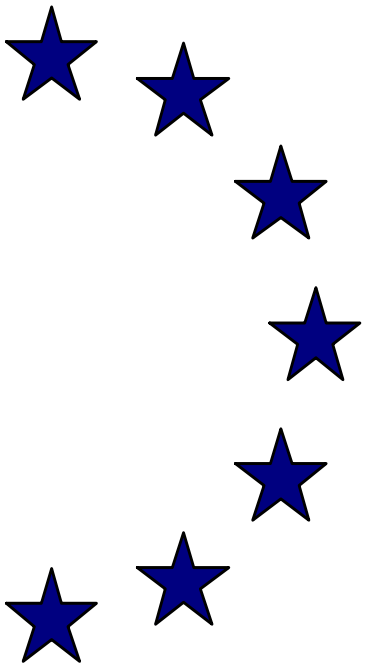
# EUROPEAN ECONOMY

EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ECONOMIC AND FINANCIAL AFFAIRS

ECONOMIC PAPERS



ISSN 1725-3187
http://ec.europa.eu/economy_finance/index_en.htm

N° 260 December 2006

**International profit shifting within multinationals: a multi-country perspective**

by

Harry Huizinga (Tilburg University) and
Luc Laeven (International Monetary Fund)

**Economic Papers** are written by the Staff of the Directorate-General for Economic and Financial Affairs, or by experts working in association with them. The "Papers" are intended to increase awareness of the technical work being done by the staff and to seek comments and suggestions for further analyses. Views expressed represent exclusively the positions of the author and do not necessarily correspond to those of the European Commission. Comments and enquiries should be addressed to the:

European Commission
Directorate-General for Economic and Financial Affairs
Publications
BU1 - -1/13
B - 1049 Brussels, Belgium

ISBN 92-79-03836-2

KC-AI-06-260-EN-C

# International Profit Shifting within Multinationals: A Multi-Country Perspective

Harry Huizinga
(Tilburg University and CEPR)

and

Luc Laeven*
(International Monetary Fund and CEPR)

**Abstract**

We model the opportunities and incentives generated by international tax differences for international profit shifting by multinationals. Unlike previous work, we consider not only profit shifting arising from international tax differences between affiliates and parent companies, but also from tax differences between affiliates in different host countries. Our model yields the prediction that a multinational's profit shifting in a country depends on a weighted average of international tax rate differences between all countries where the multinational is active. Using a unique dataset containing detailed firm-level information on the parent companies and subsidiaries of European multinationals and detailed information about the international tax system, we test our model and empirically examine the extent of intra-European profit shifting by European multinationals. On average, we find a semi-elasticity of reported profits with respect to the top statutory tax rate of 1.43, while shifting costs are estimated to be 1.6 percent of the tax base. International profit shifting leads to a substantial redistribution of national corporate tax revenues. Many European nations appear to gain revenues from profit shifting by multinationals largely at the expense of Germany.

**Key words**: corporate taxation, international profit shifting

**JEL Classification**: F23, H25

* We thank Stijn Claessens, Gaëtan Nicodème and seminar participants at the University of Mannheim and the University of Würzburg for useful comments, and Ying Lin for excellent research assistance. This paper was largely written while the second author was at the World Bank. The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the views of the International Monetary Fund, the World Bank, their Executive Directors, or the countries they represent. June 2006. *This paper was presented at the Commission of the European Communities Directorate-General on Economic Affairs Workshop on Corporation Income Tax Competition and Coordination in the European Union, held in Brussels September 25, 2006*

## 1. Introduction

Corporate income taxation continues to be a national affair in Europe despite economic integration brought on by free trade and the single currency. Corporate income in Europe is taxed at different rates in different countries. Cross-border income flows within the multinational may in addition be subject to double taxation, even if some form of double tax relief is normally provided. Europe's current corporate tax system no doubt distorts the international allocation of real activity. A voluminous literature specifically suggests that foreign direct investment (FDI) flows are sensitive to taxation (see Gresik (2001) and De Mooij and Ederveen (2003) for recent surveys). Tax rate differences further provide multinationals with incentives to re-allocate accounting profits internationally so as to reduce their worldwide corporate tax liability. The scope for international profit shifting for tax purposes is considerable in Europe, as large European multinational firms typically operate in many, if not all, European countries.

A multinational can shift profits from high-tax countries to low-tax countries through a variety of techniques. First, a multinational can manipulate its transfer prices for international, intra-firm transactions. Specifically, the multinational can reduce accounting profits in a high-tax country by overstating the prices of imports into this country and conversely by understating the prices of exports. Several studies, mainly based on U.S. data and surveyed by Hines (1999) and Newlon (2000), find evidence of profit shifting through the manipulation of transfer prices. Clausing (2003), for instance, reports some direct evidence that intra-firm trade prices deviate from outside, 'arm's length' prices in ways that are consistent with international tax minimization. Second, the multinational can affect the international allocation of accounting profits through its financial structure. Particularly, by assigning (high-interest) debt to high-tax locales the multinational firm can reduce its worldwide tax bill.[1] Thirdly, the multinational can aim to re-assign common expenses, such as R&D expenses or headquarter services, to high-tax countries, thereby reducing accounting profits in these countries. International profit shifting, by any technique, imposes potentially significant accounting and other costs on the firm.

International profit shifting efforts, if effective, should reduce multinational company profits reported in high-tax countries. For the case of U.S. outward FDI, Grubert and Mutti (1991) indeed find a negative relationship between the reported profitability and tax burdens in foreign countries. Hines and Rice (1994) [henceforth, HR] similarly investigate the relationship between the profitability of U.S. FDI abroad and foreign tax burdens after controlling for labor and capital inputs in these countries. Profits reported abroad by U.S. multinationals are found to be sensitive to national tax burdens, not least because U.S. multinationals operate in a variety of tax havens with presumably rather lax enforcement, if any, of anti-profit shifting statutes. Haufler and Schjelderup (2000) examine international tax competition in a model where countries can use the tax rate and the definition of the tax base as strategic variables. International profit shifting can explain a relatively low tax rate and a relatively broad definition of the tax base as Nash equilibrium outcomes. Demirgüç-Kunt and Huizinga (2001) find that the profitability reported by foreign-owned banks across 80 countries is negatively related to national top statutory tax rates as evidence of international profit shifting, while similarly Bartelsman and Beetsman (2003) find

[1] Hines and Hubbard (1990), Collins and Shackelford (1992), Froot and Hines (1992) and Grubert (1998) provide evidence that multinational financial structure and the pattern of intra-firm interest and other income flows are consistent with tax minimization objectives.

that value added reported at the sectoral level in OECD countries is negatively related to statutory tax rates.

In this paper, we present a model of the opportunities and incentives generated by international tax differences for international profit shifting by multinationals. Unlike previous work (see, for example, HR), we consider not only profit shifting arising from international tax differences between affiliates and parent companies, but also profit shifting arising from tax differences between affiliates in different host countries. As indicated, multinationals typically operate in several countries. A multinational may carry out substantial business activities in its domicile country and, in addition, own subsidiaries in several other countries. In this setting, profits can be shifted between the parent firm and a foreign subsidiary, but also between foreign subsidiaries. To the best of our knowledge, we are the first to offer a framework to describe profit shifting in such a multi-country setting.

Our model yields the prediction that a multinational's profit shifting in a country depends on both national tax rates and differences between national and foreign tax rates in all countries in which the multinational operates. In particular, we show that profit shifting into a country by a multinational is negatively related to a weighted average of international tax rate differences between this country and all other countries where the multinational is active.

To implement this framework, we use a unique dataset containing detailed firm-level information on the parent companies and subsidiaries of European multinationals from the Amadeus database. This database allows us to link each multinational's parent company to its foreign subsidiaries. We complement this dataset with detailed information about the international tax system, including data on double taxation provisions in Europe and bilateral tax treaties among European countries. We focus on Europe because of the availability of detailed data on the structure of European multinationals, including financial statements of not only parent companies but also subsidiaries, but also because international tax policy and its impact on international profit shifting is a hotly debated topic in Europe, with the European Commission (2001) favoring the introduction of a common tax base for multinationals operating in Europe, in part to combat international profit shifting in Europe. Nevertheless, our framework can be applied to all countries.

Using this unique dataset, we test our model and empirically examine the extent of intra-European profit shifting by European multinationals. We find that international profit shifting by European multinationals is significant, and compare our estimates with those obtained by others in the literature. The estimation implies that European firms incur significant costs in shifting profits internationally. On average, these costs are estimated to be 1.6 percent of the tax base of multinational firms in Europe.

We aggregate our firm-level estimates of profit shifting to arrive at national measures of international profit shifting. On average, we find a semi-elasticity of reported profits with respect to the top statutory tax rate of 1.43. This elasticity is large enough for international profit shifting to be a serious issue for European tax authorities. This is confirmed by estimates of the corporate tax revenue losses (or gains) that European governments currently experience on account of international profit shifting. We find that Germany has been a large tax revenue loser, both on account of its high top statutory tax rate and its large size. Most other European countries in fact appear to have experienced net corporate tax revenue gains, at Germany's expense.

The remainder of the paper is organized as follows. Section 2 outlines the international tax system facing European multinationals. Of particular importance is whether a multinational's foreign-source income is subject to double taxation in both the domicile and foreign countries. Section 3 outlines our model of international tax shifting by a multinational firm operating in multiple countries. Section 4 discusses the company-level data used in this study. Section 5 provides the empirical estimates of the impact of the tax regime on international profit shifting based on our micro data. Section 6 discusses the macro implications of these empirical estimates. First, we present estimates of macro elasticities of reported profits with respect to national tax rates and, second, we discuss estimates of the national tax revenue implications of international profit shifting by European multinationals. Section 7 concludes.

## 2. The international tax system

A multinational firm is domiciled for tax purposes in its parent country and has subsidiaries in at least one foreign country. Profit shifting can occur between the parent country and one foreign country or between two foreign countries. Such shifts affect the reported pre-tax profitability in the two or more affected locales. To see how profit shifting affects the multinational's worldwide tax liability, we generally have to take into account the tax rates of the countries involved as well as the rules used by the parent country to alleviate the potential double taxation of foreign-source income. To start, the marginal tax rate on income reported in the multinational's parent country is simply equal to the top statutory tax rate in that country, denoted $t_p$. In some countries such as Germany, corporate income is taxed at the national as well as the sub-national level. In these instances, the top statutory tax rate is calculated to reflect the various levels of taxation. Table 1 provides information on top statutory rates in 1999 for the 32 European countries in our study taken from several sources: Taxation of Companies in Europe (International Bureau of Fiscal Documentation), Corporate Taxes 1999-2000 Worldwide Summaries (PriceWaterhouseCoopers), and Worldwide Corporate Tax Guide (Ernst & Young). The notes to Table 1 provide more details on the calculation of the effective tax rates.

A multinational's foreign-source income is generally taxed in the foreign country as well as in the parent country. To fix ideas, let us consider a multinational, headquartered in country $p$, with a single subsidiary in a foreign country $i$. Income reported in the foreign country is first taxed in this foreign country at the rates reported in Table 1. The parent country subsequently may or may not use its right to tax the income generated abroad. In case the parent country operates a territorial or source-based tax system, it effectively exempts foreign-source income from taxation. The effective marginal tax on income reported in country $i$, denoted $\tau_i$, in this instance equals the statutory tax $t_i$ in country $i$. Alternatively, the parent country operates a worldwide or residence-based tax system. In this instance, the parent country subjects income reported in country $i$ to taxation, but it generally provides a foreign tax credit for taxes already paid in country $i$ to reduce the potential for double taxation.[2] The OECD model treaty, which summarizes recommended practice, in fact gives countries an option between an exemption and a foreign tax credit as the only two ways to relieve double taxation (see OECD, 1997). The foreign tax credit reduces domestic taxes on foreign source income one-for-one with the taxes already paid abroad. Foreign tax credits in practice are limited to prevent the domestic tax liability on

[2] Firms generally are subject to a set of indirect (non-income) taxes in additional to corporate income taxes. Foreign indirect taxes are generally not creditable against a parent company's corporate income taxes. See Desai, Foley and Hines (2004).

foreign source income from becoming negative. Thus, the multinational will effectively pay no additional tax in the parent country, if the parent tax rate, $t_p$, is less than the foreign tax rate, $t_i$. The multinational then has unused foreign tax credits and is said to be in an excess credit position. Alternatively, the parent tax rate, $t_p$, exceeds the foreign tax rate, $t_i$ . In that instance, the firm pays tax in the parent country at a rate equal to the difference between the parent and foreign country tax rates, i.e. at a rate $t_p - t_i$. The effective, combined tax rate on foreign source income, $\tau_i$, then equals the parent country tax rate, $t_p$. To summarize, with the credit system the effective rate on income generated in country $i$, $\tau_i$ , is given by $\max[t_p, t_i]$. A few countries with worldwide taxation do not provide foreign tax credits, but instead allow foreign taxes to be deducted from the multinational's taxable income. Under this deduction method, foreign taxes are essentially seen as a tax-deductible cost of doing business at par with other business costs. In this scenario, one euro of foreign-source income is reduced to $(1- t_p)(1- t_i)$ of net-of-tax income, which implies that $\tau_i = t_i + t_p(1- t_i)$.

The effective tax rates $\tau_i$ and $\tau_p$ as applied to the multinational's income reported in countries $i$ and $p$ determine the tax savings from international profit shifting. Specifically the multinational can reduce its worldwide tax liability by $\tau_p - \tau_i$ euro for each euro of profits shifted from the parent to the subsidiary if $\tau_p > \tau_i$, and vice versa. In the exemption case, this simply requires $t_p > t_i$, and vice versa. With the credit system, the firm faces an incentive to shift profits from country $i$ to county $p$ if $t_p < t_i$ , while there is no incentive to shift profits otherwise. With the deduction system, finally, there always is an incentive to shift profits from the subsidiary to the parent to avoid double taxation.

Many multinationals have subsidiaries in more than one foreign country. With subsidiaries in n foreign countries, we can distinguish effective tax rates $\tau_i$ and $\tau_j$ on income reported in foreign countries $i$ and $j$. The multinational then can reduce its worldwide taxes by shifting profits from country $i$ to country $j$ if $\tau_i > \tau_j$, and vice versa. This would be the case if the parent country operates a territorial tax system or a worldwide tax system with a deduction and if $t_i > t_j$. In case the home country instead provides a foreign tax credit with $t_i > t_j$, we have $\tau_i > \tau_j$ if and only if $t_i > t_p$.

