. \end{aligned} \tag{15}$$

We assume that MNEs fully (and immediately) 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 ($t_j$) taxation in the host country. Upon repatriation, foreign-earned profits are additionally subject to withholding taxes and taxation at home ($t^M_{ji}$), where the first subscript 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-earned income from affiliates is exposed to double taxation. Otherwise, the extent to which double taxation occurs depends on the method of double taxation relief (see Alworth, 1988, for a detailed discussion).[5]

$$\begin{aligned} t^M_{ji} &= t^w_j & &\text{(exemption)} \\ &= max\left[\frac{t_i - t_j}{1-t_j}, t^w_j\right] & &\text{(credit)} \\ &= t_i(1-t^w_j) + t^w_j & &\text{(deduction)} \end{aligned} \tag{16}$$

All production factors are owned by the households, so that consumer income is determined by the sum of factor rewards in country $i$ ($w_{Si}S_i + w_{Li}L_i$)

[5] See 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. See Davies (2004) for a survey.

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.

### 3.3 Public sector

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

$$\begin{aligned} G_i \;=\; & n_i\left[\left(X^n_{iii}+X^n_{iij}\right)\frac{p_i}{\sigma}t_i - D^n_i\right] \\ & + h_i\left[X^h_{iii}\frac{p_i}{\sigma}t_i + X^h_{ijj}\frac{p_j}{\sigma}(1-t_j)(t^M_{ji}-t^w_j) - D^h_{ii} - D^h_{ij}\right] \\ & + v_i\left[\left(X^v_{ijj}+X^v_{iji}\right)\frac{p_j}{\sigma}(1-t_j)(t^M_{ji}-t^w_j) - D^v_{ii} - D^v_{ij}\right] \\ & + h_j\left[X^h_{jii}\frac{p_i}{\sigma}(t_i - t_i t^w_i + t^w_i) - D^h_{ji}\right] \\ & + v_j\left[\left(X^v_{jii}+X^v_{jij}\right)\frac{p_j}{\sigma}(t_i - t_i t^w_i + t^w_i) - D^v_{ji}\right]. \end{aligned} \tag{17}$$

Public Expenditure is either used to finance a lump-sum transfer to consumers or to provide public infrastructure to the firms to lower their fixed input requirements. In case of lump-sum transfers, the 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 the 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.[6] Accordingly, the level of public infrastructure ($I_i$) in country $i$ equals

$$I_i = \frac{G_i}{(w_{Si}+w_{Li})}. \tag{18}$$

We assume that public infrastructure reduces the fixed factor requirement of firms headquartered in a given country. Then, the fixed costs of setting up a national firm in country $i$ are

$$FC^n_i = \frac{2w_{Si}+w_{Li}}{I_i^{\beta}}, \tag{19}$$

where $\beta$ is a scaling parameter. Similarly, the fixed costs for horizontal and vertical multinationals are reduced by the public infrastructure in the relevant

[6]This guarantees that the production of public infrastructure as such does not induce direct effects on relative factor prices of skilled and unskilled labor.

country

$$FC_i^h = \frac{(2+\theta)w_{Si} + w_{Li}}{I_i^\beta} + \frac{(1+\gamma)w_{Lj}}{I_j^\beta}, \tag{20}$$

$$FC_i^v = \frac{(2+\theta)w_{Si}}{I_i^\beta} + \frac{(1+\gamma)w_{Lj}}{I_j^\beta}. \tag{21}$$

### 3.4 Model parameterization

Due to the non-linearities and the numerous possible corner solutions, an analytical solution of the model is not feasible (see Markusen, 2002). Therefore, we proceed by deriving the empirically testable hypotheses of interest by means of numerical simulation. For this, we use the following parameter values. World factor endowments are set at $L = 200$ and $K = 50$. The elasticity of substitution in the production of the homogeneous good is $(1/(1-\rho)) = 3$, while we assume $a = 0.9$ 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 $a_{LXi} = 0.75$ and $a_{SXi} = 0.25$ (see Markusen, 2002). We parameterize the additional effort of transferring knowledge abroad with $\theta = 0.1$ and the difficulties of setting up a plant abroad with $\gamma = 0.1$. According to the United Nation's World Trade Database, the share of manufacturing good trade in the 1990s amounts to 70%-80% 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 to be high with $\tau = 0.25$ being in line with Carr, Markusen and Maskus (2001).

Concerning the public sector, we initially set the corporate tax rates symmetrically at $t_i = t_j = 0.3$, 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 $t_i^w = t_j^w = 0.05$ at a low level. We assume that about 20 percent of fixed costs are tax deductible so that $\delta = 0.2$.[7] The scaling parameter to model the relative importance of public infrastructure is set at $\beta = 0.1$.

[7]We use depreciation allowances (including first-year extra allowances) to approximate the tax base (see Devereux and Griffith, 1998b, 2003). In our data set used below, the net present value of depreciation allowances for tax purposes are about 30 percent higher than the assumed depreciation rate. The mean of the periodical depreciation rates in the sample are about 22 (machinery) and 5 percent (buildings), respectively.

## 4 Simulation results and hypotheses

The determination of multinational activity without corporate taxation (all parameters of taxation are set at zero) in our model is as in Carr, Markusen, and Maskus (2001). Horizontal multinational firms prevail, if country size and relative factor endowments are not too different among the two countries. Vertical multinationals 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 (MNEs). With all parameters of taxation set at zero, the chosen calibration of the model leads to a surface for outbound foreign affiliate production of country $i$ – defined as $(h_i + v_i)X_{ijj} + v_i X_{iji}$, as a share of the world production of $X$ being virtually identical to the ones in Carr, Markusen, and Maskus (2001) and in Markusen and Maskus (2002).

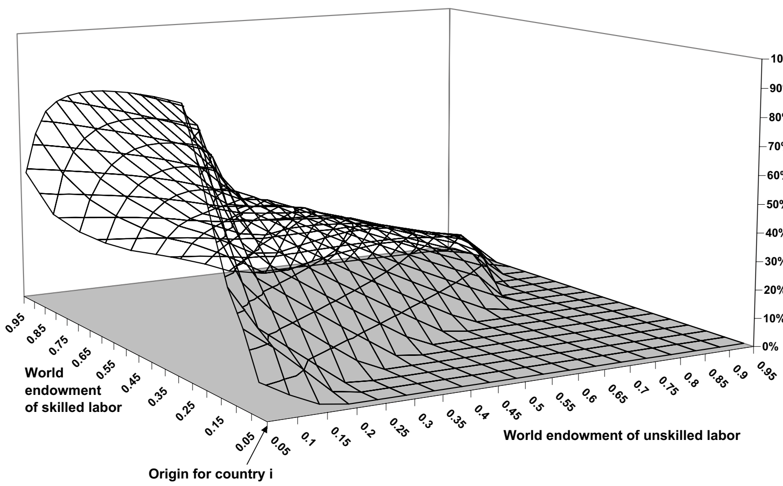


Figure 1: **Share of affiliate production without corporate taxation**

Figure 1 displays foreign affiliate production in an Edgeworth box with factor endowments on the axes for this benchmark case. Consider countries with identical relative factor endowments, so that NEs and horizontal MNEs prevail. Foreign affiliate production by horizontal MNEs increases if two countries become more similar in size, when moving along the diagonal of the Edgeworth box. Foreign affiliate production by vertical MNEs rises if relative factor endowment differences increase, all else equal. The latter can be seen when moving from the center of the Edgeworth box in Figure 1 towards its North-Western corner.

Figure 2 displays the share of foreign affiliate production under a tax ex-

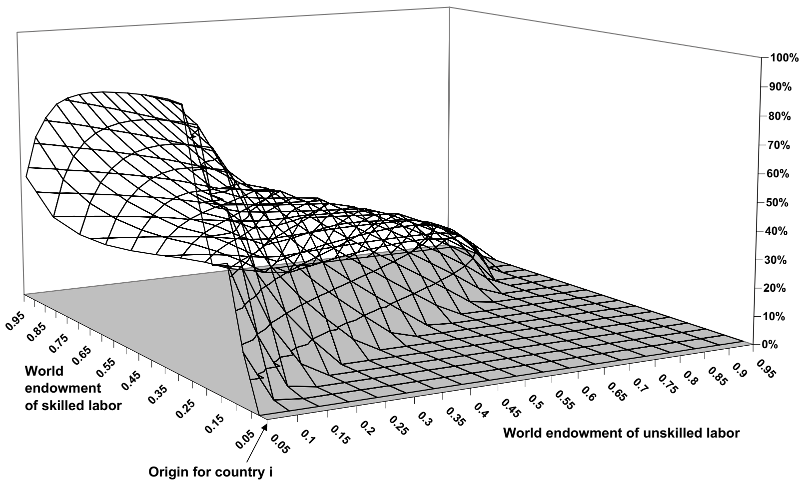


Figure 2: **Share of affiliate production with exemption or credit method ($t_i = t_j = 0.3$; $t_i^w = t_j^w = 0.05$; $\delta_i = \delta_j = 0.2$; public infrastructure investments)**

emption or tax credit system.[8] In this case, multinational activity is affected only to a minor extent by corporate taxation (see the small differences between Figures 1 and 2). In the knowledge-capital model, this holds true with both a lump-sum redistribution of tax revenues and public infrastructure investments aimed at reducing fixed set-up cost.[9]

Under the deduction method, the distortion of multinational activity becomes evident (see Figure 3). In contrast to the exemption or the credit system, the existence of horizontal multinationals is significantly reduced, since the extent of double taxation is larger here. Horizontal multinationals come only into existence between countries with similar relative endowments, if the tax revenues are spent to reduce fixed costs (public infrastructure expenditures). Multinationals become extinct in the center of the Edgeworth box (where countries are identically endowed), if tax revenues are redistributed via lump-sum transfers.[10] This holds true even with moderate levels of national tax rates, given the remaining calibration of the model. Only at large relative factor endowment differences (i.e., in the North-Western and South-Eastern corners of the Edgeworth box), (vertical) MNEs prevail under tax deduction and lump-sum transfers, given the chosen model parameterization.