Most countries apply a default method of double tax relief, i.e., exemption, credit, or deduction, to the foreign-source income generated by its multinationals. Table 1 reports the default method of double tax relief for all European countries in our sample. In individual country cases, a different rule may apply as agreed in bilateral tax treaties. To get a complete picture of double tax relief methods used in Europe, one thus needs to know (i) a country's default method of double tax relief, and (ii) where a bilateral tax treaty exists that amends the general rule. For information on a country's general rule for dealing with foreign source income, we turned to Taxation of Companies in Europe (International Bureau of Fiscal Documentation), Corporate Taxes 1999-2000 Worldwide Summaries (PriceWaterhouseCoopers), and Worldwide Corporate Tax Guide (Ernst & Young). Bilateral tax treaties are available from Taxation of Companies in Europe (International Bureau of Fiscal Documentation), and Tax Analysts (www.taxanalysts.com). Each of these sources of data on tax systems are widely used in the literature.

As seen in Table 2, some countries apply the same double tax relief method to income from all other European countries in the table, while other countries apply more than one rule to income from different countries. France and the Netherlands, for instance, are countries that exempt foreign-source income generated anywhere outside France and the Netherlands,

respectively. Italy and the United Kingdom, instead, are countries that generally apply the credit method. Belgium is a country that applies the deduction method to some countries (Czech Republic, Estonia, Iceland, Latvia, Lithuania, Slovak Republic and Slovenia), while it exempts foreign source income from other countries. It should be noted that Belgium applies only half of its normal tax rate of 40.17 percent to any foreign-source income (after deduction of foreign taxes) in 1999.[3]

## 3. The model

The model considers a multinational firm that generally operates establishments in n countries. In one of these countries, denoted *p*, the parent firm is located. The variable $B_i$ represents the profits actually generated by the multinational firm in country *i*. The multinational can manipulate its transfer prices for international intra-firm transactions to shift profits $S_i$ into country *i*. Manipulating transfer prices is assumed to be costly, as the multinational needs to modify its books, and perhaps also its real trade and investment pattern, to be able to justify the distorted transfer prices with the tax authorities. Following HR, we assume that the marginal cost of shifting profits rises in proportion to the ratio of shifted profits to true profits given by $S_i/B$ with $\gamma$ being this factor of proportionality. This reflects that a company's accounts have to be distorted relatively little to accommodate profit shifting $S_i$ if true profits $B_i$ are relatively large. Total shifting expenses, $E_i$, incurred by the multinational in country *i* are calculated as $\frac{\gamma}{2}\frac{(S_i)^2}{B_i}$.[4] Total profits shifted by a multinational into its n countries of operation are non-positive so that $\sum_{i=1}^{n} S_i \leq 0$. The firm chooses the profit shifting level $S_i$ to maximize worldwide after-tax profits given by

$$L = \sum_{i=1}^{n}(1-\tau_i)(B_i + S_i - \frac{\gamma}{2}\frac{(S_i)^2}{B_i}) \; - \; \lambda\sum_{i=1}^{n} S_i \qquad (1)$$

where $\lambda$ is a Lagrange multiplier and $\tau_i$ is the effective tax rate. In equation 1, shifting expenses are taken to be tax-deductible.

The first order condition with respect to $S_i$ is given by

$$(1-\tau_i)(1-\gamma\frac{S_i}{B_i}) - \lambda = 0 \qquad \text{for all } i = 1,\ldots,n \qquad (2)$$

Note that the term $(1-\tau_i)(1-\gamma\frac{S_i}{B_i})$ in equation 2 is the after-tax, after-marginal-shifting-cost value of additional profits reported in country *i*. Equation 2 simply says that this marginal

[3] The deduction method as applied by Belgium can be seen as an exemption applied to half of the foreign-source income and the standard deduction method applied to the other half.

[4] Even if firms comply with transfer pricing regulations, they may face considerable costs in dealing with, for instance, documentation requirements. The European Commission (2004a, Table 3-5) reports qualitative survey results that indicate that the majority of European multinationals consider these requirements a difficulty.

value of reported profits should be equalized across all countries where the multinational firm operates. HR use equation 2 to derive an estimating equation relating aggregate profits reported by US multinationals in a set of countries to a measure of these countries' corporate tax rate. In the present paper, we use micro-level data on the operations of Europe-based multinational firms in many European countries. In this setting, it is necessary to know how a multinational's incentive to shift profits into any one country depends on the tax regimes of all the countries where it operates. For this purpose, we proceed to solve equation 2 for the optimal profit shifting $S_i$ into country *i* to yield

$$S_i = \left(\frac{B_i}{\gamma(1-\tau_i)}\right)\frac{\sum_{k\neq i}^{n}\left(\frac{B_k}{1-\tau_k}\right)(\tau_k-\tau_i)}{\sum_{k=1}^{n}\left(\frac{B_k}{1-\tau_k}\right)} \qquad (3)$$

where it should be noted that the sum of the $S_i$ internationally equals zero.

Equation 3 indicates that the optimal inward profit shifting $S_i$ is proportional to *i*) the true tax base $B_i$, ii) the inverse of $\gamma(1-\tau_i)$, and iii) a weighted average of the effective tax rate differences $\tau_k-\tau_i$ with weights $\frac{\frac{B_k}{1-\tau_k}}{\sum_{k=1}^{n}\left(\frac{B_k}{1-\tau_k}\right)}$. The effective tax rates $\tau_i$ and $\tau_k$ in the term $\gamma(1-\tau_i)$ and in the weights $\frac{\frac{B_k}{1-\tau_k}}{\sum_{k=1}^{n}\left(\frac{B_k}{1-\tau_k}\right)}$ reflect that shifting costs are taken to be tax deductible in the country where they are incurred, with the tax rate $\tau_i$ in country *i* being relatively important in the determination of $S_i$. At the same time, a higher scaling variable $B_k$ in country *k* is seen to increase the weight on $\tau_k-\tau_i$ in the overall expression of $S_i$, which reflects that a larger scale of operation in country *k* makes it less costly for the multinational to shift profits into or out of this country. Other things equal, optimal profit shifting $S_i$ into country *i* sensibly increases in the tax rate differences $\tau_k-\tau_i$ and decreases with the shifting cost parameter γ.

Reported profits, denoted $B_i^r$, are equal to the sum of $B_i$ and $S_i$ as follows

$$B_i^r = B_i\left[1-\frac{1}{\gamma(1-\tau_i)}\frac{\sum_{k\neq i}^{n}\left(\frac{B_k}{1-\tau_k}\right)(\tau_i-\tau_k)}{\sum_{k=1}^{n}\left(\frac{B_k}{1-\tau_k}\right)}\right] \qquad (4)$$

After taking logs, we can approximate equation (4) to get

$$b_i^r = b_i - \frac{1}{\gamma} C_i \qquad (5)$$

where $b_i^r = log\left(B_i^r\right)$, $b_i = log\left(B_i\right)$, and $C_i = \frac{1}{(1-\tau_i)} \frac{\sum_{k \neq i}^{n} \left( \frac{B_k}{1-\tau_k} \right) (\tau_i - \tau_k)}{\sum_{k=1}^{n} \left( \frac{B_k}{1-\tau_k} \right)}$. The variable $C_i$ is a composite tax variable that summarizes all information about profit shifting incentives (or the effective tax rates $\tau$ in all countries) and about profit shifting opportunities (or the scale of the firm's operations *B* in all countries). A positive value of $C_i$ implies that the multinational firm optimally shifts profits out of county *i*. The variable $C_i$ is seen to be the product of two terms: $\frac{1}{(1-\tau_i)}$ and a weighted average of the effective tax rate differences $\tau_i - \tau_k$ with weights $\frac{\frac{B_k}{1-\tau_k}}{\sum_{k=1}^{n} \left( \frac{B_k}{1-\tau_k} \right)}$.[5]

The true profit variables $B_i$ are not directly observable. Following HR, we assume that true profits are the return to capital in a scenario where capital, $K_i$, and labor, $L_i$, are jointly employed by the firm to produce output $Q_i$. More specifically, we will assume a Cobb-Douglas production function given by $Q_i = cA_i^{\varepsilon} L_i^{\alpha} K_i^{\varphi} e^{u_i}$. The variable $A_i$ is a productivity parameter that may reflect cross-country differences in technology or factor qualities, while $u_i$ is a random term. True profits, $B_i$, are equal to output $Q_i$ minus the wage bill, which gives $B_i = Q_i - w_i L_i$. The wage $w_i$ is taken to be equal to the marginal product of labor given by $c\alpha A_i^{\varepsilon} L_i^{1-\alpha} K_i^{\varphi} e^{u_i}$. This implies that true profits $B_i$ equal $c(1-\alpha) A_i^{\varepsilon} L_i^{\alpha} K_i^{\varphi} e^{u_i}$. Taking logs of this expression for $B_i$, we next get

$$b_i = log\ (c) + log\ (1-\alpha) + \varepsilon\, a_i + \alpha\, l_i + \varphi\, k_i + u_i \qquad (6)$$

where $a_i = log\ A_i$, $l_i = log\ L_i$, and $k_i = log\ (K_i)$. Substituting for $b_i$ from (6) into (5), we get the following estimating equation

---

[5] Again the tax deductibility of profit shifting costs explains the presence of the tax rates in the term $\frac{1}{(1-\tau_i)}$ and in the weights $\frac{\frac{B_k}{1-\tau_k}}{\sum_{k=1}^{n} \left( \frac{B_k}{1-\tau_k} \right)}$. In the absence of this deductibility, $C_i$ would collapse to the simpler expression given by $\frac{\sum_{k \neq i}^{n} B_k (\tau_i - \tau_k)}{\sum_{k=1}^{n} B_k}$.

$$b_i^r = \beta_1 + \beta_2 a_i + \beta_3 l_i + \beta_4 k_i - \hat{\gamma} C_i + u_i \qquad (7)$$

where $\beta_1 = \log(c) + \log(1-\alpha)$, $\beta_2 = \varepsilon$, $\beta_3 = \alpha$, $\beta_4 = \varphi$, $\hat{\gamma} = \frac{1}{\gamma}$. Equation 7 indicates that logged reported profits $b_i^r$ respond negatively to the composite tax factor $C_i$. In fact, equation 7 suggests that we can interpret $\hat{\gamma}$ as the semi-elasticity of reported profits $B_i^r$ with respect to the composite tax variable $C_i$, as $-\frac{1}{B_i^r}\frac{dB_i^r}{dC_i} = \hat{\gamma}$.

As indicated, $C_i$ reflects both a multinational's international structure and the international tax system. Tax authorities can affect $C_i$ and hence reported profits $B_i^r$ through changes in effective tax rates $\tau_i$. These, as seen in section 2, are determined by the top statutory tax rates $t_i$ and by the international pattern of double tax relief.

In practice, double tax relief rules are changed less frequently than tax rates, and hence most of the changes in effective tax rates result from changes in statutory tax rates. In this paper, we will consider how changes in either effective tax rates $\tau_i$ or in statutory tax rates $t_i$ affect reported profits $B_i^r$. Straightforwardly, the elasticity of $B_i^r$ with respect to $\tau_i$ is given by $-\frac{1}{B_i^r}\frac{dB_i^r}{d\tau_i} = \hat{\gamma}\frac{dC_i}{d\tau_i} > 0$, while at the same time we have $-\frac{1}{B_i^r}\frac{dB_i^r}{d\tau_k} = \hat{\gamma}\frac{dC_i}{d\tau_k} < 0$ for effective tax rate changes in countries $k$ different from $i$.[6] Next, a general expression for the semi-elasticity of reported profits in country $i$ with respect to the statutory tax rate $t_i$ in this country is given by $-\frac{1}{B_i^r}\frac{dB_i^r}{dt_i} = \hat{\gamma}\frac{dC_i}{dt_i} = \hat{\gamma}\sum_{k=1}^{n}\frac{dC_i}{d\tau_k}\frac{d\tau_k}{dt_i}$. This expression reflects that a change in the statutory tax rate $t_i$ in country $i$ may affect reported profits $B_i^r$ through its effects on effective tax rates $\tau_k$ in several countries. Hence, quite some information is necessary to assess how a change in a country's statutory tax rate affects the effective tax rates and the $C_i$ facing all multinationals with business operations in a country, and in the end how these affect reported profits $B_i^r$. Assessments of the implications of tax rate changes on international profit shifting are therefore best addressed through computer simulation. This is done in section 6. Simulations of this kind require an estimated value for the elasticity parameter $\hat{\gamma}$ as provided in section 5.

## 4. The company data

The data on multinational firms is taken from the Amadeus database compiled by Bureau Van Dijk.[7] This database provides accounting data on private and publicly owned European firms

[6] Note that $\frac{dC_i}{d\tau_i} = \frac{\left(\sum_{k=1}^{n} B_k\right)\left(\sum_{k\neq i}^{n}\frac{B_k}{1-\tau_k}\right)}{(1-\tau_i)^2\left[\sum_{k=1}^{n}\frac{B_k}{1-\tau_k}\right]^2} > 0$, while $\frac{dC_i}{d\tau_k} = -\frac{B_k\left(\sum_{k=1}^{n} B_k\right)}{(1-\tau_i)(1-\tau_k)^2\left[\sum_{k=1}^{n}\frac{B_k}{1-\tau_k}\right]^2} < 0$.

[7] The database is created by collecting standardized data received from 50 vendors across Europe. The local source for this data is generally the office of the Registrar of Companies.

as well as on their ownership relationships. These ownership data allow us to match European firms with their domestic subsidiaries and subsidiaries located in other European firms. A firm is defined to be a subsidiary, if at least 50 percent of the shares are owned by another single firm. As we are interested in international profit shifting, we restrict our sample to multinational firms that have at least one foreign subsidiary. Multinational firms tend to provide consolidated and unconsolidated accounting statements. Consolidated statements reflect the activities within the parent companies themselves and of all domestic and foreign subsidiaries. Separate, non-consolidated statements in contrast reflect the activities directly within the parent firm and in each of its subsidiaries. Using non-consolidated statements, we can define the sales of domestic multinationals in a country as the sum of the sales of the country's parent companies and their domestic subsidiaries, if any. The sales of foreign multinationals in a country in turn are the sales of foreign subsidiaries located domestically. Using this breakdown, Table 3 shows that sales by foreign multinationals represent about 23 percent of all sales by multinationals in Europe for 1999. The table also reports sales data for a smaller sample of multinational firms for which we have some basic accounting data beyond sales data. For this smaller sample, the total foreign share in sales by multinationals is 22 percent.

The accounting data in Amadeus are needed to construct the variables used in the subsequent empirical analysis. For multinationals with more than one establishment in a country, variables are aggregated at the country level. Aggregation of this type does not affect the relationships between actual profits, reported profits and taxes in equation 5. This follows from the fact that the optimal inward or outward profit shifting by a multinational at the national level only depends on true profits at the national level and not on the dispersion of these true profits among the multinational's establishments within countries (as is shown in Appendix 1).[8] Our main dependent variable will be the log of earnings before interest and taxes (for definitions of variables and data sources, see Appendix 2). Alternatively, we consider the log of pre-tax profits defined as earnings net of interest expense but before taxes. As our measure of capital we will use the log of fixed assets on the assumption that fixed assets are more easily valued than intangible assets.

To represent labor input, we use the labor variable, defined as the log of total labor compensation and, alternatively, employment defined as the log of the number of employees. Financial leverage is defined as total debt over total assets. On account of the tax deductibility of interest expenses, pre-tax profits are expected to be negatively related to financial leverage. Earnings before interest and taxes may be affected by leverage as well, if leverage affects investment choices and other non-financial aspects of firm performance.

Table 4 provides summary statistics for the firm-level variables, including the composite tax variable *C* in Panels A through D. Panel A provides these statistics for all firms regardless of whether they are domestic or foreign and for all sectors, while Panel B only considers foreign subsidiaries. Panels C and D represent all manufacturing firms and foreign subsidiaries in the manufacturing sectors only. Comparing Panels A and B, it is interesting to see that on average foreign subsidiaries are relatively small in terms of both the income measures and the input measures. The same pattern is seen in Panels C and D for manufacturing firms only. As the composite tax variable *C* is a weighted average of bilateral tax differences, it is not surprising that the median value of *C* is zero in all four panels. The mean value of *C*, however, is negative at -

[8] With constant returns to scale, production functions can be exactly aggregated. Otherwise, the aggregation introduces some additional noise in the estimation of equation 7.

0.01 in Panel A and -0.02 in Panels B through D. Given that *C* is an average of bilateral tax differences weighted by sales, this suggests that – for any multinational firm – establishments in low-tax countries register relatively low sales. This is to be expected as low-tax countries tend to be small countries with small market sizes.

Next, Panel E of Table 4 provides a correlation matrix for some of the main firm-level variables and also per capita income. These correlations are for all establishments, both within and across multinational firms. The earnings variable is, not surprisingly, positively related to the input measures compensation, employees and capital. All of these are also positively related to per capita income, suggesting that firms are larger in richer countries. Finally, the composite tax variable, *C*, is negatively related to the income and input variables. This suggests that multinationals economize on inputs as well as on reported income in high-tax countries. The variable *C*, finally, is positively related to per capita income. This may reflect that wealthy countries tend to have higher corporate income tax rates.

## 5. Empirical results

### 5.1 Basic results

In the basic regressions, the dependent variable is the log of earnings before interest and taxes. The benchmark sample is restricted to observations for foreign subsidiaries and thus excludes parent companies. We also restrict the base sample to manufacturing firms for which the production function approach of equation 6 may describe output better than for, say, service industries. We further limit the sample to include only multinational firms for which we have at least 20 percent of all (European) subsidiaries in the sample. As robustness checks, we later will (i) expand the sample to include parent companies, alternatively (ii) expand the sample to include non-manufacturing firms, or (iii) limit the sample to include only firms for which we have at least 50 percent of all subsidiaries in our sample. In Table 5, regression 1, we see that the sum of the coefficients on the labor and capital variables is 0.887. This suggests that overall the technology displays decreasing returns to scale. The per capita income variable as a proxy for overall economic development enters with a negative coefficient that is significant at the 10 percent level. This coefficient reflects the sum effect of several possibly opposite channels by which economic development potentially affects profitability. Higher profitability could materialize in richer countries on account of more advanced technologies. To the contrary, profitability could on average be negatively impacted by the state of development, if firms require higher expected returns in poorer countries characterized by less effective property rights and regulations. Our finding of a negative coefficient for the per capita income variable suggests that effects of the second kind dominate. Finally, the composite tax variable *C* enters with an estimated coefficient $\hat{\gamma}$ of 1.068 that is significant at the 1 percent level.

Regression 2 adds industry fixed effects to the regression to yield an estimated $\hat{\gamma}$ of 0.933. As indicated in the table, an F-test of no significance of these industry fixed effects is rejected. Next, regression 3 includes a dummy variable that equals one for firms in Eastern Europe and zero for firms in Western Europe, along with an interaction term of this variable with the composite tax variable *C*. The purpose of including these two additional variables is to see whether the implied estimated relationship between reported profitability and profit shifting incentives, as represented by *C*, is different in Eastern Europe. This does not seem to be the case, as both the Eastern European dummy variable and its interaction term with *C*, while negative, are

not statistically significant. The coefficient for the non-interacted *C* variable, in contrast, is estimated at 0.912 and significant at 1 percent. Finally, in regression 4 we split *C* into two variables for each observation: one variable is the part representing the tax difference of a subsidiary vis-à-vis its parent firm and the other is the (weighted) sum of the tax difference vis-à-vis subsidiaries in other (foreign) countries. The first part – relating to parent firms – obtains a coefficient of 1.059 that is significant at the 1 percent level, but the second part – while negative – obtains a coefficient that is not statistically significant at 10 percent.[9]

**5.2 Robustness checks**

We next report several alternative regressions as robustness checks taking regression 2 in Table 5 as a starting point. First, we compute the composite tax variable *C* on the assumption that the multinational's ability to shift profits into or out of a country is unrelated to the scale of activities in each county. This is achieved by calculating *C* after setting all the *B*'s to a constant. In Table 6, regression 1, we see that this gives rise to an estimated coefficient $\hat{\gamma}$ of 0.670 that is not statistically significant at 10 percent. Hence, a composite tax variable *C* only based on tax system information does not appear to be able to explain international profit shifting. Next, in regression 2 we use assets rather than sales to represent the *B*'s in the construction of *C*. This would be appropriate, if sales data are too distorted by profit shifting to proxy for a multinational's scale of activities in different locales. This results in an estimated $\hat{\gamma}$ of 0.854, which is very similar to the benchmark estimate of 0.933 in regression 2 of Table 5. In regression, 3 we in turn use the log of the number of employees rather than of employee compensation to represent labor input. By its very nature, the employment variable fails to reflect international differences in labor quality as reflected in international wage differences. The estimated value of $\hat{\gamma}$ is now slightly lower at 0.764.

So far, our sample has contained only observations on foreign subsidiaries to the exclusion of parent companies. This ensures that not all the establishments of any particular multinational enter our sample as separate observations. This way we sidestep the potential problem that deviations from optimal profit shifting for the various establishments of a given multinational as given by equation 3, at least theoretically, add up to zero. The random term $u_i$ in regression equation 7 in practice, of course, also reflects establishment-specific productivity or perhaps demand shocks that would not add up to zero for the overall multinational firm. The inclusion of parent firms in regression 4 expands the sample with 476 observations to a total of 1484, and yields an estimated $\hat{\gamma}$ of 0.907 very similar to the benchmark estimate of 0.933. Regression 5 includes foreign subsidiaries in all industries to yield 2210 observations and an estimated $\hat{\gamma}$ of 0.754. Regression 6 again restricts the simple to manufacturing, but now takes the log of pre-tax profits rather than of earnings before interest and taxes as the dependent variable. This results in a somewhat smaller estimated $\hat{\gamma}$ of 0.754.

[9] However, in an unreported regression we restrict the sample to subsidiaries of multinationals for which we have data on at least 50 percent of the subsidiaries to obtain an estimated $\hat{\gamma}$ of -1.6 that is statistically significant at 10 percent. Hence, there is some evidence of international profit shifting among a multinational's subsidiaries in different foreign countries. The absence of strong evidence of profit shifting among a firm's foreign subsidiaries may reflect that these foreign subsidiaries perform similar tasks, e.g. sales, and hence there is little scope for transactions among foreign subsidiaries.

In deriving the regression equation 7, we have assumed a uniform shifting cost parameter $\gamma$ for profit shifting into all countries. This assumption implies that we could interact the *C* variable with a set of country dummies to yield similar coefficients for $\hat{\gamma}$. Regression 7 in fact replaces a single *C* variable by a set of interaction terms of *C* with country dummies, while the country dummies themselves are included as well. For some countries, there are rather few subsidiary observations. Therefore, coefficients for individual country interaction terms are not expected to be estimated with precision, and indeed the (unreported) coefficients for the interaction terms vary widely. The table, however, reports an F-test of the hypothesis that all coefficients on the interaction terms are equal, which is not rejected.

Next, in regressions 8 we restrict the sample to subsidiaries of multinationals for which we have complete data on at least 50 percent of the (European) foreign subsidiaries. This reduces the sample size to 354 observations, and increases the estimated coefficient of $\hat{\gamma}$ to 1.949. In regression 9, we include leverage as an additional explanatory variable. Leverage enters the regression with a negative coefficient that is statistically significant at the 1 percent level. Hence, leverage appears to reduce reported earnings before earnings and taxes, perhaps because it makes profitable investments more difficult to finance, while $\hat{\gamma}$ is estimated at 0.792. Regression 10 also includes the leverage variable and, as regression 6, has the log of pre-tax earnings after interest but before taxes as the dependent variable. Leverage has a more negative impact on pre-tax profits than on pre-tax earnings, no doubt on account of the tax deductibility of interest expenses. Relative to equation 6, the inclusion of the leverage variable reduces the estimated $\hat{\gamma}$ to 0.656. Regression 11 adds the Corruption variable constructed by ICRG (with higher values denoting less corruption) to see whether less corruption would lead to higher reported earnings. Indeed the Corruption variable enters the regression with a positive coefficient, but it is not statistically significant.

To construct our effective tax rate variable, we consulted the entire grid of Europe's bilateral tax treaties for information on double taxation relief rules. Davies (2004) explains that tax treaties may affect international transfer pricing in other ways as well. First, tax treaties in some instances specify the preferred method of transfer price calculation to be used by firms, which would eliminate firms' discretion in this area and presumably the scope for international profit shifting through transfer price manipulation. Secondly, tax treaties may specify the dispute resolution mechanisms to be followed in case different national tax authorities disagree on international transfer prices. This is expected to weaken the position of the firm in any dispute on transfer pricing and may similarly make transfer price manipulation more difficult. To test this, in regression 12 we include a treaty dummy variable that takes on a value of one if a subsidiary country has concluded a bilateral tax treaty with the firm's parent country, and a value of zero otherwise. Information on whether a bilateral tax treaty exists has been collected from Tax Analysts (www.taxanalysts.com) and is reproduced in Appendix 3. The treaty variable enters regression 12 with a negative coefficient that is statistically insignificant. Blonigen and Davies (2002) similarly fail to find a significant effect of bilateral tax treaties on FDI.

Finally, regression 13 restricts the sample to subsidiary observations in Western Europe on the assumption that reported profitability in Western Europe may be depressed relatively little by tax or other fraud not related to transfer prices. This reduces the sample to 906 observations to yield an estimated $\hat{\gamma}$ to 0.908 close to the benchmark estimate of 0.933.

### 5.3 Comparison with Hines and Rice (1994)

The work by HR implies a semi-elasticity of reported pre-tax profits with respect to the tax rate of 2.83 based on regression 1 in their Table II. This figure is much larger than our benchmark estimate of 0.933 of the elasticity of reported pre-tax profits with respect to the composite tax variable *C*. The two numbers, clearly enough, are not directly comparable as the HR study and our study differ in several important ways. First, HR examine the profits reported by US multinationals on their FDI in other countries including in set of tax havens. The present study instead examines the profits reported by European multinationals within Europe to exclude most of the countries considered tax havens in the HR study.[10] Second, the sample periods in the two studies differ, as HR and the present study use data for 1982 and 1999, respectively. Third, HR use aggregate FDI data, while we have firm-level micro data on FDI. Related to this, HR construct a tax rate on the basis of aggregate tax accounting data, while our tax variable *C* is based on statutory tax information. The use of tax accounting data by HR also prevents them from distinguishing between the cases where US multinationals would or would not be in an excess credit position with regard to their corporate income taxes in the US. This distinction, of course, would not matter if US multinationals in practice can defer US taxation on a substantial part of their foreign-source income. By focusing on effective tax rates that reflect double tax relief rules, the *C* variable makes a distinction between excess and no excess credit positions experienced by multinationals based in a country.

In this section, we examine what explains the difference in results between the two studies. To do this, we first estimate a semi-elasticity of reported profits with respect to the tax rate with our data in a way closely resembling the approach in HR. This helps to see whether differences in the approach or in the samples are the main explanation behind the different estimated coefficients. Next, we estimate a series of regressions that one step at a time modify the HR approach to more closely resemble the approach of this paper. The purpose of this is to see which of the stated methodological differences are important in explaining the difference in estimated coefficients.

To start, we use our micro-level data from Amadeus to construct aggregate profitability, tax rate and capital and labor input variables as used in the HR study. Our aggregate tax rate thus is calculated as taxes paid divided by total pre-tax profits. As we examine FDI in a grid of countries rather than from a single sending country, our tax variable will be the difference in the average tax rates in the subsidiary and parent countries. Other variables are constructed on a bilateral basis as well. As seen in Table 7, regression 1, the semi-elasticity of pre-tax profits with respect to the difference in average tax rates in estimated to be 1.421. This figure is about half the mentioned HR estimate of 2.83. This suggests that profit-shifting in the current sample of European multinationals is less pronounced than profit shifting in the sample of US multinationals in the HR study, perhaps because the HR study includes many tax haven countries.

Firms with negative profits tend to pay zero taxes. Such firms clearly depress aggregate profit figures and hence may lead to an overly high calculated average tax rate. To see whether this matters, we next calculate aggregate bilateral data, including average tax rates, after excluding subsidiaries that report negative profits. The resulting regression 2 reports a somewhat

[10] Of the countries listed in Table 1, Cyprus, Ireland, Luxembourg and Switzerland are labeled tax havens in HR.

smaller estimate of 1.222 of the tax semi-elasticity.[11] Regressions 3 and 4 are based on the same data as regressions 1 and 2, but they use individual firm data rather than aggregate data. This gives rise to somewhat smaller estimated semi-elasticities of 0.528 and 1.016, respectively. The step from aggregate to firm-level data apparently may account for part of the difference in the estimated coefficients in the HR and the present study. As a next step, we replace the difference of the accounting-based, average based tax rates by the difference of top statutory tax rates yielding an estimated semi-elasticity of 1.229 in regression 5. Thus replacing average tax rates by statutory tax rates matters little for the estimated semi-elasticity.