[8] Note that we assume symmetric tax rates in the initial equilibrium so that the exemption and the credit method are identical in this case.

[9] For the sake of brevity, we display only the results under public infrastructure investments. The corresponding figures for lump-sum transfers are available from the authors upon request.

[10] We do not display the corresponding figure for lump-sum transfers for the sake of brevity. But it is available from the authors upon request.

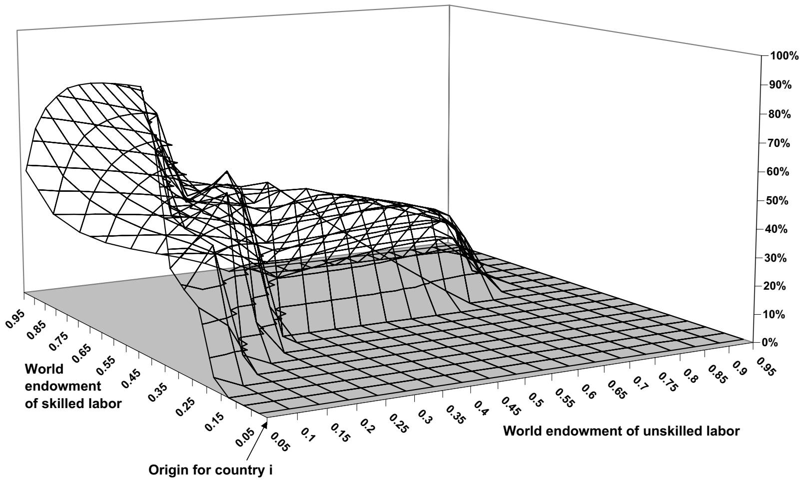


Figure 3: **Share of affiliate production with deduction method ($t_i = t_j = 0.3$; $t_i^w = t_j^w = 0.05$; $\delta_i = \delta_j = 0.2$; public infrastructure investments)**

In the following, we focus on five factor endowment configurations within the Edgeworth box to derive the marginal effects of the taxation parameters of interest on MNE activity. For each of these allocation 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 3.4 with a counterfactual case where the taxation parameters of interest are increased by one percentage point, one at a time.

We consider the following endowment configurations. First, one where country $i$ is small but the relative factor endowments are identical across 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 1.65 percent of the world production of $X$ under tax credit or exemption (there is no MNE activity under deduction). The reason for the small scale of MNE activity is that it is not very attractive to run a plant in the small country for MNEs in $i$. Second, at $L_i/(L_i + L_j) = S_i/(S_i + S_j) = 0.85$ and zero relative factor endowment differences, country $i$ is large relative to $j$. Still, its MNE activity is relatively small. However, there are more MNEs than in the small country, since the domestic market is larger as well. Country $i$'s foreign affiliate production relative to the world production of $X$ amounts to 14.98 percent under tax credit or exemption (8.07 percent under deduction) in this case. 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, exactly 50 percent of a horizontal MNE's production takes place in its foreign subsidiary. Vertical MNEs do not exist in this case. The foreign affiliate production accounts for 25 percent of the overall production of $X$ by NEs and MNEs. Fourth, consider an endowment allocation where country $i$ is unskilled labor abundant so that $L_i/(L_i + L_j) = 0.85$ and $S_i/(S_i + S_j) = 0.15$. In this case, the country exhibits a comparative advantage in goods production rather than in setting up firms, since unskilled labor is relatively cheap as compared to skilled labor. Accordingly, the country does not headquarter MNEs in this case. Finally, in an endowment configuration where country $i$ is skilled labor abundant with $L_i/(L_i + L_j) = 0.15$ and $S_i/(S_i + S_j) = 0.85$, it headquarters many (vertical) MNEs that exploit the gains from comparative advantage. Then, 45.26 (45.94) percent of the production of $X$ is due to country $i$'s foreign subsidiary activity. These results are summarized in Table 1.

> Table 1 <

Furthermore, Table 1 provides a summary of the marginal effects of the individual parameters of taxation on country $i$'s MNE activity. Note that the table does not report any impact of the parameters of taxation on the outbound MNE activity of an unskilled labor abundant economy, since such an economy does not run foreign affiliates.

**Corporate tax rate:** Under the exemption method, any increase in the parent country tax rate stimulates foreign plant location.[11] The reason for the positive nexus of parent country tax rates and outbound MNE activity is that only production within the country is affected by the change in domestic tax rates under exemption. For similar reasons, a higher tax rate in the host country reduces affiliate production within that country. Hence, the predicted marginal effect of an increase in parent (host) country corporate tax rates on a country's outbound MNE activity is positive (negative) under exemption.

With a deduction system, an increase in the corporate tax rate of a small or large parent country reduces its horizontal MNE activity. The reason is that profits of foreign subsidiaries are taxed at a higher rate than profits of foreign

[11] Slemrod (1990) was the first who has pointed to a positive nexus 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 home country corporate tax rates as a determinant of FDI.

NEs. Then, the parent country's MNE activity is crowded out by the host's NEs. Interestingly, an increase in the corporate tax rate of a small or large host country reduces the parent's MNE activity as well. In this case, the increase in the corporate tax rate there hurts all production abroad (that of domestic horizontal MNEs as well as that of foreign MNEs). There is no direct impact of the tax rate on the parent's NEs who then replace domestic horizontal MNEs. For the same reasons as before, an increase in the parent (host) country corporate tax rate increases (reduces) the outbound MNE activity for two countries that are identical in the initial equilibrium. There, a moderate increase in the host country's corporate tax rate may increase the parent's outbound MNE activities, as long as the host country's corporate tax rate is low enough. The tax burden of the domestically headquartered horizontal MNEs increases more than for the foreign-owned ones. If the host's corporate tax rate exceeds a certain level, a further increase in the tax rate reduces the parent's outbound MNE activity for the same reasons as for a small/large parent country. For skilled labor abundant parent countries, the effect of an increase in the corporate tax rate under deduction is the same as under exemption. Then, an increase in the foreign (domestic) corporate tax rate fosters the parent's (the host's) NE activity at the expense of the parent's MNE activity. The reason is simply that the host country does not run MNEs and there is no direct negative effect on these NEs at all, whereas there is one on the host's (the parent's) NEs as well as on the MNEs.

With a tax credit system, the effects of changing corporate tax rates on MNE activity tend to be non-monotonic if horizontal MNEs prevail (i.e., the factor endowment differences are not important; see the first three columns of effects in Table 1). The reason is that a parent's NEs and MNEs are differently affected by changing corporate tax rates, depending on the differential in the domestic and foreign corporate tax rates before and after the change. An increase in the statutory tax rate of a large parent country fosters its foreign affiliate production only, if the tax rate is higher than that one applying to foreign profits. Then, the effect of a domestic statutory tax rate change is identical to the one under exemption, and horizontal MNEs crowd out domestic NEs. Otherwise, the increase in the parent country corporate tax rate affects domestic MNEs in a similar way as under deduction. In this case, the domestic tax rate applies to domestic MNEs, rendering foreign NEs better off. For similar reasons, an increase in the host country's corporate tax rate can boost a parent's outbound MNE activity there, if the parent country's corporate tax rate is high enough.

Then, an increase in the corporate tax rate under the credit system does not exert a direct impact on MNEs with foreign subsidiaries there. But rather, it negatively affects both NEs and MNEs headquartered in the host country. Now, assume that the two countries are identical in the initial equilibrium and the corporate tax rate increases such that $(t_j - t^w j) < t_i > (t_j + t_j^w)$. Then, the resulting effect on MNE activity is identical to the one under exemption. Otherwise, the production facilities are asymmetrically affected by the tax change and the effect resembles the one under deduction, for the same reasons as with small/large parent countries.

**Withholding tax:** The effects of an increase in the withholding tax are unambiguous and straight-forward. Independently of the method of double taxation relief, an increase in the withholding tax rate only affects MNEs. These direct negative effects on MNE activity dominate and, accordingly, MNEs are crowded out by NEs.

**Depreciation allowances:** Interestingly, an increase in the depreciation allowances in the parent country ($\delta_i$) reduces the parent's horizontal outbound MNE activity. Note that fixed costs are deductable 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). For economies with similar relative factor endowments, any increase in depreciation allowances in a country increases local production, there. In particular, domestically headquartered firms (NEs and MNEs) benefit more than proportionally from this. Inbound MNE activity is replaced, whereas the country's outbound MNE activity increases. However, this effect is maintained only with cross-hauling, i.e., a coexistence of outbound and inbound horizontal MNE activity at small (zero) relative factor endowment differences. At large relative factor endowment differences where vertical MNEs and, hence, one-way MNE activities prevail, the signs for the marginal effects of depreciation are reversed. For vertical MNEs in a skilled labor abundant parent country, an increase in the depreciation allowances has a smaller positive effect than it would have for horizontal MNEs. The reason is that vertical MNEs, in contrast to domestic NEs or horizontal MNEs, can only deduct fixed plant set-up costs, since they do not operate a production facility at the headquarters' location. Accordingly, an increase in domestic depreciation allowances leads to a distortion in favor of domestic NEs and vertical outbound MNE activity is crowded out. An increase in the depreciation allowances in the unskilled labor abundant host country attracts even more affiliate production from abroad (i.e., increases the skilled labor abundant parent country's vertical outbound MNE activity).