To proceed, we replace the bilateral difference of the statutory tax rates by the difference of effective tax rates. This implies that we adjust the statutory tax rates for any double tax relief offered by the parent country in case this country taxes the multinational firm's profits on a worldwide basis. As before, the effective tax rate in the parent country is set equal to the top statutory tax rate in the parent country. This results in a very similar estimated semi-elasticity of 1.199 in regression 6. Hence, adjusting tax rates for double tax relief in the form of deductions or foreign tax credits appears to make little difference in the estimated value of the semi-elasticity. Next, in regressions 7 and 8 we take the tax variables of regressions 5 and 6 and divide them by one minus the effective tax rate of the parent country. This brings the tax variable closer to the definition of the composite tax variable *C*. This division by a variable less then unity naturally leads to smaller estimated coefficients at 0.654 and 0.624 in regressions 7 and 8. Finally, in column 9 we reproduce the benchmark regression of Table 5, regression 2 that includes *C* as an explanatory variable. This again leads to a larger semi-elasticity of 0.933, perhaps because the *C* variable weights bilateral tax differences by the scale of the multinational's activities in different countries. Unlike the HR study, our framework – with the composite tax term *C* as an explanatory variable – does not directly yield an estimated semi-elasticity of pre-tax profits with respect to actual tax rates. However, a semi-elasticity with respect to actual tax rates is implied in the estimation. We return to this issue in section 6.

### 5.4 Endogeneity of tax policy

So far we have assumed that tax policy is exogenous to reported pre-tax profits. In practice, however, tax policy may to some extent be endogenous. To see this, note that firms and also countries may differ in whether they can generate rents through the exploitation of natural resources or perhaps better access to consumer markets. Rents would register as higher reported pre-tax profits and, at the same time, warrant higher levels of taxation if these rents are internationally immobile. Hence, higher pre-tax profits could give rise to higher tax levels. Similarly, reported pre-tax profits may be relatively high in countries that provide relatively plentiful public inputs to production in the form of, say, high-quality infrastructure. To finance extensive public inputs, countries may need to levy relatively high corporate income taxes. Again, higher pre-tax profits would endogenously be associated with higher corporate tax burdens. Such endogeneity is expected to lead to a downward bias of the OLS estimate of $\hat{\gamma}$.

To correct for this and following HR, this section presents instrumental variables estimates of $\hat{\gamma}$, where we take the size of the country, as proxied by its population, as an

[11] Paradoxically, excluding loss making subsidiaries enlarges the sample of regression 2 relative to regression 1. The exclusion of firms with negative profits apparently leads to more observations where aggregate profits (on a bilateral basis) are positive.

instrument for the corporate tax burden. This reflects the notion that on account of international tax competition smaller countries tend to levy lower corporate income taxes.[12] To implement this, we first regress the top statutory tax rate on the log of total population to obtain a predicted value of the top statutory tax rate. We next use these predicted values rather than the actual ones to construct the composite tax variable *C*. By its very nature, this approach uses bilateral information on double tax relief rules and in fact takes this information to be exogenous. This may be a reasonable assumption as double taxation relief rules tend to be longstanding. The result is an estimated $\hat{\gamma}$ of 1.682 in regression 1 of Table 8. This estimate is higher than our benchmark estimate of 0.933 in Table 5, regression 2, which suggests that the OLS estimate of $\hat{\gamma}$ is indeed biased downward. Next, in regression 2 we use the difference of the logs of the populations of the subsidiary and parent countries to instrument for the overall variable *C*. This approach implies that the overall tax variable *C*, in part reflecting double taxation relief conventions, is taken to be endogenous.[13] Now we find an estimated $\hat{\gamma}$ of 2.032 in regression 2. In regression 3, we exclude subsidiaries of multinational firms for which we have incomplete data for more than half of European subsidiaries from regression 2. The estimated $\hat{\gamma}$ of 2.238 is very similar to the estimate of 2.032 in regression 2. In the remainder of this paper, we take the estimated $\hat{\gamma}$ of 2.032 in regression 2 as our preferred estimate, as the results of this section suggest that endogeneity of tax policy is a relevant issue.

## 6. Interpretation of results

Our estimates of the semi-elasticity of pre-tax profits with respect to the composite tax variable *C* by themselves suggest that reported pre-tax profits in Europe reflect tax rates. The variable *C*, however, is not a direct tax policy variable. Therefore it is useful to see what our regression estimates imply about the semi-elasticities of reported pre-tax profits with respect to actual tax rates as considered in subsection 6.1. Next, subsection 6.2 provides estimates of how national tax revenues are currently affected by the implied degree of international profit shifting.

### 6.1 Implied elasticities of aggregate reported profits with respect to tax rates

Aggregate international profit shifting experienced by a country is the simple sum of the profit shifting by all the multinationals operating within its territory. To arrive at an estimate of aggregate profit shifting in response to, say, a change in the top statutory tax rate, we thus first need to estimate how profit shifting by each and every multinational is affected by the tax policy change. Profit shifting by any multinational depends, as seen in section 3, on its own particular structure as well as on the tax incentives it faces. More specifically, estimated changes in reported profits per firm in country *i* in response to a change in the effective or the top statutory tax rate in country *i* are given by the expressions $dB_i^r = -\hat{\gamma} B_i^r \frac{dC_i}{d\tau_i} d\tau_i$ and $dB_i^r = -\hat{\gamma} B_i^r \frac{dC_i}{dt_i} dt_i$, respectively. To proceed, we take the estimated $\hat{\gamma}$ of 2.032 from regression 2 in Table 8. Next, to evaluate the derivatives $\frac{dC_i}{d\tau_i}$, and $\frac{dC_i}{dt_i}$, we examine by raw calculation how much $C_i$ is impacted by an

[12] Huizinga (1987) finds that corporate tax rates are positively correlated with country populations.
[13] Bond and Samuelson (1989) and Mintz and Tulkens (1996) consider the choice of different double taxation relief conventions.

increase of 0.01 in $\tau_i$ and $t_i$, respectively. In either case, the change in nationally reported pre-tax profits, denoted $d\overline{B}_i^r$, is calculated as the sum of the changes $dB_i^r$ by all multinationals operating within the country. Subsequently, we can calculate the national semi-elasticities of the reported tax base w.r.t the effective and statutory tax rates, i.e. $-\frac{1}{\overline{B}_i^r}\frac{d\overline{B}_i^r}{d\tau_i}$ and $-\frac{1}{\overline{B}_i^r}\frac{d\overline{B}_i^r}{dt_i}$.

Table 9 reports our simulated semi-elasticities of reported pre-tax profits w.r.t the effective and statutory tax rates. In column 1, we see that Germany is estimated to have the lowest semi-elasticities of pre-tax profits with respect to the effective tax rate of 0.32. This low estimate may reflect Germany's high statutory tax rate and the fact that multinational-firm establishments in Germany may be relatively large, which makes (marginal) shifts of profits out of Germany relatively hard. Other large European countries, and in particular France, Italy, the United Kingdom and Spain, similarly obtain relatively low semi-elasticities with respect to effective tax rates (all below the average of 1.74 for all European countries). Next, in column 2 we report national semi-elasticities with respect to statutory tax rates. As discussed in section 3, a change in the statutory tax rate in one country may or may not affect the effective tax rate in that country and in other countries depending on the pertinent double tax relief rule and the statutory tax rates in other countries. In the simplest (theoretical) case, all countries operate exemption systems and changes in national effective tax rates mimic changes in national statutory tax rates. In that instance, the two simulated semi-elasticities should be the same as well. In practice, we see that for some countries in the table that apply exemptions (to at least some foreign countries) the two simulated elasticities are indeed equal. These countries are Austria, Bulgaria, Germany, Luxembourg, Poland, Portugal and the Slovak Republic. Note, however, that these simulated elasticities are a reflection of the international tax system as well as of the actual patterns of European multinational investment as revealed by our data set. For all other countries in the table, the estimated semi-elasticity with respect to the statutory rate is less then the semi-estimated elasticity with respect to the effective rate. This is the case, for instance, with the UK where the two elasticities are reported to be 1.13 and 1.10, respectively. This can be explained by the fact that the UK operates a credit system, while some UK multinationals operate subsidiaries in countries with a lower statutory tax rate than the UK (at 30 percent, as seen in Table 1). A higher statutory tax rate in the UK then does not affect incentives for UK multinationals to shift profits to these low-tax countries (in fact, the tax incentive remains zero). This reduces the aggregate semi-elasticity of reported profits with respect to the statutory rate in the UK below the analogous semi-elasticity with respect to the effective tax rate.

Next, we report separate national aggregate profit semi-elasticities for the groups of parent companies and foreign subsidiaries in any particular country. The semi-elasticities with respect to the two tax rates for parent firms are reported in columns 3 and 4, while the two semi-elasticities for foreign subsidiaries are reported in columns 5 and 6. Semi-elasticities reported for parent firms tend to be smaller for the foreign subsidiaries. Comparing columns 3 and 5, for instance, we see that the semi-elasticities with respect to effective tax rates are smaller for parent firms than foreign subsidiaries in all countries (for which we have figures) apart from Belgium and Hungary. An explanation may be that parent firms tend to be larger than foreign subsidiaries so that reported profit shifts between a parent firm and a foreign subsidiary imply small relative profit shifting for the parent firm.

Semi-elasticities can in principle be used to calculate the rate that maximizes tax revenues (in fact, the revenue-maximizing tax rate is simply the inverse of the relevant semi-elasticity). Based on the European average semi-elasticities of 1.74 and 1.43 for the two tax rates for all firms, this would yield revenue maximizing effective and statutory tax rates of 0.58 and 0.70, respectively. These numbers, however, have to be interpreted with caution. First, by construction our profit shifting elasticities indicate how reported profits change for given inputs of capital and labor. In practice, of course, inputs are affected by tax policy, especially at higher rates, and thus revenue maximizing tax rates are likely to be lower.[14]

### 6.2 Implications of current profit shifting for national tax revenues

In this subsection, we provide estimates of current levels of profit shifting in Europe and their tax revenue implications for European treasuries. To do so, we compare the outcome with profit shifting to the hypothetical outcome without profit shifting that materializes if profit shifting expenses are prohibitively high, say on account of perfect tax enforcement. Within our model, the latter case obtains if we let the shifting cost parameter $\gamma$ go to infinity.[15] The composite tax variable, $C_i$, the profit shifting variable, $S_i$, and profit shifting expenses, $E_i$, then all collapse to zero. Estimates of $S_i$ and $E_i$ in case of profit shifting along with information on the international tax system can be used to estimate how national tax revenues are affected by international profit shifting.

To proceed, first note that equation 5 can be written as $B_i^r = B_i - \hat{\gamma} B_i C_i$ from which we can solve for true profits $B_i$ as $\frac{B_i^r}{1-\hat{\gamma}C_i}$ for each multinational in each country. Noting that $B_i^r = B_i + S_i$, we now see that inward profit shifting, $S_i$, can be calculated as $-\frac{\hat{\gamma} B_i^r C_i}{1-\hat{\gamma}C_i}$. Expenses incurred by shifting profits into country *i* by a firm can be estimated by $E_i = (1/2\hat{\gamma})(S_i)^2 / B_i$. Individual firm estimates of $S_i$ can next be used to construct aggregate measures of international profit shifting by all multinationals. To wit, let $\overline{S}_{ij}$ be the aggregate profit shifting into country *i* by multinationals domiciled in country *j*. Aggregating this over countries *j*, we subsequently get $\overline{S_i}$, or the total profit shifting into country *i* by multinationals domiciled anywhere. Adding aggregate inward profit shifting $\overline{S_i}$ to the aggregate reported pre-tax profits, $\overline{B}_i^r$, we arrive at an estimate of the true aggregate pre-tax profits $\overline{B}_i$. Similarly, $\overline{E}_{ij}$ is defined as the total profit shifting expense incurred in country *i* by multinationals domiciled in country *j*, while $\overline{E}_i$ is the total profit shifting expense in country *i* incurred by multinationals domiciled anywhere.

[14] Even within our framework, our estimated semi-elasticities are local semi-elasticities that themselves can vary with the tax rate. To see this, we can again take the example of a multinational firm with a parent firm in a credit country, such as the UK, with a single foreign subsidiary. Theoretically, the semi-elasticity of reported profits in the subsidiary country is zero, as long as the subsidiary-country tax rate is below the parent-country tax rate. Increasing the subsidiary-country tax rate, however, at some point makes both countries' tax taxes equal to render the semi-elasticity of reported profits with respect to the statutory tax rate in the subsidiary country positive.

[15] Alternatively profit shifting would be eliminated following tax rate harmonization in which case tax revenues also change on account of tax rate changes.

The implications of the revealed aggregate international profit shifting for national corporate tax revenues depend on the intricacies of the international tax system, and in particular on whether countries tax profits on a territorial or a worldwide basis and, in the latter case, whether a credit or a deduction is provided to alleviate double taxation. To start, let $\Delta T_i^e$ be the change in tax revenues for an exemption country *i* compared to a world without international profit shifting (but with the same tax policies). This change is given by $t_i(\overline{S_i} - \overline{E_i})$ given that the top statutory rate $t_i$ applies to profits shifted inward net of shifting expenses. In case country *i* operates a credit system, the change in tax revenues, $\Delta T_i^c$, is instead given by $t_i(\overline{S_i} - \overline{E_i}) + \sum_{j \neq i}^{n}(t_i - t_j)A_{ji}(\overline{S}_{ji} - \overline{E}_{ji})$, where $A_{ji}$ equals 1 if $t_i > t_j$ and zero otherwise. To calculate $\Delta T_i^c$ we thus need to know a substantial part of the overall bilateral profit shifting grid $\overline{S}_{ji}$. In the deduction case, finally, the change in tax revenues $\Delta T_i^d$ is given by $t_i(\overline{S_i} - \overline{E_i}) + t_i \sum_{j \neq i}^{n}(1 - t_j)(\overline{S}_{ji} - \overline{E}_{ji})$.[16]

Table 10 gives estimates of profit shifting at the national level. The country with the highest statutory tax rate in the sample, Germany, operates an exemption system, and therefore can only experience outward profit shifting, and indeed the ratio of inward profit shifting to the true tax base, $\overline{S_i} / \overline{B}_i$, is estimated to be –0.274 for Germany.[17] At the other extreme, the country with the lowest statutory tax rate, Hungary, is expected to mostly experience inward profit shifting, and indeed the same ratio is 0.339 for Hungary.[18] All other countries may simultaneously experience significant outward and inward profit shifting. For these countries, actual aggregate profit shifting depends as much on the actual pattern on European multinational investment as on the size of the national statutory tax rate vis-à-vis other countries. In the table, we see that most countries on net experience inward profit shifting (with a positive $\overline{S_i}$). Only Germany, as already mentioned, and Italy and Romania experience net outward profit shifting. The predominance of inward profit shifting across Europe no doubt reflects the dominant position of Germany as the country with the highest statutory tax rate and the largest multinational activity (as measured, for instance, by sales in Table 3). Thus even a country such as France with a relatively high statutory tax rate of 40 percent on net receives inward profit shifting (albeit small in relative terms, with $\overline{S_i} / \overline{B}_i$ = 0.004), as Europe's main economy, i.e. Germany, has an even higher tax rate of almost 54 percent.