# 5 Specification of bilateral outbound FDI

Our empirical analysis employs a panel data set of bilateral outbound FDI stocks among the OECD economies. To guard against the bias from omitted time-invariant variables and time-specific common shocks that affect all country-pairs in the same way, we include fixed country-pair and time effects. According to recent empirical research, the most important determinants of multinational firm location are country size, skilled labor endowments, trade and investment costs, and interaction terms thereof (Carr, Markusen, and Maskus, 2001; Markusen and Maskus, 2002; Blonigen, Davies, and Head, 2003). Whereas most of the estimated specifications employ dependent and independent variables in levels, Mutti and Grubert (2004) find that a specification in logs is superior from an econometric point of view.

Therefore, we specify the log of FDI from country $i$ to country $j$ in year $t$, $FDI_{ijt}$, as a log-linear function of the following explanatory variables (see Carr, Markusen, and Maskus, 2001; Markusen and Maskus, 2002; Markusen, 2002). The sum of parent and host country GDP in period $t$, $\Sigma GDP_{ijt} = \log GDP_{it} + \log GDP_{jt}$, the similarity between the parent and the host market in country size, $\Delta GDP_{ijt}^2 = (\log GDP_{it} - \log GDP_{jt})^2$, and four interaction terms to account for the impact of knowledge-capital (skilled labor endowment differences, $\Delta SK_{ijt} = \log SK_{it} - \log SK_{jt}$) on FDI: $INT1_{ijt} = \Delta SK_{ijt} \times \Delta GDP_{ijt} \times \mathbf{I}(\Delta SK_{ijt} > 0)$, where $\Delta GDP_{ijt} = (\log GDP_{it} - \log GDP_{jt})$ and $\mathbf{I}(\Delta SK_{ijt} > 0)$ is a dummy variable that is set to 1, if $\Delta SK_{ijt} > 0$, and 0 else; $INT2_{ijt} = \Delta SK_{ijt} \times \Sigma GDP_{ijt} \times \mathbf{I}(\Delta SK_{ijt} > 0)$; $INT3_{ijt} = -\Delta SK_{ijt} \times \Sigma GDP_{ijt} \times \mathbf{I}(\Delta SK_{ijt} < 0)$, where $\mathbf{I}(\Delta SK_{ijt} < 0)$ is a dummy variable that is set to 1, if $\Delta SK_{ijt} < 0$, and 0 else; and $INT4_{ijt} = \Delta SK_{ijt} \times \log DIST_{ij}$, where $DIST_{ij}$ is the great circle distance between the parent's and the host's capitals, serving as a proxy for trade costs. According to the literature, horizontal FDI is expected to rise, if two markets grow larger and become more similar (i.e., $\Sigma GDP_{ijt}$ rises and $\Delta GDP_{ijt}$ declines). Vertical FDI is expected to increase, if the parent country becomes smaller and/or relatively better endowed with skilled labor, especially, if the trade costs between the two markets are low. Hence, we expect a positive sign for the parameters of $\Sigma GDP_{ij}$ and $\Delta GDP_{ij}$, but a negative one for the parameters of $INT1_{ijt}, ..., INT4_{ijt}$.

Most importantly for our purpose, the above theoretical model supports the use of the following components of country-pair (bilateral) tax rates: the parent and the host country statutory corporate tax rates $(t_{it}, t_{jt})$, whose impact depends on the prevailing method of double taxation relief established in tax treaties (i.e., exemption, credit, and deduction);[12] the withholding tax rate applying to repatriated profits in a given host country $(t_{jt}^{w})$; and the parent and host country-specific net value of depreciation allowances $(\delta_{it}, \delta_{jt})$. To avoid a possible endogeneity bias, we use the lagged values of all tax variables.

# 6 Empirical analysis

**Baseline results:** We provide details on the data sources and descriptive statistics for all variables of interest in the Appendix (see Tables A1 to A3 and Figure 4). Most importantly, Figure 4 illustrates the change in all considered components of corporate taxation: parent and host country statutory tax rates, their depreciation allowances, and the host economy's withholding tax rate. The Figure covers the same sample of host countries and years that is also considered in the empirical analysis. We report the mean as well as the minimum and maximum values of each component and year. Obviously, there is time variation in every component, rendering parameter estimation in fixed effects models possible. In the following, we concentrate on a summary of our most important findings based on fixed country-pair and time effects regressions. To facilitate the comparison of the point estimates with the theoretical hypotheses, we indicate in Table 2 whether our findings are in line with the predictions (indicated by $Y$) or not (indicated by $N$). If the expected effects are ambiguous according to Table 1 (e.g., for $\delta_{it}$ and $\delta_{jt}$), this is indicated by a '?' in the table. With regard to the usual knowledge-capital variables, we find across the board that the impact of overall and relative country size ($\Sigma GDP_{ijt}$ and $\Delta GDP_{ijt}^2$) is in line with theory, whereas the skill-endowment interaction term parameters $(INT1_{ijt}, ..., INT4_{ijt})$ are ambiguous.[13] All estimated standard er-

[12] Note that for about 97 percent of the observations a tax treaty is effective. Of the remaining three percent, about one percentage point (i.e., 18) of the observations are covered by the European Union's Parent-Subsidiary Directive (Directive 90/435) that applies to FDI within the European Union. For these and the remaining two percent or 54 observations in our database, methods of double taxation relief (exemption, credit, deduction) are applied unilaterally.

[13] Also, our findings do not match with the empirical results in Carr, Markusen, and Maskus (2001) and Markusen and Maskus (2002). However, there are three reasons for why our results differ from those in the literature. First, we use stocks of outbound FDI rather than foreign affiliate sales as our dependent variable (however, Blonigen, Davies, and Head, 2003, indicate that the results tend to be very similar for FDI and foreign affiliate sales). Second, we apply a log-linear specification (as suggested by Mutti and Grubert, 2004) rather than one in levels.

rors and test statistics are corrected for heteroskedasticity and autocorrelation, following Newey and West (1987). In general, the model fit is very well across all estimated models. Also, we checked for a potential bias due to sample selection arising from missing FDI data (see Razin, Rubinstein, and Sadka, 2005). However, in our sample of OECD country-pairs, there is no indication for such a selection bias. See the insignificant parameter of the inverse Mills ratio given in the table footnotes. In the subsequent discussion of Table 2, we summarize our findings regarding the impact of the tax rate components on bilateral outbound FDI in the OECD.

> Table 2 <

Table 2 summarizes the results for (i) the full sample (covering all country-pairs and years, independent of the implemented method of double taxation relief), (ii) only country-pairs applying the exemption method, and (iii) only country-pairs applying the credit method.[14] In each case, we estimate two specifications. Whereas Model 1 is based on (statutory corporate and withholding) tax rates only. Further, the model suggests including a similar interactive term of the parent corporate tax rate, $t_{it} \times \Delta SK_{ijt} \times \mathbf{I}(\Delta SK_{ijt} > 0)$, where we expect a positive sign for the exemption as well as the credit method and, hence, also in the full sample. Model 2 additionally includes the present values of depreciation allowances and three interaction terms, whose inclusion is necessary, since our theoretical model does not predict a clear-cut relationship between the depreciation allowances ($\delta_{it}$ and $\delta_{jt}$) and outbound FDI. But rather, their impact depends on the relative skilled-to-unskilled labor endowments in the parent country relative to the host (see Table 1). Hence, the model points to the inclusion of the interactive terms $\delta_{it} \times \Delta SK_{ijt} \times \mathbf{I}(\Delta SK_{ijt} > 0)$ and $\delta_{jt} \times \Delta SK_{ijt} \times \mathbf{I}(\Delta SK_{ijt} > 0)$, where we expect a negative parameter estimate

Third, our sample covers a panel of OECD parent and host countries that are relatively similarly endowed, which differs from that one in Carr, Markusen, and Maskus (2001) and Markusen and Maskus (2002), who use U.S. foreign affiliate sales across a larger set of hosts over time. Finally, we employ country-pair and time fixed effects. In particular, this wipes out all time-invariant level information so that the parameters are necessarily estimated from the time variation in the data.

[14]In our sample, for around 59% (34%) of the observations the exemption (credit) method is implemented (either through unilateral tax law or through bilateral tax treaties). The remaining observations apply the deduction method (around 7%). Since the latter group contains only 149 observations, it is not possible to estimate the tax effects precisely there. Hence, Table 2 only reports the results for the pooled sample and the exemption and credit sub-samples.

for the former and a positive one for the latter.

In general, we would expect that the parent country tax rate exerts a positive impact on the country's outbound FDI.[15] This is in line with the positive point estimate in the pooled sample and in the exemption method sub-sample. For instance, the point estimate of Model 2 in the full sample indicates that a one percentage point increase in the parent country statutory tax rate ($t_{it}$) is associated with an increase of outbound FDI by about 0.85 percent. For the credit method sub-sample, the impact of the parent country corporate tax rate is theoretically ambiguous, which is in line with our findings in Model 2. The interactive term $t_{it} \times \Delta SK_{ijt} \times \mathbf{I}(\Delta SK_{ijt} > 0)$ enters as expected in Model 1 (in all samples), but not so in Model 2 for country pairs in the full sample and in the credit sub-sample. Regarding the host country corporate tax rate, we expect a negative impact on a country's outbound FDI there.[16] This is confirmed by the empirical finding of a significantly negative estimate of the corresponding parameter in Models 1 and 2. Similarly, Table 1 clearly suggests a negative relationship between the host country withholding tax rate and outbound FDI, which is confirmed by the significantly negative parameter estimates in all samples.

With respect to the depreciation allowances, the empirical evidence is in favor of a significantly negative impact of the parent country depreciation rate ($\delta_{it}$) and a negative but insignificant one for its host country counterpart ($\delta_{jt}$). Further, it turns out that the parameters of $\delta_{it} \times \Delta SK_{ijt} \times \mathbf{I}(\Delta SK_{ijt} > 0)$ and $\delta_{jt} \times \Delta SK_{ijt} \times \mathbf{I}(\Delta SK_{ijt} > 0)$ exhibit the expected signs in Model 2. In general, across the board the support for the tax-related hypotheses through Model 2 is remarkable, regarding the large number of parameters to be estimated.

**Sensitivity analysis and discussion:** We have checked the sensitivity of our findings in Model 2 in various ways. Table 3 provides a summary, pointing to their robustness in qualitative terms. For the sake of brevity, we refer to the full sample in Table 2 and only report the taxation parameters of interest.

$>$ Table 3 $<$

[15] The expected impact from our model across all methods (i.e., the pooled sample) is ambiguous. However, the number of cases in our sample, where deduction is applied is rather small. Accordingly, we expect the positive impact to dominate in the pooled sample.

[16] Again, the prediction is ambiguous. But for the same reasons as in the previous footnote, we expect the negative impact to dominate.

In our first sensitivity check, we use alternative measures instead of tertiary school enrollment as the skill measure underlying the construction of $INT1_{ijt}, ..., INT4_{ijt}$: gross secondary school enrollment in Model 2$a$; the sum of professional, technical, kindred and administrative workers to total employment in Model 2$b$ (which has been used by Markusen, 2002); and capital stock per worker in Model 2$c$. As can be seen, most of the point estimates, especially the ones of tax rates and depreciation allowances, exhibit the same sign as in Model 2. Only in the case of host country depreciation allowances ($\delta_{jt}$) we now obtain positive but insignificant parameter estimates in Models 2$a$ and 2$c$, which, according to the theoretical predictions of our model, should be negative. Similarly, the sign of $\delta_{it} \times \Delta SK_{ijt} \times \mathbf{I}(\Delta SK_{ijt} > 0)$ is now positive in Models 2$a$ and 2$c$ (it was and should be negative), and the coefficient of $\delta_{jt} \times \Delta SK_{ijt} \times \mathbf{I}(\Delta SK_{ijt} > 0)$ becomes positive in Models 2$b$ and 2$c$ (it was negative in Table 2, as expected). $t_{it} \times \Delta SK_{ijt} \times \mathbf{I}(\Delta SK_{ijt} > 0)$ is now positive in Models 2$b$ and 2$c$, as it should be (it was negative before). Generally, we would prefer Models 2 and 2$a$ over Models 2$b$ and 2$c$, since for the latter ones the sample size is substantially reduced (to 1011 and 1410 observations, respectively). Further, as can be seen from Table A3 in the Appendix, the correlation between the interaction effects is much lower for tertiary school enrollment as for secondary school enrollment. Therefore we consider Model 2 as preferable over Model 2$a$.

In our second sensitivity check (Model 2$d$), we replace the knowledge-capital model variables that are not related to corporate taxation by standard gravity model variables. For instance, such a specification is suggested by Mutti and Grubert (2004), Bénassy-Quéré, Fontagné, and Lahrèche-Révil (2005), and also by Blonigen and Davies (2004), in a paper on the tax treaty effects on FDI. In this model, the parameter signs are very similar to their counterparts in the original Model 2, except for the interaction effects $t_{it} \times \Delta SK_{ijt} \times \mathbf{I}(\Delta SK_{ijt} > 0)$, $\delta_{it} \times \Delta SK_{ijt} \times \mathbf{I}(\Delta SK_{ijt} > 0)$ and $\delta_{jt} \times \Delta SK_{ijt} \times \mathbf{I}(\Delta SK_{ijt} > 0)$, which have changed their sign. $t_{it} \times \Delta SK_{ijt} \times \mathbf{I}(\Delta SK_{ijt} > 0)$ is now significantly positive, as expected. However, it must be said that a test on the joint significance of the skilled labor endowment variables $INT1_{ijt}, ..., INT4_{ijt}$ indicates that the gravity specification is less suitable than the knowledge-capital model for bilateral FDI in our sample of countries. Next, we estimate a dynamic model including the lagged dependent variable on the right-hand-side of the regression (Model 2$e$). To avoid an endogeneity bias inherent in dynamic panels with fixed effects (see Baltagi, 2005, p. 135), we use a GMM estimator as proposed by

Arellano and Bond (1991). The estimate for the lagged dependent variable is rather low at 0.22 and not significant at 10 percent (see the notes of Table 3). Apart from this, we almost obtain the same coefficients as in Model 2 (with the exceptions of $t_{it} \times \Delta SK_{ijt} \times \mathbf{I}(\Delta SK_{ijt} > 0)$ and $\delta_{jt} \times \Delta SK_{ijt} \times \mathbf{I}(\Delta SK_{ijt} > 0)$).

In the last two exercises, we exclude the transition economies (Model $2f$) and, alternatively, the transition countries as well as non-EU members from the sample (Model $2g$). Note that these countries are characterized by a strong reduction in corporate tax rates as well as a strong increase in inward FDI in the period of interest. With the exception of the interaction terms $t_{it} \times \Delta SK_{ijt} \times \mathbf{I}(\Delta SK_{ijt} > 0)$ and $\delta_{jt} \times \Delta SK_{ijt} \times \mathbf{I}(\Delta SK_{ijt} > 0)$) we obtain the same signs on the coefficients of interest. In Model $2g$, several of the originally significant parameter estimates are now insignificant, especially, that one of the host country corporate tax rate. However, this comes at no surprise, since the sample size is dramatically reduced to only 846 observations.

How do the results relate to those in previous research? Similar to the above mentioned evidence regarding U.S. outbound FDI, parent (host) country tax rates exert a positive (negative) impact (see, e.g., Grubert and Mutti, 1991, 2000; Hines and Rice, 1994; Mutti and Grubert, 2004; Desai, Foley and Hines, 2005). Our evidence on FDI stocks is also in line with the finding of Razin, Rubinstein, and Sadka (2005) for bilateral FDI flows (in levels rather than logs) in a broader sample of country-pairs. However, in contrast to existing research we additionally include other tax parameters such as host country withholding tax rates and parent and host depreciation allowances. The parameter estimates of these variables are typically not accounted for in previous research.[17]

# 7 Conclusions

This paper analyzes the role of corporate taxation for outbound FDI. In doing so, the paper pays particular attention to the fact that FDI flows among the developed economies are not subject to country-specific but rather to country-pair specific taxation. This follows from the prevalence of tax treaties (or the Parent-Subsidiary-Directive within the EU members) among these countries, where deviations from unilateral taxation principles are the rule rather than

[17]Following Devereux and Griffith (1998b, 2003), we also computed and employed effective (average and marginal) tax rates with country-pair and time variation. We found a positive (negative) impact of the parent (host) country effective tax rates, being in line with this line of research. However, we have decided to focus on estimates of the tax parameters separately, since general equilibrium theory provides better guidance on their impact on multinational activity rather than on that of effective tax rates.

the exception. One could think of bilateral effective tax rates as nonlinear aggregates of their components: parent and host country statutory corporate tax rates where the levels of the former depend on the applied assignment of taxing rights (i.e., credit, exemption or deduction method), bilateral withholding tax rates, and depreciation allowances. Hence, one could analyze the marginal impact of corporate taxation on FDI at level of the separate tax parameters.

The hypotheses are naturally derived from a theoretical model that distinguishes between the respective parameters. In spite of this theoretical support, we admit that an empirical analysis relying on tax components has not yet been pursued. Our empirical findings for a panel of bilateral FDI stocks among the OECD countries provide strong support for the theoretical model. By and large, an increase in parent (host) country statutory tax rates tends to foster (reduce) outbound FDI stocks. Host country withholding tax rates exert an unambiguously negative impact on outbound FDI. Parent and host country depreciation allowances have a non-monotonic impact on outbound FDI, as expected from our theoretical model. The signs of several of the parameters inherently depend on the relative factor endowment configurations as predicted by the knowledge-capital model of multinational firms.

## Acknowledgements

We are grateful to Assaf Razin, Efraim Sadka and seminar participants at the University of Innsbruck for helpful comments and suggestions. Financial support from the Austrian Fond zur Förderung der wissenschaflichen Forschung (FWF, grant no. P 17028-G05) is gratefully acknowledged.

## References

Altshuler, R., Grubert, H. and T.S. Newlon, 2001. Has US investment abroad become more sensitive to tax rates?, in J.R. Hines, Jr. (ed.), *International Taxation and Multinational Activity*, Chicago: University of Chicago Press.

Arellano, M. and S. Bond, 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to unemployment equations, *The Review of Economic Studies* 58, 277-294.

Baier, S., Dwyer, G.P. and R. Tamura, 2002. How important are capital and total factor productivity for economic growth?, *unpublished manuscript*, Clemson University.

Baltagi, B.H., 2005, *The econometrics of panel data*, 3rd ed., Chichester: John Wiley & Sons.

Bartik, T.J., 1985. Business location decisions in the United States: estimates of the effects of unionization, taxes and other characteristics of States, *Journal of Business and Economic Statistics* 3, 14-22.

Bénassy-Quéré, A., Fontagné, L. and A. Lahrèche-Révil, 2005. How does FDI react to corporate taxation?, *International Tax and Public Finance* 12, 583–603.

Blonigen, B.A., 2005. Empirical FDI studies: A critical assessment, *Atlantic Economic Journal*, forthcoming.

Blonigen, B.A. and R.B. Davies, 2004. The effects of bilateral tax treaties on U.S. FDI activity, *International Tax and Public Finance* 11, 601–622.

Blonigen, B.A., Davies, R.B. and K. Head, 2003. Estimating the knowledge-capital model of the multinational enterprise: Comment, *American Economic Review* 93, 980-994.

Bond, E.W. and L. Samuleson, 1989. Strategic behavoir and the rules for international taxation of capital, *The Economic Journal* 99, 1099-1111.

Braconier, H., Norbäck, P.-J. and D. Urban, 2005. Reconciling the evidence of the knowledge capital model, *Review of International Economics*, forthcoming.