As seen in Table 10, countries that experience significant outward or inward profit shifting relative to the tax base $\overline{S_i} / \overline{B}_i$ also incur high relative profit shifting expenses $\overline{E_i} / \overline{B}_i$. On average, profit shifting expenses are 1.6 percent of the tax base of multinational firms in Europe. Finally, the estimated tax revenue implications in the table reflect the revealed pattern of

---

[16] Note that for the Belgian deduction case, we have $\Delta T_i = t_i(\overline{S_i} - \overline{E_i}) + t_i 0.5 \sum_{j \neq i}^{n}(1 - t_j)(\overline{S}_{ji} - \overline{E}_{ji})$.

[17] Note that $(\overline{S}_i / \overline{B}_i) / 2.032$ is an estimate of the marginal profit shifting expense (weighted by the tax base). For Germany, for instance, the marginal expense of shifting profits inward is calculated to be negative at -0.135.

[18] Note that a multinational domiciled in a deduction country would face an incentive to shift profits out of Hungary despite its low tax rate.

international profit shifting as well as profit shifting expenses. All European countries in fact are estimated to gain tax revenues on account of international profit shifting, apart from Germany, Italy and Romania. Note that the tax revenue losses by Germany, Italy and Romania together are estimated to exceed the tax revenue gains by all the other countries. This is to be expected as countries engage in international profit shifting with a view to reducing their worldwide tax liabilities.[19]

## 7. Conclusions

Europe's firms are increasingly multinational following the creation of a single market in the EU and the introduction of the euro. At the same time, multinational firms continue to report taxable profits separately in each European country where they have a permanent establishment. European multinationals, typically active in several countries, have many opportunities to re-allocate profits internationally, while significant international tax rate differences provide powerful incentives to actually do this. Our theoretical framework suggests that the international profit shifting by an individual multinational firm depends on its international structure and on the international tax regime it faces in each of the countries it operates. Using a unique dataset of European multinational firms and tax regimes, we find evidence in support of significant profit shifting. Using our estimates, we compute aggregate semi-elasticities of reported profits with respect to tax rates. The average semi-elasticity of reported profits with respect to the top statutory tax rate is estimated to be 1.43, which is substantial. The costs of international profit shifting appear to be considerable, and profit shifting leads to a significant redistribution of national corporate tax revenues in Europe. Germany, with the highest tax rate in 1999 and the largest economy, appears to have lost considerable tax revenues on account of international profit shifting. Most other countries may on net have gained some corporate tax revenues – at Germany's expense.

The proclivity of multinationals to shift profits so as to reduce their worldwide tax bill provides countries with the incentive to reduce their top statutory tax rate – to reduce outward profit shifting and perhaps to attract some inward profit shifting. Many European countries have indeed started to lower their top statutory tax rates in recent years. For the EU-15, the average top statutory tax rate declined from 38.0 percent in 1995 to 31.4 percent in 2004 (as documented by European Commission, 2004b). Notably, Germany lowered its federal tax rate in 2001 to 25 percent. This tax rate slashing has been accompanied by base-broadening reforms so as to leave the effective marginal tax rate on investment fairly stable (see Devereux et al., 2002).

The root cause of international profit shifting in Europe is the system of separate, national bookkeeping and tax bases. The introduction of a common tax base for multinational firms in Europe would eliminate all potential for international profit shifting – at least within Europe.

[19] At the same time, the profits shifted out of Germany, Italy and Romania are estimated to exceed the profits shifted into all the other countries. Taken at face value, this finding contradicts the model of section 3, which suggests that worldwide shifts in profits should add up to zero. However, one should note that the profit shifting estimates are calculated on the basis of a sample that does not include all parent companies and subsidiaries because data are lacking for firms that do not report independent unconsolidated statements and for subsidiaries located outside of Europe. For the subset of European firms included in our analysis, aggregate profit shifting is therefore unlikely to exactly add up to zero.

However, until such a system has been put in place, the evidence of this paper suggests that international profit shifting in Europe will continue to generate massive redistributions of national tax revenues.

**References**


Bartelsman, Eric J. and Roel M. Beetsma, 2003, Why pay more? Corporate tax avoidance through transfer pricing, *Journal of Public Economics* 87, 2225-2252.

Bond, Eric W. and Larry Samuelson, 2004, Strategic behavior and the rules for international taxation of capital, *Economic Journal* 99, 1099-1111.

Blonigen, Bruce A. and Ronald B. Davis, 2002, The effects of bilateral tax treaties on U.S. FDI activity, *International Tax and Public Finance* 11, 601-622.

Clausing, Kimberly A., 2003, Tax-motivated transfer pricing and US intrafirm trade prices, *Journal of Public Economics* 87, 2207-2223.

Collins, J. H. and D. A. Shackelford, 1992, Foreign tax credit limitations and preferred stock issuance, *Journal of Accounting Research* 30 (Supplement), 103-124.

Davis, Ronald B., 2004, Tax treaties and foreign direct investment: potential versus performance, *International Tax and Public Finance* 11, 775-802.

Demirgüç-Kunt, Asli and Harry Huizinga, 2001, The taxation of domestic and foreign banking, *Journal of Public Economics*, 429-453.

Desai, Mihir A., C. Fritz Foley and James R. Hines, 2004, Foreign direct investment in a world of multiple taxes, *Journal of Public Economics* 88, 2727-2744.

Devereux, Michael P., Rachel Griffith and Alexander Klemm, 2001, Corporate income tax reforms and international tax competition, *Economic Policy* 35, 451-488.

Ernst & Young, 2000, *Worldwide Corporate Tax Guide*, Ernst & Young Limited.

European Commission, 2001, Company taxation in the internal market, Commission staff working paper, COM(2001) 582 final.

European Commission, 2004a, European tax survey, Taxation paper 3, Directorate-General Taxation and Customs Union.

European Commission, 2004b, Structures of the taxation systems in the European Union.

Froot, Kenneth A. and James R. Hines, 1992, Interest allocation rules, financing patterns, and the operations of US multinationals in M.S. Feldstein, J.R. Hines and R.G. Hubbard (eds.), *The effects of taxation on multinational corporations*, University of Chicago Press, Chicago.

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

Grubert, Harry, 1998, Taxes and the division of foreign operating income among royalties, interest, dividends and retained earnings, *Journal of Public Economics* 68, 269-290.

Grubert, Harry and John Mutti, 1991, Taxes, tariffs and transfer pricing in multinational corporate decision making, *Review of Economics and Statistics* 73, 285-293.

Haufler, Andreas and Guttorm Schjelderup, 2000, Corporate tax systems and cross country profit shifting, *Oxford Economic Papers* 52, 306-325.

Hines, James R., 1999, Lessons from behavioral responses to international taxation, *National Tax Journal* 52, 305-322.

Hines, James R. and R. G. Hubbard, 1990. Coming home to America: dividend repatriation by U.S. multinationals in A. Razin, R.G. Hubbard (eds.), *Taxation in the Global Economy*. University of Chicago, Chicago.

Hines, James R., and Eric M. Rice, 1994, Fiscal paradise: foreign tax havens and American business, *Quarterly Journal of Economics* 109, 149-182.

Huizinga, Harry, 1987, International tax competitiveness: the advantage of smallness, mimeo, Harvard University.

Mintz, Jack and Henry Tulkens, 1996, Optimality properties of alternative systems of taxation of foreign capital income, *Journal of Public Economics* 60, 373-399.

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

Newlon, Scott T., 2000, Transfer pricing and income shifting in integrating economies, in Sijbren Cnossen, ed., *Taxing Capital Income in the European Union: Issues and Options for Reform*, Oxford University Press.

Organization for Economic Cooperation and Development, 1997, Model tax convention on income and on capital, Paris.

PriceWaterhouseCoopers, 2000, *Corporate Taxes 1999-2000 Worldwide Summaries*, PriceWaterhouseCoopers Limited.

Table 1. Corporate tax rates on domestic income in 1999

This table reports top statutory tax rates taking into account subnational corporate income taxes where applicable and the base rule applied by each country for avoidance of double taxation on foreign income. All data are as of end 1999. Sources: Taxation of Companies in Europe, International Bureau of Fiscal Documentation; Corporate Taxes 1999-2000 Worldwide Summaries, PriceWaterhouseCoopers; and Worldwide Corporate Tax Guide, Ernst & Young.

| Country | Corporate tax rate | Default method of double tax relief |
|---|---|---|
| Austria | 34 | Exemption (j) |
| Belgium | 40.17 (a) | Foreign tax deduction (k) |
| Bulgaria | 34.30 (b) | Foreign tax credit |
| Croatia | 35 | Foreign tax credit |
| Cyprus | 25 | Foreign tax credit |
| Czech Republic | 35 | Foreign tax credit |
| Denmark | 32 | Foreign tax credit |
| Estonia | 26 | Foreign tax credit |
| Finland | 28 | Foreign tax credit |
| France | 40 (c) | Exemption |
| Germany | 53.76 (d) | Foreign tax credit |
| Greece | 40 | Foreign tax credit |
| Hungary | 18 | Foreign tax credit |
| Iceland | 30 | Foreign tax credit |
| Ireland | 28 | Foreign tax deduction |
| Italy | 41.25 (e) | Foreign tax credit |
| Latvia | 25 | Foreign tax credit |
| Liechtenstein | 15 | No relief (l) |
| Lithuania | 29 | Foreign tax credit |
| Luxembourg | 37.45 (f) | Foreign tax credit |
| Malta | 35 | Foreign tax credit |
| Netherlands | 35 | Exemption |
| Norway | 28 | Foreign tax credit |
| Poland | 34 | Foreign tax credit |
| Portugal | 37.4 (g) | Foreign tax credit |
| Romania | 38 | Foreign tax credit |
| Slovak Republic | 40 | Foreign tax credit |
| Slovenia | 25 | Foreign tax credit |
| Spain | 35 | Foreign tax credit |
| Sweden | 28 | Foreign tax credit |
| Switzerland | 33.19 (i) | Exemption |
| United Kingdom | 30 | Foreign tax credit |
| Average | 34.44 | |

Notes:
(a) The corporate income tax rate in Belgium is 39%. This rate is increased by a 3% crisis tax levied on the 39%, which leads to a total corporate tax rate of 40.17%.

(b) In addition to the basic corporate tax of 27%, there is a municipal tax of 10% of the taxable profit. The taxable base for the corporate income tax is reduced by the municipalities tax paid (i.e., the municipal tax is a deductible expense for profit tax purposes). The total tax rate is therefore 34.3%.

(c) The total tax rate on corporate income of 40% includes a base rate of 33.33%, plus two surtaxes equal to 10% each of the base corporate tax rate.

(d) German business profits are subject to two taxes, corporation tax and municipal trade tax. Corporation tax is levied under a split-rate imputation system at the following rates: 30% on profits distributed to stockholders and 40% on undistributed profits. Branches of foreign corporations: 40% on total profits. The total amount of corporation tax due is subject to a surcharge of 5.5% (the "solidarity levy"). The total tax rate of the municipal trade tax varies by location from just under 12% to 20.5% (around 20% for most larger cities). This tax is deductible as an expense for corporation tax. The total income tax rate, which includes corporation tax and municipal trade tax is 53.76%. In the calculation of the total income tax rate we assume a trade tax of 20% (the average for large cities) and zero distributed profits.

(e) This includes a local (regional) tax on productive activities (IRAP) on Italian-source income.

(f) The base corporate income tax rate is 30%. A solidarity tax of 4% of the above tax is levied. In addition, a municipal tax on income is levied at a rate of between rate of 7.46% and 12.31%, depending on the commune in which the undertaking is located (the municipal tax is 10% in Luxembourg City). The municipal tax is deductible as an expense from its own, as well as from the corporate income tax basis. The total income tax rate, which includes income tax and municipal business tax, is therefore between 36.29% and 39.65% (37.45% for Luxembourg City). We use the rate for Luxembourg City.

(g) The base corporate tax rate in Portugal is 34%, which increases to 37.4% in almost all cases by a municipal surcharge (derrama) of 10%.

(i) The Swiss Federation levies direct federal income tax at a flat rate of 8.5% on profits after tax. In addition, each canton has its own tax law and levies cantonal and communal income taxes at different rates. Therefore, the tax burden of income (and capital) varies from canton to canton. Cantonal and communal taxes are generally imposed at progressive rates, based on the ratio of profit to capital and reserves. As a general rule, the approximate range of the maximum total income tax rate on profit for federal, cantonal, and communal taxes is between 14.42% and 44.98%, depending on the company's profitability and place of residence. Taxes are treated as tax-deductible expenses, so that the maximum total tax rate varies between 12.6% and 31.02%. For Geneva, the Federal tax is 8.5% and the Cantonal tax is 23.39%, thus the total is 31.89%. In Zurich, the Federal tax rate is 8.5% and the cantonal tax rate is 24.69% for the model firm (in the example provided in PWC's Corporate Taxes 1999-2000 Worldwide Summaries), hence the total is 33.19%. We take the rate for Zurich.

(j) Provided foreign source income has been subject to at least a 15% tax rate in the source country; otherwise, the rule applied is a foreign tax credit.