Carr, D., Markusen, J.R. and K.E. Maskus, 2003. Estimating the knowledge-capital model of the multinational enterprise: Reply, *American Economic Review* 93, 693-708.

Clark, S.W., 2000. Tax incentives for foreign direct investment: Empirical evidence on effects and alternative policy options, *Canadian Tax Journal* 48, 1139-1180.

Coughlin, C.C., Terza, J.V. and V. Arromdee, 1991. State characteristics and the location of foreign direct investment within the United States, *Review of Economics and Statistics* 68, 675–683.

de Mooij, R.A. and S. Ederveen, 2003. Taxation and foreign direct investment: a synthesis of empirical research, *International Tax and Public Finance* 10, 673-693.

Davies, R.B., 2003. The OECD model tax treaty: Tax competition and two-way capital flows, *International Economic Review* 44, 725-753.

Davies, R.B., 2004. Tax treaties and foreign direct investment: Potential versus performance, *International Tax and Public Finance* 11, 775–802.

Desai, M.A., Foley, F.C. and J.R. Hines, 2005. The demand for tax haven operations, *Journal of Public Economics*, forthcoming.

Devereux, M.P. and H. Freeman, 1995. The impact of tax on foreign direct investment: Emprical evidence and the implications for tax integration schemes, *International Tax and Public Finance* 2, 85-106.

Devereux, M.P. and R. Griffith, 1998a, Taxes and the location of production: evidence from a panel of US multinationals, *Journal of Public Economics* 68, 335-367.

Devereux, M.P. and R. Griffith, 1998b. The taxation of discrete investment choices, *IFS Working Paper* No. W98/16, London: Institute for Fiscal Studies.

Devereux, M.P. and R. Griffith, 2003. Evaluating tax policy for location decisions, *International Tax and Public Finance* 10, 107-126.

Devereux, M.P., Griffith, R. and A. Klemm, 2002. Corporate income tax reforms and international tax competition, *Economic Policy* 35, 451-495.

Dixit, A.K. and J.E. Stiglitz, 1977. Monopolistic competition and optimum product diversity, *American Economic Review* 67, 297-308.

Gresik, T.A., 2001. The taxing task of taxing multinationals, *Journal of Economic Literature* 39, 800-838.

Grubert, H. and J. Mutti, 1991. Taxes, tariffs and transfer pricing in multinational corporate decision making, *Review of Economics and Statistics* 73, 285–293.

Grubert, H. and J. Mutti, 2000. Do taxes influence where US multinational corporations invest?, *National Tax Journal* 53, 825–839.

Grubert, H. and J. Slemrod, 1998. The effect of taxes on investment and income shifting to Puerto Rico, *Review of Economics and Statistics* 80, 365–373.

Hartman, D.G., 1984. Tax policy and foreign direct investment in the United States, *National Tax Journal* 37, 475-488.

Hartman, D., 1985, Tax policy and foreign direct investment, *Journal of Public Economics* 26, 107-121.

Hartman, D.G., 1990. Comment on Slemrod "Tax effects on foreign direct investment in the US: evidence from a cross-country comparison", in A. Razin and J. Slemrod (eds.), *Taxation in the global economy*, Chicago: University of Chicago Press.

Head, K.C., Ries, J.C. and D.L. Swenson, 1999. Attracting foreign manufacturing: Investment promotion and agglomeration, *Regional Science and Urban Economics* 29, 197-218.

Hines, J.R., 1996. Altered states: taxes and the location of foreign direct investment in America, *American Economic Review* 86, 1076-1094.

Hines, J.R., 1997. Tax policy and the activities of multinational corporations, in A.J. Auerbach (ed.), *Fiscal policy: lessons from economic research*, Cambridge MA: MIT Press.

Hines, J.R., 1999. Lessons from behavioral responses to international taxation, *National Tax Journal* 52, 305-323.

Hines, J.R. and E.M. Rice, 1994. Fiscal Paradise: Foreign tax havens and American business, *Quarterly Journal of Economics* 109, 149-182.

Janeba, E., 1995. Corporate income tax competition, double taxation treaties, and foreign direct investment, *Journal of Public Economics* 56, 311–326.

King, M.A. and D. Fullerton, 1984. *The taxation of income from capital*, Chicago: University of Chicago Press.

Markusen, J.R., 1984. Multinationals, multi-plant economies, and the gains from trade, *Journal of International Economics* 16, 205-226.

Markusen, J.R., 1997. Trade versus investment liberalization, *NBER Working Paper* No. 6231, Cambridge MA: National Bureau of Economic Research.

Markusen, J.R., 2002. *Multinational firms and the theory of international trade*, Cambridge MA: The MIT Press.

Markusen, J.R. and K.E. Maskus, 2002. Discriminating among alternative theories of the multinational enterprise, *Review of International Economics* 10, 694-707.

Markusen, J.R. and J.A. Venables, 2000. The theory of endowment, intraindustry and multinational trade, *Journal of International Economics* 52, 209-234.

Mutti, J. and H. Grubert, 2004. Empirical asymmetries in foreign direct investment and taxation, *Journal of International Economics* 62, 337-358.

Newey, W.K. and K.D. West, 1987. A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix, *Econometrica* 55, 703-708.

OECD, 2001. Corporate tax incentives for foreign direct investment, *OECD Tax Policy Studies* No. 4, Paris: Organisation for Economic Co-operation and Development.

Razin, A., Rubinstein, Y. and E. Sadka, 2005, Corporate taxation and bilateral FDI with threshold barriers, *NBER Working Paper* No. 11196, Cambridge MA.

Scholes, M.S. and M.A. Wolfson, 1990, The effects of changes in tax laws on corporate reorganization activity, *Journal of Business* 63, S141-S164.

Shah, A. and J. Slemrod, 1991. Do taxes matter for foreign direct investment?, *World Bank Economic Review* 5, 473-491.

Sinn, H.-W., 1993. Taxation and the birth of foreign subsidiaries, in H. Heber and N. van Long (Eds.), *Trade, Welfare, and Economic Policies, Essays in Honor of Murray C. Kemp*, University of Michigan Press: Ann Arbor.

Slemrod, J., 1990. Tax effects on foreign direct investment in the US: evidence from a cross-country comparison, in A. Razin and J. Slemrod (eds.), *Taxation in the global economy*, Chicago: University of Chicago Press.

Swenson, D.L., 1994. The impact of US tax reform on foreign direct investment in the United States, *Journal of Public Economics* 54, 243-266.

Swenson, D.L., 2001. Transaction type and the effect of taxes on the distribution of foreign direct investment in the United States, in J.R. Hines (ed.), *International Taxation and Multinational Activity*, Chicago: University of Chicago Press.

Yoo, K.-Y., 2003. Corporate taxation of foreign direct investment income 1991-2001, *OECD Economics Department Working Paper* No. 365, Paris: Organisation for Economic Co-operation and Development.

# Appendix: Data and descriptive statistics

1. **Data on foreign direct investment:** We use bilateral outbound FDI stock data into Europe as published by UNCTAD (FDI Country profiles), covering the period 1991-2001.

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

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

2. **Data on country size and factor endowments:** Real GDP figures at constant U.S. dollars (base year is 2000) are collected from the World Bank's World Development Indicators. Gross tertiary (and, alternatively, gross secondary) school enrollment figures from the same source serve as our measure of a country's skilled labor endowment. Capital stocks are available from Baier, Dwyer and Tamura (2002). The sum of professional, technical, kindred and administrative workers is taken from the Yearbook of Labor Statistics published by the International Labor Organization (ILO).

3. **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):

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

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

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

   The computation of the net present value of depreciation allowances is derived in King and Fullerton (1984). 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 the most generous one.

4. **Descriptive statistics:** Table A1, Table A2, Table A3

**Table 1: Affiliate production (base case) and their change due to a change in parameters of taxation**

| | Affiliate production in country $j$ if country $i$ is: | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **small** | | **large** | | **identical** | | **skilled labor abundant** | |
| | EX or C | DED | EX or C | DED | EX or C | DED | EX or C | DED |
| **Affiliate production**[a] | **1.65%** | **0** | **14.89%** | **8.07%** | **25.00%** | **25.00%** | **45.26%** | **45.94%** |
| $\Delta t_i$ | + -/+[b] | - | + -/+[b] | - | + -/+[d] | - | + + | + |
| $\Delta t_j$ | - -/+[c] | - | - -/+[c] | - | - -/+[e] | +[f] | - - | - |
| $\Delta t_j^w$ | - - | - | - - | - | - - | - | - - | - |
| $\Delta \delta_i$ | + + | + | + + | + | + + | + | - - | - |
| $\Delta \delta_j$ | - - | - | - - | - | - - | - | + + | + |

**Notes:** The assumptions about 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**: $L_i/(L_i + L_j) = 0.15, S_i/(S_i + S_j) = 0.85$.
**unskilled labor abundant**: $L_i/(L_i + L_j) = 0.85, S_i/(S_i + S_j) = 0.15$.
$\Delta t_i$ indicates an increase of the corporate tax rate in country $i$.
$\Delta t_i^w$ indicates an increase of the withholding tax in country $i$.
$\Delta \delta_i$ indicates an increase in the depreciation allowances in country $i$.
[a] Affiliate production is measured in percent of the total production of the $X$-good.
[b] If $t_i < (t_j + t_j^w)$ the sign is positive, otherwise negative.
[c] Only positive if $t_j$ is substantially lower than $t_i$, otherwise negative.
[d] Within the range $(t_j - t_j^w) < t_i > (t_j + t_j^w)$ the sign is positive, otherwise negative.
[e] Within the range $(t_i - t_j^w) < t_j > (t_i + t_j^w)$ the sign is negative, otherwise positive.
[f] For a reasonably large tax increase, otherwise negative.

**Table 2: Estimation Results - Dissecting the Impact of Corporate Income Taxation on FDI**

| | Full sample | | | | Exemption countries | | | | Credit countries | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Explanatory variables** | **Model 1** | Est. as predicted | **Model 2** | Est. as predicted | **Model 1** | Est. as predicted | **Model 2** | Est. as predicted | **Model 1** | Est. as predicted | **Model 2** | Est. as predicted |
| Parent country corporate tax rate: $t_i$ | -0.558 | N | 0.850 | Y | 0.505 | Y | 0.872 | Y | -2.486 | ? | -0.000 | ? |
| | (-0.85) | | (1.80) | | (0.91) | | (1.61) | | (-1.94) | | (0.00) | |
| Host country corporate tax rate: $t_j$ | -1.803 | Y | -1.428 | Y | -1.816 | Y | -1.887 | Y | -1.289 | ? | -0.685 | ? |
| | (-2.90) | | (-2.45) | | (-3.13) | | (-2.58) | | (-1.06) | | (-0.76) | |
| Withholding tax rate on repatriated profits: $t^w_{jt}$ | -1.212 | Y | -1.612 | Y | -1.787 | Y | -2.111 | Y | -0.745 | Y | -1.256 | Y |
| | (-2.69) | | (-3.26) | | (-2.66) | | (-2.65) | | (-1.15) | | (-2.11) | |
| Parent country depreciation allowances: $\delta_i$ | – | | -4.257 | ? | – | | -3.508 | ? | – | | -3.301 | ? |
| | | | (-4.51) | | | | (-2.10) | | | | (-2.78) | |
| Host country depreciation allowances: $\delta_j$ | – | | -0.427 | ? | – | | -0.544 | ? | – | | -0.495 | ? |
| | | | (-0.65) | | | | (-0.67) | | | | (-0.49) | |
| $t_i \times \Delta SK_{it} \times \mathbf{I}(\Delta SKijt > 0)$ | 0.066 | Y | -0.004 | N | 0.044 | Y | 0.014 | Y | 0.069 | Y | -0.220 | N |
| | (1.57) | | (-0.11) | | (-0.11) | | (0.35) | | (0.30) | | (-1.24) | |
| $\delta_i \times \Delta SK_{it} \times \mathbf{I}(\Delta SKijt > 0)$ | – | | -0.165 | Y | – | | -0.136 | Y | – | | -0.361 | Y |
| | | | (-2.31) | | | | (-1.33) | | | | (-2.28) | |
| $\delta_j \times \Delta SK_{it} \times \mathbf{I}(\Delta SKijt > 0)$ | – | | 0.074 | Y | – | | 0.089 | Y | – | | 0.015 | Y |
| | | | (2.08) | | | | (1.23) | | | | (0.45) | |
| Log$(GDP_{it} + GDP_{it})$: $\Sigma GDP_{ij}$ | 2.700 | Y | 1.955 | Y | 2.394 | Y | 2.340 | Y | 6.599 | Y | 4.951 | Y |
| | (3.84) | | (3.36) | | (3.62) | | (3.02) | | (2.85) | | (2.99) | |
| Log$(GDP_{it}/GDP_{it})$: $\Delta GDP_{ij}$ | -0.196 | Y | -0.138 | Y | -0.041 | Y | 0.002 | N | -0.398 | Y | -0.312 | Y |
| | (-3.97) | | (-2.79) | | (-0.57) | | (0.03) | | (-5.55) | | (-5.12) | |
| $\Delta SK_{it} \times \Delta GDP_{ij} \times \mathbf{I}(\Delta SKijt > 0)$: INT1$^a$ | 0.199 | N | 0.119 | N | 0.095 | N | 0.316 | N | 0.237 | N | 0.330 | N |
| | (1.65) | | (0.94) | | (0.36) | | (1.13) | | (0.80) | | (1.23) | |
| $\Delta SK_{it} \times \Sigma GDP_{ijt} \times \mathbf{I}(\Delta SKijt > 0)$: INT2$^a$ | -0.058 | Y | 0.217 | N | -0.058 | Y | 0.106 | N | -0.047 | Y | 0.940 | N |
| | (-1.08) | | (1.43) | | (-1.10) | | (0.43) | | (-0.17) | | (2.42) | |
| $\Delta SK_{it} \times \Delta GDP_{ijt} \times \mathbf{I}(\Delta SKijt < 0)$: INT3$^a$ | 0.034 | N | 0.047 | N | -0.003 | Y | 0.015 | N | 0.082 | N | 0.085 | N |
| | (1.97) | | (2.90) | | (-0.13) | | (0.71) | | (2.69) | | (2.90) | |
| $(\Delta SK_{it})^2 * log(dist_{ij})$: INT4$^a$ | -0.001 | Y | -0.002 | Y | 0.001 | N | -0.000 | Y | -0.001 | Y | -0.002 | Y |
| | (-1.03) | | (-2.10) | | (0.44) | | (-0.12) | | (-0.35) | | (-1.44) | |
| Observations | 2347 | | 2195 | | 1375 | | 1257 | | 823 | | 789 | |
| $R^2$ | 0.996 | | 0.997 | | 0.998 | | 0.998 | | 0.994 | | 0.996 | |
| Fixed country-par effects: F-statistic | 568.37 | | 506.59 | | 3.71E+06 | | 2.68E+05 | | 391.01 | | 315.68 | |
| degrees of freedom(DF1/DF2) | (388,1938) | | (388,1782) | | (222,1130) | | (223,1008) | | (138,664) | | (138,626) | |
| p-value | 0.000 | | 0.000 | | 0.000 | | 0.000 | | 0.000 | | 0.000 | |
| Fixed time effects: F-statistic | 12.21 | | 10.53 | | 18.33 | | 13.77 | | 6.47 | | 6.44 | |
| degrees of freedom(DF1/DF2) | (11,1938) | | (10,1782) | | (11,1130) | | (11,1008) | | (10,664) | | (11,626) | |
| p-value | 0.000 | | 0.000 | | 0.000 | | 0.000 | | 0.000 | | 0.000 | |

**Notes :** HAC-corrected t-values in parentheses (Newey and West, 1987). $^a$ Parameter and standard error multiplied by 100.
Mills ratio (Model 2): Full sample: -0.133 (s.e.: 0.087); Exemption countries: -0.149 (0.136); Credit countries: 0.373 (0.424)

**Table 3: Robustness**

| Tax components | Model 2a | Model 2b | Model 2c | Model 2d | Model 2e | Model 2f | Model 2g |
|---|---|---|---|---|---|---|---|
| Parent country corporate tax rate: $t_{it}$ | 0.845 | 0.817 | 1.170 | 1.113 | 0.446 | 0.517 | -0.262 |
| | (1.80) | (0.87) | (2.21) | (2.41) | (0.80) | (1.15) | (-0.36) |
| Host country corporate tax rate: $t_{jt}$ | -1.498 | -2.161 | -1.716 | -1.302 | -0.892 | -1.136 | -1.402 |
| | (-2.57) | (-1.91) | (-2.57) | (-2.21) | (-1.27) | (-2.10) | (-1.66) |
| Withholding tax rate on repatriated profits: $t_{jt}^{w}$ | -1.545 | -2.439 | -2.415 | -1.359 | -1.354 | -1.606 | -1.554 |
| | (-3.06) | (-1.80) | (-3.33) | (-2.79) | (-2.32) | (-3.24) | (-2.14) |
| Parent country depreciation allowances: $\delta_{it}$ | -4.530 | -4.869 | -4.452 | -4.294 | -3.360 | -5.106 | -4.296 |
| | (-4.74) | (-2.28) | (-3.77) | (-4.45) | (-2.93) | (-4.91) | (-2.04) |
| Host country depreciation allowances: $\delta_{jt}$ | 0.201 | -1.176 | 0.067 | -0.229 | 0.562 | -0.721 | -1.620 |
| | (0.29) | (-1.19) | (0.10) | (-0.34) | (0.72) | (-0.98) | (-1.22) |
| $t_{it} \times \Delta SK_{it} \times \mathbf{I}(\Delta SKijt > 0)$ | -0.001 | 0.164 | 1.077 | 0.079 | 0.063 | 0.034 | 0.044 |
| | (-0.02) | (2.48) | (0.84) | (2.22) | (0.85) | (0.85) | (0.96) |
| $\delta_{it} \times \Delta SK_{it} \times \mathbf{I}(\Delta SKijt > 0)$ | 0.005 | -0.073 | 0.698 | 0.018 | -0.113 | -0.063 | -0.188 |
| | (0.09) | (-0.56) | (0.53) | (0.54) | (-0.98) | (-0.79) | (-1.42) |
| $\delta_{it} \times \Delta SK_{it} \times \mathbf{I}(\Delta SKijt > 0)$ | 0.006 | -0.007 | -0.465 | -0.093 | -0.375 | -0.000 | -0.110 |
| | (0.15) | (-0.06) | (-0.59) | (-2.33) | (-1.52) | (-0.01) | (-1.49) |

**Notes :** HAC-corrected t-values in parentheses (Newey and West, 1987).

Model 2a (2195 observations): Secondary school enrollment instead of tertiary school enrollment.

Model 2b (1011 observations): Skill measure as proposed by Markusen (2002: p. 228) rather than tertiary school enrollment.

Model 2c (1410 observations): Capital stock per worker instead of tertiary school enrollment.

Model 2d (2195 observations): Gravity model instead of Knowledge Capital model.

Model 2e (1792 observations): Dynamic model as proposed by Arellano and Bond (1991) for panel data; Lagged dependent variable amounts to 0.221 (s.e. = 0.110).

Model 2f (2011 observations): Excluding transition economies (Czech Republic, Hungary and Poland).