(k) Belgium applies only half of its normal tax rate to any foreign-source income (after deduction of foreign taxes). Hence, the deduction method as applied by Belgium can be seen as an exemption applied to half of the foreign-source income and the standard deduction method applied to the other half.

(l) Liechtenstein has no tax on foreign source income.

Table 2. Bilateral international double taxation alleviation

E=Exemption, C=Credit ,D=Deduction, BD=Belgian Deduction. Rule applies to income received by parent firm in country in left column from subsidiary in country in top row. For example, income received by a parent firm in France is exempted from income in France regardless of its foreign origin.

Sources: Taxation of Companies in Europe, International Bureau of Fiscal Documentation; Tax Analysts (www.taxanalysts.com); Corporate Taxes 1999-2000 Worldwide Summaries, PriceWaterhouseCoopers; and Worldwide Corporate Tax Guide, Ernst & Young.

| Parent \ Subsidiarity | Austria | Belgium | Bulgaria | Croatia | Cyprus | Czech Republic | Denmark | Estonia | Finland | France | Germany | Greece | Hungary | Iceland | Ireland | Italy | Latvia | Lithuania | Luxembourg | Netherlands | Norway | Poland | Portugal | Romania | Slovak Republic | Slovenia | Spain | Sweden | Switzerland | United Kingdom |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | | E | E | E | E | E | E | E | E | E | E | E | E | E | C | C | E | E | E | E | E | E | E | E | E | E | C | E | C |
| Belgium | E | | E | E | E | BD | E | BD | E | E | E | E | E | BD | E | E | BD | BD | E | E | E | E | E | E | BD | BD | E | E | E | E |
| Bulgaria | E | E | | C | C | C | E | C | E | E | E | E | E | C | C | E | C | C | E | E | E | E | E | E | E | C | E | E | E | E |
| Croatia | C | E | C | | E | E | E | C | C | E | E | C | C | C | C | E | C | C | C | E | E | C | C | C | C | C | C | E | C | E |
| Cyprus | E | E | C | C | | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C |
| Czech | E | C | C | E | E | | E | C | C | E | E | E | C | C | C | E | C | C | E | E | E | C | E | C | C | C | C | E | E | E |
| Denmark | E | C | C | C | C | C | | C | C | E | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | E | C | C |
| Estonia | C | C | C | C | C | C | C | | C | C | C | C | C | C | C | C | C | E | C | C | C | C | C | C | C | C | C | C | C | C |
| Finland | E | C | C | C | C | C | C | C | | E | C | C | C | C | C | C | C | C | C | C | C | C | C | E | C | C | C | E | C | C |
| France | E | E | E | E | E | E | E | E | E | | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E |
| Germany | E | E | E | E | E | E | E | E | E | E | | E | E | E | E | E | E | E | E | E | E | E | E | C | E | E | E | E | E | E |
| Greece | E | C | C | C | C | C | C | C | C | C | C | | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C |
| Hungary | E | E | E | E | E | E | E | C | E | E | E | E | | C | E | E | C | C | E | E | E | E | E | E | E | E | E | E | E | E |
| Iceland | C | C | C | C | C | C | E | E | E | E | E | C | C | | C | C | E | E | C | E | E | C | C | C | C | C | C | C | E | E |
| Ireland | C | C | D | D | C | C | C | C | C | C | C | D | C | D | | C | C | C | C | C | C | C | C | D | C | D | C | C | C | C |
| Italy | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | | C | C | C | C | C | C | C | C | C | C | C | C | C | C |
| Latvia | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | | E | C | C | C | C | C | C | C | C | C | C | C | C |
| Lithuani | C | C | C | C | C | C | C | E | C | C | C | C | C | C | C | C | E | | C | C | C | C | C | C | C | C | C | C | C | C |
| Luxemb | E | E | E | C | C | E | E | C | E | E | E | E | E | C | E | E | C | C | | E | E | E | C | E | E | C | E | E | E | E |
| Netherla | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | | E | E | E | E | E | E | E | E | E | E |
| Norway | C | E | E | E | C | C | C | C | C | C | E | C | C | C | E | E | C | C | C | C | | C | E | C | C | E | C | C | E | C |
| Poland | E | E | E | E | E | E | C | E | C | E | E | E | E | C | E | E | E | E | E | C | E | | E | E | E | E | E | C | E | E |
| Portugal | E | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | | C | C | C | C | C | C | C |
| Romania | E | E | E | E | C | C | C | C | C | C | C | C | C | C | C | C | C | C | E | C | C | C | C | | C | C | C | C | C | C |
| Slovak | E | C | C | C | E | C | E | C | C | E | E | E | C | C | C | E | C | C | E | E | E | C | E | E | | E | E | E | E | E |
| Slovenia | C | C | C | C | E | C | E | C | C | E | E | C | E | C | C | E | C | C | C | E | E | C | C | E | E | | C | E | C | E |
| Spain | C | C | C | C | C | E | E | C | E | E | E | C | C | C | C | C | C | C | C | E | C | E | C | C | E | C | | C | E | C |
| Sweden | C | C | E | E | E | C | C | C | C | C | C | E | C | C | C | C | C | C | C | C | C | C | C | C | C | E | C | | C | C |
| Switzerl | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | | E |
| United | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | |

Table 3. Sample of multinational firms in Amadeus

Sales are in billions of US dollars. Foreign to total sales is the ratio of sales to foreign subsidiaries and total sales. Firms with basic accounting data are firms with data on total assets, fixed assets, sales, labor compensation, pre-tax profits, taxes and the number of employees. Data are from Amadeus.

| | Firms with at least one foreign subsidiary | | | | | Firms with at least one foreign subsidiary and basic accounting information | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Parent companies and domestic subsidiaries | | Foreign subsidiaries | | | Parent companies and domestic subsidiaries | | Foreign subsidiaries | | |
| Country | Sales | Number of firms | Sales | Number of firms | Foreign to total sales | Sales | Number of firms | Sales | Number of firms | Foreign to total sales |
| Austria | 18.40 | 223 | 11.50 | 223 | 0.38 | 8.56 | 61 | 4.04 | 109 | 0.32 |
| Belgium | 58.30 | 1053 | 39.00 | 618 | 0.40 | 53.70 | 830 | 24.40 | 426 | 0.31 |
| Bulgaria | 0.07 | 6 | 0.00 | 2 | 0.07 | 0.07 | 6 | 0.00 | 2 | 0.07 |
| Croatia | 0 | 0 | 0.07 | 1 | 1.00 | 0 | 0 | 0 | 0 | |
| Czech Republic | 2.05 | 38 | 0.05 | 5 | 0.02 | 2.05 | 38 | 0.01 | 2 | 0.00 |
| Denmark | 27.20 | 354 | 15.10 | 468 | 0.36 | 27.00 | 288 | 12.80 | 333 | 0.32 |
| Estonia | 0.01 | 2 | 0.00 | 1 | 0.13 | 0.01 | 2 | 0.00 | 1 | 0.13 |
| Finland | 64.70 | 593 | 24.10 | 488 | 0.27 | 57.60 | 436 | 22.20 | 359 | 0.28 |
| France | 395.00 | 4247 | 95.00 | 1695 | 0.19 | 349.00 | 3419 | 77.50 | 1151 | 0.18 |
| Germany | 510.00 | 1453 | 78.50 | 992 | 0.13 | 402.00 | 339 | 65.00 | 768 | 0.14 |
| Greece | 5.18 | 198 | 0.06 | 33 | 0.01 | 0 | 0 | 0.06 | 29 | 1.00 |
| Hungary | 1.23 | 32 | 0.11 | 17 | 0.08 | 0.27 | 11 | 0.07 | 13 | 0.20 |
| Ireland | 0.91 | 19 | 3.20 | 84 | 0.78 | 0 | 0 | 2.87 | 65 | 1.00 |
| Italy | 92.60 | 414 | 16.80 | 194 | 0.15 | 92.30 | 387 | 13.30 | 139 | 0.13 |
| Luxembourg | 3.20 | 23 | 2.48 | 65 | 0.44 | 1.83 | 18 | 2.29 | 40 | 0.56 |
| Netherlands | 1.74 | 56 | 50.30 | 704 | 0.97 | 1.38 | 12 | 40.70 | 493 | 0.97 |
| Norway | 27.40 | 786 | 9.50 | 312 | 0.26 | 20.40 | 579 | 8.33 | 228 | 0.29 |
| Poland | 7.71 | 108 | 0.41 | 9 | 0.05 | 2.80 | 47 | 0.41 | 8 | 0.13 |
| Portugal | 0.13 | 11 | 6.99 | 15 | 0.98 | 0.03 | 3 | 6.96 | 12 | 1.00 |
| Slovenia | 2.73 | 27 | 0.12 | 8 | 0.04 | 0 | 0 | 0.04 | 4 | 1.00 |
| Slovak Republic | 1.46 | 2 | 0.02 | 3 | 0.01 | 0.07 | 1 | 0.01 | 2 | 0.14 |
| Spain | 177.00 | 751 | 10.30 | 172 | 0.05 | 175.00 | 649 | 6.20 | 120 | 0.03 |
| Sweden | 126.00 | 2846 | 44.00 | 984 | 0.26 | 121.00 | 2139 | 39.10 | 713 | 0.24 |
| Switzerland | 16.10 | 156 | 40.60 | 711 | 0.72 | 1.09 | 5 | 36.00 | 450 | 0.97 |
| United Kingdom | 293.00 | 2552 | 86.90 | 1365 | 0.23 | 247.00 | 1753 | 76.40 | 922 | 0.24 |
| Total | 1830.00 | 15955 | 535.00 | 9171 | 0.23 | 1560.00 | 11023 | 439.00 | 6390 | 0.22 |

Table 4. Summary statistics

Pre-tax earnings is the logarithm of earnings before interest and taxes. Pre-tax profit is the log of earnings before taxes. Capital is the log of the amount of fixed assets. Labor is the log of total labor compensation. Employees is the log of the number of employees. Our sample consists of the parent company and all foreign subsidiaries for all firms that have at least one subsidiary in a European country other than the country where the parent company is located and for which basic accounting data are available (earnings, sales, capital, and labor). For each firm, we aggregate all establishments located in one country (i.e., all subsidiaries and the parent company, if applicable) to one observation. Hence, each observation represents the total business operation of a particular multinational firm in a given country. In panel B we restrict the sample to foreign subsidiaries only. In panels C and D and the remainder of the tables, we restrict the sample to manufacturing companies only (NACE industry codes 15 to 40). Data are from Amadeus.

Panel A: All firms

| | Mean | Median | St. dev. | Minimum | Maximum | Number |
|---|---|---|---|---|---|---|
| Pre-tax earnings | 7.75 | 7.68 | 2.50 | -3.88 | 15.77 | 3302 |
| Pre-tax profit | 7.51 | 7.46 | 2.56 | -4.12 | 15.53 | 3036 |
| Capital | 8.72 | 8.85 | 3.14 | -1.84 | 17.81 | 3302 |
| Labor | 8.61 | 8.61 | 2.20 | 1.20 | 16.24 | 3302 |
| Employees | 4.99 | 5.00 | 2.15 | 0.00 | 12.11 | 3302 |
| Financial leverage | 0.62 | 0.64 | 0.33 | -6.10 | 4.77 | 3302 |
| C | -0.01 | 0.00 | 0.10 | -0.43 | 0.53 | 3302 |

Panel B: Foreign subsidiaries only

| | Mean | Median | St. dev. | Minimum | Maximum | Number |
|---|---|---|---|---|---|---|
| Pre-tax earnings | 6.99 | 6.96 | 2.20 | -3.88 | 15.74 | 2210 |
| Pre-tax profit | 6.76 | 6.80 | 2.28 | -4.12 | 15.53 | 2026 |
| Capital | 7.65 | 7.71 | 2.76 | -1.84 | 16.04 | 2210 |
| Labor | 7.92 | 7.93 | 1.92 | 1.20 | 15.74 | 2210 |
| Employees | 4.31 | 4.30 | 1.89 | 0.00 | 11.80 | 2210 |
| Financial leverage | 0.64 | 0.68 | 0.37 | -6.10 | 4.77 | 2210 |
| C | -0.02 | 0.00 | 0.12 | -0.43 | 0.53 | 2210 |

Panel C: Manufacturing firms

| | Mean | Median | St. dev. | Minimum | Maximum | Number |
|---|---|---|---|---|---|---|
| Pre-tax earnings | 7.69 | 7.69 | 2.43 | -3.88 | 15.77 | 1484 |
| Pre-tax profit | 7.46 | 7.44 | 2.49 | -4.12 | 15.24 | 1360 |
| Capital | 8.60 | 8.81 | 3.01 | -0.32 | 17.66 | 1484 |
| Labor | 8.58 | 8.58 | 2.15 | 1.51 | 16.24 | 1484 |
| Employees | 4.99 | 5.00 | 2.08 | 0.00 | 12.07 | 1484 |
| Financial leverage | 0.61 | 0.64 | 0.27 | -2.01 | 1.62 | 1484 |
| C | -0.02 | 0.00 | 0.11 | -0.43 | 0.53 | 1484 |

Panel D: Manufacturing firms, foreign subsidiaries only

| | Mean | Median | St. dev. | Minimum | Maximum | Number |
|---|---|---|---|---|---|---|
| Pre-tax earnings | 6.93 | 6.92 | 2.19 | -3.88 | 12.96 | 1008 |
| Pre-tax profit | 6.72 | 6.77 | 2.28 | -4.12 | 12.80 | 922 |
| Capital | 7.53 | 7.63 | 2.67 | -0.32 | 15.36 | 1008 |
| Labor | 7.86 | 7.83 | 1.88 | 1.51 | 13.02 | 1008 |
| Employees | 4.27 | 4.26 | 1.83 | 0.00 | 9.63 | 1008 |
| Financial leverage | 0.63 | 0.66 | 0.29 | -2.01 | 1.62 | 1008 |
| C | -0.02 | 0.00 | 0.13 | -0.43 | 0.53 | 1008 |

Panel E: Correlation matrix of main variables. Sample includes manufacturing firms and foreign subsidiaries only. P-values are between round brackets. Number of observations is reported between square brackets.