Model 2g (846 observations): Excluding transition economies and non-EU members. 12 remaining EU economies.

All sensitivity checks should be compared to the full sample results of Model 2 in Table 4.

**Figure 4: Tax components in parent and host countries, 1991 - 2002**

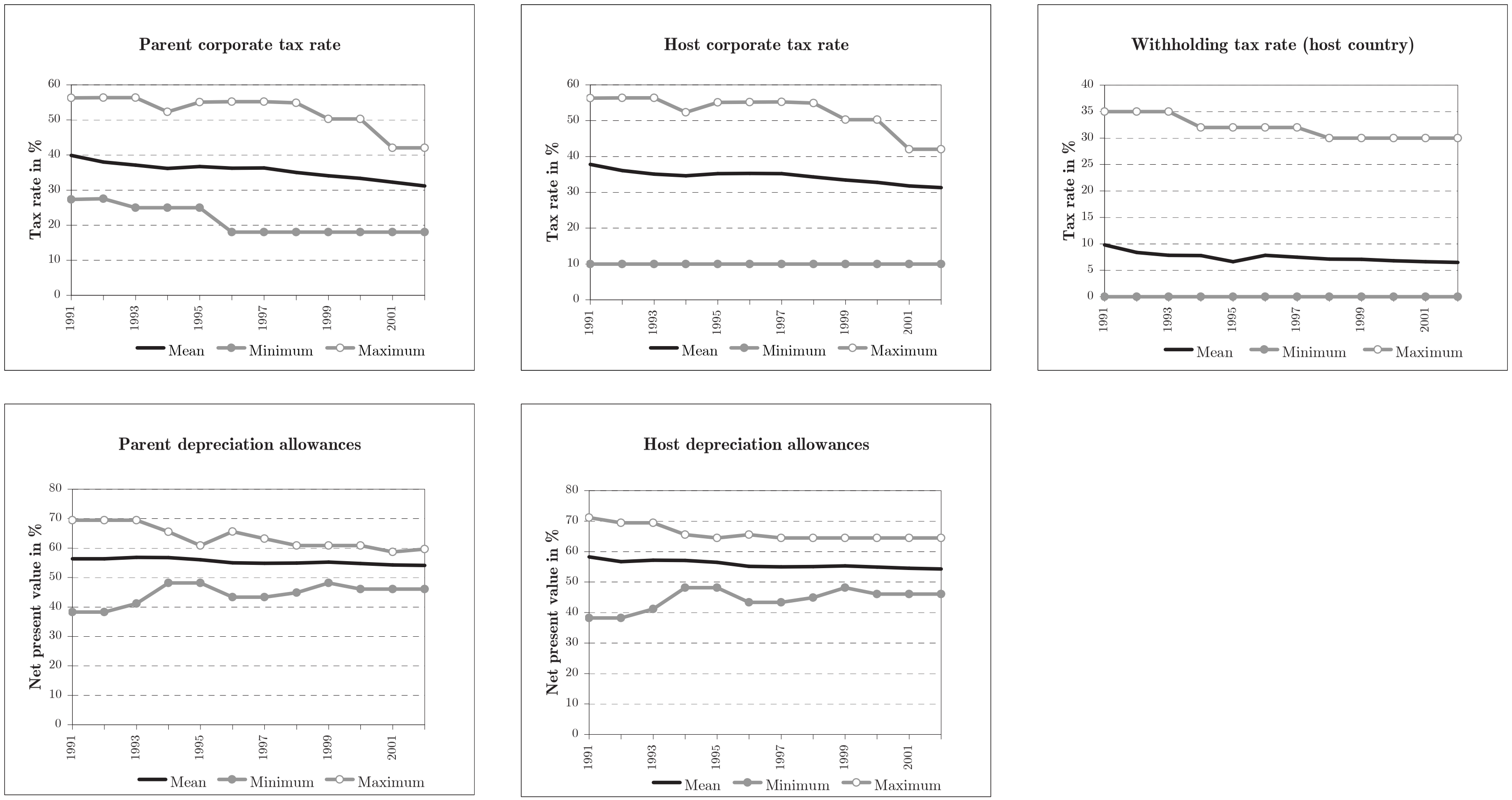

**Table A1: Descriptive statistics**

| Variable | Observations | Mean | Standard deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| Real outward FDI stock (in Tsd. 2000 US$) | 2195 | 8.893 | 23.487 | 0.000 | 301.313 |
| Host country statutory corporate tax rate | 2195 | 0.345 | 0.088 | 0.100 | 0.564 |
| Parent country statutory corporate tax rate | 2195 | 0.353 | 0.078 | 0.180 | 0.564 |
| Host country depreciation allowances (present value) | 2195 | 0.555 | 0.041 | 0.382 | 0.694 |
| Parent country depreciation allowances (present value) | 2195 | 0.558 | 0.038 | 0.433 | 0.694 |
| Host country withholding tax rate | 2195 | 0.056 | 0.063 | 0.000 | 0.300 |
| Host country real GDP (in Billions 2000 US$) | 2195 | 1180.000 | 2210.000 | 12.700 | 9820.000 |
| Parent country real GDP (in Billions 2000 US$) | 2195 | 1410.000 | 2470.000 | 7.250 | 9820.000 |
| Host country real GDP per capita | 2195 | 22069.850 | 8702.759 | 3799.710 | 45205.650 |
| Parent country real GDP per capita | 2195 | 23739.240 | 8461.111 | 3799.710 | 45205.650 |
| Host country secondary school enrollment | 2195 | 113.284 | 19.987 | 72.000 | 178.152 |
| Parent country secondary school enrollment | 2195 | 112.321 | 18.333 | 82.542 | 178.152 |
| Host country tertiary school enrollment | 2195 | 53.815 | 14.729 | 7.100 | 87.200 |
| Parent country tertiary school enrollment | 2195 | 54.562 | 15.458 | 9.287 | 87.200 |
| Host country capital stock per worker (in Tsd. US$) | 1730 | 77.171 | 30.745 | 7.224 | 162.531 |
| Parent country capital stock per worker (in Tsd. US$) | 1797 | 71.752 | 28.905 | 7.224 | 162.531 |
| Bilateral distance | 2195 | 2566.883 | 2856.513 | 98.202 | 11241.860 |

**Table A2: Correlation matrix**

| | | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Real outward FDI stock | (1) | 1 | | | | | | | | | | | | | | |
| Parent country corporate tax rate: $t_{it}$ | (2) | -0.30 | 1 | | | | | | | | | | | | | |
| Host country corporate tax rate: $t_{jt}$ | (3) | -0.42 | 0.26 | 1 | | | | | | | | | | | | |
| Withholding tax rate on repatriated profits: $t_{jt}^{w}$ | (4) | -0.32 | 0.18 | 0.25 | 1 | | | | | | | | | | | |
| Parent country depreciation allowances: $\delta_{it}$ | (5) | -0.47 | 0.41 | 0.27 | 0.35 | 1 | | | | | | | | | | |
| Host country depreciation allowances: $\delta_{jt}$ | (6) | -0.10 | 0.12 | -0.07 | 0.01 | 0.05 | 1 | | | | | | | | | |
| $t_{it} \times \Delta SK_{it} \times \mathbf{I}(\Delta SKijt > 0)$ | (7) | 0.12 | 0.03 | 0.00 | -0.05 | -0.06 | -0.04 | 1 | | | | | | | | |
| $\delta_{it} \times \Delta SK_{it} \times \mathbf{I}(\Delta SKijt > 0)$ | (8) | 0.11 | -0.05 | -0.01 | -0.06 | -0.05 | -0.08 | 0.95 | 1 | | | | | | | |
| $\delta_{jt} \times \Delta SK_{it} \times \mathbf{I}(\Delta SKijt > 0)$ | (9) | 0.18 | -0.06 | -0.09 | -0.09 | -0.08 | 0.07 | 0.91 | 0.94 | 1 | | | | | | |
| $\text{Log}(GDP_{it} + GDP_{it}) : \Sigma GDP_{ijt}$ | (10) | 0.64 | -0.43 | -0.42 | -0.25 | -0.52 | -0.14 | 0.13 | 0.14 | 0.19 | 1 | | | | | |
| $\text{Log}(GDP_{it}/GDP_{it}) : \Delta GDP_{ijt}$ | (11) | -0.18 | 0.11 | 0.08 | 0.16 | 0.20 | 0.09 | 0.02 | -0.01 | -0.01 | -0.29 | 1 | | | | |
| $\Delta SK_{it} \times \Delta GDP_{ijt} \times \mathbf{I}(\Delta SKijt > 0)$: INT1 | (12) | -0.16 | 0.02 | 0.13 | 0.12 | 0.10 | 0.04 | -0.44 | -0.49 | -0.48 | -0.16 | 0.30 | 1 | | | |
| $\Delta SK_{it} \times \Sigma GDP_{ijt} \times \mathbf{I}(\Delta SKijt > 0)$: INT2 | (13) | 0.14 | -0.05 | -0.04 | -0.07 | -0.07 | -0.07 | 0.96 | 0.99 | 0.95 | 0.18 | -0.02 | -0.52 | 1 | | |
| $-\Delta SK_{it} \times \Delta GDP_{ijt} \times \mathbf{I}(\Delta SKijt < 0)$: INT3 | (14) | 0.08 | -0.09 | -0.08 | -0.09 | -0.07 | 0.01 | -0.06 | -0.06 | -0.06 | 0.04 | -0.07 | 0.02 | -0.06 | 1 | |
| $(\Delta SK_{it})^2 \times$ Log($dist_{ij}$): INT4 | (15) | 0.09 | -0.06 | -0.05 | -0.12 | -0.06 | -0.02 | 0.45 | 0.47 | 0.46 | 0.09 | -0.12 | -0.28 | 0.48 | 0.69 | 1 |

**Table A3: Correlation between interactions using different skill measures**

| | | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | (21) | (22) | (23) | (24) | (25) | (26) | (27) | (28) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Tertiary school enrollment** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $t_{it} \times \Delta SK_{it} \times \mathbf{I}(\Delta SKijt > 0)$ | (1) | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $\delta_{it} \times \Delta SK_{it} \times \mathbf{I}(\Delta SKijt > 0)$ | (2) | 0.95 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $\delta_{jt} \times \Delta SK_{it} \times \mathbf{I}(\Delta SKijt > 0)$ | (3) | 0.93 | 0.96 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| $\Delta SK_{it} \times \Delta GDP_{ijt}$: INT1 | (4) | -0.30 | -0.35 | -0.35 | 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| $\Delta SK_{it} \times \Sigma GDP_{ijt}$: INT2 | (5) | 0.96 | 0.99 | 0.97 | -0.36 | 1 | | | | | | | | | | | | | | | | | | | | | | | |
| $-\Delta SK_{it} \times \Delta GDP_{ijt}$: INT3 | (6) | -0.06 | -0.06 | -0.06 | 0.02 | -0.06 | 1 | | | | | | | | | | | | | | | | | | | | | | |
| $(\Delta SK_{it})^2 \times$ Log$(dist_{ij})$: INT4 | (7) | 0.50 | 0.52 | 0.51 | -0.26 | 0.53 | 0.66 | 1 | | | | | | | | | | | | | | | | | | | | | |
| **Secondary school enrollment** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $t_{it} \times \Delta SK_{it} \times \mathbf{I}(\Delta SKijt > 0)$ | (8) | 0.16 | 0.12 | 0.11 | 0.07 | 0.14 | -0.05 | 0.04 | 1 | | | | | | | | | | | | | | | | | | | | |
| $\delta_{it} \times \Delta SK_{it} \times \mathbf{I}(\Delta SKijt > 0)$ | (9) | 0.13 | 0.11 | 0.09 | 0.08 | 0.12 | -0.04 | 0.03 | 0.99 | 1 | | | | | | | | | | | | | | | | | | | |
| $\delta_{jt} \times \Delta SK_{it} \times \mathbf{I}(\Delta SKijt > 0)$ | (10) | 0.11 | 0.08 | 0.10 | 0.06 | 0.10 | -0.04 | 0.03 | 0.98 | 0.99 | 1 | | | | | | | | | | | | | | | | | | |
| $\Delta SK_{it} \times \Delta GDP_{ijt}$: INT1 | (11) | 0.04 | 0.07 | 0.05 | 0.18 | 0.07 | 0.00 | -0.01 | 0.69 | 0.70 | 0.70 | 1 | | | | | | | | | | | | | | | | | |
| $\Delta SK_{it} \times \Sigma GDP_{ijt}$: INT2 | (12) | 0.13 | 0.11 | 0.10 | 0.07 | 0.13 | -0.04 | 0.04 | 0.99 | 1.00 | 0.99 | 0.72 | 1 | | | | | | | | | | | | | | | | |
| $-\Delta SK_{it} \times \Delta GDP_{ijt}$: INT3 | (13) | 0.00 | 0.01 | 0.02 | -0.03 | 0.02 | 0.04 | -0.02 | -0.08 | -0.07 | -0.07 | 0.00 | -0.07 | 1 | | | | | | | | | | | | | | | |
| $(\Delta SK_{it})^2 \times$ Log$(dist_{ij})$: INT4 | (14) | 0.06 | 0.06 | 0.06 | 0.08 | 0.07 | -0.05 | -0.07 | 0.60 | 0.61 | 0.61 | 0.50 | 0.62 | 0.64 | 1 | | | | | | | | | | | | | | |
| **Capital stocks per worker** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $t_{it} \times \Delta SK_{it} \times \mathbf{I}(\Delta SKijt > 0)$ | (15) | 0.05 | -0.04 | -0.06 | 0.16 | -0.05 | 0.00 | -0.02 | 0.03 | 0.01 | 0.02 | 0.00 | 0.01 | -0.23 | -0.17 | 1 | | | | | | | | | | | | | |
| $\delta_{it} \times \Delta SK_{it} \times \mathbf{I}(\Delta SKijt > 0)$ | (16) | -0.06 | -0.08 | -0.10 | 0.16 | -0.11 | 0.00 | -0.07 | -0.01 | 0.00 | 0.00 | -0.01 | -0.01 | -0.27 | -0.20 | 0.76 | 1 | | | | | | | | | | | | |
| $\delta_{jt} \times \Delta SK_{it} \times \mathbf{I}(\Delta SKijt > 0)$ | (17) | -0.06 | -0.07 | 0.04 | 0.08 | -0.08 | 0.00 | -0.04 | -0.07 | -0.06 | 0.01 | -0.05 | -0.05 | -0.11 | -0.09 | 0.60 | 0.62 | 1 | | | | | | | | | | | |
| $\Delta SK_{it} \times \Delta GDP_{ijt}$: INT1 | (18) | 0.12 | 0.07 | 0.08 | 0.17 | 0.07 | -0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.06 | 0.07 | 0.17 | 0.09 | 0.08 | 1 | | | | | | | | | | |
| $\Delta SK_{it} \times \Sigma GDP_{ijt}$: INT2 | (19) | 0.10 | 0.06 | 0.05 | 0.09 | 0.05 | -0.03 | -0.03 | 0.05 | 0.04 | 0.05 | 0.01 | 0.04 | -0.16 | -0.09 | 0.38 | 0.36 | 0.24 | 0.11 | 1 | | | | | | | | | |
| $-\Delta SK_{it} \times \Delta GDP_{ijt}$: INT3 | (20) | 0.18 | 0.14 | 0.13 | 0.01 | 0.14 | -0.05 | 0.03 | 0.03 | 0.02 | 0.01 | -0.04 | 0.01 | -0.09 | -0.07 | 0.07 | 0.02 | -0.02 | 0.09 | 0.88 | 1 | | | | | | | | |
| $(\Delta SK_{it})^2 \times$ Log$(dist_{ij})$: INT4 | (21) | -0.02 | -0.04 | -0.05 | 0.09 | -0.07 | 0.03 | -0.01 | -0.05 | -0.06 | -0.04 | -0.08 | -0.07 | -0.11 | -0.13 | 0.56 | 0.55 | 0.62 | 0.09 | 0.31 | 0.25 | 1 | | | | | | | |
| **Skill measure as proposed by Markusen (2002)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $t_{it} \times \Delta SK_{it} \times \mathbf{I}(\Delta SKijt > 0)$ | (22) | 0.05 | 0.01 | 0.02 | 0.04 | 0.02 | -0.03 | -0.09 | 0.11 | 0.12 | 0.11 | 0.10 | 0.12 | 0.05 | 0.12 | 0.28 | 0.19 | 0.17 | 0.12 | 0.10 | -0.03 | 0.06 | 1 | | | | | | |
| $\delta_{it} \times \Delta SK_{it} \times \mathbf{I}(\Delta SKijt > 0)$ | (23) | 0.00 | -0.01 | -0.01 | 0.02 | -0.01 | -0.04 | -0.12 | 0.10 | 0.10 | 0.10 | 0.09 | 0.11 | 0.08 | 0.13 | 0.16 | 0.20 | 0.15 | 0.09 | 0.06 | -0.07 | 0.01 | 0.94 | 1 | | | | | |
| $\delta_{jt} \times \Delta SK_{it} \times \mathbf{I}(\Delta SKijt > 0)$ | (24) | 0.01 | 0.01 | 0.06 | 0.03 | 0.01 | -0.05 | -0.10 | 0.08 | 0.09 | 0.11 | 0.08 | 0.10 | 0.07 | 0.13 | 0.22 | 0.23 | 0.42 | 0.10 | 0.07 | -0.08 | 0.16 | 0.90 | 0.92 | 1 | | | | |
| $\Delta SK_{it} \times \Delta GDP_{ijt}$: INT1 | (25) | -0.08 | -0.07 | -0.07 | -0.05 | -0.07 | 0.01 | -0.02 | -0.04 | -0.03 | -0.02 | -0.04 | -0.03 | 0.01 | -0.02 | -0.04 | -0.03 | 0.00 | -0.40 | -0.23 | -0.23 | -0.02 | -0.09 | -0.08 | -0.07 | 1 | | | |
| $\Delta SK_{it} \times \Sigma GDP_{ijt}$: INT2 | (26) | -0.06 | -0.02 | -0.02 | -0.07 | -0.02 | -0.01 | 0.00 | -0.07 | -0.07 | -0.06 | -0.01 | -0.06 | 0.10 | 0.02 | -0.18 | -0.17 | -0.08 | -0.25 | -0.33 | -0.28 | -0.16 | -0.10 | -0.08 | -0.06 | 0.68 | 1 | | |
| $-\Delta SK_{it} \times \Delta GDP_{ijt}$: INT3 | (27) | -0.02 | -0.01 | -0.01 | 0.01 | -0.02 | 0.00 | -0.02 | 0.06 | 0.08 | 0.07 | 0.09 | 0.08 | -0.06 | 0.01 | -0.02 | 0.00 | 0.00 | -0.01 | 0.01 | -0.06 | -0.09 | 0.02 | 0.01 | 0.00 | 0.01 | -0.02 | 1 | |
| $(\Delta SK_{it})^2 \times$ Log$(dist_{ij})$: INT4 | (28) | -0.02 | 0.02 | 0.02 | -0.05 | 0.02 | -0.03 | -0.01 | -0.02 | 0.00 | 0.00 | 0.07 | 0.00 | 0.05 | 0.03 | -0.24 | -0.22 | -0.12 | -0.25 | -0.28 | -0.24 | -0.28 | -0.09 | -0.08 | -0.07 | 0.48 | 0.66 | 0.50 | 1 |