| | Pre-tax earnings | Capital | Labor | Employees | Financial leverage | Per capita income | C |
|---|---|---|---|---|---|---|---|
| Pre-tax earrnings | 1.00 | | | | | | |
| | [1008] | | | | | | |
| Capital | 0.77*** | 1.00 | | | | | |
| | (0.00) | | | | | | |
| | [1008] | [1008] | | | | | |
| Labor | 0.80*** | 0.84*** | 1.00 | | | | |
| | (0.00) | (0.00) | | | | | |
| | [1008] | [1008] | [1008] | | | | |
| Employees | 0.76*** | 0.86*** | 0.91*** | 1.00 | | | |
| | (0.00) | (0.00) | (0.00) | | | | |
| | [1008] | [1008] | [1008] | [1008] | | | |
| Financial leverage | -0.15*** | -0.12*** | -0.02 | -0.08*** | 1.00 | | |
| | (0.00) | (0.00) | (0.45) | (0.01) | | | |
| | [1008] | [1008] | [1008] | [1008] | [1008] | | |
| Per capita income | 0.10*** | 0.04 | 0.24*** | -0.08** | 0.12*** | 1.00 | |
| | (0.00) | (0.10) | (0.00) | (0.02) | (0.00) | | |
| | [1008] | [1008] | [1008] | [1008] | [1008] | [1008] | |
| C | -0.15*** | -0.11*** | -0.08*** | -0.14*** | 0.11*** | 0.09*** | 1.00 |
| | (0.00) | (0.00) | (0.01) | (0.00) | (0.01) | (0.00) | |
| | [1008] | [1008] | [1008] | [1008] | [1008] | [1008] | [1008] |

Table 5. Estimation of the profit shifting equation

This table reports OLS estimates of the profit shifting equation: $b_i^r = \beta_1 + \beta_2 A_i + \beta_3 l_i + \beta_4 k_i - \tilde{\gamma} C_i + u_i$. The dependent variable is the logarithm of earnings before interest and taxes. Labor (l) is the log of the total labor compensation. Capital (k) is the log of the amount of fixed assets. Per capita income (A) is the log of GDP per capita. C is the composite tax variable in the model, calculated using country-level effective tax rates and the firm's total sales as a proxy for the tax base *B*. Regressions 2-4 include industry dummies at the 2-digit NACE industry code level (not reported). Regression 3 includes a dummy variable indicating Eastern European firms and an interaction variable of the Eastern Europe dummy and the C variable. Regression 4 splits up the C variable into parts that represent profit shifting incentives vis-à-vis the parent and subsidiaries in other countries. We report White's (1980) heteroskedasticity-consistent standard errors in parentheses. The standard errors are corrected for clustering at the multinational firm level. *, **, and *** denote significance at 10%, 5% and 1% levels, respectively.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Labor | 0.641*** | 0.639*** | 0.635*** | 0.637*** |
| | (0.059) | (0.059) | (0.059) | (0.059) |
| Capital | 0.246*** | 0.235*** | 0.237*** | 0.235*** |
| | (0.041) | (0.039) | (0.040) | (0.039) |
| Per capita income | -0.127* | -0.104* | -0.207 | -0.103 |
| | (0.065) | (0.063) | (0.129) | (0.063) |
| C | -1.068*** | -0.933*** | -0.912*** | |
| | (0.344) | (0.331) | (0.338) | |
| Eastern Europe*C | | | -0.310 | |
| | | | (0.902) | |
| Eastern Europe | | | -0.290 | |
| | | | (0.350) | |
| C vis-à-vis parent | | | | -1.059*** |
| | | | | (0.389) |
| C vis-à-vis other subsidiaries | | | | -0.451 |
| | | | | (0.899) |
| Industry dummies | No | Yes | Yes | Yes |
| F-test of no significance of industry dummies (p-value) | | 3.64*** (0.00) | 3.33*** (0.00) | 3.65*** (0.00) |
| Observations | 1008 | 1008 | 1008 | 1008 |
| R-squared | 0.67 | 0.69 | 0.69 | 0.69 |

Table 6. Robustness of the estimated profit shifting equation

This table reports OLS estimates of the profit shifting equation. The dependent variable is the logarithm of earnings before interest and taxes. Labor is the log of the total labor compensation. Employment is the log of the number of employees. Capital is the log of the amount of fixed assets. Per capita income is the log of GDP per capita. C is the composite tax variable in the model, calculated using country-level effective tax rates and a proxy for the firm's tax base *B*. Financial leverage is total debt over total assets. Corruption is the ICRG corruption index, with higher values denoting less corruption. Treaty is a dummy variable that takes a value of one if the subsidiary country and the parent country have signed a bilateral tax treaty (in effect in 1999), and zero otherwise. In regression 1, C is calculated under the assumption that *B* equals 1 throughout so that the costs of profit shifting are taken to be unrelated to the scale of activities at the multinational's establishments. In regression 2, *C* is calculated using total assets as a proxy for *B* to reflect that assets may be less misrepresented by transfer pricing than sales. In regressions 3 to 13, *C* is calculated using sales as a proxy for *B*. In regression 3, we use the log of the number of employees as a proxy for the labor input rather than the log of total labor compensation. In regression 4, we include observations on parent companies. In regression 5, we include all industries (not only manufacturing). In regressions 6 and 10, the dependent variable is the logarithm of pre-tax profits. In regression 7, we include a set of country dummies and a set of country dummies interacted with the C variable (both sets not reported). In regression 8, we exclude firms if we have incomplete data on more than 50 percent of the subsidiaries of the firm (of all subsidiaries located in Europe). Regressions 9 and 10 control for leverage. Regression 11 controls for corruption at the country level. Regression 12 controls for whether a treaty between the subsidiary and parent countries has been signed. The sample in regression 13 excludes subsidiaries located in Eastern Europe. All regressions include a constant and industry dummies at the 2-digit NACE industry code level (not reported). We report White's (1980) heteroskedasticity-consistent standard errors in parentheses. The standard errors are corrected for clustering at the multinational firm level. *, **, and *** denote significance at 10%, 5% and 1% levels, respectively.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Labor | 0.645*** | 0.639*** | | 0.621*** | 0.572*** | 0.629*** |
| | (0.059) | (0.059) | | (0.047) | (0.033) | (0.065) |
| Employment | | | 0.545*** | | | |
| | | | (0.061) | | | |
| Capital | 0.237*** | 0.235*** | 0.282*** | 0.282*** | 0.286*** | 0.233*** |
| | (0.040) | (0.040) | (0.041) | (0.033) | (0.023) | (0.045) |
| Per capita income | -0.119* | -0.107* | 0.394*** | -0.086 | -0.118*** | 0.038 |
| | (0.063) | (0.063) | (0.064) | (0.056) | (0.042) | (0.089) |
| C | -0.670 | -0.854*** | -0.764*** | -0.907*** | -0.754*** | -0.908*** |
| | (0.437) | (0.307) | (0.347) | (0.317) | (0.230) | (0.408) |
| Financial leverage | | | | | | |
| Corruption | | | | | | |
| Treaty | | | | | | |
| Industry dummies | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 1008 | 1008 | 1008 | 1484 | 2210 | 922 |
| R-squared | 0.69 | 0.69 | 0.67 | 0.78 | 0.70 | 0.64 |

(Table 6, continued)

| | (7) | (8) | (9) | (10) | (11) | (12) | (13) |
|---|---|---|---|---|---|---|---|
| Labor | 0.673*** | 0.476*** | 0.662*** | 0.689*** | 0.651*** | 0.644*** | 0.629*** |
| | (0.055) | (0.077) | (0.057) | (0.061) | (0.061) | (0.059) | (0.064) |
| Capital | 0.212*** | 0.296*** | 0.212*** | 0.182*** | 0.233*** | 0.234*** | 0.237*** |
| | (0.037) | (0.054) | (0.039) | (0.042) | (0.040) | (0.039) | (0.043) |
| Per capita income | | -0.007 | -0.079 | 0.076 | -0.103 | -0.113* | -0.371** |
| | | (0.079) | (0.064) | (0.086) | (0.073) | (0.063) | (0.168) |
| C | | -1.949*** | -0.792** | -0.656* | -0.834** | -0.944*** | -0.908*** |
| | | (0.637) | (0.326) | (0.395) | (0.342) | (0.332) | (0.338) |
| Financial leverage | | | -0.751*** | -1.422*** | | | |
| | | | (0.208) | (0.246) | | | |
| Corruption | | | | | 0.055 | | |
| | | | | | (0.064) | | |
| Treaty | | | | | | -0.134 | |
| | | | | | | (0.149) | |
| Industry dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 1008 | 354 | 1008 | 922 | 999 | 1008 | 906 |
| F-test of equality of country dummies*C variables (p-value) | 1.30 (0.17) | | | | | | |
| R-squared | 0.71 | 0.69 | 0.70 | 0.67 | 0.69 | 0.69 | 0.69 |

Table 7. Comparison with results in Hines and Rice (1994)

The dependent variable is the logarithm of earnings before interest and taxes. Labor is the log of the total labor compensation. Capital is the log of the amount of fixed assets. Per capita income is the log of per capita GDP. Average tax rate is the minimum of the accounting average tax rate and the top statutory tax rate, where the accounting average tax rate is calculated as taxes paid divided by the sum of pre-tax profits. If the accounting-based average tax rate is negative due to negative profits, we set the average tax rate to missing. Statutory tax rate is the statutory tax rate of the country of subsidiary location. Effective tax rate is the effective tax rate of a subsidiary located in a country *i* with a parent company in country *p*. Difference in average tax rates is the difference in the average tax rate in country *i* and the top statutory tax rate in country *p*. Difference in statutory tax rates is the difference in the top statutory tax rates in countries *i* and *p*. Difference in effective tax rates is the difference of the effective tax rate in country *i* and the top statutory tax rate in country *p* . Adjusted difference in statutory tax rates is $(t_i - t_p)/(1 - t_p)$ or the difference in statutory tax rates divided by one minus the statutory tax rate of country *p*. Adjusted difference in effective tax rates is $(\tau_i - t_p)/(1 - t_p)$ or the difference in effective tax rates divided by one minus the statutory tax rate of country *p*. *C* is the composite tax variable calculated using effective tax rates and the firm's total sales as a proxy for the tax base *B*. Regressions 1-2 are based on aggregate data with one observation for each subsidiary county, parent country pair. All other regressions use firm level observations. All regressions include a constant and industry dummies at the 2-digit NACE industry code level (not reported). We report White's (1980) heteroskedasticity-consistent standard errors in parentheses. The standard errors are corrected for clustering at the multinational firm level. *, **, and *** denote significance at 10%, 5% and 1% levels, respectively.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| Labor | 0.541*** | 0.517*** | 0.638*** | 0.642*** | 0.639*** | 0.637*** | 0.637*** | 0.635*** | 0.639*** |
| | (0.104) | (0.103) | (0.060) | (0.059) | (0.059) | (0.059) | (0.059) | (0.059) | (0.059) |
| Capital | 0.367*** | 0.381*** | 0.242*** | 0.230*** | 0.236*** | 0.237*** | 0.236*** | 0.237*** | 0.235*** |
| | (0.087) | (0.087) | (0.040) | (0.040) | (0.040) | (0.040) | (0.040) | (0.040) | (0.039) |
| Per capita income | -0.100 | -0.036 | -0.118* | -0.114* | -0.095 | -0.103 | -0.094 | -0.102 | -0.104* |
| | (0.090) | (0.080) | (0.067) | (0.062) | (0.063) | (0.063) | (0.063) | (0.063) | (0.063) |
| Difference in average tax rate | -1.421*** | -1.122*** | -0.528* | -1.016*** | | | | | |
| | (0.422) | (0.456) | (0.294) | (0.312) | | | | | |
| Difference in statutory tax rates | | | | | -1.229*** | | | | |
| | | | | | (0.393) | | | | |
| Difference in effective tax rates | | | | | | -1.199*** | | | |
| | | | | | | (0.402) | | | |
| Adj. difference in statutory tax rates | | | | | | | -0.654*** | | |
| | | | | | | | (0.211) | | |
| Adj. difference in effective tax rates | | | | | | | | -0.624*** | |
| | | | | | | | | (0.214) | |
| C | | | | | | | | | -0.933*** |
| | | | | | | | | | (0.331) |
| Industry dummies | No | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 178 | 192 | 962 | 1008 | 1008 | 1008 | 1008 | 1008 | 1008 |
| R-squared | 0.88 | 0.87 | 0.72 | 0.69 | 0.69 | 0.69 | 0.69 | 0.69 | 0.69 |

Table 8. Endogeneity of tax variables

This table reports instrumental variables (IV) estimates of the profit shifting equation. The dependent variable is the logarithm of earnings before interest and taxes. Labor is the log of total labor compensation. Capital is the log of the amount of fixed assets. Per capita income is the log of GDP per capita of the country. C is the composite tax variable calculated using country-level effective tax rates and the firm's total sales as a proxy for the tax base *B*. Difference in effective tax rates is $(\tau_i - t_p)/(1-t_p)$ where $\tau_i$ is the effective tax rate of a subsidiary located in country *i* with a parent company located in country *p* and $t_p$ the top statutory tax rate of the country where the parent company is located. In regression 1, the log of the country's total population is used as an instrument for the top statutory tax rate used to calculate the *C* variable. In regression 2, the difference between the log population of countries *i* and *p* is used as an instrument for *C*. Regression 3 is as regression 2 but excludes firms for which we have incomplete data on more than half of the subsidiaries of the firm. All regressions include a constant and industry dummies (not reported). We report White's (1980) heteroskedasticity-consistent standard errors in parentheses. The standard errors are corrected for clustering at the multinational firm level. *, **, and *** denote significance at 10%, 5% and 1% levels, respectively.

| | (1) | (2) | (3) |
|---|---|---|---|
| Labor | 0.637*** | 0.637*** | 0.470*** |
| | (0.059) | (0.059) | (0.078) |
| Capital | 0.233*** | 0.232*** | 0.298*** |
| | (0.039) | (0.040) | (0.054) |
| Per capita income | -0.092 | -0.087 | -0.002 |
| | (0.062) | (0.062) | (0.079) |
| C | -1.682** | -2.032** | -2.238* |
| | (0.777) | (0.809) | (1.171) |
| Industry dummies | Yes | Yes | Yes |
| R-squared first-stage | 0.28 | 0.27 | 0.36 |
| Observations | 1008 | 1008 | 354 |
| R-squared | 0.69 | 0.69 | 0.69 |

Table 9. Aggregate profit shifting semi-elasticities

This table reports aggregate tax base shifting semi-elasticities with respect the effective tax rate and the top statutory rate of the country of location. Simulated aggregate effective tax rate semi-elasticities are obtained as follows. For a given country, we increase the effective tax rate by 0.01. This leads to changes in the *C*'s for all firms doing business in this country whether or not they are foreign subsidiaries. The change in reported tax base is calculated from $dB_i^r = -\hat{\gamma} B_i^r \frac{dC_i}{d\tau_i} d\tau_i$ for any firm located in country *i*. Aggregating the changes in $dB_i^r$ for all firms located in country *i* gives the aggregate change in reported profits $d\overline{B}_i^r$ to be used to calculate the aggregate tax base shifting semi-elasticity $-\frac{1}{\overline{B}_i^r}\frac{d\overline{B}_i^r}{d\tau_i}$. The aggregate tax base shifting semi-elasticity with respect to the statutory tax rate $-\frac{1}{\overline{B}_i^r}\frac{d\overline{B}_i^r}{dt_i}$ is simulated in an analogous fashion. We report the two semi-elasticities for all firms located in a country and separately for the groups of parent companies and foreign subsidiaries.

| | All firms | | Parent companies | | Subsidiaries | |
|---|---|---|---|---|---|---|
| Country | 1% change in effective tax rate (1) | 1% change in top statutory tax rate (2) | 1% change in effective tax rate (3) | 1% change in top statutory tax rate (4) | 1% change in effective tax rate (5) | 1% change in top statutory tax rate (5) |
| Austria | 1.57 | 1.57 | 0.33 | 0.33 | 2.25 | 2.25 |
| Belgium | 3.38 | 3.37 | 3.72 | 3.71 | 2.10 | 2.10 |
| Bulgaria | 1.04 | 1.04 | 0.24 | 0.24 | 2.17 | 2.17 |
| Czech Republic | 1.11 | 1.08 | 0.16 | 0.16 | 1.12 | 1.09 |
| Denmark | 1.64 | 1.41 | 1.53 | 1.27 | 2.53 | 2.53 |
| Estonia | 2.55 | 0.30 | 0.73 | 0.73 | 2.71 | 0.26 |
| Finland | 0.67 | 0.45 | 0.63 | 0.42 | 2.33 | 2.01 |
| France | 0.64 | 0.59 | 0.29 | 0.29 | 2.22 | 1.96 |
| Germany | 0.32 | 0.32 | 0.22 | 0.22 | 4.30 | 4.30 |
| Hungary | 2.21 | 2.09 | 3.64 | 3.64 | 1.63 | 1.46 |
| Italy | 0.62 | 0.57 | 0.15 | 0.10 | 3.09 | 3.09 |
| Luxembourg | 1.05 | 1.05 | 0.06 | 0.06 | 2.50 | 2.50 |
| Netherlands | 3.42 | 3.31 | 2.49 | 2.49 | 3.43 | 3.32 |
| Norway | 0.61 | 0.41 | 0.44 | 0.28 | 2.42 | 1.72 |
| Poland | 2.63 | 2.63 | n.a. | n.a. | 2.63 | 2.63 |
| Portugal | 3.03 | 3.03 | n.a. | n.a. | 3.03 | 3.03 |
| Romania | 3.47 | 0.50 | n.a. | n.a. | 3.47 | 0.50 |
| Slovak Republic | 2.89 | 2.89 | n.a. | n.a. | 2.89 | 2.89 |
| Spain | 1.01 | 0.94 | 0.32 | 0.25 | 2.47 | 2.38 |
| Sweden | 1.52 | 1.37 | 1.29 | 1.25 | 2.19 | 1.72 |
| United Kingdom | 1.13 | 1.10 | 1.00 | 0.98 | 2.70 | 2.56 |
| Average | 1.74 | 1.43 | 1.01 | 0.97 | 2.58 | 2.21 |

Table 10. Estimates of international profit shifting and national tax revenue losses

This table reports the estimated changes in national tax revenues due to international profit shifting. For this purpose, we use the instrumental variables estimate of $\hat{\gamma}$ from the model in Table 8, column 2. To estimate a multinational firm's true profits in country *i*, we use $B_i = B_i^r/(1-\hat{\gamma}C_i)$. Profits shifted into country *i* by a firm are estimated as $S_i = -\hat{\gamma}B_i^r C_i/(1-\hat{\gamma}C_i)$. Expenses incurred by shifting profits into country *i* by a firm are estimated by $E_i = (1/2\hat{\gamma})(S_i)^2/B_i$. Firm-level data are aggregated to national true profits, $\overline{B}_i$, inward profit shifting $\overline{S}_i$, and aggregate profit shifting costs $\overline{E}_i$ and their ratios $\overline{S}_i/\overline{B}_i$ and $\overline{E}_i/\overline{B}_i$. The estimated national tax change, $dT_i$, in country *i* is calculated using tax system data and estimates of bilateral aggregated tax base shifting $\overline{S}_{ij}$ and bilateral shifting expenses $\overline{E}_{ij}$ in country *i* for a multinational domiciled in country *j*. Figures on $\overline{B}_i$, $\overline{S}_i$, $\overline{E}_i$, and $dT_i$ are reported in millions of US dollars.

| Country | $\overline{B}_i$ | $\overline{S}_i$ | $\overline{S}_i/\overline{B}_i$ | $\overline{E}_i$ | $\overline{E}_i/\overline{B}_i$ | $dT_i$ |
|---|---|---|---|---|---|---|
| Austria | 96.55 | 17.75 | 0.184 | 2.53 | 0.026 | 5.17 |
| Belgium | 2669.78 | 75.11 | 0.028 | 11.20 | 0.004 | 25.67 |
| Bulgaria | 12.86 | 1.79 | 0.139 | 0.17 | 0.013 | 0.44 |
| Czech Republic | 302.60 | 124.42 | 0.411 | 16.25 | 0.054 | 37.13 |
| Denmark | 1567.28 | 75.25 | 0.048 | 2.28 | 0.001 | 23.35 |
| Estonia | 8.88 | 0.60 | 0.067 | 0.07 | 0.008 | 0.14 |
| Finland | 3825.36 | 294.30 | 0.077 | 9.64 | 0.003 | 79.73 |
| France | 12600.00 | 50.55 | 0.004 | 43.39 | 0.003 | 2.86 |
| Germany | 18300.00 | -5011.25 | -0.274 | 879.02 | 0.048 | -3166.61 |
| Hungary | 13.78 | 4.67 | 0.339 | 0.65 | 0.047 | 0.72 |
| Italy | 9577.71 | -99.95 | -0.010 | 23.31 | 0.002 | -50.84 |
| Luxembourg | 19.97 | 2.02 | 0.101 | 0.19 | 0.010 | 0.68 |
| Netherlands | 321.74 | 25.98 | 0.081 | 2.07 | 0.006 | 8.37 |
| Norway | 1705.96 | 45.95 | 0.027 | 2.60 | 0.002 | 12.20 |
| Poland | 61.29 | 13.19 | 0.215 | 1.76 | 0.029 | 3.89 |
| Portugal | 9.12 | 0.76 | 0.083 | 0.02 | 0.002 | 0.28 |
| Romania | 23.63 | -4.11 | -0.174 | 0.33 | 0.014 | -2.25 |
| Slovak Rep | 0.35 | 0.11 | 0.311 | 0.01 | 0.024 | 0.04 |
| Spain | 2338.70 | 109.32 | 0.047 | 9.86 | 0.004 | 34.81 |
| Sweden | 3718.19 | 313.21 | 0.084 | 24.39 | 0.007 | 81.19 |
| United Kingdom | 7854.55 | 501.53 | 0.064 | 27.40 | 0.003 | 142.27 |
| Total | 65028.29 | -3458.80 | -0.053 | 1057.13 | 0.016 | -2760.75 |

**Appendix 1. Aggregation of a multinational's establishment within a country**

This appendix shows that the international pattern of profit shifting at the country level is unaffected by whether the multinational has true profits $B_i^j$ at establishments $j = 1,\ldots, k$ in country $i$ or only true profits $B_i = \sum_{j=1}^{k} B_i^j$ at a single establishment in country $i$. In the latter case, let $S_i$ be the optimal profit shifting into country $i$. This yields costs equal to $\frac{\gamma_i}{2}\frac{(S_i)^2}{B_i}$. In the absence of aggregation, we can optimally allocate $S_i^j$ to establishment $j$ with $S_i = \sum_{j=1}^{k} S_i^j$. In the disaggregated case, the firm allocates profits so as to minimize total profit shifting costs as follows

$$L = -\frac{\gamma}{2}\sum_{j=1}^{k}\left[\frac{(S_i^j)^2}{B_i^j}\right] + \lambda\left[\sum_{j=1}^{k} S_i^j - S_i\right]$$

The first order condition with respect to $s_{ij}$ is $-\gamma_i \frac{S_i^j}{B_i^j} + \lambda = 0$, which shows that $S_i^j$ optimally is proportional to $B_i^j$ so that $S_i^j = B_i^j \frac{S_i}{B_i}$. Now total shifting costs in country $i$ are given by

$$\frac{\gamma}{2}\sum_{j=1}^{k}\frac{(S_i^j)^2}{B_i^j} = \frac{\gamma}{2}\sum_{j=1}^{k}\left[B_i^j \frac{S_i}{B_i}\right]^2 \frac{1}{B_i^j} = \frac{\gamma}{2}\frac{(S_i)^2}{B_i},$$

which demonstrates that shifting costs in country $i$ are not affected by the aggregation of establishments in country $i$.

**Appendix 2. Variable definitions and data sources**

| Variable | Definition | Source |
|---|---|---|
| Statutory tax rate | Top statutory tax rate on corporate income (between 0 and 1) | Taxation of Companies in Europe, International Bureau of Fiscal Documentation; Tax Analysts (www.taxanalysts.com); Corporate Taxes 1999-2000 Worldwide Summaries, PriceWaterhouseCoopers; and Worldwide Corporate Tax Guide, Ernst & Young |
| Average tax rate | Average tax rate constructed as ratio of taxes paid to pre-tax earnings | Amadeus |
| C | Composite tax variable (constructed using information on sales (not in log) and effective tax rates | Data on sales and pre-tax profits from Amadeus. Data on effective tax rates from: Taxation of Companies in Europe, International Bureau of Fiscal Documentation; Tax Analysts (www.taxanalysts.com); Corporate Taxes 1999-2000 Worldwide Summaries, PriceWaterhouseCoopers; and Worldwide Corporate Tax Guide, Ernst & Young |
| Difference in average tax rates | Difference in average tax rate in one of the multinational's countries of establishment and the multinational's parent country' top statutory tax rate (between 0 and 1) | Amadeus; Taxation of Companies in Europe, International Bureau of Fiscal Documentation; Tax Analysts (www.taxanalysts.com); Corporate Taxes 1999-2000 Worldwide Summaries, PriceWaterhouseCoopers; and Worldwide Corporate Tax Guide, Ernst & Young |
| Difference in effective tax rates | Difference in effective tax rates in one of the multinational's countries of establishment and the multinational's parent country (between 0 and 1) | Taxation of Companies in Europe, International Bureau of Fiscal Documentation; Tax Analysts (www.taxanalysts.com); Corporate Taxes 1999-2000 Worldwide Summaries, PriceWaterhouseCoopers; and Worldwide Corporate Tax Guide, Ernst & Young |

| | | |
|---|---|---|
| Difference in statutory tax rates | Difference in top statutory tax rates in one of the multinational's countries of establishment and the multinational's parent country (between 0 and 1) | Taxation of Companies in Europe, International Bureau of Fiscal Documentation; Tax Analysts (www.taxanalysts.com); Corporate Taxes 1999-2000 Worldwide Summaries, PriceWaterhouseCoopers; and Worldwide Corporate Tax Guide, Ernst & Young |
| Effective tax rate | Effective tax rate on income reported in a country for a multinational headquartered in the same or any other country (between 0 and 1) | Taxation of Companies in Europe, International Bureau of Fiscal Documentation; Tax Analysts (www.taxanalysts.com); Corporate Taxes 1999-2000 Worldwide Summaries, PriceWaterhouseCoopers; and Worldwide Corporate Tax Guide, Ernst & Young |
| Capital | Amount of fixed assets in log | Amadeus |
| Employment | Number of employees in log | Amadeus |
| Labor | Total labor compensation | Amadeus |
| Financial leverage | Ratio of total debt to total assets | Amadeus |
| Per capita income | Per capita GDP in log | World Bank Development Indicators |
| Corruption | Index of corruption with higher values denoting less corruption | International Country Risk Guide |
| Pre-tax earnings | Earnings before interest and taxes in log | Amadeus |
| Pre-tax profits | Pre-tax profits in logs | Amadeus |
| Sales | Total sales | Amadeus |
| Treaty | Dummy variable equal to 1 if there exists a treaty between a multinational's foreign country of establishment and its parent country, and 0 otherwise | Taxation of Companies in Europe, International Bureau of Fiscal Documentation, and Tax Analysts (www.taxanalysts.com). |

## Appendix 3. Bilateral tax treaties in force as of 1999

1=Bilateral tax treaty in force; 0=No bilateral tax treaty in force. Source: Taxation of Companies in Europe, International Bureau of Fiscal Documentation (IBFD), and Tax Analysts (www.taxanalysts.com). Note that table displays symmetry.

| Country | Austria | Belgium | Bulgaria | Croatia | Cyprus | Czech Republic | Denmark | Estonia | Finland | France | Germany | Greece | Hungary | Iceland | Ireland | Italy | Latvia | Lithuania | Luxembourg | Netherland | Norway | Poland | Portugal | Romania | Slovak Republic | Slovenia | Spain | Sweden | Switzerland | United Kingdom |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Belgium | 1 | | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 |
| Bulgaria | 1 | 1 | | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| Croatia | 0 | 1 | 1 | | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| Cyprus | 1 | 1 | 1 | 1 | | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| Czech Republic | 1 | 0 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Denmark | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| Estonia | 0 | 0 | 0 | 0 | 0 | 1 | 1 | | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| Finland | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 |
| France | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Germany | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| Greece | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |
| Hungary | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Iceland | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |
| Ireland | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 |
| Italy | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Latvia | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |
| Lithuania | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| Luxembourg | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| Netherlands | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Norway | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 |
| Poland | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Portugal | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| Romania | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 |
| Slovak Republic | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 |
| Slovenia | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | | 0 | 1 | 1 | 1 |
| Spain | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | | 1 | 1 | 1 |
| Sweden | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | | 1 | 1 |
| Switzerland | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 |
| United Kingdom | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |