Ludwig–Maximilians–Universität München

Essays on the Impact of International Taxation and Bilateral Treaties on Multinational Firm Activity

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zur Erlangung des Grades
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(Dr. oec. publ.)

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Introduction

Multinational enterprises (MNEs) have been the leading actors in the process of globalization of the last three decades. According to UNCTAD, exports of foreign affiliates of MNEs constitute about one third of total world exports of goods and services, and one third of international trade is intra-firm trade. In 2009, foreign affiliates employed about 80 million people – four times more than in 1982 – and their contribution to world GDP reached, despite the slowdown in economic activity caused by the global crisis, a new maximum of 11% (see UNCTAD 2010).

The phenomenal increase in foreign direct investment (FDI) flows came along with a proliferation of policy instruments to protect – and attract – foreign investors. The number of international investment agreements (IIAs), the most important being bilateral investment treaties (BITs) and double taxation treaties (DTTs), grew exponentially since the early 1960s (see Sachs and Sauvant 2009). While BITs principally aim at protecting foreign investments, DTTs deal with the allocation, between host and home countries, of taxable capital flows (dividends, interest, and royalties) generated by MNEs, and intend to reduce investors' costs of tax compliance. The surge of DTTs signed not only reflects – as in the case of BITs – the countries' efforts to attract FDI by avoiding double taxation; it also reflects the growing effort made by developed countries coordinate anti-tax-avoidance measures.

The increased mobility of capital, made possible by the liberalization of regulations and the development of communication technologies, poses a challenge to national tax systems. Moving actual or recorded activity – i.e. taxable profits – across jurisdictions became easier and less costly, increasing both the sensitivity of real capital or paper profits to tax differentials, and the competition among jurisdictions for either of them. Attempts to relieve the resulting jurisdictional tax conflicts have been made not only through bilateral tax treaties but also through initiatives to coordinate tax rules within the OECD and the EU (see Griffith, Hines and Sørensen 2010). While proposals for partial harmonization of corporate tax rates within the EU failed, the number of tax-related cases presented at the European Court of Justice increased significantly in the last years, as international companies consider national tax rules discriminating and infringing on their fundamental freedoms guaranteed by the EU Treaty (free movement of goods, services, capital and persons).[1]

In this context, it is of great relevance to the policy maker to learn about multinational firms' responses to tax instruments and to quantify those re-

[1] See European Commission, Taxation and Customs Union, http://ec.europa.eu/taxation_customs/resources/documents/common/infringements/case_law/court_cases_direct_taxation_en.pdf.

sponses. There is now a vast literature on the responsiveness of FDI to taxation. De Mooij and Ederveen (2003) provide a survey and a meta-study of the literature and document a big variance of the estimated profit tax elasticities of FDI across studies. Griffith, Hines and Sørensen (2010) consider the existing empirical evidence on corporate taxation in the open economy, and conclude that *"[...] while we can say that tax policy is important, we are unable to say precisely how strongly international real investment will react to specific changes in national policies"*.

This dissertation contributes to the empirical literature on multinational firm behavior by using state of the art econometric methods, and an exceptionally good data-set on foreign affiliates' balance sheets, to assess the impact of different policy instruments on different margins and outcomes of MNE activity in four self-contained chapters. The data used is the *Microdatabase Direct Investment* (*MiDi*) provided by the Deutsche Bundesbank. The feature of the data-set that makes it especially apt for evaluating the sensitivity of MNE activity to policy instruments, is that reporting is mandatory above a threshold set by law (See Lipponer, 2009, for details). In fact, *MiDi* comprises both the universe of foreign affiliates in Germany and the universe of German affiliates abroad. In its current version, the data-set is available as a panel over the period 1996-2009. Since Germany is not only one of the most important home economies, but also a major recipient of foreign investments,[2] we observe a significant sample of the world's MNEs, rendering the estimated responses to policy instruments highly relevant for the evaluation

[2]In 2009, Germany ranked fourth and seventh in terms of FDI outflows and inflows respectively (see UNCTAD 2010).

of the effectiveness of such policies.[3]

The first chapter is concerned with the location of foreign investments within Germany, and their sensitivity to the local municipal business tax rate. The main contribution of this chapter is the compilation of a panel data-set of more than $11,000$ of the $12,300$ German municipalities, which is linked to the location of inbound FDI in Germany to assess the impact of profit taxation on multinational firm activity in a sub-national context. Most existing empirical evidence on the impact of profit taxation on multinational firm activity is based on cross-country data. One major drawback of such data is that countries differ not only with regard to taxes but along other dimensions which might be hard to capture by means of observable characteristics. We show that – after controlling for other determinants of firm location decisions – higher business tax rates have a negative effect on three alternative measures of MNE activity: the number of foreign MNEs, MNE employment, and MNE fixed assets. Our results suggest that tax competition among regional entities for foreign investors is a game of a few. We find that a one-percent reduction of the municipal business tax rate (equivalent to a decline by about 0.14 percentage points) leads to an increase in the number of legally independent foreign-owned firms by about 0.45. The average municipality would have to reduce its business tax rate by about 2.2 percentage points (or 15%) from its average level to attract one foreign MNE. Hence, municipalities need to be

[3]Throughout all chapters, we strive to make the least restrictions to the samples as possible, the main reason for such restrictions being the lack of data on some control variables. In Chapter 4, for example, we have a sample of 38,705 German foreign affiliates. These represent almost 5% of the world's foreign affiliates, which are estimated to amount to 810,000 (See UNCTAD 2009).

attractive in other dimensions to be able to use tax instruments to attract firms at the margin.

The remaining chapters focus on the location and activity of German foreign affiliates abroad. Chapter 2 is dedicated to the analysis of bilateral investment treaties (BITs), one of the few policy instruments that are directly intended to attract foreign investments. Previous research aimed at a quantification of the impact of BITs on foreign direct investment at aggregated levels only. We use the data at hand to deliver a detailed analysis of BITs' effects on multinational activity at the micro level, and contribute to improving our understanding of the precise channels through which BITs determine aggregate investment. We provide descriptive evidence on changes in intensive and extensive margins of multinational firm activity around the adoption of BITs. The results of multivariate empirical models broadly support the hypotheses derived from a parsimonious model of heterogeneous firms on the effects of BITs on different margins of investment: BITs raise the number of multinational firms active in a particular host country and have a positive effect on the number of plants per firm, as well as on FDI stocks and fixed assets per firm.

In Chapter 3 we turn the attention back to corporate profit taxation. This chapter analyzes the impact of statutory corporate tax rates and of double taxation treaties (DTTs) on multinational firm activity at the micro level. It provides an assessment of the effects of these profit tax instruments on the extensive and the intensive margin of MNE activity. While we can expect statutory corporate tax rates to have a negative effect on FDI, the effect of DTTs is not a priori clear. On the one hand, DTTs typically reduce uncertainty about after-tax profits by specifying the mode of taxation relief and by agreeing on maximum levels of withholding tax rates. At the same time, they contain provisions for the exchange of information to limit transfer pricing, and restrict tax evasion, which might rather discourage FDI. Our findings suggest that while statutory tax rates affect MNE activity negatively both at the extensive and the intensive margin of investment, DTTs primarily induce a positive effect at the extensive margin.

Finally, Chapter 4 focuses on the (unobserved) profit-shifting activities of MNEs. In particular, the chapter investigates the tax responsiveness of multinationals' investment decisions in foreign countries, distinguishing firms that are able to shift profits (*shifters*) from those that are not (*non-shifters*). From a theoretical point of view, the tax responsiveness of firms crucially depends on this distinction. Empirically, however, a firm's ability to shift profits is inherently unobserved. To address this problem, we use a finite mixture modeling approach which allows us to distinguish shifters from non-shifters stochastically from a mixture of distributions of the two types of firms. We find that shifters do not respond to host-country profit taxes at all, as expected, while taxes affect the investment decision of non-shifters. More specifically, we identify a larger group of affiliates with a relatively low average investment, which is negatively affected by the local corporate tax rate on profits. The estimated tax effect for the latter group amounts to 1.85% less fixed assets, or 68,000 Euro for the average affiliate per percentage point tax increase. A smaller group of affiliates is able to avoid taxation by shifting its tax base, and shows no significant response to corporate tax rates. The affiliates in this group have, on average, significatively higher investments in fixed assets, so that – were they to be prevented from shifting profits – the implied effect in Euro of a one-percentage-point change in the tax rate would be 42 times higher. We conclude that, to the extent that a considerable proportion of a country's foreign investments are carried out by firms that shift profits, the introduction of anti-tax-avoidance measures to restrict profit shifting in the pursuit to cash tax revenue will come at the cost of entering in tax competition with other countries for that firms' investments. In fact, the broadening of the tax base has to be accompanied by a policy of cutting the statutory tax burden to avoid losing real economic activity.

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Chapter 1

How Low Business Tax Rates Attract MNE Activity: Municipality-Level Evidence from Germany

Abstract*

Most existing empirical evidence on the impact of profit taxation on multinational firm activity is based on cross-country data. One major drawback of such data is that countries differ not only with regard to taxes but along other dimensions which might be hard to capture by means of observable characteristics. We compile a database of more than 11,000 municipalities in Germany to analyze the sensitivity of location decisions of foreign MNEs in Germany with respect to business tax rates which are levied directly by the municipalities. We find that higher business tax rates have a negative effect on three alternative measures of MNE activity, after controlling for other determinants of firm location decisions: the number of foreign MNEs, MNE employment, and MNE fixed assets. Our results suggest that tax competition among regional entities for foreign investors is a game of a few. In cross-section instrumental-variables regressions, a one-percent reduction of the municipal business tax rate (equivalent to a decline by about 0.14 percentage points) leads to an increase in the number of legally independent foreign-owned firms by about 0.45. The average municipality would have to reduce its business tax rate by about 2.2 percentage points (or 15%) from its average level to attract one foreign MNE. Hence, municipalities need to be attractive in other dimensions to be able to use tax instruments to attract foreign firms at the margin.

1.1 Introduction

A sizable literature in theoretical public finance argues that the location of capital in general and that of multinational enterprises (MNEs) in particular reacts sensitively to profit tax policy (Wilson, 1987; Janeba, 1995; Huizinga

*This chapter is joint work with Sascha Becker and Peter Egger. It is based on our paper "How Low Business Tax Rates Attract MNE Activity: Municipality-Level Evidence from Germany". An earlier version is available as CESifo Working Paper No. 2517.

and Nielsen, 1997; Haufler and Wooton, 1999; Wilson, 1999; Ludema and Wooton, 2000; Davies, 2003, 2005; Devereux and Hubbard, 2003; Baldwin and Krugman, 2004; Raff, 2004; Borck and Pflüger, 2006; Bucovetsky and Haufler, 2008; this list is by no means exhaustive). When lumpy investment – i.e., firm or plant location – is sensitive to profit taxation, many of these models predict a *race to the bottom* in profit tax rates so that, in equilibrium, countries have to offer a tax rate of zero to attract investors. Otherwise, a jurisdiction will lose the whole profit tax base to its competitors. One key reason for this outcome is that – in most of the traditional models of tax competition – countries differ only in terms of profit taxes or, more precisely, low profit taxes are the only attraction governments may offer to firms.

Empirically, there is hardly any evidence of a race to the bottom in profit taxes (except for the existence of a few small tax havens). Therefore, recent theoretical work suggested mechanisms to avoid this knife-edge case. The New Economic Geography literature hypothesizes that there are factors generating agglomeration economies which, in turn, reduce the sensitivity of location decisions of foreign MNEs with respect to profit (or capital) taxation (Ludema and Wooton, 2000; Baldwin and Krugman, 2004; Borck and Pflüger, 2006). More generally, taxes are only one factor affecting firm location. There is little reason for a municipality to eliminate profit taxes provided that the overall environment – e.g. available infrastructure and human capital endowment of the work force – makes it attractive enough to locate there.

It is by now well documented in empirical research at various levels of aggregation (firms, industries, and aggregate bilateral activity) that the location of MNE activity across countries *inter alia* depends on national profit tax policy (Devereux and Griffith, 1998; de Mooij and Ederveen, 2003, 2006, 2008; Blonigen and Davies, 2004; Grubert and Mutti, 2004; Huizinga and Nicodème, 2006; Egger, Pfaffermayr, Loretz, and Winner, 2009; Overesch and Wamser, 2009). However, two concerns may be raised with such work. First, for some countries, such as Germany, Switzerland, or the United States, *the* (unique) profit tax rate is an artifact, since tax authorities at the sub-national level may determine taxes on profits in their jurisdiction. Second, host countries differ in many ways rather than only in profit taxes, most importantly with regard to institutional characteristics that are hard to measure. Omission of relevant institutional determinants of MNE activity is likely in cross-country studies and may bias empirical estimates of the sensitivity of MNE activity with respect to taxation and other variables. Both problems can be avoided when considering firm location decisions at the sub-national level. Of course, a prerequisite for this is the existence of sub-national jurisdictions with tax authority and some heterogeneity in the profit tax rates.

There is a small literature on the nexus between firm births (national and foreign firms) and taxation which focuses on location decisions across regions *within* a country. For instance, Slemrod (1990; analyzing direct investments in 50 U.S. states by parent country), Papke (1991; exploiting information across 22 U.S. states), Hines (1996; analyzing foreign direct investment in 50 U.S. states by home country), List (2001; using 58 Californian counties), Swenson (2001; considering investment decisions across U.S. states by distinguishing investment types and industries of investment), and Brühlhart, Jametti, and Schmidheiny (2007; focusing on 213 large Swiss municipalities) belong here. Of these studies, only Slemrod (1990), Hines (1996), List (2001), and Swenson (2001) focus on the location decisions of *foreign* firms (i.e., foreign MNEs) explicitly and, hence, ask questions which are comparable to ours. List (2001) analyzes the impact of the per-capita property tax rate on MNEs rather than a profit tax burden which is directly levied on businesses. Slemrod (1990) and Hines (1996) are interested not only in the impact of state-level corporate tax rates in the U.S. but also in the role of the system of double taxation relief in the recipient countries. Swenson (2001) primarily focuses on the different responsiveness of alternative types of investments in the United States.[1] Apart from the differences in the research questions posed in this paper as compared to the ones just mentioned, the number of subnational jurisdictions (i.e., the number of host locations) available is larger than in previous work by more than one order of magnitude.

We compile a large panel data-set on local business tax rates and other data at the municipality level. In Germany, municipalities may independently set a so-called *Gewerbesteuer* (or business tax rate). This business tax rate is levied on profits of companies and represents the most important source of revenues accruing to policy instruments which are at a municipality's discretion. Our data-set covers more than $11,000$ German municipalities over the period 2001 to 2005. We link it with data on the location of foreign MNEs in Germany from Deutsche Bundesbank's *Micro-Database Direct Investment*

[1] Already Auerbach and Hassett (1993) suggested that alternative forms of investment should respond differently to tax policy.

(*MiDi*).[2] The set of locations (municipalities) considered here is much more homogeneous than in cross-country data. For instance, in contrast to an international setting, other tax parameters such as taxes on income are identical across German municipalities since they are levied at the national level. The variability of the effective profit tax rate across municipalities is brought about by the variability in business tax rates alone while other determinants of the tax base (such as the method of double taxation relief, withholding tax rates, depreciation allowances, etc.) are homogeneous across municipalities. Moreover, sub-national data allow one to control for the heterogeneity of locations within countries, which is more difficult with national data.

Attracting foreign-owned firms to a municipality promises jobs and local business tax income. There is anecdotal evidence of municipalities which lower their tax rates so as to explicitly attract foreign firms. One well-known example is the small town of Holzkirchen, close to Munich in Upper Bavaria, that lowered its business tax rate to appeal to Sandoz, a big pharmaceutical firm.[3] Another example constitutes the municipality of Amering which

[2]The work of Slemrod (1990) and Hines (1996) blends home country and host jurisdiction issues with corporate taxation. Unlike them, we do not distinguish foreign MNEs according to their country of origin. We focus on the responsiveness of MNE location (from anywhere) to host jurisdiction business tax rates for two reasons. First, we are interested in how a *given number* of foreign investments to just one country (Germany) is allocated *within* the country in response to tax rates. Hence, we disregard multilateral considerations of investors – e.g., decisions related to whether to invest in Germany at all. Second, the huge number of host jurisdictions involves a relatively large fraction of municipalities where no investment is undertaken at all. The fraction of zeros would necessarily rise more than proportionately if we distinguished investors by their country of origin. We discuss this issue further in section 6.3.

[3]See http://www.sueddeutsche.de/wirtschaft/artikel/10/51958/ reporting that Holzkirchen had lowered its local business tax rate by 30 percent, making it the second-lowest in the state of Bavaria, in its (successful) attempt to attract Sandoz.

managed to lure Kathrein, the world leader in satellite dishes, to locate its headquarters there, by lowering its local business tax rate.[4]

Although these examples illustrate that some municipalities consider the attraction of foreign MNEs of prime interest, it is not only the number of MNEs that matters, but the real activity they develop. We therefore also consider two further measures of MNE activity: MNE employment and MNE real assets.

Econometrically, we have to deal with the fact that the majority of municipalities in Germany does not attract any foreign MNEs. Moreover, many of the municipalities which successfully attract foreign MNEs host only a small number of them. We use count data models (when looking at the number of foreign MNEs) as well as linear and non-linear estimation models (for all outcomes), to estimate the impact of business taxation on the foreign MNE activity in a municipality, controlling for other determinants such as population characteristics, the skill level of the work force, and geographical characteristics. We estimate both cross-section and panel data models, where business tax rates are treated as endogenous and instrumented by characteristics of neighboring municipalities. Across the board, we identify a negative impact of business tax rates on the number of MNEs in a municipality which is significantly different from zero.

For all three measures of MNE activity, we find that lower (simple or formula-apportioned) business tax rates attract MNEs, conditional on other deter-

[4] See http://www.kathrein.de/de/presse/cont/texte2005/pi0553.htm.

minants of MNE activity. We discuss the magnitude of the effects and find them to be of reasonable size. For instance, in cross-section IV regressions, a one-percent reduction of the municipal business tax rate (equivalent to a decline by about 0.14 percentage points) leads to an increase in the number of foreign MNEs there by about 0.45. The average municipality would have to reduce its business tax rate by about 2.2 percentage points (or 15%) from its average level to attract one foreign MNE. Hence, municipalities need to be attractive in other dimensions to be able to use tax instruments to attract firms at the margin.

The remainder of the paper is organized as follows. Section 1.2 describes the most important institutional details of the German municipal business tax. We summarize the literature on determinants of MNE location in section 1.3. Section 1.4 describes features of the data-set. Section 1.5 introduces the empirical strategy for the analysis of the impact of business taxes on the number of MNEs locating in a municipality. Section 1.6 summarizes the empirical findings from both cross-section and panel data analyses. The last section provides some concluding remarks.

1.2 The German municipal business tax

German municipalities have autonomy in determining the local business tax rate (*Gewerbesteuer*), levied on profits of companies.[5] The local business

[5]For exceptions, see §3 of the German business tax law.

tax rate is one of the most important policy instruments at a municipality's discretion, because it represents their main source of revenue. The tax base is defined by the federal tax law which applies uniformly in all municipalities. What municipalities may actually choose is the so-called *Hebesatz* (or multiplier) which is a factor that is measured in percent and applied on the constant *Steuermesszahl* (or base) of 5 percent for corporate entities in all municipalities.[6] The tax rate on corporate profits in municipality i with a multiplier H_i is determined as $t_i = H_i \times 0.05/[(100 + (H_i \times 0.05)]$.[7] For instance, a multiplier of 200 means that the business tax rate determined by the municipality amounts to 9 percent. To avoid detrimental effects of tax competition, the federal Gewerbesteuergesetz *GewStG* (business tax law; §16 Abs. 4 S. 2 GewStG.) determined a floor of 200 percent for the multiplier from 2004 onwards. Hence, municipalities may only choose a multiplier of 200 or higher. If they do not specify a multiplier, a value of 200 percent (i.e., a business tax rate of 9 percent) is set by default. Before 2004, municipalities were free to set a business tax rate of less than 9 percent, but only a very small fraction of municipalities did so. Tax exemptions to attract firms are illegal (see Glanegger and Güroff, 1999, p. 929).

To some extent, profit-shifting between plants in an attempt to escape the local business tax is limited by formula apportionment: firm profits to be taxed are apportioned to each municipality according to the share of payroll

[6] In 2008 the *Steuermesszahl* for corporate entities was changed to 3.5 percent for all municipalities.

[7] The tax payments are deductible from the tax base.

paid there.[8] By German tax law, all profits associated with a legally independent (domestically- or foreign-owned) firm in Germany are attributed to the controlled entities within Germany according to the respective wage bill shares. Suppose a firm f is located in municipality A and has two branches, one in municipality B and one in C. Total profits in those locations are $\pi_f = \pi_{fA} + \pi_{fB} + \pi_{fC}$ and the total wage bill is $w_f = w_{fA} + w_{fB} + w_{fC}$. With tax rate t_i in municipality $i \in \{A, B, C\}$, profit tax revenue in i is then $t_i(w_{fi}/w_f)\pi_f$.

As mentioned in the introduction, other tax parameters such as taxes on income are levied at the national level and thus identical across German municipalities. The variability of the effective profit tax rate across municipalities is brought about by the variability in business tax rates *alone* while other determinants of the tax base such as depreciation allowances, or in the specific case of foreign-owned firms the method of double taxation relief or withholding tax rates, are homogeneous across municipalities.

1.3 Determinants of MNE activity abroad

In our empirical analysis, we estimate parsimonious models of the number of foreign MNEs locating in German municipalities. As suggested by previous research on the impact of profit (or capital) taxation on lumpy investment

[8]However, formula apportionment can be avoided by a strategic choice of the organization structure of firms and location decisions about their incorporation.

decisions by MNEs, we expect higher business tax rates levied by municipalities to exert a negative impact on the number of foreign MNEs locating there. To the extent that foreign MNE location entails real activity, we expect the same to hold for MNE employment and real assets. However, to isolate the role of business taxes on MNEs' location decisions, we have to control for other key explanatory variables suggested by the literature. These are the following.

According to a sizable body of work in theoretical international economics, knowledge-capital embodied in skilled workers is one of the key determinants of MNE activity (see Markusen, 2002). In accordance with that line of reasoning, empirical research identified a key role of the local supply of skilled labor to play for the location MNEs (see Carr, Markusen, and Maskus, 2001; Markusen and Maskus, 2002; Blonigen, Davies, and Head, 2003). While previous evidence is available for investment (and foreign affiliate sales) at the national level, similar arguments ought to hold for the location *within* a country. Our skill measure is the share of workers with tertiary school education per municipality.

A second key factor determining MNE activity according to previous research is host country location size (see Markusen, 2002; Barba Navaretti and Venables, 2004). Using country (or country-pair) data in previous empirical work, host market size is typically controlled for by variables based on gross domestic product (GDP). However, GDP is not available (as well as endogenous) at regionally very disaggregated levels. For this reason, we include population density, the independency ratio of the population (i.e., the number of people aged between 15 and 65 years as a fraction of total population in the region) and geographical area.[9] Notice that – once including log geographical area as well – we may interpret the coefficient of log population density as reflecting the elasticity with respect to population size. The independency ratio is the best measure available to capture the relative size of the working-age population in a region. Including log area along with population density also provides a measure of the relative abundance of land as such, which may be used relatively intensively in some of the sectors MNEs operate in.[10,11]

Research at the aggregate level has further pointed to the role of physical capital for MNEs' plant set-up (see Bergstrand and Egger, 2007). Since data on capital stocks are not available at the regional level, the best we can do to proxy for capital is to include the log gross investment share (in total expenditures) of a municipality. In line with previous theoretical work, we expect that larger gross investments – reflecting bigger local stocks of

[9]One might think of distance to a metropolitan area as a further possible determinant. However, this is highly correlated with geographical area and population in the cross-section, and it is wiped out by the method applied with panel data. Therefore, we do not include this variable.

[10]There are various ways of specifying these influences. For instance, including log population and log area obtains identical results to those where we use population density and log area. This has to do with the chosen functional form of the regression models. Similarly, using the area covered with buildings and streets (instead of log total geographical area) along with the log share of area reserved for building obtains similar results. However, the models we propose later on are less prone to multi-collinearity than the latter one.

[11]Another strand of research includes market potential – i.e., some inverse-trade-cost-weighted average of market size of other regions as a determinant of firm location (see Head and Mayer, 2004). However, due to the lack of data on municipality-level GDP, we may not employ such a measure here.

capital in equilibrium – positively affect the inclination of foreign MNEs to locate in a German municipality. For similar reasons, we include the fraction of land area covered with infrastructure (buildings and streets). We also include the log land price per square meter in Euro to proxy for the quality of infrastructure.

Finally, we may be concerned about structural differences between Western and Eastern German municipalities in their ability to attract foreign MNEs. To capture the latter, we include an indicator variable which takes a value of zero for municipalities in the former *Western Germany* and a value of one for municipalities in the *New Länder*.[12] Since the available infrastructure in Germany's *New Länder* was and still is of a lower quality, on average, than in the *Old Länder* in the sample period, we expect the parameter of this variable to take a negative sign.

1.4 Data

The data on MNE activity come from Deutsche Bundesbank's *Micro-Database Direct Investment* (*MiDi*). All German firms with a balance sheet total of more than 3 million Euro in which foreign investors hold 10% or more of the

[12] Overall, Germany consists of 16 Länder. Of those, the following 11 are located in the former Western German part of the country (the Old Länder): Baden-Württemberg, Bayern, Berlin, Bremen, Hamburg, Hessen, Niedersachsen, Nordrhein-Westfalen, Rheinland-Pfalz, Saarland, and Schleswig-Holstein. The following 5 Länder are located in the former Eastern German part of the country (the New Länder): Brandenburg, Mecklenburg-Vorpommern, Sachsen, Sachsen-Anhalt, and Thüringen.

shares or voting rights are required by law to report to Deutsche Bundesbank balance sheet information as well as information on the sector, legal form, and number of employees.[13] Indirect participating interests are to be reported whenever nonresidents hold more than 50% in a domestic firm and these dependent enterprises themselves hold 10% or more of the shares or voting rights in other domestic enterprises. An appealing feature of this data-set is that it comprises the universe of inward FDI (above the reporting threshold) undertaken in Germany. For each foreign-owned, legally independent firm, we know its location (municipality) in Germany. The number of MNEs located in a municipality is our first measure of MNE activity. Two additional measures capture the size of the firms' operations in terms of their employment and fixed assets. Note that employment and fixed assets are reported as part of the Germany-wide balance sheet of legally independent foreign-owned firms and thus refer to their activity not only at the main location, but possibly also at further (legally dependent) locations across Germany (if there are any).[14]

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[13]The reporting requirements are set by the Foreign Trade and Payments Regulation. For details and a documentation on the micro-level data set *MiDi* see Lipponer (2008).

[14]Each *legally independent* firm that is owned abroad is associated with one address in *MiDi*. The address in Germany notified to Deutsche Bundesbank either refers to a unit of a foreign MNE with only a single plant in Germany or one with other legally dependent locations in case of a multi-plant structure in Germany. If a foreign investor owns several *legally independent* affiliates in Germany, we observe the location of each one. To give an example, if the Austrian controlled Egger Inc. with headquarters in Munich owns 100% in Merlo Ltd. and Merlo Ltd. is a legal entity of its own, Merlo Ltd. also needs to report. In contrast, legally dependent branches of a foreign-owned firm report no separate balance sheet information. Note that different affiliates and branches can be located within the same town (for instance, Siemens has many different units in Munich), in which case the same tax rate applies.

The fact that MNE employment and fixed assets cannot be fully attributed to the location of the legally independent unit poses a challenge with regard to multi-location firms. Unfortunately, the MiDi data do not reveal which MNEs are single-location firms and which are multi-location firms, so we cannot run separate regressions for the two groups of firms.

We therefore have to address the issue of multi-location firms differently. To do so, we draw additional information from the Monthly Survey of Plants in Manufacturing and Mining (own translation of *Monatsbericht für Betriebe im Verarbeitenden Gewerbe sowie Bergbau und Gewinnung von Steinen und Erden*) in Germany that is held at the German Federal Statistical Office in Wiesbaden. This survey covers both national firms as well as MNEs in MiDi.[15] At the descriptive level, this survey reveals that the vast majority of manufacturing firms with more than 20 employees in Germany (more than three quarters of all firms) are single-plant firms. Only 16.4% of firms have plants in two (or more) of the 16 German states. Admittedly, we cannot exclude the possibility that MNEs are more likely to be multi-location firms than the average firm.[16] Multi-location firms are of interest for a second reason: the German tax law stipulates formula apportionment: firm profits to be taxed are apportioned to each municipality according to the share of payroll paid there.[17]

[15] German law does not allow us to merge, at the firm level, the survey data with the MiDi data. Hence, we can only draw information on "representative firms" per municipality.

[16] However, we know from German MNEs' outbound activity that the median German MNE hosts a single foreign affiliate per country in every year since 1996, and 80.6% of the firms run only a single foreign affiliate per country. Hence, we conjecture that a similar pattern prevails for inbound MNE activity.

[17] See the German business tax law, in particular, §29 GewStG (Gewerbesteuergesetz).

We address the issue of multi-location firms and formula apportionment by computing a municipality-specific formula-apportioned tax rate (FATAX) of the representative multi-location firm in each municipality. We define the latter as the average business tax rate paid by a representative firm located in municipality i which takes account of the structure and distribution of production activities across municipalities in Germany. To obtain the FATAX of municipality i in year t on the basis of the Monthly Survey of Plants in Manufacturing and Mining in Germany, we proceeded as follows. First, we identified all firms with a production plant in municipality i and year t. Second, we identified the set J_{it} of all municipalities which hosted firms with one or more plants in municipality i at time t. Let us use acronym $w_{fijt} \geq 0$ with the following definition: $w_{fijt} = 0$ for any firm which does not have a production site in i at time t and $w_{fijt} \geq 0$ is firm f's wage bill in j otherwise. All firms with a production site in i have a wage bill $w_{fiit} > 0$ there. All firms which have a plant in i and possibly elsewhere but not in $j \neq i$ have $w_{fijt} = 0$. Then, $B_{ijt} = \sum_f w_{fijt}$ is the total wage bill of all i-based firms across municipalities j in year t. It may be viewed as the ij-th entry of an $N \times N$ matrix B_t for year t, where N is the number of municipalities. Define $W_{ijt} = B_{ijt}(\sum_j \sum_f w_{fijt})^{-1}$ as the ij-th element of the $N \times N$ matrix W_t and note that W_t may be viewed as a row-sum-normalized counterpart to B_t. All elements in a row sum up to unity and, hence, the entries across columns in a row of W_t reflect shares of the wage bill of all firms with plants in i across municipalities j in year t. If there were only single-plant firms in Germany, both B_t and W_t would be diagonal matrices. More specifically, W_t would then be an identity matrix of size N. In the data, these matrices do have positive off-diagonal elements and neither of them is symmetric. We use W_t to premultiply the $N \times 1$ vector of original business tax rates across municipalities, TAX_t, to generate the $N \times 1$ vector $FATAX_t = W_t TAX_t$ whose typical element is $FATAX_{it}$. $FATAX_t$ is a vector of weighted tax rates consistent with formula apportionment for the representative firm in i and year t. We will generally provide results based on TAX and, alternatively, $FATAX$.

Data on variables capturing other determinants of MNE location are drawn from several further sources. Municipality-level data on the qualification of employees were compiled on special request based on the universe of German social-security records of the German Federal Labor Agency (Bundesagentur für Arbeit). The observations are the universe of workers registered for unemployment insurance, representing around 80% of the German workforce.[18] Our skill measure is the share of workers with tertiary school education in municipality i and year t.

Municipality-level data on business tax rates, population, geographical area, the independency ratio, the fraction of land area covered with buildings and streets (a measure of available infrastructure), and gross investments are provided by different federal statistical offices of the 16 German states (Länder) in the database *Statistik Lokal* distributed by the German Statistical Office (Statistisches Bundesamt).

[18]Coverage includes full- and part-time workers of private enterprises, apprentices, and other trainees, as well as temporarily suspended employment relationships. Civil servants, student workers, and self-employed individuals are excluded and make up the remaining 20% of the formal-sector labor force.

As mentioned before, there are two advantages of looking at location choices at the sub-national level. One is that firms face a much more homogeneous institutional setting across municipalities within a country than at the international level. Another advantage of using sub-national data is that one may account more accurately for the heterogeneity of locations. Cross-country data use national averages that might suffer from aggregation bias.[19] By looking at the smallest regional unit (municipalities), aggregation bias is ruled out.

In Germany, there are over $12,000$ municipalities. For $11,200$ of those, we have a panel data-set of the dependent and explanatory variables over the period 2001 to 2005 with at least two consecutive observations in the sample period.[20] Table 1.1 shows descriptive statistics for the whole panel data-set covering annual data over 2001-2005. Altogether, one obtains $39,124$ observations after eliminating ones where explanatory variables are missing. As indicated before, for each of the covered $11,200$ municipalities at least two consecutive years are available. Across all years, only $6,073$ observations – or somewhat less than 16% – pertained to municipality-year dyads with a positive number of foreign MNEs (i.e, where $y_{it} > 0$ independent of the outcome considered).

[19] Consider two countries A and B with identical national averages. For instance, country A might have a skilled labor force but a bad infrastructure in one half of the country and a good infrastructure but unskilled labor in the other half of the country. Country B, in contrast, might have both skilled labor and a good infrastructure in one half of the country and neither skilled labor nor a good infrastructure in the other half of the country. These sub-national differences might matter for aggregate outcomes, but are washed out in national aggregates.

[20] The difference between the total number of more than 12,000 municipalities and the smaller one in the panel data-set accrues to lacking data on some of the explanatory variables for municipalities in the state of Mecklenburg-Vorpommern (except for the six *Kreisfreie Städte* – i.e., larger cities – in that state: Greifswald, Neubrandenburg, Rostock, Schwerin, Stralsund, and Wismar).

Table 1.1: Descriptive statistics (panel 2001-2005)

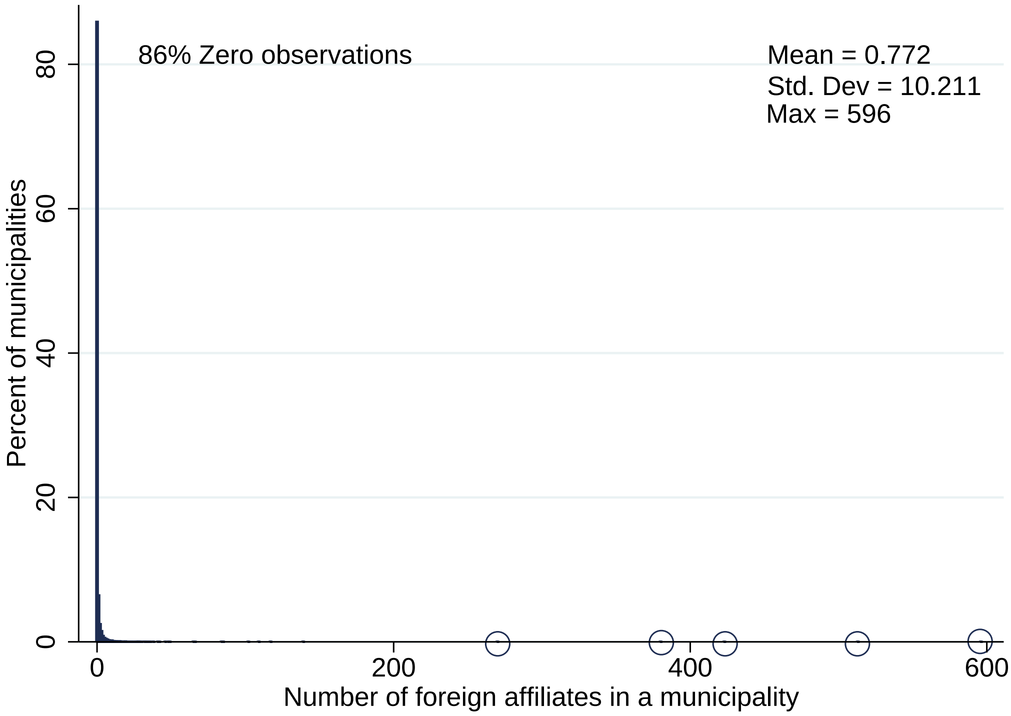
Variable	Whole Sample				Municipalities with at least one MNE			
	Mean	Std. dev.	Min.	Max.	Mean	Std. dev.	Min.	Max.
Business tax rate	0.143	0.012	0.048	0.310	0.149	0.014	0.091	0.197
Formula-apportioned business tax rate	0.144	0.012	0.048	0.310	0.152	0.014	0.091	0.197
General Expenditures	15,993.670	247,175.800	2.588	21,800,000.000	80,573.560	623,249.700	160.978	21,800,000.000
Investment Expenditure	1,683.104	9,445.867	-735.214	652,524.700	6,734.103	23,150.390	0.272	652,524.700
Population	7.251	45.643	0.003	3,395.189	30.643	112.556	0.118	3,395.189
Skilled labor share	0.058	0.032	0.003	0.599	0.074	0.048	0.009	0.599
Area covered with buildings and streets	3.854	10.395	0.040	619.280	11.952	23.941	0.290	619.280
Land price	69.669	66.837	4.880	1,296.840	115.240	99.547	4.880	1,296.840
Total area	28.620	34.193	0.400	891.820	56.600	53.145	1.290	891.820
East Germany dummy	0.212	0.409	0	1	0.124	0.330	0	1
Municipalities		11,200				1,831		
Observations		39,124				6,073		

Note: Statistics refer to 11,200 German municipalities with at least two consecutive observations over the period 2001-2005. Last four columns report the statistics for a subsample of 1,831 municipalities which host at least one MNE over that period. Expenditures in 1,000 Euro. Population in 1,000. Area in km^2. Land price in Euro per m^2. Sources: German Federal Labor Agency, Statistik Lokal, Ed. 2003-07, and Statistical offices of Berlin-Brandenburg, Bremen, Hamburg and Sachsen-Anhalt.

Figure 1.1 shows a histogram of the number of legally independent foreign-owned firms across all municipalities in 2005. Whereas 86% of the municipalities did not host a single foreign MNE, six municipalities (Hamburg, Munich, Frankfurt, Düsseldorf, Berlin, and Cologne) hosted more than 200 each in that year. Altogether, the latter six municipalities hosted almost one-third of all foreign-owned firms in Germany in that year. Figure 1.2 illustrates the geographical distribution of foreign MNEs using a map of Germany.[21]

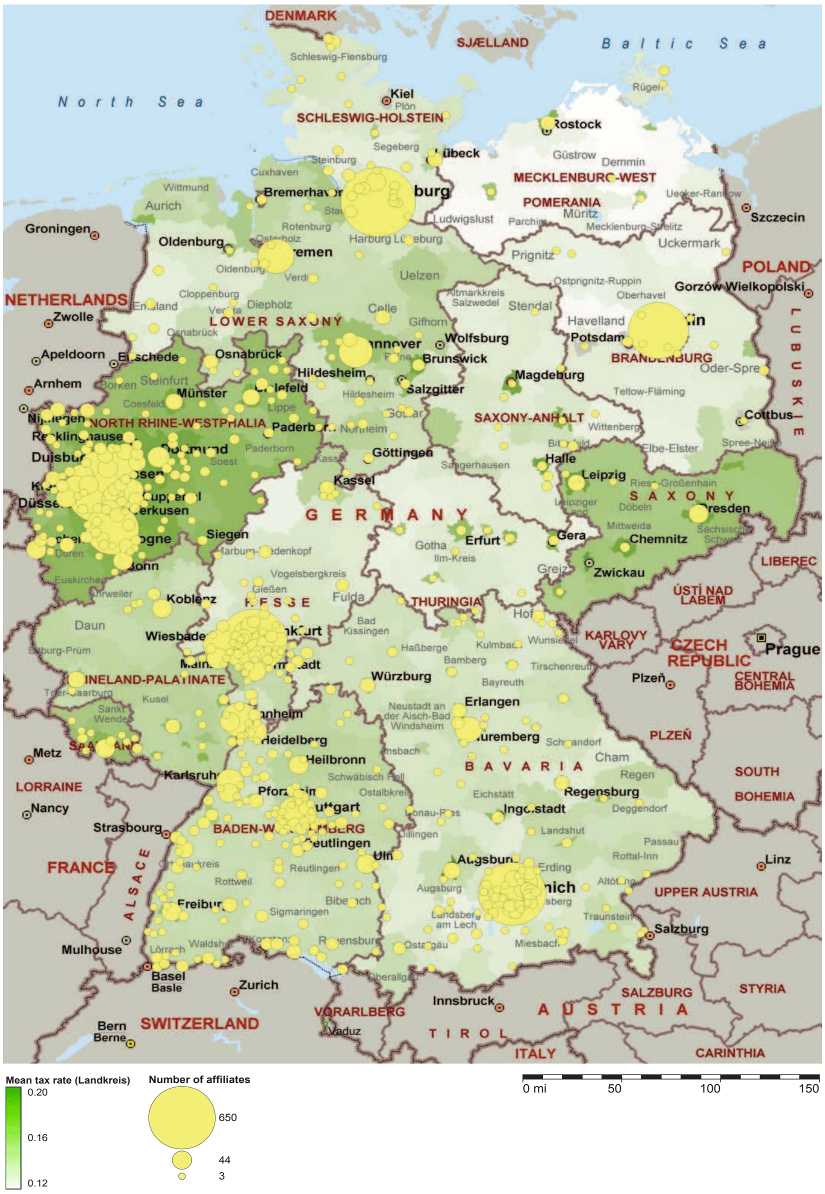
[21]For reasons of confidentiality and as mentioned in the notes to Figure 1.2, we may only display data for municipalities with three or more MNEs. For that reason we decided against a representation of data on employment or fixed assets in terms of a map.

Figure 1.1: Histogram of number of foreign affiliates in a municipality



Data source: Deutsche Bundesbank's *Microdatabase Direct Investment* (*MiDi*). See main text for details.

Figure 1.2: Geographical distribution of foreign affiliates



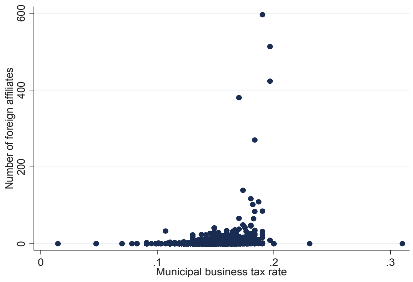
Note: For reasons of confidentiality, we may only display data for municipalities with three or more headquarters. Data source: Deutsche Bundesbank's *Microdatabase Direct Investment* (*MiDi*). See main text for details.

For the same cross section of our panel data-set in 2005, we may visualize the simple correlation between the presence of foreign MNEs, employment, and fixed assets with the business tax rate in German municipalities unconditional on other determinants of location by means of simple scatter plots.

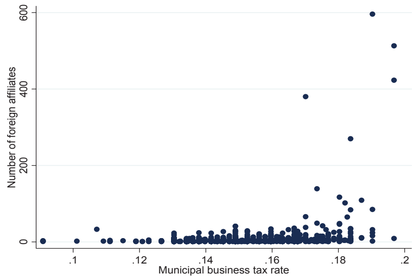
In Figure 1.3 a, c, and e we consider the relationship for all municipalities, including ones with no foreign MNEs ($y_{it} = 0$). In Figure 1.3 b, d, and f we illustrate it only for municipalities with a positive number of foreign MNEs ($y_{it} > 0$). Irrespective of which of the figures we look at, the unconditional relationship between business tax rates and outcome looks to be weakly positive, if anything. Do municipalities with higher business tax rates attract a larger number of foreign-owned firms? This sounds counter-intuitive. However, conditional on other factors – such as the availability of skilled workers, region size, a relatively large fraction of population in working-age, etc. – high business tax rates may well be harmful for MNE location, irrespective of the unconditional relationship in Figure 1.3. We may refer to the source of the positive relationship between the number of foreign-owned firms and the local business tax rate in Figure 1.3 as one of endogeneity of business tax rates – i.e., their correlation with observable or unobservable determinants of the number of foreign-owned firms, as well as their employees, and their assets held per municipality. To reduce or avoid this endogeneity bias, we now turn to various forms of multivariate regression analysis.

Figure 1.3: Scatter plots

Foreign affiliates and the tax rate

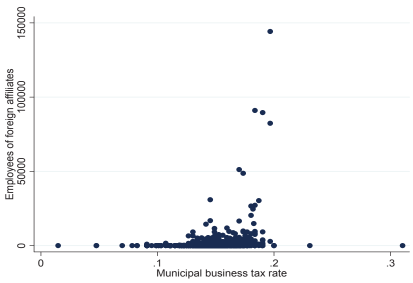


(a) Whole sample

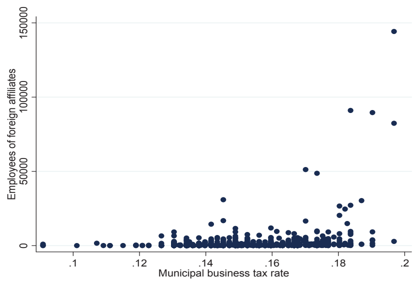


(b) Municipalities with at least one affiliate

Employees and the tax rate

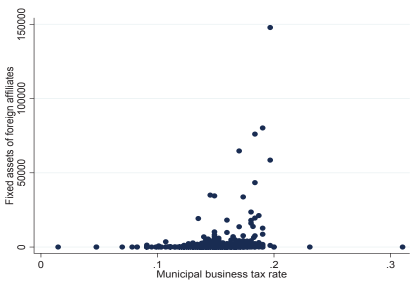


(c) Whole sample

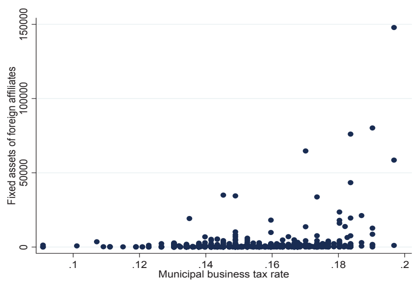


(d) Municipalities with at least one affiliate

Fixed assets and the tax rate



(e) Whole sample



(f) Municipalities with at least one affiliate

1.5 Econometric issues

Regarding the econometric analysis of the dependent variables of interest, two issues of the data are particularly relevant. First, there is a large number of zeros across municipalities in every given year. Hence, a randomly drawn municipality has a low chance (14 percent) of attracting one or more foreign-owned firms. Second, municipalities may set their taxes specifically to attract foreign firms. The former requires estimation of models which can deal with disproportionate amounts of zeros in the data and the latter call for an approach which avoids or at least reduces the endogeneity bias of business tax rates on the outcome.

We address these problems in a number of ways. First, we estimate cross section models for count data using the last available year of data, 2005. Second, we estimate fixed effects panel data models which exploit the time variation in the outcome variables within each municipality. In both cases we allow for endogenous municipal taxes, which are instrumented by weighted averages (within a certain distance radius) of characteristics of the neighboring municipalities.[22] Empirical tax competition models unequivocally model tax rates in some unit i as a weighted function of tax rates in non-i units. Such models may be referred to as spatial econometric frameworks, where observations are cross-sectionally dependent. The corresponding reduced form of tax rates can then be portrayed as a nonlinear weighted function, where

[22] A detailed description of the instruments used in each regression is found in sections 1.6.1 and 1.6.2

i's tax rate depends on characteristics of i as well as of weighted characteristics of non-i units (see Kelejian and Prucha, 1999; Kelejian, Prucha, and Yuzefovich, 2004).

1.5.1 Cross section models for count data

The number of foreign-owned firms is in fact a count variable. The most frequently applied count data model is the Poisson regression model.[23] It is obtained by assuming that each realization of the count dependent variable y_i for cross-sectional observation i is drawn from a Poisson distribution with parameter $\lambda(x_i;\beta) = exp(x_i\beta)$, where x_i is a $1 \times K$ vector of explanatory variables (which includes TAX_{it} or, alternatively, $FATAX_{it}$) and β the corresponding $K \times 1$ vector of regression parameters. The conditional mean and variance are simultaneously determined by the parameter $\lambda(x_i;\beta)$:

$$E(y_i|x_i) = Var(y_i|x_i) = exp(x_i\beta).$$

This last feature of the Poisson distribution (referred to as equi-dispersion, or equality of mean and variance) renders the Poisson regression model often too restrictive in applications. In particular, the model tends to under-predict the frequency of zeros and of large counts for data in which the actual variance is larger than the mean (referred to as over-dispersion). In our application, we have both a large number of zeros and a few very large counts so that over-

[23]For a thorough discussion of the count data models described in this section, see Winkelmann (2003) and Cameron and Trivedi (1998).

dispersion is likely a problem. A possibly suitable model in this case is the negative binomial model (NB). This model is obtained by setting $\lambda_i = \mu_i \nu_i$, where $\mu_i = exp(x_i \beta)$ and $\nu_i > 0$ is a gamma-distributed disturbance term with $E(\nu_i) = 1$ and $Var(\nu_i) = \alpha$. The conditional mean and variance of the NB model are[24]

$$E(y_i|x_i) = \mu_i \quad Var(y_i|x_i) = \mu_i(1 + \alpha\mu_i)$$

thus allowing for over-dispersion and providing a good fit to many types of data.

For data like ours, with 86% of zero observations in 2005, a zero-inflated (ZI) model – which assumes an extra proportion of zeros additionally to the zero observations arising from the count data distribution – should fit the data even better. Zeros are allowed to occur as an outcome of two different regimes. In one regime the outcome will always be zero and in the other one the standard count process is at work resulting in either zero or positive values.[25]

[24] The model with this particular parametrization is known as NB type-II model (see Cameron and Trivedi, 1998).

[25] The model combines a binary variable describing the probability of extra zeros with a standard count variable. The probability function is given by

$$f(y_i) = \begin{cases} \omega_i + (1-\omega_i)g(y_i = 0) & \text{if } y = 0 \ , \\ (1-\omega_i)g(y_i \mid y_i > 0) & \text{if } y \geq 1, \end{cases}$$

where, for instance, ω_i can be a logit and $g(y_i)$ a NB density. In our application, the binary process reflects the economic suitability of a municipality for hosting a foreign MNE at all, and the conditional mean of the count process describes the number of foreign-owned firms that are actually attracted given a municipality's general suitability for foreign MNE location.

Such models (including Poisson, NB, and ZI versions thereof) can be estimated by the maximum likelihood method. Both the NB model and the ZI-NB model assume that business tax rates are exogenous. If the average municipality altered business tax rates to attract foreign MNEs, assuming exogeneity could be hardly tenable.[26] Mullahy (1997) derives moment conditions for generalized method of moments (GMM) estimation of count data models with endogenous regressors and valid instruments. We use Mullahy's approach with cross-sectional data under the assumption of endogenous tax rates.

1.5.2 Fixed effects panel data models

Eventually, one might doubt the possibility to circumvent the endogeneity problem in a cross section at all. In particular, one could push things further and assume that any information contained in the stock of legally independent foreign-owned firms hosted in a municipality could lead to endogeneity. Focusing on *new* headquarters could help reducing the endogeneity bias in tax rates significantly. For this, we resort to fixed effects panel data analysis. The corresponding models for municipality i in year t about outcome y_{it} may

[26] Notice that this is more than to say that municipalities use business tax rates to attract firms in general. In our application, the average municipality is not able to attract any foreign MNEs. This may be seen as an indication that the attraction of such firms is not the most important (or even an impossible) policy objective of the average German municipality. Hence, we expect the endogeneity issue as subordinate, here. However, we mention and apply suitable methods for completeness and as a robustness check to the conventional count data models.

be characterized as

$$y_{it} = x_{it}\beta + \mu_i + u_{it} \tag{1.1}$$

where i is an index for municipalities, $t = 1, ...T$ is an index for time with $T = 5$ denoting the number of years our panel covers (2001-2005), x_{it} is a $1 \times K$ vector of explanatory variables (one of them being TAX_{it} or, alternatively, $FATAX_{it}$), β is a corresponding $K \times 1$ parameter vector, μ_i is a fixed municipality-specific effect, and u_{it} is a time-variant idiosyncratic disturbance term.[27]

Fixed effects estimation of (1.1) identifies the parameter vector β by exploiting the time variation in y_{it}. In general, the model in (1.1) will be based only on municipalities for which $y_{it} \neq y_{is}$ at least for one tuple t, s. Furthermore, fixed effects estimation of (1.1) is immune against correlation of the elements in x_{it} with $\mu_i + u_{it}$ as long as this correlation involves only μ_i but not u_{it}. Hence, that model reduces problems of endogeneity of TAX_{it} or $FATAX_{it}$ by allowing time-invariant unobserved heterogeneity to be correlated with the tax variables.

While some of the panel data regressions involve the strictly nonnegative y_{it} as dependent variable, others will be based upon $\ln y_{it}$.[28] In the former case, the number of covered observations will be much larger than in the latter

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[27] In principal, fixed effects model estimation is possible with nonlinear models such as Poisson, NB, or ZI versions thereof. However, it turns out that pooling cross-section and time-series data in a short panel such as ours leads to convergence problems with maximum likelihood estimation. Since we are mostly interested in conditional means, we therefore employ linear models and truncated models with sample selection in this case.

[28] In our context the problem of a large mass of zeros in the data is greatly reduced for estimation of β in models involving $\ln y_{it}$ instead of y_{it}.

case. The parameters are not directly comparable between models using y_{it} and those using $\ln y_{it}$. In the latter case, the parameters on TAX_{it} and $FATAX_{it}$ are semi-elasticities,[29] while in the former case they are not.[30] In any case, log-transformation of y_{it} leads to a truncated sample about which – given that the number of zeros in y_{it} is relatively large – the assumption of random selection of municipalities into positive numbers of foreign-owned firms may be called into question.

Although the bias associated with either sample selection or endogeneity of TAX_{it} or $FATAX_{it}$ is mitigated to some extent by fixed effects estimation of (1.1), it is unlikely fully removed. For this reason, for models with y_{it} as dependent variables, we estimate a fixed effects two-stage least squares model assuming that TAX_{it} or $FATAX_{it}$ is correlated with u_{it} (see Baltagi, 2008). When using a truncated sample in models which involve $\ln y_{it}$ instead of y_{it}, we follow an established literature in econometrics that model *participation* (the process of $y_{it} = 0$ versus $y_{it} > 0$) and *outcome* (the process of $y_{it} > 0$) by a bivariate model (see Wooldridge, 2002, or Cameron and Trivedi, 1998, for an overview).[31] Specifically, we follow the approach of Wooldridge (1995) as adapted for endogenous regressors by Semykina and Wooldridge (2005) to account for endogeneity of TAX_{it} or $FATAX_{it}$ in the fixed effects model (1.1) based on $\ln y_{it}$.

[29] Then, a one-percentage-point change in the tax rate induces a one-hundredth change in $\ln y_{it}$.

[30] Then, a one-percentage-point change in the tax rate induces a one-hundredth change in y_{it}.

[31] An alternative to a selection model which rests on somewhat stronger assumptions would be a two-part approach which models zero-versus-positive y_{it} and positive y_{it} as two independent processes.

1.6 Empirical analysis

In this section, we will analyze the determinants of the location of foreign-owned firms across municipalities in Germany. We will primarily focus on numbers of such firms per municipality as an outcome in cross section and fixed effects panel data regressions. However, in an extension we will consider other outcomes such as employment or fixed assets of foreign-owned firms.

1.6.1 Cross section models

We start by estimating models on the cross-sectional data-set and assume that the matrix of explanatory variables includes – apart from TAX or $FATAX$ – the following variables: $SKILL$ (the log share of employees with a tertiary education), $POPDEN$ (the log population density), $AREA$ (the log total area of the municipality in square kilometers), $IDEPRAT$ (the log independency ratio, defined as the population aged 15-64 divided by the total population), $BUILT$ (the log fraction of area in a municipality which is covered by buildings and streets), INV (the log share of investment expenditures of the municipality in total expenditures), $LPRICE$ (the log land price per square meter in Euro), and $EAST$ (a dummy for municipalities located in the New Länder, i.e., in the former Eastern German part of the country). While Table 1.2 provides summary statistics for the covariates included in the analysis across all years 2001-2005, the ones for the cross section of 2005 as used in this subsection are very similar.

Table 1.2: Dependent and explanatory variables

Variable	Description	Mean	Std. dev.
No. FO firms (S)	stock of foreign-owned firms in municipality i as of 2005	0.772	10.211
No. FO firms (N)	number of new foreign-owned firms in municipality i in year t *(all)*	0.072	1.076
Smallest 50% FO firms (S)	stock of foreign-owned firms with below-median employment in municipality i as of 2005	0.337	5.524
Smallest 50% FO firms (N)	number of new foreign-owned firms with below-median employment in municipality i in year t *(all)*	0.039	0.751
Tax Credit FO firms (S)	stock of foreign-owned firms from countries granting foreign tax-credit in municipality i as of 2005	0.193	2.909
Tax Credit FO firms (N)	number of new foreign-owned firms from countries granting foreign tax-credit in municipality i in year t *(all)*	0.015	0.266
No. non-holding (S)	stock of foreign-owned firms in municipality i as of 2005 *(excluding holdings)*	0.640	8.257
No. non-holding (N)	number of new foreign-owned firms in municipality i in year t *(excluding holdings)*	0.059	0.886
No. direct non-holding (S)	stock of *directly-held* foreign-owned firms in municipality as of 2005 *(excluding holdings)*	0.308	3.958
No. direct non-holding (N)	number of new *directly-held* foreign-owned firms in municipality i in year t *(excluding holdings)*	0.015	0.235
Employees (S)	stock of employees of foreign-owned firms in municipality i as of 2005 *(all)*	156.537	2275.445
Employees (N)	employees of new foreign-owned firms in municipality i in year t *(all)*	15.324	577.520
Fixed assets (S)	stock of fixed and intangible assets of foreign-owned firms in municipality i in year t *(all)*	121.379	2162.542
Fixed assets (N)	fixed and intangible assets of new foreign-owned firms in municipality i in year t *(all)*	13.626	462.454
TAX	statutory business tax rate in year $t-1$	0.142	0.012
FATAX	average formula-apportioned business tax rate in year $t-1$	0.142	0.012
SKILL	ln (share of employees with tertiary education) in year $t-1$	−2.985	0.475
POPDEN	ln (total population / total area) in year $t-1$	0.169	0.942
AREA	ln (total area) in year $t-1$	7.425	1.030
IDEPRAT	ln (population aged 15-65 / total population) in year t-1	−0.411	0.051
BUILT	ln (area covered with buildings and streets / total area) in year $t-1$	−2.262	0.529
INV	ln (investment expenditure / total expenditure) in year $t-1$	−1.911	0.836
LPRICE	ln (land price in Euro per m^2) in year $t-1$	3.863	0.822
EAST	Dummy for East Germany	0.261	0.439

Notes: Panel of 11,200 municipalities with at least two consecutive observations over the period 2001-2005. *Fixed assets* in 100,000 Euro.

We generally use once-lagged values of the explanatory variables in the econometric models. Hence, we employ values for 2004 on the right-hand side of all cross-section models. This is to avoid any bias associated with contemporaneous shocks in the dependent and the explanatory variables. Since all explanatory variables except for TAX or $FATAX$ and $EAST$ are in logs, all but those variables' parameters can be interpreted as elasticities. Table 1.3 summarizes the corresponding regression results.

The numbers in Table 1.3 indicate that the over-dispersion parameter is significantly different from zero. Hence, the negative binomial model is better suited for the data and specification at hand than the Poisson model (see Winkelmann, 2003; and Cameron and Trivedi, 1998). With the fairly large fraction of zeros in the dependent variable, a separate modeling of the zero threshold is recommended.

Regarding the covariates, we find that larger municipalities ($AREA$) with a greater population density ($POPDEN$), a higher skill endowment ratio ($SKILL$), and a larger fraction of infrastructure ($BUILT$) are more successful in attracting foreign MNEs. These effects are consistent with predictions from the theoretical literature on MNE location (Carr, Markusen, and Maskus, 2001; Markusen, 2002; Markusen and Maskus, 2002; Barba Navaretti and Venables, 2004). Given everything else, German municipalities in the *Old Länder* are more successful in attracting foreign MNEs than municipalities in the *New Länder* (East). In contrast to our expectations, land prices ($LPRICE$) and MNE activity are positively correlated. This could be interpreted in two ways: $LPRICE$ could reflect the quality of infrastructure, which we do not have good controls for; or $LPRICE$ is endogenous to foreign MNE location. However, the latter is not quite likely, since the average exposure of municipalities to foreign-owned firms is quite low. Other covariates except tax rates do not display an important impact on foreign MNE location.[32]

[32] One might add spatially lagged control variables to the models estimated. However, this strategy leads to convergence problems in the nonlinear cross section models, arguably due to multicollinearity with the tax rates (tax rates are a function of spatially lagged exogenous variables in nonlinear tax competition models such as ours), and they would be

Table 1.3: CROSS SECTION 2005

	Negative Binomial		Zero-Inflated Negative Binomial		IV Poisson	
	No. FO firms (S)		*No. FO firms (S)*		*No. FO firms (S)*	
TAX	-12.893***	-	-6.825**	-	-59.738***	-
	(2.407)		(2.730)		(22.273)	
FATAX	-	-6.522**	-	-5.465*	-	-49.220***
		(2.510)		(3.253)		(23.590)
SKILL	0.588***	0.590***	0.730***	0.739***	0.643***	0.511***
	(0.067)	(0.067)	(0.081)	(0.081)	(0.219)	(0.164)
POPDEN	0.879***	0.816***	0.269**	0.242*	0.693***	0.597***
	(0.104)	(0.103)	(0.122)	(0.125)	(0.239)	(0.225)
AREA	1.190***	1.154***	0.792***	0.761***	1.507***	1.517***
	(0.033)	(0.033)	(0.049)	(0.045)	(0.131)	(0.136)
IDEPRAT	1.192	1.199	1.128	1.030	-3.717	-3.468
	(0.868)	(0.886)	(1.189)	(1.191)	(2.865)	(2.726)
BUILT	0.959***	1.003***	1.060***	1.076***	1.849***	2.024***
	(0.169)	(0.170)	(0.178)	(0.180)	(0.304)	(0.294)
INV	0.324	0.049	-0.042	-0.040	-0.040	-0.006
	(0.045)	(0.045)	(0.054)	(0.054)	(0.147)	(0.141)
LPRICE	0.298***	0.320***	0.314***	0.319***	0.240	0.396**
	(0.051)	(0.052)	(0.054)	(0.054)	(0.192)	(0.154)
EAST	-0.500***	-0.465***	-0.968***	-0.952***	0.384	0.513
	(0.126)	(0.128)	(0.133)	(0.134)	(0.431)	(0.408)
constant	-6.384***	-6.927***	-2.488***	-2.399***	-1.929	-3.914
	(0.730)	(0.738)	(0.766)	(0.797)	(3.353)	(3.355)
Wald	4,712.880	4,566.290	1,601.590	1,663.300		
p-value	0.000	0.000	0.000	0.000		
Log-likelihood	-5,379.003	-5,437.092	-5,255.841	-5,259.002		
Observations	11,048	11,048	11,048	11,048	11,048	11,048
Nonzero obs.	1,559	1,559	1,559	1,559	1,559	1,559

Notes: Table shows coefficient estimates of the respective regression models. Robust standard errors reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively. All explanatory variables are lagged once. In columns 5 and 6, *TAX* and *FATAX* instrumented. The instruments used are the averages of the share of area covered with buildings and streets, the share of agricultural area, and the total area (all in logs) for (i) all municipalities within a radius of 0 and 25 kilometers from the center of a given municipality and for (ii) all municipalities within a radius of 25 and 50 km from the center of a given municipality. The lower part of the table reports the Wald (χ^2) test statistic for joint significance of the regressors and its p-value, the pseudo log-likelihood, the number of observations, and the number of groups (municipalities).

In all models of Table 1.3, TAX and $FATAX$ exert a negative impact on the outcome. Hence, controlling for the suggested determinants of foreign MNE location eliminates a large part of the bias in the unconditional relationships portrayed in Figures 1.3. In Table 1.3, the estimated parameter of interest is unambiguously statistically significantly different from zero at least at 10% conventional levels. In the zero-inflated negative binomial model, the parameter estimates on TAX and $FATAX$ are lower than in the simple negative binomial models. However, this should be interpreted with care, since now extra weight is given to zero outcomes relative to the simple negative binomial models. However, the parameters on TAX and $FATAX$ differ in both the negative binomial and the corresponding IV Poisson models.[33] In every one of the estimated models in Table 1.3 is the parameter on $FATAX$ lower than its counterpart on TAX. This could be consistent with a lower inclination of foreign-owned firms to have a multi-plant organization across municipalities in Germany than this is the case for average German firms.

Among the cross section models, we consider the IV Poisson model to be the preferred approach, since it addresses the potential endogeneity of business tax rates.[34] With univariate models assuming an exogeneity of tax rates,

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insignificant in the fixed effects panel data models.

[33]The identifying instruments behind the reduced-form models used for TAX and $FATAX$ are the averages of the share of area covered with buildings and streets, the share of agricultural area, and the total area (all in logs) for (i) all municipalities within a radius of 0 and 25 kilometers from the center of a given municipality and for (ii) all municipalities within a radius of 25 and 50 km from the center of a given municipality. They are individually and jointly significant at the one percent level in all first-stage models. This is not surprising, since what we estimate there is a reduced-form version of a tax competition model which is known to work well at the national and sub-national level.

[34]We are not aware of IV versions of the NB and ZI-NB models, hence we only present

one might expect that the estimated responsiveness of outcomes to tax rates overestimates the true causal impact. For instance, this would be the case, if municipalities competed over MNEs via low tax rates, and MNEs successfully lobbied for low tax rates in a municipality which they would have picked anyway for reasons other than local taxes. However, the direction of the endogeneity bias is generally unclear in a multivariate setting as ours. With the data and specifications at hand, the point estimates suggest that the tax responsiveness is biased towards some positive value in models assuming exogeneity of tax rates in Table 1.3.

How big is the impact of business tax rates on outcomes? For this, consider a one-percentage-point change in TAX of the negative binomial model. Such a change induces an outcome response by about 12%. The unconditional mean of the number of affiliates is 0.772. Of that, 12% is about 0.09. Hence, the average municipality would have to reduce its tax rate by about 11 (of an average level of 14) percentage points to attract a single foreign-owned firm. The IV Poisson model suggests that MNEs are somewhat more responsive than that. There, a one-percentage-point reduction in TAX raises the stock of MNEs by about 60 percent, i.e., by 0.45 legally independent foreign-owned firms. Hence, the average municipality would have to reduce its business tax rate by about 2.2 percentage points (or 15%) from its average level.[35] From

IV Poisson models.

[35]Notice that such a municipality would (so far) earn all of its business tax revenues from domestic firms. Hence, it would have to forego 15% of its tax revenues from such firms in exchange for additional tax revenues of a single foreign-owned unit. Later on, we will provide estimates suggesting that a 2.2 percentage-point reduction in the business tax rate would raise employment in foreign-owned firms by less than 157. Hence, the tax revenue loss from domestic firms would unlikely balance the tax revenue gains from the one

that perspective, it seems remarkably difficult for the average municipality to attract foreign firms. However, this is consistent with the fact that most municipalities indeed do not attract foreign MNEs at all.

1.6.2 Fixed effects panel models

We start by estimating linear models on the panel data-set involving outcomes in levels, y_{it}, as well as sample selection models as proposed by Semykina and Wooldridge (2005) involving $\ln y_{it}$ as the dependent variable. The former avoids dropping zero values of the outcome while the latter controls for selection and truncation. With y_{it} as the dependent variable, the parameters of log-transformed variables represent the impact of a unitary log-change on the level of the outcome. With $\ln y_{it}$ such parameters represent elasticities.[36] We are primarily interested in the impact of business tax rates (TAX or $FATAX$) on outcomes. These tax rates are measured as ratios. Hence, a one-percentage point increase in TAX or $FATAX$ leads to a response of y_{it} by one-hundredth of the parameter value and to one of $\ln y_{it}$ by one percent (a semi-elasticity). Table 1.4 summarizes the results for the two linear and the sample selection panel data models using the numbers of foreign-owned firms per municipality in y_{it} and $\ln y_{it}$.

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new foreign-owned firm, even when assuming that there is no substitution in employment between foreign-owned and domestic firms.

[36]Since inverse Mills ratios are not significantly different from zero, we may refrain from discussing issues with the nonlinearity of selection models and the corresponding nonlinearity of marginal effects. Rather, we may interpret the parameter in the outcome equation as to directly reflect the impact of TAX or $FATAX$ on the conditional mean of the outcome of interest.

Table 1.4: PANEL 2001-2005

	Fixed-effects IV *No. FO firms (N)*		Sample selection IV *ln(No. FO firms (N))*	
TAX	-19.490*	-	-227.784***	-
	(11.016)		(83.183)	
FATAX	-	-21.591	-	-62.021**
		(13.172)		(24.605)
SKILL	-3.5e-04	4.1e-04	0.590**	0.149
	(0.018)	(0.018)	(0.306)	(0.200)
POPDEN	-0.027	-0.042	-3.239	-1.863
	(0.145)	(0.146)	(2.267)	(1.366)
IDEPRAT	-0.032	-0.022	-10.961*	-7.534
	(0.249)	(0.250)	(6.218)	(5.096)
BUILT	-0.024	-0.020	2.712**	0.837
	(0.081)	(0.082)	(1.285)	(1.026)
INV	-1.6e-04	-1.3e-04	-0.088	-0.053
	(0.005)	(0.005)	(0.104)	(0.069)
LPRICE	-0.006	-0.006	0.112	-0.034
	(0.014)	(0.014)	(0.159)	(0.096)
IMR			-0.046	0.165
			(0.566)	(0.366)
Wald	860.880	848.390	84.620	139.910
p-value	0.000	0.000	0.000	0.000
Sargan-Hansen	5.841	6.141	0.946	2.069
p-value	0.119	0.105	0.814	0.558
Observations	39,124	39,124	941	941
Groups	11,200	11,200	680	680

Notes: Table shows coefficient estimates of the respective regression models. *TAX* and *FATAX* are instrumented. The instruments used are the averages of the share of area covered with buildings and streets, the share of agricultural area, the independency ratio, and the skilled labor share (all in logs) for all municipalities within a radius of 25 and 50 km from the center of a given municipality. *IMR* is the inverse Mills ratio from a pooled probit model for the probability of the dependent variable being positive, results upon request. The probit model includes the share of agricultural area of the municipality as an instrument that affects selection. All regressions include time dummies. Standard errors reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively. All explanatory variables are lagged once. The lower part of the table reports the Wald (χ^2) test statistic for joint significance of the regressors and its p-value, the Sargan-Hansen statistic for the null hypothesis of validity of the excluded instruments and its p-value, the number of observations, and the number of groups (municipalities).

All second-stage models involve – apart from TAX (the simple business tax rate) or $FATAX$ (the formula-apportioned business tax rate) – the following explanatory variables: $SKILL$ (the log share of employees with a tertiary education), $POPDEN$ (the log population density), $AREA$ (the log total area of the municipality in square kilometers), $IDEPRAT$ (the log independency ratio, defined as the population aged 15-64 divided by the total population), $BUILT$ (the log fraction of area in a municipality which is covered by buildings and streets), INV (the log share of investment expenditures of the municipality in total expenditures), and $LPRICE$ (the land price per square meter in Euro). Mean and standard deviation for these as well as the outcome variables are provided in Table 1.2.

The regressors in these models display a high level of joint significance. The identifying instruments behind the reduced-form models used for TAX and $FATAX$[37] are individually (except for the weighted share of buildings) and jointly significant at less than one percent in any first-stage model. The reported over-identification tests do not reject the null hypothesis that the instruments are valid.[38]

The numbers in Table 1.4 suggest the following results. First, recall that the data underlying these models pertain to new locations of foreign-owned

[37] The instruments used are the averages of the share of area covered with buildings and streets, the share of agricultural area, the independency ratio, and the skilled labor share (all in logs) for all municipalities within a radius of 25 and 50 km from the center of a given municipality. In the sample selection model we include the share of agricultural area of the municipality in the selection equation.

[38] That is, that the excluded instruments are uncorrelated with the error term and correctly excluded from the estimated equation.

firms and they wipe out all time-constant factors (e.g., that a municipality is regularly able to attract such firms for measurable or unmeasurable reasons). As a consequence, this renders most of the independent variables insignificant for such location decisions from year to year across municipalities. However, this radical strategy is capable of reducing the bias from endogeneity of TAX and $FATAX$ to a minimum. This is true for numbers of affiliates as well as numbers of employees.

The covariates are not only insignificant because the between variation is wiped out and they do not vary much over time. There is also some multicollinearity, since the covariates (after conditioning out the fixed effects) have a jointly highly significant impact on outcome y_{it} and $\ln y_{it}$. Interestingly, the variation in TAX and $FATAX$ is different enough from the other regressors to exhibit a significant effect in all models. The reason for the latter is that these variables do not change continuously and gradually as $SKILL$, $LPRICE$ or other regressors, which facilitates identification of their effect on the outcome.

The panel data models do not suggest any qualitative change in the impact of tax rates on location choice of foreign firms within Germany, relative to the cross-section models. How does the quantitative impact of tax rates compare with the cross-section results? For this, it is easiest to use the parameters in the first column of Table 1.4, since the selection models are nonlinear in nature and the inverse Mills ratio terms are insignificant (suggesting that selection is not important). According to the first column of Table 1.4, if a municipality wanted to attract one additional MNE, it would have to lower its tax rate by about $19.490^{-1} \simeq 5$ percentage points or more than one-third of the average level of TAX in the sample. This is about twice as much as the effect estimated from the IV Poisson model in Table 1.3. However, the cross-section IV Poisson results may be viewed as responses that pertain to the long run where we could expect MNEs to display a greater response to tax rates than from year to year.

1.6.3 Sensitivity and extensions

In this subsection, we summarize the effects from a variety of alternative regressions. In particular, we use models for alternative types of MNEs (small versus large units; firms which are held in countries with a tax credit system versus all firms; non-holding and directly-held non-holding units instead of all types of MNEs combined) as well as models with alternative outcomes. To keep the discussion as short as possible, we only summarize the corresponding coefficients on TAX and $FATAX$ in Table 1.5.

Table 1.5: Alternative Outcomes

Cross Section IV	*Smallest 50% FO firms (S)*	*Tax Credit country's FO firms (S)*	*No. non-holding (S)*	*No. directly-held non-holding (S)*	*Employment (S)*	*Fixed assets (S)*
TAX	-81.361***	-87.765	-23.492	-22.834	-71.172***	-28.563
	(28.795)	(66.420)	(22.876)	(21.287)	(23.990)	(25.455)
FATAX	-60.023**	12.401	-8.949	-20.012	-45.820	-26.620
	(27.047)	(71.024)	(22.712)	(25.148)	(32.688)	(25.645)
Observations	11,048	11,048	11,048	11,048	11,048	11,048
Nonzero obs.	906	588	1,529	1,015	1,559	1,530
Panel IV sample selection	*Smallest 50% FO firms (N)*	*Tax Credit country's FO firms (N)*	*No. non-holding (N)*	*No. directly-held non-holding (N)*	*Employment (N)*	*Fixed assets (N)*
TAX	-217.268**	-383.695	-263.948**	-166.897**	-583.606***	-816.803**
	(98.718)	(268.915)	(117.154)	(72.608)	(166.561)	(335.331)
FATAX	-166.549***	-219.198*	-67.327***	-187.444**	-98.431*	-84.770
	(61.117)	(123.731)	(22.561)	(92.964)	(60.481)	(71.818)
Observations	324	272	903	317	941	908
Groups	258	217	657	261	680	661

Notes: Table shows coefficient estimates of the respective regression models. *TAX* and *FATAX* instrumented. The instruments used are the averages of the share of area covered with buildings and streets, the share of agricultural area, the independency ratio, and the skilled labor share (all in logs) for (i) all municipalities within a radius of 0 and 25 kilometers from the center of a given municipality and for (ii) all municipalities within a radius of 25 and 50 km from the center of a given municipality. The cross-sectional results for the directly-held non-holding are based on a two-part model approach due to an excessive number of zeros. All panel regressions include time dummies. Standard errors reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively. All explanatory variables are lagged once.

The upper panel of Table 1.5 pertains to cross section estimates so that coefficients should be compared to the last pair of columns in Table 1.3, while the lower panel of Table 1.5 refers to panel data estimates and should be compared to the last two columns in Table 1.4. The six columns refer to six types of sensitivity checks. The first four columns reflect parameter estimates for sub-samples of different MNE types, namely units with below-median employment in the sample, units which are held in countries applying a tax credit system, non-holding units, and directly-held non-holding units. As in the previous tables, the outcome variable in these columns is a count of foreign MNEs of the specific type in a municipality.

The last two columns display tax parameter estimates for two alternative outcomes, namely employment and fixed assets. Akin to the counts, we use Poisson-type models for these outcomes in the cross section estimates to avoid dropping zeros from the data. However, now these models are pseudo-maximum-likelihood models. Again, we use selection models with panel data, but the results are very similar to the ones of Poisson pseudo-maximum likelihood models due to the lack of important correlation between the latent process underlying the extensive municipality margin equation of inward investment in Germany and the intensive margin model.

The figures in Table 1.5 suggest the following conclusions. First, the point estimates of the tax parameters are in almost all cases negative. The qualitative insights from the models focusing on firms with below-median employment are unchanged from the previous estimates.[39] The results for firms which are

[39]Notice that the parameters should not be directly compared to the earlier estimates

held in tax credit countries are much less clear-cut than those for all firms. One reason for that is that there are only 16 economies which unilaterally apply a tax credit system and hold firms in Germany. Hence, there is a considerably smaller fraction of municipalities with a positive foreign-owned firm count in comparison to the original estimates. Moreover, following Hines (1996) we would expect that firms originating from such countries should be less sensitive to foreign taxation than others.

The point estimates for the number of foreign-owned non-holding and directly-held non-holding units in the cross section are not significantly different from zero. Yet, the point estimates are somewhat smaller but also not significantly different from the ones based on the sample of all firms in the last pair of columns of Table 1.3. The main reason for their insignificance relates to the drop in the number of observations with positive outcomes so that these models are harder to estimate than the ones in Table 1.3. When considering panel data estimates in the lower panel of Table 1.5, we find, e.g., that the parameter estimates for non-holding companies are quite similar to their counterparts in the last two columns of Table 1.4. The point estimates differ slightly more (but not statistically so) when using directly-held non-holding units with panel data.

Similar to counts of firms, the point estimates for employment and fixed assets for all types of MNEs are negative. However, only the one for employment when using TAX is estimated significantly different from zero in the cross section. With panel data, the effects of business taxation on employ-

since the average number of such firms per municipality is much smaller than before.

ment or fixed assets are better identifiable.

With the exception of the number of directly-held non-holding units as outcome, the point estimates of $FATAX$ are smaller in absolute value than the ones of TAX. The latter may indicate that a municipality's own tax may be more important for the location decision even of multi-plant firms than the one of other locations where units are based. This may be rationalized as follows. First, we can expect foreign firms to typically enter the German market with one unit and, eventually, to start forming a local tree of units from that first location so that mainly the first location's tax rate and less so those of the branches are relevant for the location of legally independent foreign-owned firms.[40] Second, legally independent foreign-owned firms often carry out important tasks and services not only for them but also for legally dependent branches. Such tasks tend to involve high-skilled labor and sizable wage bills so that the weight of independent units through formula apportionment may be relatively high. Then, the business tax rate at the location of an independent unit should be relatively important independent of whether it is a stand-alone unit or it has independent subsidiaries attached to it.

One further extension would be to shed light on the variability of the estimated tax (semi-)elasticities with observable determinants such as municipality size, population density, or other determinants of MNE location. This could be achieved by including interaction terms of business tax rates and

[40]MNEs tend to set up one affiliate at a time (see Egger, Fahn, Merlo, and Wamser, 2011). The unit by which firms explore a market upfront may likely develop the function of a regional headquarter in the course of the development of a bigger foreign affiliate network.

other fundamentals. We have attempted to shed light on this matter by involving municipality area and, alternatively, population density in interaction terms with TAX or FATAX. However, we encountered two problems with this strategy. First, interaction terms between business tax rates and other covariates are highly correlated with the main effects of the interacted variables since the latter tend to vary more strongly than business tax rates do (see Table 1.1). Second, interaction terms which involve an endogenous variable (such as business tax rates) are endogenous as is the main effect of TAX or FATAX. Hence, the number of endogenous variables which have to be instrumented in a first stage increases. Both issues lead to a dramatic loss of precision so that neither the parameter on the main effect of TAX or FATAX nor the one on the interactive term can be estimated at conventionally accepted significance levels.

1.6.4 Estimated tax effects in comparison to other work

Two fundamental differences between this paper and other work on profit tax effects on MNE activity are the following. First, we focus on location decisions or activity at the micro-regional level rather than the country or macro-regional (such as state) level. Second, we mainly focus on the extensive margin of activity in terms of numbers of firms that are held by foreign MNEs rather than foreign direct investment.

By and large, the descriptive statistics and estimates provided in this paper suggest that micro-regional units such as municipalities have to reduce tax rates on profits much more dramatically to be able to attract any foreign-owned firms than estimates at the country (see Hines, 1999; de Mooij and Ederveen, 2003, 2006, 2008, for an overview) or even the macro-regional level (see Slemrod, 1990; Hines, 1996) would suggest. Aggregate bilateral FDI activity of MNEs is known to display a semi-elasticity of between -1 and -3.5 according to the aforementioned work. Elasticities estimated from subnational macro-regional data are higher than those obtained at the aggregate level (see Slemrod, 1990; Hines, 1996, for examples and de Mooij and Ederveen, 2003, for pointing to this fact). In comparison to both country-level and macro-regional work, the estimated business tax elasticities on foreign investments in this paper are relatively high.

However, using regional data with a finer granularity unveils that there is an enormous heterogeneity in regional entities with regard to their ability to attract foreign firms, which display a very high degree of subnational spatial concentration. In spite of the high estimated tax elasticity, most German municipalities would have to reduce their business tax rates for the sake of attracting only a single foreign firm to an extent that does not seem financially viable. The latter suggests that tax competition for lumpy investments is a game for a small number of municipalities. Our findings indicate that a marginal reduction of business tax rates in the average municipality is not enough to attract foreign MNEs. Municipality size and the availability of workers, especially skilled workers, are important. Only those municipalities which have a sufficiently attractive non-tax environment for foreign MNEs will be able to attract such firms by reasonable reductions in their tax rates. Municipalities with less favorable non-tax environments would have to trade these off with unrealistically large reductions in the business tax rate. For instance, the IV Poisson estimates in Table 1.3 imply that a one-percent reduction in business tax rates increases the number of foreign-owned firms in a region by about 0.45. Hence, the preferred model indicates that the average municipality has to reduce its tax rate by about 15% (or 2.2 percentage points) to attract a single such firm. The average municipality may not want to do so, since the associated losses in tax income from national firms may easily outweigh the expected raise of tax income collected from the foreign MNE.

The elasticities on employees and fixed assets in the upper block of Table 1.5 suggest that a 2.2 percentage-point reduction of the tax rate would raise employment in foreign-owned firms by about 157 and fixed assets by about 6.28 million Euro. For the average municipality not hosting a foreign-owned firm prior to the reduction of the tax rate, these figures would represent the stock of employees and fixed assets of foreign-owned firms after the tax reduction.

Suppose one would apply estimates of tax semi-elasticities (on FDI) as found in country-level or macro-regional work in the literature, say, of -3.3 as in de Mooij and Ederveen (2003) in order to predict numbers of foreign MNEs in Germany. Recall that the corresponding semi-elasticity was about -60 in the IV Poisson model. Then, a municipality would have to lower its business tax rate by almost 40 percentage points or about 280% (i.e., way below zero; corresponding to a business tax subsidy) in order to attract a single foreign-owned firm. Even when applying this concept to fixed assets rather than firm number counts, such an exercise clearly suggests that semi-elasticities which are relatively robust across country-samples, time, and methods applied are not applicable when considering micro-regional location decisions of foreign-owned firms.

1.7 Concluding remarks

This paper provides evidence on the impact of profit taxation for the location of foreign-owned firms using data for more than $11,000$ German municipalities. We link data on local public finance and other municipality characteristics available from the German Statistical Office and the Federal Employment Agency with firm-level data from the German Central Bank about inbound foreign direct investments in Germany for the years 2001-2005.

One advantage of this data-set is that institutional characteristics and the taxation of other factors are much more homogeneous across municipalities *within* a country than in cross-country studies. Moreover, the number of municipalities foreign MNEs may locate in is larger by more than one order of magnitude than the number of countries for which profit taxes are typically available. So, the impact of profit taxes on the location of legally independent foreign-owned firms may be identified much more precisely than in an international context.

Overall, we find that the business tax rate levied by a municipality negatively affects the number of MNEs it can attract as well as their employment and fixed assets invested. This impact is found after controlling for other important determinants of a foreign MNE's location decision. Irrespective of whether we assume that business tax rates are endogenous or not, the elasticities of numbers and magnitudes of investments to business tax rates are reasonably high. As a matter of fact, the average German municipality was not able to attract any legally independent foreign-owned firm at all over the years covered by our data. Such a municipality would have to lower its business tax rate by about 15 percent (or 2.2 percentage points) to lure only one foreign MNE into its jurisdiction, according to our results. It is very likely that the associated gains in taxes collected from the foreign MNE would be lower than the losses the average municipality encountered from foregone business tax revenues collected from national enterprises.

Obviously, most municipalities do not find this attractive, since foreign capital is not the only important profit tax base to consider. However, larger municipalities with an abundant workforce, especially of skilled workers, may attract foreign MNEs by much smaller changes in their tax rates. Implicitly, these results suggest that municipalities with generally favorable environments for firm location should be able to use their tax rates more successfully to attract foreign MNEs than those with less favorable environments.

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Chapter 2

BITs Bite: An Anatomy of the Impact of Bilateral Investment Treaties on Multinational Firms

Abstract*

Bilateral investment treaties (BITs) are one of the few policy instruments countries can use to directly attract foreign investment. Previous research aimed at a quantification of the impact of BITs on foreign direct investment at aggregated levels only. By contrast, this paper delivers an anatomy of BITs' effects on multinational activity at the micro level. We hope that this strategy will improve our understanding of the precise channels through which BITs determine aggregate investment. Using data on the foreign activity of the universe of German multinationals, we provide descriptive evidence on changes in intensive and extensive margins of multinational firm activity around the adoption of BITs. The results of multivariate empirical models broadly support the hypotheses derived from a parsimonious model of heterogeneous firms on the effects of BITs on different margins of investment: BITs raise the number of multinational firms active in a particular host country and have a positive effect on the number of plants per firm, as well as on FDI stocks and fixed assets per firm.

2.1 Introduction

While tax policy and even trade policy are known to have an indirect impact on multinational firms' (MNEs') location decisions, bilateral investment treaties (BITs) constitute an instrument which is directly targeted towards foreign investors. As with other bilateral agreements – such as modern preferential trade agreements or environmental agreements – the cradle of BITs lies in the 1950s: the first BIT was adopted in 1959 between Germany and

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Pakistan.[1] Since then, BITs have been signed and ratified seemingly at an exponential rate of growth which has not yet come to a halt: UNCTAD (2000, p. 1) reports the number of BITs to be 165 by the end of 1979 and 1,857 at the end of 1999; almost 2,500 BITs have been concluded until the end of 2005 (UNCTAD, 2006), in 2006 – on average – more than one BIT was concluded per week (see Sauvant, 2008), and by the end of 2007 the total number of BITs signed in the past was a stunning 2,608 (UNCTAD, 2008). By June 2007, six countries had adopted 100 BITs or more, and this list was headed by Germany with 135 BITs concluded (see Sachs and Sauvant, 2009a).

The matter of BITs is by now an intensively-studied topic.[2] Yet, practically everything we know about their quantitative impact on the target they aim for – foreign investments – is based on aggregate levels of analysis (see Sauvant and Sachs, 2009b, for an overview and Hallward Driemeier, 2003;

[1] Just one year before that, in 1958, the Treaties of Rome entered into force among the six members of the European Economic Community (EEC), EURATOM, and the European Community on Steal and Coal (ECSC) which were the predecessors of today's European Union (EU). The first multilateral environmental agreement has been concluded in 1960 among 8 countries.

[2] The last years have seen a number of books on BITs and their role for foreign investors (see UNCTAD, 1998, 2000, 2006; Chiswick-Patterson and Sauvant, 2008; Sauvant and Sachs, 2009b). The number of articles in academic journals tells a similar story. A search conducted on March 9, 2010, about the terms *"Bilateral investment treaties"* across all journals and years covered by JSTOR gave 1,545 hits for all disciplines (211 hits for economics only). Most of them pertained to articles published within the last decade. A refined search for an overlap of *"Bilateral investment treaties"* and *"Foreign direct investment"* still gave 1,107 hits in all disciplines. Of those, 164 pertained to economics, 657 to political science, and 198 to law (obviously, these categories are not mutually exclusive). A similar search for such an overlap in Google Scholar even gave 3,080 hits. Even when considering all the problems associated with such crude routines, these numbers are indicative of the broad research interest in the topic.

Egger and Pfaffermayr, 2004; Neumayer and Spess, 2005; Tobin and Rose-Ackerman, 2005; for recent examples).[3]

From a theoretical point of view, bilateral investments of MNEs should increase with the adoption of BITs (see UNCTAD, 2000, 2006; Elkins, Guzman, and Simmons, 2006; and others). According to Sachs and Sauvant (2009a, p. 36-37) the basic purpose of BITs from the perspective of capital-importing countries is to "*help to attract FDI*" while their purpose from the viewpoint of capital-exporting countries is to "*protect investors from political risks and instability and, more generally, safeguard the investments made by its nationals in the territory of the other state.*" Broadly speaking, empirical evidence at the level of bilateral aggregate stocks of foreign investments on the effects of BITs is mixed (see Sauvant and Sachs, 2009b, for an overview). A host of questions related to the detailed effects of BITs on *extensive margins of foreign investment* (e.g., the number of a parent country's firms or plants per host country in response to the adoption of BITs) or *intensive margins of foreign investment* (e.g., the amount of investments or the number of employees per firm) commemorates a gaping hole in the debate about the consequences of BITs for investors and investments.

This paper aims at contributing to the debate by providing micro-level evidence on the effects of BITs on the bilateral activity of MNEs. Among the advantages of a micro-level study of the impact of BITs on MNE activity are

[3]Similar conclusions apply for other bilateral agreements such as tax treaties (see, e.g., Blonigen and Davies (2004), preferential trade agreements (see, e.g., Globerman and Shapiro, 1999; Levi Yeyati, Stein, and Daude, 2003), or environmental agreements (see, e.g., Naughton, 2007).

(i) the possible distinction of effects on the aforementioned various extensive margins of investment and (ii) the opportunity of guarding against heterogeneity across firms and the associated aggregation bias which may conceal possibly countervailing effects of BITs at various margins of firm activity.

We investigate effects of BITs on foreign investments by German firms, using the data-set *Microdatabase Direct Investment* (*MiDi*) provided by the Deutsche Bundesbank.[4] The data-set accounts for all foreign investments of German individuals or companies abroad – by host country and sector – above a certain balance sheet total.[5] Our first goal is to provide descriptive evidence on changes in extensive and intensive margins of investment around events of an adoption of new BITs. In particular, we shed light on such changes with host countries where BITs were adopted and control countries where no BITs had been adopted at the time.

Apart from providing exploratory descriptive evidence, we estimate multivariate empirical models to quantify effects of BITs on various margins of investment. We rationalize the expected results of BITs on the number of firms in a country and on the different outcomes per firm with a parsimonious model of heterogeneous firms. To the extent that BITs reduce firm and plant fixed costs of investing in a particular host country, we should expect BITs to raise the number of MNEs active in that country as well as the number

[4]The German Central Bank. The data-set is made available under strict conditions and for clearly defined academic research purposes and can be used exclusively at Bank's Research Center.

[5]A detailed description of the data and the reporting requirements is found in Section 4.

of plants per firm. The derived hypotheses are broadly supported by the regression results. Signing and ratifying BITs raises the number of firms in the average host country and year in our sample by 26 units. On average, these firms will open only a single plant. The inception of a BIT reduces the fixed costs of investing in a typical host country and year by about 3.7 mn. Euro.

We will proceed by highlighting key features and expected effects of BITs on investment in the next section. In section 2.3 we sketch a simple model of heterogeneous MNEs to illustrate the expected effect of BITs on the number of firms active as well as the number of plants per firm and on sales per firm and host country. Section 2.4 presents the data-set and summarizes the findings from descriptive evidence. In section 2.5 we strive for a quantification of the effects of BITs on *extensive margins of investment* such as numbers of firms, in *intermediate margins of investment* such as the number of sectors firms operate in a particular host country, and in *intensive margins of investment* such as firm size in terms of numbers of plants, foreign direct investments, fixed assets, total assets, or employment. The last section concludes with a summary of the main findings.

2.2 The Aim and Content of BITs

BITs are the main international instrument used to protect and promote investments by nationals or companies of one contracting party in the territory of the other contracting party.[6] By providing protection to foreign investments under international law, BITs reduce the political risks of the foreign investor in the host country and may promote FDI to signatory host countries by improving their investment climate.[7]

Although they vary across countries, all BITs cover four main areas: admission of foreign investments, treatment, expropriation, and dispute settlement. The first BITs signed focused on the *protection* of investments. Only later on BITs started emphasizing the *promotion* of investments, claiming that BITs – through such investments – would increase the *economic development* and *prosperity* of the contracting parties.[8]

BITs stipulate standards of treatment that foreign investments are to receive in the host country. The principal general standards cover fair and equitable treatment, national treatment, and the most favored nation (MFN) standard.[9] BITs also include provisions dealing with the free transfer of

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[6]Past efforts to reach a multinational agreement on investment didn't succeed. For example in the framework of the Havana Charter in 1947 which never entered into force, and in failed negotiations in the 1990s within the OECD. For an account on the history of international investment agreements see Vandevelde (2009).

[7]UNCTAD (1998).

[8]The contracting countries usually state their intentions and objectives in a preamble, which is important for the interpretation of the treaty (e.g., see the preamble of the BIT between Germany and Bangladesh). Recently, the increase in the number of investment disputes led in some cases to the explicit formulation that the promotion and protection of investments should not be sought at the expense of public interests such as health, national security, environment and labor (see UNCTAD 2006, p.3).

[9]For an assessment of each one of those in the context of BITs, see Muchlinski (2009). Most BITs include some exceptions to the MFN standard, excluding privileges granted to third states by virtue of membership in a customs union, a common market or free trade area, or a double taxation agreement.

payments, conditions under which an expropriation is considered lawful, and compensations in case of expropriation, armed conflict, or internal disorder.

Most importantly, BITs include dispute settlement provisions. These ensure the effective implementation and enforcement of the treaty, so as to reduce uncertainty to foreign investors, and *"constitute one of the key elements in diminishing the country risk, and thus encourage investors of one contracting party to invest in the territory of the other"* (UNCTAD, 2006, p.99).

In short, BITs provide transparency with respect to all non-commercial risks investors face when investing abroad, and thus lower the fixed costs of such investments. For example, the right given to investors to initiate arbitral proceedings against a state (one of the most powerful devices of BITs), relieves investors from the need to use that country's domestic courts, and from the related costs that would follow suit.[10]

2.3 Theoretical Background

To illustrate the expected effect of BITs on on various firm margins, we sketch a simple model of heterogeneous firms and associate the conclusion of a BIT with a reduction in the fixed costs of investing in a foreign market.

[10]While arbitration in an international tribunal is costly, those costs are easier to anticipate than the ones related to a dispute at domestic courts of a host country with weak law enforcement and legal institutions.

Assume that households may be characterized by a love of variety and firms generally engage in monopolistic competition. Firms are heterogeneous and differ with regard to their productivity φ_i (as in Melitz, 2003), and the amount of labor needed to produce q units of output is $L_{ij} = \frac{q_{ij}}{\varphi_i} + F_{ij}$, where F_{ij} are fixed costs associated with production in foreign market j. Each monopolist firm faces a demand curve $x_{ij} = p_{ij}^{-\sigma} Y_j P_j^{\sigma-1}$ with constant elasticity σ, where p_{ij} is the price at which the firm sells its output to consumers in country j, and Y_j and P_j are aggregate demand and the consumer price index in the sector firm i operates in at market j. Firms charge the same markup $\frac{\sigma}{\sigma-1}$ over marginal costs, setting the price $p_{ij} = \frac{\sigma}{(\sigma-1)\varphi_i}$, where we normalize the wage rate to one.

Suppose that profits of horizontal MNEs in some parent country may be decomposed additively into the profits across plants ℓ at home and abroad.[11] We assume $F_{ij} = f_\ell n_{ij} + f_j$, where f_ℓ is the cost of setting up a plant in country j, n_{ij} the number of plants firm i has in country j, and f_j are fixed costs of entering foreign market j. Then, firm i makes profits π_{ij} in market j according to

$$\pi_{ij} = p_{ij} x_{ij} - \frac{x_{ij}}{\varphi_i} - f_\ell n_{ij} - f_j. \tag{2.1}$$

With free entry, the marginal firm will earn exactly zero profits with the first

[11] Allowing for more complex integration strategies such as export-platform MNEs (see Ekholm, Forslid, and Markusen, 2007) would unnecessarily complicate the subsequent analysis for our purpose which is primarily to provide empirical evidence on the consequences of BITs for MNEs at the micro level.

plant. Then, the marginal firm's output is determined as

$$\pi_{ij} = 0 \Rightarrow x_{ij}^{\pi=0} = \varphi^*(\sigma - 1)(f_\ell + f_j), \tag{2.2}$$

and is associated with the minimum productivity level φ^* required to enter foreign market j.

Now, assume there is a maximum plant size that can be maintained. Let $\overline{x}_\ell$ denote the maximum plant size and $f_\ell = f_\ell^*$ if $x_{ij} < \overline{x}_\ell$, while $f_\ell = \infty$ if $x_{ij} \geq \overline{x}_\ell$. This assumption establishes the notion of optimal plant size in the most parsimonious way. Also, it is consistent with monitoring costs for plant managers getting excessive beyond a certain plant size. If demand exceeds $\overline{x}_\ell$, the firm has to decide whether to sell $\overline{x}_\ell$ or set up a second affiliate (or several ones) in market j, provided it can cover the fixed costs of the additional plant(s) with the respective sales.[12]

Suppose firm i faces demand of $n_{ij}\overline{x}_\ell > x_{ij} > (n_{ij} - 1)\overline{x}_\ell$ in market j. It will then either operate $(n_{ij} - 1)$ plants and produce $(n_{ij} - 1)\overline{x}_\ell$ units of output or set up n_{ij} plants and produce x_{ij}. In case it sets up $(n_{ij} - 1)$ plants, its profits are

$$\pi_{ij}^{n-1} = (p_{ij} - \frac{1}{\varphi_i})\overline{x}_\ell(n_{ij} - 1) - f_\ell(n_{ij} - 1) - f_j,$$

[12] Unlike in most other models of MNEs (see Markusen, 2002; Barba Navaretti and Venables, 2004), this will lead to MNEs with multiple plants in one market.

and if it sets up n plants, profits become

$$\pi_{ij}^{n} = (p_{ij} - \frac{1}{\varphi_i})x_{ij} - f_\ell n_{ij} - f_j.$$

The corresponding difference in profits amounts to

$$\pi_{ij}^{n} - \pi_{ij}^{n-1} = [x_{ij} - \overline{x}_\ell(n_{ij} - 1)](p_{ij} - \frac{1}{\varphi_i}) - f_\ell. \tag{2.3}$$

Hence, firm i will set up n_{ij} plants in j whenever

$$\pi_{ij}^{n} - \pi_{ij}^{n-1} \geq 0 \Leftrightarrow [x_{ij} - \overline{x}_\ell(n_{ij} - 1)](p_{ij} - \frac{1}{\varphi_i}) \geq f_\ell, \tag{2.4}$$

that is, if the extra revenue achieved by opening the next plant is enough to cover the extra fixed costs associated with it.

Actual supply of firm i with n_{ij} plants in country j in equilibrium will then be

$$\widetilde{x}_{ij} = \begin{cases} (n_{ij} - 1)\overline{x}_\ell + x_\ell & \text{if } \pi_{ij}^{n} - \pi_{ij}^{n-1} \geq 0 \\ n_{ij}\overline{x}_\ell & \text{if } \pi_{ij}^{n+1} - \pi_{ij}^{n} < 0 \end{cases}$$

Where x_ℓ is the output of the last plant, which has not reached its maximum plant size. If the fixed costs of opening the last plant can not be covered, x_ℓ will not be produced and denotes the difference between demand and the actual supply of firm i. Of course, bounded firm size complicates the analysis of models with MNEs (in general and even in partial equilibrium). However, when associating the existence of BITs with a reduction of f_ℓ (and f_j) in such a framework, the above parsimonious framework is helpful to shed light on most of the testable hypotheses investigated below in a straightforward way, without delivering a full-blown analysis of the model in general equilibrium.

2.3.1 Effects of BITs on the Extensive and Intensive Foreign Firm Margin:

Associate the inception of a BIT between the parent country of foreign firm i with a proportional reduction of f_j and f_ℓ and consider the effects on the number of firms in country j (*extensive margin*), and on the number of plants, profits and sales of firm i in country j (*intensive margin*).

Lower market entry costs f_j and plant fixed costs f_ℓ (associated with the inception of a BIT) will reduce the minimum productivity φ^* required to enter foreign market j and, hence, sales of the marginal firm. The marginal firm *after* inception of a BIT will make zero profits but the marginal firm as of *before* inception of a BIT will make positive profits with a BIT in place. Therefore, a BIT will cause new firms to enter j. Equation (2.3) suggests that a reduction in the fixed costs of setting up a plant in j, induced by the implementation of a BIT, will increase the profit difference $\pi_{ij}^n - \pi_{ij}^{n-1}$ at any n_{ij}. Given the distribution of productivity φ_i, there will always be some firms for which any given reduction in f_ℓ will make it profitable to set up a new plant and expand production. Hence, there will be entry of new plants and expansion of production both by firms already present in j prior to the BIT and by new MNEs who set up their first plant in that market.

These effects are depicted in Figure 2.1. The corresponding figure contains

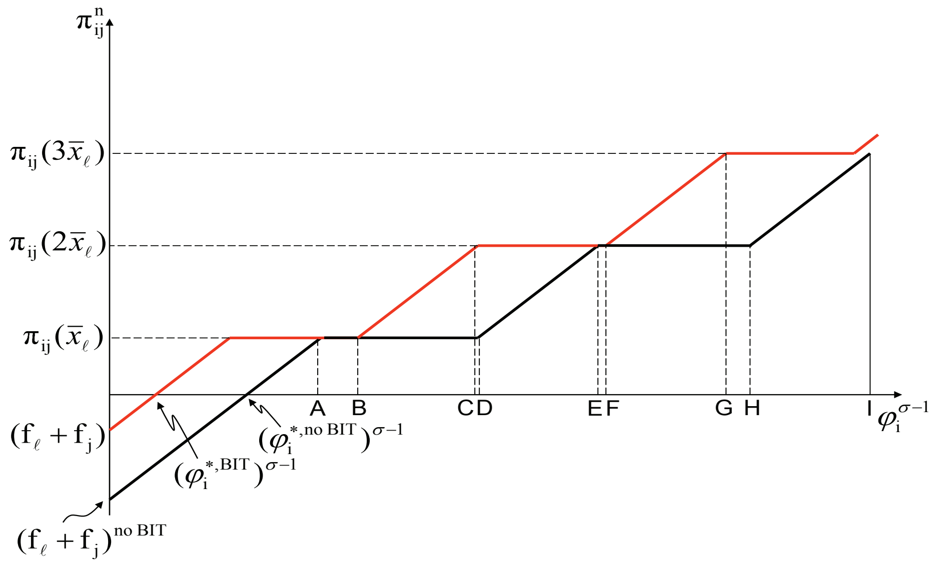

Figure 2.1: Profits of a multinational firm in host country j, before and after the inception of a BIT

two nonmonotonic schedules, one reflecting a profit function prior to a BIT (at the outer right) and one reflecting a profit function after the inception of a BIT (at the outer left). This illustrates that the effects on the plant-specific and firm-specific output differ across brackets of the firm productivity distribution. At productivity levels $\varphi_i^{*,\text{BIT}} \leq \varphi_i < \varphi_i^{*,\text{no BIT}}$, inception of a BIT has an effect on the extensive margin, causing firm as well as plant entry. To the right of $\varphi_i^{*,\text{no BIT}}$, adjustments on the intensive margin of firm activity will raise per-firm output and may imply an increase or a decline of per-plant production.

At productivity levels $\varphi_i \in [B^{\frac{1}{\sigma-1}}, C^{\frac{1}{\sigma-1}})$, $\varphi_i \in [F^{\frac{1}{\sigma-1}}, G^{\frac{1}{\sigma-1}})$, etc., there would be plant entry along with an expansion in production: output, sales, and profit *per firm* would increase while output, sales, and profit *per plant* would decline. At productivity levels $\varphi_i \in [\varphi_i^{*,\text{no BIT}}, A^{\frac{1}{\sigma-1}})$, $\varphi_i \in [D^{\frac{1}{\sigma-1}}, E^{\frac{1}{\sigma-1}})$, $\varphi_i \in [H^{\frac{1}{\sigma-1}}, I^{\frac{1}{\sigma-1}})$, etc., the number of firms and number of plants remain constant but plant-specific and firm-specific output, sales, and profits change: they increase both at the firm level (*per firm*) and at the plant level (*per plant*). Finally, at productivity levels $\varphi_i \in [A^{\frac{1}{\sigma-1}}, B^{\frac{1}{\sigma-1}})$, $\varphi_i \in [E^{\frac{1}{\sigma-1}}, F^{\frac{1}{\sigma-1}})$, etc., there would be no change whatsoever.

Overall, in response to the inception of a BIT between a parent and a host country, we expect an increase in the number of firms and in the number of plants (both aggregate and per-firm) of a given parent country in host market j. We also expect an increase in aggregate output and revenue, and in profits of a subset of the firms as well as for the average existing MNE of a given parent country in host market j.

2.4 Data and Descriptive Evidence

To shed light on the effects of BITs on the different margins of MNE activity, we use the *Microdatabase Direct Investment* (*MiDi*) data-set provided by Deutsche Bundesbank which comprises the universe of outward FDI (above the reporting threshold) undertaken by German MNEs. All German firms holding 10% or more of shares or voting rights in foreign firms with a balance sheet total of more than 3 mn. Euro are required by law to report to Deutsche

Bundesbank their balance sheet information as well as information on the sector, legal form, and number of employees.[13] Indirect participating interests are to be reported whenever residents hold more than 50% in a foreign firm and these dependent enterprises themselves hold 10% or more of the shares or voting rights in other foreign enterprises. Our sample period covers 1996-2005.

Before turning to regression analysis, let us shed light on the evolution of MNE activity around BIT (signature or ratification) events. For this, consider the number of German MNEs per country, and the number of plants per firm and country around such events. In particular, we inspect the evolution of MNE activity in the average host country with a treatment (signature or ratification of a BIT) within the sample period as compared to a control group (i.e., firms in countries which never got treated or did so before 1996). Notice that BIT treatment (irrespective of signature or ratification) is unequally spaced in time. Hence, some countries signed or ratified BITs at the beginning and others in the center or the end of the sample period. To align units of observation properly, we center them around an artificial treatment time zero when a BIT was signed or ratified. Then, we follow the evolution of MNE activity in treated countries (referred to as *Treated* in subsequent figures) up to two years before and after treatment. We do so also with MNE activity in untreated countries in the same years (referred to as *Controls* in subsequent figures).

[13]The reporting requirements are set by the Foreign Trade and Payments Regulation. Reporting thresholds have been changed in the past, for details and a documentation on the micro-level data set *MiDi* see Lipponer (2009).

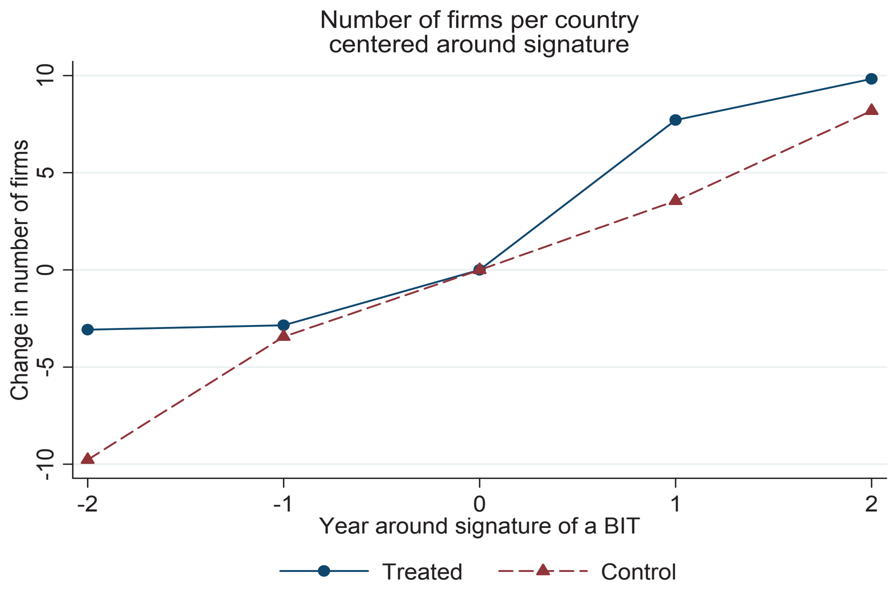

Figure 2.2: Number of firms at the country level around signature of a BIT

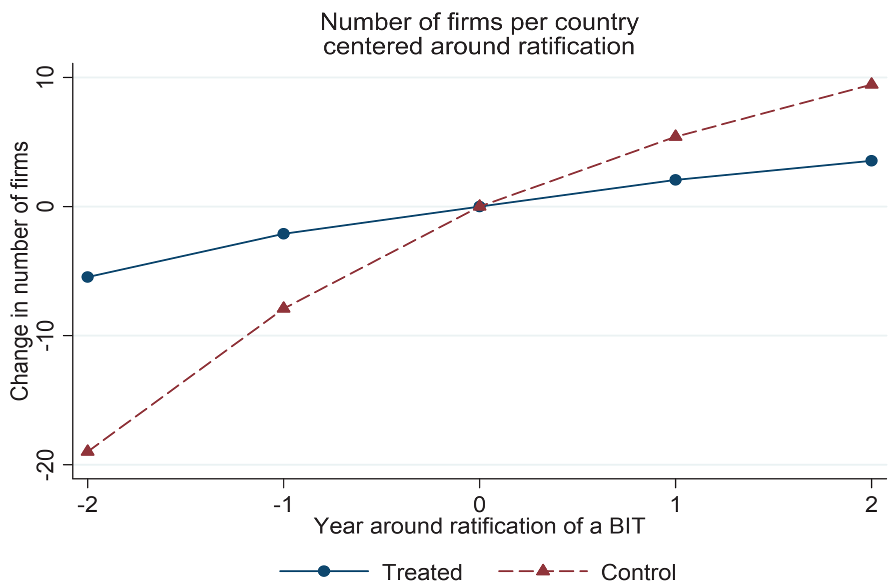

Figure 2.3: Number of firms at the country level around ratification of a BIT

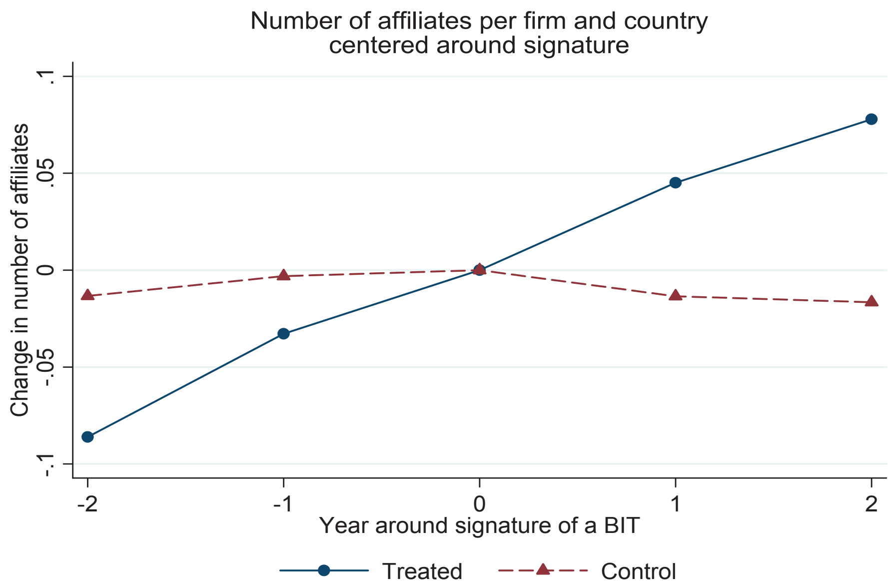

Figure 2.4: Number of affiliates by firm and country around signature of a BIT

In Figures 2.2 and 2.3 we focus on the number of firms in a host country, which most closely reflect decisions at the extensive margin as discussed in Section 2.3. While Figure 2.2 suggests a discontinuity in average outcome around the time of signature of a BIT, Figure 2.3 indicates that there is a trend in outcome – with a different slope – around treatment time zero which looks similar before and after treatment. Altogether, these two figures suggest that BIT signatures lead to an increase in the number of firms active in a host country around treatment, but we should not expect an effect of similar magnitude for ratification afterwards.

Figures 2.4 and 2.5 display the number of plants per *firm and host country.*

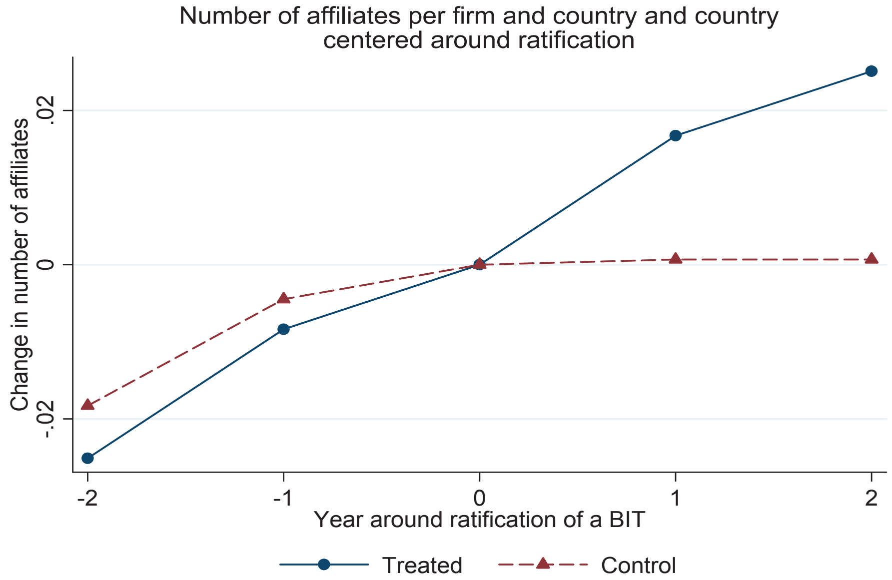

Figure 2.5: Number of affiliates by firm and country around ratification of a BIT

We focus on a constant number of firms around treatment in each figure.[14] Figures 2.4 and 2.5 suggest that, at the intensive firm margin, a clear increase in the number of foreign affiliates per firm and host country happens around the ratification but less so around the signature of BITs. graphical inspection unconditional on other influences and can not provide causal evidence about the effect of BITs on outcome.[15] Therefore, we move on to an econometric

[14]Changes at the extensive firm margin as in Figures 2.2 and 2.3 could not have an impact on Figures 2.4 and 2.5.

[15]Also, recall that BITs with many of the important host countries of Germany had been signed before the sample period. The countries with new BITs are among the smaller recipients of German investment abroad. It is impossible to infer external validity of the effect of BITs for the past and, hence, the ones with Germany's most important host countries. Yet, high-quality, census-type micro-data on MNEs are available only for relatively recent time spans in any developed country we know of.

exploration which has the greater potential of isolating causal effects of BIT treatment. In our benchmark regressions, we treat the binary BIT indicator as exogenous conditional on a set of covariates, as we expect the average firm investing abroad to take the inception of a BIT as given. Beyond that, we consider some regressions in a subsample of treated and control countries which are similar in terms of their propensity of signing a BIT with Germany. The latter is capable of reducing a potential bias of the average BIT treatment effect on outcome accruing to self selection. In the appendix, we present results which suggest that there is no evidence of such a bias with the data and specifications at hand so that we may interpret the estimate effects as causal ones.

2.5 Regression Analysis

2.5.1 Econometric Model

In this section we proceed by running multivariate empirical models to quantify effects of BITs. We are interested in the partial effects of the signature and ratification of BITs on the conditional mean of different outcomes of firm i in host country j. In particular, we look at the number of affiliates held, number of employees abroad, FDI stock,[16] fixed assets, turnover, and the number of sectors firm i operates in. We estimate multiplicative individual-

[16]Measured according to the IMF/OECD method.

effects models for the conditional mean of the form

$$E[y_{ijt}|\mathbf{x}'_{j,t-1}, \nu_{ij}] \quad = \quad exp(\mathbf{x}'_{j,t-1}\boldsymbol{\beta})\nu_{ij}$$

where y_{ijt} is the outcome of firm i in host country j, $ij = 1, ..., N$ in year $t = 1, ..., T$, $\mathbf{x}_{j,t-1}$ is a $K \times 1$ vector of variables dated at time $t - 1$ which vary across both host countries and years, $\boldsymbol{\beta}$ is a corresponding $K \times 1$ vector of parameters to be estimated, and ν_{ij} is a permanent scaling factor for the individual, firm-by-host-country specific mean – an unobservable variable. We can consistently estimate the parameter vector $\boldsymbol{\beta}$ even if unobserved components in ν_{ij} are correlated with the regressors $\mathbf{x}'_{j,t-1}$ by using a Poisson conditional maximum likelihood estimator (see Hausman, Hall, and Griliches, 1984).

The advantage of the Poisson fixed effects estimator pertains to the sum of the outcomes in the panel being a sufficient statistic for ν_{ij}: after conditioning on $\sum_t y_{ijt}$ the conditional likelihood does not depend on ν_{ij}, and β can be estimated consistently. With the conditional mean correctly specified, the Poisson fixed effects estimator is consistent regardless of whether the data are Poisson distributed or not (see Cameron and Trivedi, 2005). Since all elements in $\mathbf{x}'_{j,t-1}$ vary across host countries and time but not firms, we correct the covariance matrix for clustering (see Wooldridge, 1999).

2.5.2 Specification and Data

The vector $x_{j,t-1}$ of determinants of firm i's activity in host country j includes the following variables. In particular, $BITSIG_{j,t-1}$ and $BITRAT_{j,t-1}$ are at the heart of our analysis. These are dummy variables which indicate whether Germany signed or ratified a BIT with country j in year $t-1$, respectively.[17] We collect information about signature and ratification of BITs by and with Germany from the online database of the United Nations' Conference on Trade and Development (UNCTAD).

There is clear-cut evidence that host country market size matters (see Blonigen, Davies, and Head, 2003). Therefore, we include $GDP_{j,t-1}$, the log of real GDP of host country j in year $t-1$.[18] Data on $GDP_{j,t-1}$ are collected from the World Bank's World Development Indicators 2009 (with 2000 as the base year). Similarly, a broad line of research indicates that skilled labor endowments are important for foreign plant set-up (see Carr, Markusen,

[17]Firm outcome observed in period t, such as the number of affiliates held, foreign employment, FDI, and fixed assets should respond in general to economic fundamentals observed in the previous period, $t-1$, rather than to contemporaneous values. The statutory corporate tax rate could however be anticipated by the firm. Yet, the results remain unchanged if we use the contemporaneous tax rate instead of the lagged one. We ran regressions which enforced contemporaneous effects of all variables and those were smaller on average than the ones based on period $t-1$.

[18]Some work suggests that market potential should be included instead or – as far as third-country foreign market potential is concerned – along with $GDP_{j,t-1}$ (see Head and Mayer, 2004). However, for the data at hand, foreign market potential – an inverse-distance weighted or trade-flow weighted version of $GDP_{j,t-1}$ across third host countries – does not exhibit much host-country-specific time variation so that the corresponding parameter estimate would be insignificant. Employing sector-level data would lead to a tremendous loss of observations (service output and even manufacturing output by sector is not available for as large a host country sample as the one considered here) so that we dismiss their use.

and Maskus, 2001; Blonigen, Davies, and Head, 2003), and so are capital-labor ratios (see Bergstrand and Egger, 2007). To control for such influences, we include $SKILL_{j,t-1}$, the tertiary school enrollment rate in country j and year $t-1$ (from the World Bank's World Development Indicators), and $KLRAT_{j,t-1}$, the capital-labor ratio (from Bergstrand and Egger, 2007).

A number of empirical studies suggested that statutory tax rates of a host country affect MNE activity there (see, e.g., Mutti and Grubert, 2004). Therefore, we include $TAX_{j,t-1}$, the statutory corporate tax rate in country j at time $t-1$, as a control variable (from the Bureau of Fiscal Documentation). Similarly, there is work on the role of double taxation treaties for MNE activity (see Blonigen and Davies, 2004, for an analysis at the aggregate level and Davies, Norbäck, and Tekin-Koru, 2009, for micro-level evidence). Accordingly, we include $DTT_{j,t-1}$ in our specification – a dummy variable indicating whether Germany had a double taxation treaty in force with country j in year $t-1$ or not (information about $DTT_{j,t-1}$ stems from Germany's Federal Ministry of Finance). Finally, some empirical work suggests that the existence of a free trade area with a host country fosters FDI of a parent there and vice versa (see Blomström and Kokko, 1997; Levi Yeyati, Stein, and Daude, 2003). Accordingly, we control for $PTA_{j,t-1}$, a dummy indicating if there is a costums union or a free trade agreement in place with country j at time $t-1$ (information about $PTA_{j,t-1}$ is collected from various sources and comes from Bergstrand, Egger, and Larch, 2009).

Table 2.1 provides the first and second moment of the distribution of the dependent and independent variables for the firm-by-country-level data and for

Table 2.1: DESCRIPTIVE STATISTICS

	Description	Firm-by-country statistics Mean	Firm-by-country statistics Std. dev.	Country statistics Mean	Country statistics Std. dev.
Dependent Variables					
$affiliates_{ijt}$	number of affiliates firm i holds in host j in year t	0.778	0.673		
$employees_{ijt}$	number of employees firm i employs in host j in year t	126.441	585.209		
FDI_{ijt}	stock of FDI of firm i in host j in year t	110.555	820.052		
$assets_{ijt}$	fixed assets of firm i in host j in year t	74.948	779.228		
$turnover_{ijt}$	turnover of firm i in host j in year t	314.610	2568.625		
$sectors_{ijt}$	number of sectors firm i is active in, in host j in year t	0.735	0.508		
$firms_{jt}$	number of firms active in host j in year t			112.573	187.993
Independent Variables					
$BITSIG_{j,t-1}$	1 if BIT signed with host j in year $t-1$, 0 otherwise	0.322	0.467	0.687	0.463
$BITRATj, t-1$	1 if BIT ratified with host j in year $t-1$, 0 otherwise	0.272	0.445	0.565	0.496
$TAX_{j,t-1}$	statutory tax rate in host j in year $t-1$	0.331	0.066	0.304	0.070
$DTT_{j,t-1}$	1 if DTT signed with host j in year $t-1$, 0 otherwise	0.865	0.340	0.662	0.473
$PTA_{j,t-1}$	1 if there is a costums union or free trade agreement in place with host j in year $t-1$, 0 otherwise	0.539	0.498	0.199	0.399
$GDP_{j,t-1}$	log(GDP) in host j in year $t-1$	13.032	1.379	11.519	1.590
$SKILL_{j,t-1}$	tertiary school enrollment rate in host j in year $t-1$	0.486	0.182	34.860	21.995
$KLRAT_{j,t-1}$	log(capital-labor ratio) in host j in year $t-1$	9.187	1.012	7.978	1.406
Firm-host pairs		15,728			
Host countries				86	
Observations		99,322		699	

Notes: Notes: FDI stocks, fixed assets, and turnover are expressed in 100,000 Euro. The first two columns report firm-by-country statistics, where each country may appear repeatedly depending on the number German firms investing there in any given year. The last two columns report country statistics: each country appears only once each year.

the country-level data. The first one covers $15,728$ firm-host pairs and $99,322$ observations, while the second one covers 86 host countries and 699 observations. Altogether, our sample covers $5,616$ unique firms and 86 unique host countries. So, for the sample period of 1996-2005, there are $86 \cdot 10 = 860$ possible data points about numbers of firms across host countries and years (including zeros), $5,616 \cdot 86 = 482,976$ possible firm-by-host-country dyads, and $4,829,760$ firm-by-host-country-by-year observations. However, the control variables (especially, the statutory corporate tax rate) are not available for all host countries and years which leads to a drop in the number of usable host-country-by-year observations from 860 to 699. Moreover, in the regression analysis, we can only estimate parameters from cross-sectional units whose outcome changes (i.e., all permanent zero investments are deleted). The latter leads to a drop of usable firm-by-host-country dyads from $482,976$ to $15,728$ (for the number of foreign affiliates) so that the number of usable observations drops to $99,322$.

Let us discuss a few selected descriptive statistics and leave the rest to the interested reader. The figures in the table suggest that, on average, a firm holds 0.778 affiliates per host country. This number is below unity, since we use a complete design matrix: the data used in the regressions cover all possible firm-by-host-country dyads where some change occurred during the sample period (all other firm-by-host-country dyads are dropped by conditioning out the fixed effects). There are firms which did not hold an affiliate in a particular host country at the beginning of but set one up during the sample period. Hence, there are numerous zeros for firms prior to investing in a host country during the sample period. Those zeros and the fact that many MNEs run only one plant in a host country reduces the average number of affiliates to less than one for the average firm, host country, and year. Firms operate in less than one sector per host country and year for the same reason. However, the average number of sectors (0.735) is smaller than the average number of affiliates (0.778). This points to the fact that multiple foreign affiliates of one parent company in a host country tend to operate in the same or at least in overlapping sectors. The average number of firms per host country is somewhat less than 113.

Furthermore, in the average host country and year, a German MNE holds a stock of FDI of slightly more than 11 mn. Euro which corresponds to about 7.5 mn. Euro of fixed assets.[19] On average, there are about 126 employees per firm, host country, and year who generate sales of, on average, almost 32 mn. Euro.

The independent variables suggest the following pattern. First, about 32% (27%) of the host countries the average German MNE in the sample invests in, in an average year, has signed (ratified) a BIT with Germany. In the left bloc of the table, all statistics are by firm, host country and year. Hence, the higher numbers for BITSIG and BITRAT in the right bloc of the table suggest that German MNEs display less presence in host countries with BITs than otherwise. This has to do with the fact that regulations in some preferential trade agreements (such as European Union membership) establish

[19] As indicated by the table footnote, FDI stocks, fixed assets, and turnover are expressed in $100,000$ Euro.

investor protection so that enacting a BIT would be superfluous.[20] According to the statistics in the table, Germany signed (ratified) a BIT with 68% (56%) of the host countries in the sample.[21] With respect to double taxation treaties and preferential trade agreements it is the other way round: German multinationals are present with higher frequency in countries Germany has taxation or trade agreements with. German MNEs even seem to invest with slightly higher probability in high-tax countries than in low-tax economies.

2.5.3 Regression Results

Let us move on to Poisson fixed effects QML regressions which may be interpreted as to reflect structural forms of the expressions of the extensive and intensive margins in a model as the one outlined in Section 2.3.[22] These regressions condition on the potential impact of other covariates whose impact on firm activity could conceal or at least bias the role of BITs for the

[20] OECD member countries attract the majority of German FDI stocks. These countries typically do not conclude BITs among each other.

[21] Table 2.4 lists all countries in the sample and the year of eventual signature and ratification of a BIT with Germany.

[22] The extensive and the intensive margins may be formulated as log-linear functions of market size, trade costs, production costs, fixed costs (see Chaney, 2008), and profitability through profit taxes. We model host country market size as being proportional to host country GDP (as said before, market potential as a possible alternative measure does not vary enough in our panel data models), trade costs as a function of PTA membership (time-invariant trade costs are controlled for by fixed effects), production costs as being proportional to GDP, skilled labor ratios, and capital-labor ratios), and fixed costs by BITs signing and ratification as well as the existence of double taxation treaties which inter alia determine the deductibility of fixed costs from the tax base time-invariant fixed set-up costs are controlled for by fixed effects), and profitability is co-determined by profit tax rates and double taxation treaties.

relevant outcome. Let us summarize our findings in Table 2.2 for the extensive firm margin and in Table 2.3 for the extensive affiliate margin and other outcomes. From a firm's perspective, we consider all outcome variables in Table 2.3 as to reflect dimensions of the intensive margin.

In Table 2.2, the dependent variable reflects the number of firms per host country and year. Accordingly, the cross-sectional dimension in that table are the 86 host countries covered. In this case, there are 699 observations altogether (see Subsection 2.5.2). The parameter estimates suggest the following conclusions.

First, all of the statistically significant estimates are aligned with our expectations. Higher host country statutory tax rates reduce a firm's propensity of investing there, larger market size (GDP) and the availability of skilled labor raise the propensity of investing there. The main reason for why capital labor ratios do not turn out significant is their high correlation with GDP and skilled labor endowments in the sample. There is also an explanation for why double tax treaties and preferential trade agreements do not display a significant positive impact: most of the countries German multinationals changed their investments in (by investing or divesting there) over the sample period already had such agreements with Germany prior to 1996.

This is different for BIT signature and ratification. Controlling for the observable variables, we are able to estimate parameters on both $BITSIG_{j,t-1}$ and $BITRAT_{j,t-1}$ which are significantly different from zero. Unlike in Figures 2.2 and 2.3, we are able to identify a significant positive impact of both

Table 2.2: NUMBER OF FIRMS PER COUNTRY (WHOLE SAMPLE)

Poisson fixed-effects QML estimation

	Dependent variable $firms$
$BITSIG_{j,t-1}$	0.100**
	(0.046)
$BITRAT_{j,t-1}$	0.112***
	(0.039)
$TAX_{j,t-1}$	-1.287***
	(0.497)
$DTT_{j,t-1}$	0.040
	(0.040)
$PTA_{j,t-1}$	-0.005
	(0.051)
$GDP_{j,t-1}$	1.598***
	(0.376)
$SKILL_{j,t-1}$	0.740***
	(0.203)
$KLRAT_{j,t-1}$	-0.062
	(0.158)
Wald	3354
p-value	0.000
Log Likelihood	-1779
Observations	699
Host countries	86

Notes: The regression includes time dummies. Robust standard errors reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively. The lower part of the table reports the Wald (χ^2) test statistic for joint significance of the regressors and its p-value, the value of the log-likelihood function, the number of observations, and the number of groups (host countries).

BIT signature and ratification on the number of firms investing in a host country. Hence, omitting changes in explanatory variables from Figures 2.2 and 2.3 mars the impact of treatment on the number of firms in treated versus untreated host countries there. Interestingly, the point estimate of $BITRAT_{j,t-1}$ is even somewhat bigger than the one of $BITSIG_{j,t-1}$. Yet, signature of BITs seems to generate non-trivial anticipation effects.

What is the impact of BITs on the number of firms in the average host country and year? Notice that, with the adopted approach, this question can not be answered in the usual way. According to Subsection 2.5.1, $E[y_{ijt}|\mathbf{x}'_{j,t-1}, \nu_{ij}] = exp(\mathbf{x}'_{j,t-1}\boldsymbol{\beta})\nu_{ij}$. Hence, the model prediction $E[y_{ijt}|\mathbf{x}'_{j,t-1}, \nu_{ij}]$ requires an estimate not only of $\boldsymbol{\beta}$ but also of the fixed effects ν_{ij}. Unlike with linear models, the latter can not easily be retrieved since they are conditioned out. However, without making any assumption on ν_{ij}, the model implies that β_k and $(e^{\beta_k} - 1)$ can be interpreted as semi-elasticities in the case of a continuous and a discrete explanatory variable $x_{k,t-1}$ respectively .[23]

The coefficient of $BITSIG_{j,t-1}$ in Table 2.2 tells us that the signature of a BIT is associated with a 10% increase in the number of German firms active in the average host country and year. Lets consider this effect on the sample mean. In the sample, the average number of German firms active in the average host country and year amounts to 112.57. Signature of a BIT with

[23]The marginal effect of a continuous variable $x_{k,t-1}$ is $\partial E[y_{ijt}|\mathbf{x}'_{j,t-1}, \nu_{ij}]/\partial x_{k,t-1} = \beta_k \times E[y_{ijt}|\mathbf{x}'_{j,t-1}, \nu_{ij}]$, so β_k can be interpreted as an elasticity. A one-unit increase in $x_{k,t-1}$ is associated with a β_k proportionate increase (or a $100 \times \beta_k$ increase in percent) in the conditional mean of the dependent variable. The effect of a discrete change in a binary variable, such as $BITSIG_{j,t-1}$ or $BITRAT_{j,t-1}$, on the conditional mean of the dependent variable is $E[y_{ijt}|\mathbf{z}'_{j,t-1}, x_{k,t-1} = 1, \nu_{ij}] - E[y_{ijt}|\mathbf{z}'_{j,t-1}, x_{k,t-1} = 0, \nu_{ij}] = exp(\mathbf{z}'_{j,t-1}\boldsymbol{\beta}+\beta_k)\nu_{ij} - exp(\mathbf{z}'_{j,t-1}\boldsymbol{\beta})\nu_{ij} = (e^{\beta_k}-1)\times E[y_{ijt}|\mathbf{z}'_{j,t-1}, \nu_{ij}]$ where $\mathbf{z}'_{j,t-1}$ denotes all the regressors other than the $x_{k,t-1}$. The discrete change in a binary variable is associated with a $100 \times (e^{\beta_k} - 1)$ percentage change in the conditional mean of the dependent variable.

Germany would increase that number from 112.57 to 123.83. Subsequent ratification of that BIT would ceteris paribus further increase the number of firms in the average host country from 123.83 to 137.70.[24] Notice that it would take a reduction of the average host country's statutory corporate tax rate by almost 8.2 percentage points to achieve the same effect as signature of a BIT, and it would take a reduction of the corporate tax rate in these countries of about 18.35 percentage points to achieve the effect of signature and ratification of a BIT. But, clearly, this is not surprising when we think BITs reduce the risk of expropriation – and, hence, fixed market entry costs – from a high level in a significant way.

[24]Table 2.2 shows that the ratification of a BIT is associated with a further 11.2% increase in average number of German firms.

Table 2.3: OUTCOMES PER FIRM AND COUNTRY (WHOLE SAMPLE)

Poisson fixed-effects QML estimation

	Dependent variable					
	affiliates	*employees*	*FDI*	*assets*	*turnover*	*sectors*
$BITSIG_{j,t-1}$	0.089**	0.141*	-0.028	0.046	0.158	0.099***
	(0.036)	(0.079)	(0.128)	(0.138)	(0.139)	(0.034)
$BITRAT_{j,t-1}$	0.119***	0.219**	0.373**	0.399**	0.179	0.113***
	(0.030)	(0.103)	(0.149)	(0.169)	(0.164)	(0.029)
$TAX_{j,t-1}$	-0.733***	-2.554***	-2.471***	-3.306***	-2.496***	-0.889***
	(0.164)	(0.522)	(0.807)	(1.029)	(0.966)	(0.139)
$DTT_{j,t-1}$	0.022	0.156*	0.104	0.088	0.144*	0.035**
	(0.023)	(0.087)	(0.075)	(0.096)	(0.086)	(0.017)
$PTA_{j,t-1}$	-0.057***	-0.169**	0.056	-0.162	-0.135	-0.037**
	(0.021)	(0.071)	(0.083)	(0.116)	(0.111)	(0.018)
$GDP_{j,t-1}$	1.404***	1.481***	2.830***	1.780***	3.222***	1.453***
	(0.153)	(0.419)	(0.558)	(0.638)	(0.575)	(0.133)
$SKILL_{j,t-1}$	0.437***	1.255***	0.742	1.027	1.232	0.508***
	(0.080)	(0.477)	(0.690)	(0.989)	(0.809)	(0.075)
$KLRAT_{j,t-1}$	0.001	0.015	-0.122	0.030	-0.402*	-0.050
	(0.058)	(0.171)	(0.198)	(0.270)	(0.233)	(0.051)
Wald	407.9	149.1	352.5	104.5	331.7	605.1
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log Likelihood	-63,679	-3,437,558	-3,725,668	-2,521,573	-9,501,741	-61,949
Observations	99,322	95,520	99,259	97,448	96,359	99,322
Firm-host pairs	15,728	15,011	15,713	15,390	15,183	15,728

Notes: All regressions include time dummies. Robust standard errors reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively. The lower part of the table reports the Wald (χ^2) test statistic for joint significance of the regressors and its p-value, the value of the log-likelihood function, the number of observations, and the number of groups (firm-host pairs).

In Table 2.3, we consider a variety of margins of adjustment from a firm's perspective. With regard to the number of affiliates per firm, host country, and year, we obtain the same qualitative result as for the extensive firm margin in Table 2.2: signature of a BIT raises the number of plants per firm, host country, and year and ratification of a BIT has an even bigger effect on top of signature. Notice that the design of the data for Table 2.3 is such that firms are included if, during the sample period, they set up new or close down existing plants. Hence, an increase at the plant margin (or other margins in Table 2.3) can but need not entail a change at the extensive firm margin. The magnitude of the coefficients is somewhat larger in Table 2.3 than in Table 2.2. What do these coefficients imply for plant numbers per firm, host country, and year? Again, we can resort to the logic applied to quantifying effects of BIT signature and ratification on the extensive firm margin.

According to Table 2.3, signature of a BIT alone raises the number of affiliates by a factor of $exp(0.089) - 1 \simeq 0.093$ and subsequent ratification of a BIT ceteris paribus raises it again by a factor of $exp(0.119) - 1 \simeq 0.126$ from there. The average number of foreign subsidiaries in a host country and year in the sample was 0.778 in Table 2.1. That number is raised to about 0.958 with signature *and* ratification of a BIT.

We can not discern effects of BIT signature from ratification for FDI stocks, fixed assets, or turnover, but – except for turnover – all intensive margin outcomes in Table 2.3 display a positive response to ratification of a BIT which is significantly different from zero. One reason for why we are not able to identify effects on turnover is that BITs affect fixed rather than variable production costs and it takes time to set up production and generate turnover after setting up affiliates and hiring employees.[25]

The regressions for FDI stocks and fixed assets allow for an approximation of the fixed cost equivalent of BITs. For this, set the parameter of $BITSIG_{j,t-1}$ to zero for convenience and calculate the effect of BITs on outcome by using the parameter of $BITRAT_{j,t-1}$. According to the model for FDI stocks and information on average FDI stocks per host country and year from Table 2.1, the impact of a BIT on FDI stocks amounts to about 5 mn. Euro. The one on fixed assets amounts to about 3.7 mn. Euro. Fixed assets are supposed to be a better measure of fixed costs than FDI stocks. In terms of the above model, we may conclude that a BIT ceteris paribus reduces fixed costs due to the reduction in uncertainty of foreign investments by approximately 3.7 mn. Euro in the average host country and year in our sample.

One could investigate the sensitivity of the above results in a number of ways, and we have aimed at doing so. For instance, rather than using GDP to measure market size, one could use market potential. Yet, market potential exhibits much less time variation than GDP and so its impact is harder to discern from the one of other covariates and the fixed effects in the model. Also, one could use sector-specific output rather than GDP. With a Cobb-Douglas upper utility function and Constant Elasticity of Scale lower utility functions at the sector level, the obtained coefficient of GDP would reflect

[25] At least, this argument should hold for greenfield investment projects. Unfortunately, the data at hand do not allow for a distinction of greenfield from brownfield investment projects.

the response to an increase in the average sector's market size. However, sector-level data (as available from United Nations Industrial Development Organization's *Industrial Statistics Database*) lead to an enormous loss of observations in both the time and the cross-sectional dimension so that convergence of the adopted procedures could not be achieved. Finally, the parameters in the model about the extensive firm margin in Table 2.2 could be affected by self-selection of countries into BITs with Germany. Self-selection bias could be avoided by restricting the sample to comparable countries (see the Appendix for details). The corresponding results are similar to those in Table 2 but the effect of BITs on the number of firms in a host country is smaller by about one-fifth and significant at 10% rather than at 5%.

2.6 Conclusions

This paper provides novel insights on the impact of bilateral investment treaties (BITs) at the firm level. Using the universe of German multinational activity abroad for the period 1996-2005, we provide evidence that BITs seem to bite at various margins of the multinational firm. BITs – as a means of reducing the fixed costs of investment in (risky) host countries – should affect the number of firms active as well as the number of plants and sales per firm and host country.

These hypotheses are broadly confirmed by our evidence from panel data of one of the biggest foreign investing countries around the world, Germany.

Data availability forces us to focus on a relatively recent period where BITs have been signed by Germany with countries that are certainly not the prime targets of its outward investment (this would be the case for other countries' firm-level data-sets, too). Yet, we are confident that our analysis provides novel evidence on the impact of BITs on firm activity which hitherto has been confined to the aggregate level only. We are able to quantify the fixed cost equivalent of BITs which amounts to about 3.7 mn. Euro in the typical host country and year. Signing and ratifying BITs raises the number of firms in the average host country and year in our sample by 26 units. On average, treated firms will open only a single plant. The FDI generated by signing and ratifying a BIT amounts to about 5 mn. Euro per firm and, hence, 130 mn. Euro per host country on average.

Table 2.4: List of countries in the sample and date of BIT signature and ratification

Host Country	Signed	Ratified	Host Country	Signed	Ratified
Algeria	1996	2002	Latvia	1993	1996
Argentina	1991	1993	Lebanon	1997	1999
Armenia*	1995	2000	Lithuania	1992	1997
Australia	-	-	Macedonia, FYR	1996	2000
Austria	-	-	Malaysia	1960	1963
Azerbaijan	1995	1998	Mauritius	1971	1973
Bangladesh	1981	1986	Mexico	1998	2001
Belarus	1993	1996	Moldova	1994	2006
Belgium	-	-	Morocco	2001	-
Bolivia	1987	1990	Netherlands	-	-
Brazil	1995	-	New Zealand	-	-
Bulgaria	1986	1988	Nicaragua	1996	2001
Cambodia*	1999	2002	Norway	-	-
Cameroon	1962	1963	Pakistan	1959	1962
Canada	-	-	Panama	1983	1989
Chile	1991	1999	Paraguay	1993	1998
China	2003	2005	Peru	1995	1997
Costa Rica	1994	1998	Philippines	1997	2000
Cote d'Ivoire	1966	1968	Poland	1989	1991
Croatia	1997	2000	Portugal	1980	1982
Czech Republic	1990	1992	Romania	1996	1998
Denmark	-	-	Rwanda*	1967	1969
Dominican Republic	-	-	Russian Federation	1989	1991
Egypt, Arab Rep.	2005	-	Saudi Arabia	1996	1999
El Salvador	1997	2001	Senegal	1964	1966
Estonia	1992	1997	Slovak Republic	1990	1992
Finland	-	-	Slovenia	1993	1998
France	-	-	South Africa	1995	1998
Georgia	1993	1998	Spain	-	-
Ghana	1995	1998	Sweden	-	-
Greece	1961	1963	Switzerland	-	-
Guatemala	2003	2005	Tanzania	1965	1968
Honduras	1995	1998	Thailand	2002	2004
Hong Kong, China	1996	1998	Trinidad and Tobago	2006	-
Hungary	1986	1987	Tunisia	1963	1966
India	1995	1998	Turkey	1962	1965
Indonesia	2003	-	Uganda	1966	1968
Iran, Islamic Rep.	2002	2005	Ukraine	1993	1996
Ireland	-	-	United Arab Emirates*	1997	1999
Italy	-	-	United Kingdom	-	-
Japan	-	-	United States	-	-
Jordan*	1974	1977	Uruguay	1987	1990
Kazakhstan	1992	1995	Uzbekistan	1993	1998
Kenya	1996	2000	Venezuela, RB	1996	1998
Korea, Rep.	1964	1967	Vietnam	1993	1998
Kyrgyz Republic	1997	2006			

Notes: * These countries appear in the figures but are dropped in the regressions.

Appendix

In Table 2.5, we provide information on the same regression as in Table 2.2, but reducing the control group to a subset of countries by means of a propensity score-matching procedure. We do this as a robustness check in which we seek to take into account possible selection into treatment. Note that since we have panel data and the treatment varies over time, as long as the treatment is uncorrelated with time-varying unobservables that affect the outcome, the fixed effects method we use allows us to consistently estimate treatment effects (See Wooldridge 2002, p.638). Still, we can exploit further information at the country level which we do not use in the main regressions which determine the likelihood of a country signing a BIT with Germany. We estimate annual probits for the probability of a country signing a BIT with Germany [26]. Given the estimated propensity scores, we match treated countries –i.e. countries that signed a BIT with Germany previous or during our sample period– with untreated countries with a similar mean propensity score over the years. To select the control set we define a propensity score radius and use all comparison units within the radius [27].

[26]The specification of the probability of signing a BIT with Germany in a given year includes following dependent variables: Bilateral GDP sum, GDP similarity, GDP per capita similarity and its square, log bilateral distance, a dummy for a border with Germany, a dummy for being in the same continent, a dummy for a free trade agreement, a measure of remoteness, difference in capital labor ratio to the rest of the world, and a dummy for membership to the OECD. Regression results available upon request.

[27]The radius is defined as the interval between the minimum and maximum propensity score of all the treated countries.

Treated countries

Argentina, Azerbaijan, Bangladesh, Bulgaria, Belarus, Bolivia, Brazil, Chile, China, Cote d'Ivoire, Cameroon, Costa Rica, Czech Republic, Algeria, Egypt, Arab Rep., Estonia, Georgia, Ghana, Greece, Guatemala, Hong Kong, Honduras, Croatia, Hungary, Indonesia, India, Iran, Islamic Rep., Kazakhstan, Kenya, Kyrgyz Republic, Korea, Rep., Lebanon, Lithuania, Latvia, Morocco, Moldova, Mexico, Macedonia, Mauritius, Malaysia, Nicaragua, Pakistan, Panama, Peru, Philippines, Poland, Portugal, Paraguay, Romania, Russian Federation, Saudi Arabia, Senegal, El Salvador, Slovak Republic, Slovenia, Thailand, Tunisia, Turkey, Tanzania, Uganda, Ukraine, Uruguay, Uzbekistan, Venezuela, Vietnam, South Africa.

Control group - Whole sample

Australia, Austria, Belgium, Canada, Switzerland, Denmark, Dominican Republic, Spain, Finland, France, United Kingdom, Ireland, Italy, Japan, Netherlands, Norway, New Zealand, Sweden, Trinidad and Tobago, United States.

Control group - Radius matching

Dominican Republic, Spain, Finland, Ireland, Netherlands, Norway, New Zealand, Sweden, Trinidad and Tobago.

Table 2.5: Number of firms per country (Subsample)

Poisson fixed-effects QML estimation

	Dependent variable $firms$
$BITSIG_{j,t-1}$	0.088*
	(0.048)
$BITRAT_{j,t-1}$	0.031
	(0.054)
$TAX_{j,t-1}$	-2.004***
	(0.566)
$DTT_{j,t-1}$	0.029
	(0.074)
$PTA_{j,t-1}$	-0.082*
	(0.049)
$GDP_{j,t-1}$	0.951**
	(0.443)
$SKILL_{j,t-1}$	0.476
	(0.334)
$KLRAT_{j,t-1}$	0.146
	(0.171)
Wald	4884
p-value	0.000
Log Likelihood	-1362
Observations	605
Host countries	75

Notes: Regression as in Table 2.2, after reducing the sample to a subset of countries by means of a propensity score-matching procedure. The regression includes time dummies. Robust standard errors reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively. The lower part of the table reports the Wald (χ^2) test statistic for joint significance of the regressors and its p-value, the value of the log-likelihood function, the number of observations, and the number of groups (host countries).

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Chapter 3

Statutory Corporate Tax Rates and Double Taxation Treaties as Determinants of Multinational Firm Activity

Abstract*

This paper analyzes the impact of statutory corporate tax rates on profits and of double taxation treaties (DTTs) on multinational firm (MNE) activity at the micro level. It provides an assessment of the effects of these profit tax instruments on the extensive and the intensive margin of activity. In particular, we estimate two-part quasi-maximum likelihood models using panel data on the foreign activity of German MNEs in the decade 1996-2005 and find that statutory tax rates affect MNE activity negatively both at the extensive and the intensive margin of investment, while DTTs primarily induce a positive effect at the extensive margin.

3.1 Introduction

Profit tax parameters should be among the most important policy instruments to attract mobile firms in the modern era, much more so than trade policy instruments. The reason is that tariffs have declined tremendously in the aftermath of World War II and taxing income – in particular from the taxation of labor and, more recently, of value added, but also of profits of incorporated firms – now remains almost the only reasonable source to generate revenues for governments.

While tax rates on labor and value added tend to remain relatively constant over long periods of time, there is much more action in tax rates on corporate profits. First of all, with the break-down of the former Soviet Union and the opening up of the former member countries of the Council for Mutual

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Economic Aid (COMECON), a new source of pressure on the taxes on mobile firms' profits has surfaced in Western Europe, which led to a sequence of associated tax rate reductions since the early 1990s there (see Overesch and Rincke, 2009, for a documentation of the decline in corporate profit tax rates in Western Europe). Second, unlike taxes on value added and much less so than taxes on labor, profit taxation has a considerable international component through the activity of multinational firms (MNEs).[1]

In general, international aspects of profit taxation root in the taxation of foreign-earned profits of MNEs abroad (and sometimes even at home) and in the existence of double taxation treaties (DTTs). DTTs have three primary goals: first, they specify the mode of double taxation relief which is relevant unless a unilateral approach is taken by the parent country;[2] second, they specify tax parameters of interest at the bilateral level such as the withholding tax rate;[3] third, in some cases they establish an agreement about information exchange so as to limit the scope of tax avoidance. The number of double

[1]First of all, multi-country activity renders MNEs' profits taxable in more than just one economy. Moreover, tax law itself contains bilateral components by the virtue of the conclusion of double taxation treaties (DTTs). We admit that the taxation of labor abroad may involve a bilateral component of personal income taxation. But there is much less of a change in that than in the taxation of profits, and there tends to be less of a variance in the treatment of expatriates across countries than of profits of MNEs across host countries.

[2]However, some countries such as Germany apply unilateral exemption of MNEs' profits earned abroad from domestic taxation. Then, the primary dimension of international taxation of MNEs' foreign-earned profits accrues to profit taxation at the level of host countries.

[3]Notice that there are exceptions from that rule. For instance, withholding tax rates are waved for profits associated with foreign investments of MNEs headquartered in European Union (EU) member countries in other EU countries by virtue of the Parent-Subsidiary Directive applying within the EU.

taxation treaties (DTTs) concluded has been rising steadily since the early 1960s up to 2,805 by the end of 2008 (UNCTAD 2009, p. 33). The first treaties were signed primarily between developed countries, which are still leading the list of countries in terms of the number of DTTs signed (see Sachs and Sauvant 2009, p. xlv).

Theoretically, the impact of profit taxation on firm-level behavior is well understood (see the next section for further details). While a large body of empirical literature is available on the impact of taxation on MNEs at the aggregate level (see de Mooij and Ederveen 2003, 2006; for a survey and the next section for more details), much less seems to be known about the role of profit taxes at the level of the individual firm (see Hogg, Mintz, and Slemrod, 1993; Grubert and Mutti, 2000; Weichenrieder and Ramb, 2005; Buettner and Wamser, 2009; Buettner et al. 2009; Davies, Norbäck, and Tekin-Koru, 2009; Egger and Loretz, 2009; Overesch and Wamser 2009, 2010a,b; Bellak and Leibrecht, 2010 for some exceptions).

This paper aims at delivering a panel data analysis of the impact of host-country statutory corporate tax rates and DTTs for the outbound activity of German MNEs. This analysis is not unprecedented (see Weichenrieder and Ramb, 2005; Buettner and Wamser, 2009; Buettner et al. 2009; Overesch and Wamser 2009, 2010a,b, for a few examples). However, we pursue a different route of empirical modeling and focus on the impact of host-country statutory tax rates and DTTs by explicitly distinguishing between the extensive versus intensive margin of activity. In particular, we argue that – in an analysis of bilateral MNE activity at the firm level – empirical researchers should account for the main set of options and alternatives of investment for MNEs. Hence, when considering the extensive margin of investment, one should consider all main locations where firms could have invested rather than only those where we actually observe investment. With MNEs that typically run affiliates in only one host country or a small number of host countries, this means that zeros feature prominently in the data. The latter requires methods which are suitable for an analysis of nonlinear models with an excessive amount of zeros and a relatively small amount of positive outcome at the firm level. The latter is what we propose in this project. In doing so, we find that host country statutory tax rates affect both the extensive as well as the intensive margin of investment and other outcomes. DTTs mainly affect the extensive margin, and they exhibit a positive effect on German MNE activity abroad.

The remainder of the paper is organized as follows. The next section summarizes insights from previous work on the impact of statutory tax rates on corporate profits abroad and on DTTs on MNE activity. Section 3.3 provides some information about the data on German MNEs we employ in this study and the estimation methods applied in order to distinguish between effects of profit taxation on the intensive and extensive margins of MNE activity. Section 3.4 summarizes estimation results and provides a quantification of the role of the considered corporate profit tax instruments on all margins and outcomes of MNE activity we focus on. The last section concludes with a summary of the most important insights.

3.2 The Effect of Foreign Statutory Tax Rates and Double Taxation Treaties on Multinational Activity

A large body of theoretical work studies the consequences of profit taxation on firm-level behavior, especially, that of MNEs (see, e.g., Janeba, 1995, 1996, 1998; Devereux and Griffith 1998; Hines 1996; Raff and Srinivasan, 1998; Haufler and Wooton, 1999; Haufler and Schjelderup, 2000; Davies, 2003, 2004, 2005; Devereux and Hubbard 2003; Haufler and Pflüger, 2004; Raff, 2004; Fuest and Hemmelgarn, 2005; Fuest and Becker, 2010; for recent examples; Wilson, 1999; Gresik, 2001; and Devereux, 2008; provide excellent surveys of associated work). Clearly, there are two main channels through which host country statutory corporate profit tax rates affect MNEs. First, they determine the attractiveness of a location as compared to other locations for MNE production for that and other markets by co-determining after-tax profits. Second, their impact might be aggravated through the double taxation of foreign-earned profits in the parent country.

Of course, even with unilateral tax exemption as in Germany, higher statutory tax rates on profits in a country reduce the incentive of foreign MNEs to locate their subsidiaries there. The latter is a statement about the extensive margin of investments and we would expect the probability of an investment and the number of subsidiaries investors of a given parent country locate in a host economy ceteris paribus to decline with an increase in the statutory corporate tax rate applied there. For a given number of subsidiaries in a market, we also expect the extent of activity ceteris paribus to decline in response to an increase in the statutory corporate tax rate of the host economy. The latter accrues to substitution of actual or recorded (e.g., through profit shifting) activity among host countries. There is a large body of evidence at the aggregate level that higher (effective or statutory) corporate profit tax rates tend to affect MNE activity negatively (see Bénassy-Quéré, Fontagné, and Lahrèche-Révil, 2005; Grubert and Mutti, 2004; and Egger, Loretz, Pfaffermayr, and Winner, 2009; for a few examples). Also some of the work on firm-level effects (see the introduction for references) points in that direction although it seems harder to identify effects with micro data.

The impact of DTTs on MNE activity is less clear-cut, especially, if a parent country applies tax exemption of foreign-earned profits on a unilateral basis as Germany does (see Egger, Larch, Pfaffermayr, and Winner, 2006). There are two model conventions most DTTs are based on: the OECD and the United Nations model conventions. The former is the one used mostly between developed countries – among which tax treaties were concluded first – and emphasizes the avoidance of double taxation and the prevention of fiscal evasion. However, with unilateral tax exemption, double taxation of foreign-earned profits is not an issue anyway so that the task of preventing fiscal evasion and, otherwise, establishing transparency about the taxation of foreign profits are dominant aspects. The United Nations model was developed to promote the conclusion of DTTs with developing countries by addressing their asymmetric situation as net importers of capital, which meant a one-sided revenue sacrifice under the OECD draft model. Both models stress the importance of "*removing the obstacles that double taxation presents to the development of economic relations between countries*" (OECD 2008, p. 7) and the United Nations model further points to the "*desirability of promoting greater inflows of foreign investment to developing countries*" (United Nations 1999, p. vi). Clearly, the spirit of both models assumes a positive effect of the conclusion of tax treaties on FDI flows. By specifying the mode of taxation relief and agreeing on maximum levels of withholding tax rates, DTTs reduce uncertainty about after-tax profits and can indeed be expected to foster foreign investment. However, other features of tax treaties such as the exchange of information to limit transfer pricing and restrict tax evasion, might rather discourage FDI. So a priori it is not clear if the effect of DTTs on foreign investment will be positive, especially, for a parent country which applies unilateral tax exemption. In the light of these arguments, it is hardly surprising that empirical evidence on the role of DTTs for FDI is not conclusive (see Davies, 2004, for a review).

3.3 Data and Estimation Method

Our goal is to shed light on the importance of host country statutory tax rates on corporate profits as well as double taxation treaties (DTTs) on MNE activity at the micro level. Broadly speaking, at the firm level, tax policy instruments may have two types of effects, namely at the extensive and at the intensive margin of investment. The former relates to entry or exit of firms in particular host countries in response to changes in statutory tax rates or the conclusion of DTTs, and the latter refers to changes in the level of activity such as the number of subsidiaries per firm (which could also be interpreted as an extensive margin), employment, foreign direct investment or foreign assets.

Obviously, aggregate effects of tax policy conceal possibly differential effects at the extensive and intensive margins of investment. If we are interested in such a distinction, we need to retreat to micro-level data analysis and apply models which support an analysis of tax effects at both the extensive and the intensive margins of MNE activity. We propose estimating two-part quasi-maximum likelihood models, using panel data of MNE activity at the firm level. The advantage of these models is that they combine a binary part – referring to the investment versus no-investment case for a given firm, host country, and year – with a continuous part. Moreover, such models are less restrictive about the structure and form of the error term in the continuous part than log-linear or sample-selection models. Finally, they are quite easy to implement and interpret (see Egger, Larch, Staub, and Winkelmann, 2010; for a discussion of the trade-off between two-part and sample selection models).[4]

[4]In the health economics literature there is a long and ongoing debate on the suitability of two-part models vs. sample selection models (for a review see Jones, 2000). The choice of any model requires assumptions. Which set of assumptions is more restrictive is arguable. Linear specification of outcome with a sample selection model will be prone to bias of estimated elasticities and semi-elasticities while two-part estimation with a nonlinear outcome equation will be unbiased with heteroskedasticity and conditionally uncorrelated errors (see Santos Silva and Tenreyro, 2006). Consistent estimation in the presence of sample selection on unobservables relies on relatively strong distributional assumptions. If selection is due only to time-invariant characteristics of the firm (within the sample period), then, a fixed-effects approach controls perfectly for sample selection. We exploit the panel structure of the data and pursue a fixed-effects approach, including

3.3.1 The *MiDi* Data-Set

The Deutsche Bundesbank provides firm-level data on the universe of German multinationals and their activity abroad through the *Microdatabase Direct Investment* (*MiDi*) (above the reporting threshold).[5] All German firms and households which hold 10% or more of the shares or voting rights in a foreign enterprise with a balance sheet total of more than 3 million Euro are required by law to report to the Deutsche Bundesbank balance sheet information as well as information on the sector, legal form, and number of employees of the investment object.[6] Altogether, our sample comprises 6,915 firms over the period 1996 to 2005 which hold foreign affiliates in at least one of 51 host countries (see the Appendix for a list of possible host countries).

This data-set allows us to analyze possible effects of statutory tax rates on corporate profits abroad and of DTTs on the different margins of investment

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firm-by-country as well as firm-by-time fixed effects. We prefer a much more flexible two-part model with a nonlinear outcome equation that is robust to heteroskedasticity to a linear sample selection model. That model allows the participation and outcome equations to be generated by different densities and makes no distributional assumptions.

[5]The data-set is made available under strict conditions and for clearly defined academic research purposes and can be used exclusively at the Research Centre of the Deutsche Bundesbank.

[6]Indirect participating interests are to be reported whenever residents hold more than 50% in a foreign firm and these dependent enterprises themselves hold 10% or more of the shares or voting rights in other foreign enterprises. The reporting requirements are set by the Foreign Trade and Payments Regulation. The reporting threshold was changed in 2002. Up to that year, a German firm had to report its international activities whenever it owned 50% of shares or voting rights of a foreign company with a balance sheet total of more than 1 million DM. As of 2002, those thresholds were changed into 10% and 3 million Euro respectively (see Lipponer, 2009). To get a uniform cutoff, we restrict the sample to those firms with a balance sheet total of 3 million Euro and an ownership of at least 50%. We exclude indirectly held affiliates, as they might be held through enterprises located in a third country.

between 1996 and 2005 at an annual basis. Also, we are able to examine their impact on different aspects of multinational activity. In particular, we consider possible effects on the following firm-level outcomes of German MNEs in a host country: the total number of affiliates held, the total number of employees, the stock of direct investment,[7] and fixed assets. By using this data-set, rather than exploiting aggregate bilateral data on MNE activity, we should be able to gain a much better understanding of the exact channels through which the considered profit tax instruments affect the behavior of MNEs.

3.3.2 Determinants of MNE Activity

We model MNE activity as a function of the following regressors. First of all, there are two tax instruments of primary interest to us: $TAX_{j,t-1}$ (the statutory tax rate on corporate profits in host country j and year $t-1$) and $DTT_{j,t-1}$ (a binary variable indicating whether a DTT applies to investments in j and year $t-1$).[8] Otherwise, the $NT \times K$ matrix of explanatory variables includes the following covariates: $DEP_{j,t-1}$ (the depreciation allowance on an average investment in the host country), $GDP_{j,t-1}$ (the log of real host country GDP), $KLRAT_{j,t-1}$ (the log of the capital-labor ratio in the host country), $SKILL_{j,t-1}$ (the log of the tertiary school enrollment rate in the

[7]As calculated by the Deutsche Bundesbank according to the IMF/OECD method; see Lipponer (2009, p.15).

[8]We assume that the firm outcomes in period t, such as number of affiliates held, employees, investment and fixed assets are affected by the tax instruments and economic fundamentals, observed in the previous period, $t-1$. Regressions using the contemporaneous tax rate instead of the lagged tax rate are available upon request. The main results remain unchanged.

host country), $STR_{ij,t-1}$ (the average turnover of other firms in firm i's sector and host country j), $SAE_{ij,t-1}$ (fixed assets per employee of other firms in firm i's sector),[9] as well as firm-year and firm-host-country fixed effects.

The choice of the control variables is motivated by the theory of MNEs and trade which suggests, apart from (over a short time horizon as ours mostly time-invariant) trade and investment costs, two key determinants of multinational activity (see Carr, Markusen, and Maskus, 2001; Markusen, 2002; Markusen and Maskus, 2002; Davies, 2005; Bergstrand and Egger, 2007): market size, skilled-to-unskilled labor endowments, and capital-labor-ratios. These determine the prevalent type of multinational firms in the host country, large-market-seeking horizontal multinationals that produce the same product at home and abroad and low-production-cost-seeking vertical ones that produce headquarter services in skill-abundant economies and goods in skill-scarce ones. We proxy market size with the host country's GDP and availability of skilled labor by tertiary school enrollment ratio. Bergstrand and Egger (2007) point to the role of physical capital for MNEs' plant set-up. We include the capital-labor ratio of the host country. Our data-base comprises starkly heterogenous firms active in numerous sectors. We lack information on sectoral gross product or capital stock at the country level for all the year coverage, therefore, we include assets per employee and average turnover of all other German firms in the same sector in the host country to capture that heterogeneity.

[9]The variables $STR_{ij,t-1}$ and $SAE_{ij,t-1}$ were constructed taking the average turnover and assets per employee respectively over all German MNEs except firm i in the same sector, host country, and year.

Table 3.1: DESCRIPTIVE STATISTICS

Variable	Description	Whole sample		$I_{ijt} = 1$	
		Mean	Std. dev.	Mean	Std. dev.
I_{ijt}	1 if firm i invests in host j in year t, 0 otherwise	0.043	0.202	1	0
$affiliates_{ijt}$	number of affiliates firm i holds in host j in year t	0.046	0.238	1.094	0.436
$employees_{ijt}$	number of employees firm i employs in host j in year t	7.809	150.35	182.73	704.97
FDI_{ijt}	stock of FDI of firm i in host j in year t	6.715	208.16	157.12	995.12
$assets_{ijt}$	fixed assets of firm i in host j in year t	4.544	199.69	106.34	960.34
$TAX_{j,t-1}$	statutory tax rate in host j in year $t-1$	0.309	0.071	0.335	0.064
$DTT_{j,t-1}$	1 if DTT signed with host j in year $t-1$, 0 otherwise	0.807	0.394	0.903	0.295
$DEP_{j,t-1}$	depreciation rate in host j in year $t-1$	0.550	0.116	0.557	0.065
$GDP_{j,t-1}$	log(GDP) in host j in year $t-1$	12.185	1.554	13.173	1.362
$SKILL_{j,t-1}$	log(tertiary school enrollment rate) in host j in year $t-1$	3.712	0.629	3.887	0.443
$KLRAT_{j,t-1}$	log(capital-labor ratio) in host j in year $t-1$	8.628	1.207	9.339	0.885
$STR_{ij,t-1}$	average turnover of German affiliates in same sector as firm i in year $t-1$ in host j	2.227	5.082	4.002	7.893
$SAE_{ij,t-1}$	assets per employee of German affiliates in same sector as firm i in year $t-1$ in host j	59.20	1031.74	96.50	3516.7
Observations		1,485,711		63,496	

Notes: FDI and fixed assets in 100,000 Euro.

Table 3.1 provides descriptive statistics and a definition of the variables. The data on DTTs signed by Germany are available from United Nations Conference on Trade and Development (UNCTAD). The data on statutory taxes ($TAX_{j,t-1}$) and depreciation allowances ($DEP_{j,t-1}$) were collected in Egger, Loretz, Pfaffermayr, and Winner (2006). The data on real GDP, capital-labor ratio, and tertiary school enrollment come from the 2007 edition of the World Bank's World Development Indicators. Data on capital-labor ratios were taken from Bergstrand and Egger (2007). Finally, $STR_{ij,t-1}$ and $SAE_{ij,t-1}$ were constructed on the basis of information contained in the *MiDi* data-set.

3.3.3 Specification and Estimation of Two-Part Models

Location decisions of MNEs will be affected by time-invariant (regulatory, geographical, institutional) as well as time-variant (economic) conditions. In particular, we would expect profit tax instruments to change these decisions indirectly but have a qualitatively different impact on decisions about the extent of investment and other outcomes. We thus expect the profit tax instruments we focus on – i.e., statutory tax rates on corporate profits and DTTs – to affect lumpy foreign investment decisions at the *extensive margin*, namely the probability of an MNE to set up an affiliate in a particular host country, and, at the *intensive margin*, the extent of an MNEs' activity there conditional on some investment differently.

A two-part model (TPM) allows us to disentangle these two effects by letting the zeros and positive outcomes be generated by different densities. The first part of the TPM is a binary outcome model and the second part describes the distribution of the outcome *conditional* on the outcome being positive. Define a binary indicator variable $I_{ijt} = 1$ if a firm i holds a foreign affiliate in host country j at time t (for pairs $ij = 1, \ldots, N$ and $t = 1, \ldots, T$) and $I_{ijt} = 0$ otherwise. Let y_{ijt} be the outcome of firm i in host country j at time t, $\mathbf{x}_{ij,t-1}$ a $1 \times K$ vector of firm- and country-specific explanatory variables (including $TAX_{j,t-1}$ the statutory tax rate on corporate profits in host country j at time $t-1$, $DTT_{j,t-1}$ a dummy variable indicating if there is a DTT in place between Germany and country j at time $t-1$, and the control variables), and α_{ij} a time-invariant firm-host specific effect. The TPM for y_{ijt} is then given by

$$f(y_{ijt}|.) = \begin{cases} Pr(I_{ijt} = 0|\mathbf{x}_{ij,t-1}, \alpha_{ij}) & \text{if } y_{ijt} = 0 \\ Pr(I_{ijt} = 1|.)f(y_{ijt}|I_{ijt} = 1, \mathbf{x}_{ij,t-1}, \alpha_{ij}) & \text{if } y_{ijt} > 0 \end{cases}$$

We estimate the effect of statutory corporate tax rates DTTs on the participation decision I_{ijt} (the *extensive* margin) by specifying $Pr(I_{ijt} = 1|.)$ as a probit for whether or not a firm i holds an affiliate in country j at time t. $I_{ijt} = 1$ whenever firm i owns any affiliate in a given host country j in year t, no matter how many or which ones. A change in the industry affiliation of an affiliate would thus not change I_{ijt}. However, if the extent of activities is below the reporting thresholds, $I_{ijt} = 0$. If the activity of firm i in j is above the reporting threshold in year $t-1$, below it in year t, and above it in year $t+1$, this would be considered as exit in t an re-entry in $t+1$. Notice that we may not include dummy variables for fixed firm-host-country effects since all model parameters would be biased due to the incidental parameter problem, then. However, we may still control for fixed firm-host-country effects (and, similarly, for fixed firm-year effects) by inserting respective means of all covariates in the corresponding dimensions, following Mundlak (1978), Chamberlain (1982, 1984), and Wooldridge (2002).[10] As indicated in the previous subsection, we include firm-year fixed effects apart from (individual) firm-host-country fixed effects to capture exhaustively common effects in the time and cross-sectional dimensions (note that we have therefore ruled out a possible bias of the omission of aggregate time-variant variables for Germany as well as the one of time-invariant effects such as distance between Germany and host country i, etc.).

We make no distributional assumptions about the second part of the model, $f(y_{ijt}|I_{ijt} = 1, .)$, and specify it as an exponential regression model.[11] The latter copes with potential mis-specification of the error term by transforming the model log-linearly (see Santos Silva and Tenreyro, 2006, for arguments in a different context), and obtains the effect of the tax instruments of interest on the *intensive* margin y_{ijt}. Similar to the first part, we include individual effects α_{ij} by specifying $E(\alpha_{ij}|\mathbf{x}_{ij}) = \bar{\mathbf{x}}'_{ij}\pi$ where $\bar{x}_{ij}$ are the firm-host-country means of the regressors (see Mundlak, 1978; Chamberlain, 1982, 1984; and

[10] Alternatively, one could estimate annual probit models by allowing the parameters of the covariates to vary across the years. However, this would come at the expense of not being able to control for firm-host-country fixed effects but only for separate firm and host country effects.

[11] See Ruf and Weichenrieder (2009) for a Poisson fixed effects model using passive assets as the dependent variable. However, in contrast to ours, their model does not represent a two-part approach.

Wooldridge, 2002). By convention, the same regressors are allowed to and, in our application, do appear in both parts of the model.

3.4 Empirical Analysis

We present the results of our empirical analysis in two parts. First, we summarize parameter estimates of covariates, in particular, of statutory tax rates on corporate profits and DTTs, on bilateral MNE activity at the firm level. As mentioned before, we use the number of affiliates, the number of employees, the FDI stock, and fixed assets as alternative outcomes and analyze effects on the extensive and the intensive margin of activity separately. Then, we discuss effects of $TAX_{j,t-1}$ and $DTT_{j,t-1}$ by taking the nonlinear nature of the estimated models into account.[12] Also, we quantify impact effects of $DTT_{j,t-1}$ on outcome by means of comparisons of predicted effects and counterfactual predictions which are based on changed $DTT_{j,t-1}$.

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[12]In principal, $TAX_{j,t-1}$ and $DTT_{j,t-1}$ could be endogenous. However, this is very unlikely for the following reasons. First, the unit of observation is an individual firm in a host country and year. These units will unlikely affect aggregate government decisions. Moreover, these variables are lagged by one year. Furthermore, we include firm-year and firm-country fixed effects so that any endogeneity bias would have to come from the remaining variation in the disturbances. If the selection bias of $DTT_{j,t-1}$ is time-invariant, or there is no impact of future firm activity (the dependent variables) on lagged $DTT_{j,t-1}$, the estimated parameters are free of selection bias.

Table 3.2: ESTIMATION RESULTS POISSON QML (WHOLE SAMPLE)

	Poisson QML			
	affiliates	*employees*	*FDI*	*assets*
$TAX_{j,t-1}$	-1.175***	-3.797***	-4.069***	-5.322***
	(0.194)	(0.754)	(1.153)	(1.549)
$DTT_{j,t-1}$	0.062**	0.184*	0.253**	0.270**
	(0.027)	(0.104)	(0.101)	(0.122)
$DEP_{j,t-1}$	-0.347***	-0.251	-0.288	-0.162
	(0.122)	(0.270)	(0.498)	(0.542)
$GDP_{j,t-1}$	0.817***	0.697*	1.432**	1.021
	(0.119)	(0.381)	(0.580)	(0.690)
$SKILL_{j,t-1}$	0.516***	0.920***	0.816***	0.992**
	(0.053)	(0.196)	(0.286)	(0.415)
$KLRAT_{j,t-1}$	0.059	-0.129	0.104	-0.134
	(0.051)	(0.137)	(0.255)	(0.306)
$STR_{ij,t-1}$	-0.002***	-0.004***	-0.004***	-0.005***
	(1.8e-04)	(5.1e-04)	(6.9e-04)	(9.8e-04)
$SAE_{ij,t-1}$	3.7e-05***	7.7e-05***	2.2e-05***	1.5e-06
	(4.3e-06)	(2.9e-05)	(8.0e-06)	(5.5e-06)
Marginal Effects				
$TAX_{j,t-1}$	-0.035***	-20.044***	-13.883***	-13.547***
	(0.006)	(4.087)	(3.880)	(3.776)
$DTT_{j,t-1}$	0.002**	0.921*	0.801***	0.636**
	(0.001)	(0.491)	(0.296)	(0.255)
Wald	13,548	3,541	3,723	2,383
p-value	0.000	0.000	0.000	0.000
Log.L.	-260,152	-46,661,315	-40,504,794	-31,801,667
Obs.	1,485,711	1,485,711	1,485,711	1,485,711
Groups	332,714	332,714	332,714	332,714

Notes: All regressions include firm-host and firm-year fixed effects. Robust standard errors clustered by firm-host pair reported in parentheses. All explanatory variables are lagged once. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively. The lower third of the table reports the Wald (χ^2) test statistic for joint significance of the regressors and its p-value, the value of the log-likelihood function, the number of observations, and the number of groups (firm-host pairs). Marginal effects evaluated at the sample mean.

In Table 3.2, we report the results of a Poisson QML model using the whole sample of firms. There, we estimate the effect of statutory tax rates and DTTs on the conditional mean of outcome y_{ijt}, irrespective of whether the firm actually operates an affiliate there or not. In principal, the associated econometric model is identical to the second part of a two-part model, except that one does not condition on positive outcome. By assumption, that model copes with a proportionate but not an excessive amount of zero outcome in the data.

The four columns of Table 3.2 refer to the outcomes number of affiliates, number of employees, FDI stock, and fixed assets, respectively. After controlling for the aforementioned economic fundamentals, statutory corporate tax rates display a negative impact on any of the outcomes while DTT generally exerts a positive effect. In any case, the parameter estimates of the two profit tax variables of interest are significantly different from zero.

The estimated semi-elasticities of host-country statutory tax rate on corporate profits range from -1.17 to -5.32, a magnitude which is comparable to previous findings, mostly for aggregate data (see de Mooij and Ederveen, 2006, for a meta-analysis where they find a typical semi-elasticity of -2.1; Overesch and Wamser, 2009, using the same data-set and a count-data analysis find a semi-elasticity of -2.17).[13] The estimated effect of a DTT ranges

[13]In the Poisson model, as in any model with an exponential conditional mean $E(y|\mathbf{x}) = exp(\mathbf{x}'\beta)$, the regression coefficients can be interpreted as semi-elasticities since the marginal effect $ME_k = E(y|\mathbf{x}) \times \beta_k$, so $\beta_k = ME_k/E(y|\mathbf{x})$. The effect of the discrete

from 6.4% (on the expected number of affiliates) to 31% (on the expected volume of fixed assets). The point estimates for a host country's depreciation allowances turns out to be negative, which is counter-intuitive, but the corresponding estimate is almost always insignificantly different from zero.

While the semi-elasticities in Table 3.2 are interesting, they are not conducive to a quantification at first glance. Therefore, we report marginal effects of $TAX_{j,t-1}$ and $DTT_{j,t-1}$ in the lower part of the table. The corresponding effects suggest that an increase in the statutory tax rate on corporate profits of the average host country and year $t-1$ by one percentage point reduces employment, stocks of outbound FDI, or total assets there by about 0.2 employees, 14,000 Euro of stocks of FDI, and 14,000 of assets, respectively. It reduces the number of affiliates by about 0.0004 on average. The corresponding effect of concluding a DTT where there was none before is considerably less important.

Regarding the non-tax location determinants, we find that both a larger host country market-size (measured by GDP) and the availability of skilled labor have a positive significant effect on the activity of a firm in that country. The capital-labor ratio, on the other hand, does not seem to have a significant effect on any firm outcome, after controlling for relative endowments with skilled relative to unskilled labor.

The results described in Table 3.2 reveal that statutory corporate tax rates

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change in a binary variable such as DTT would be $ME_k = exp(\mathbf{x}'\beta + \beta_k) - exp(\mathbf{x}'\beta) = (e^{\beta_k} - 1)exp(\mathbf{x}'\beta)$ meaning a percentage change of $100 \times (e^{\beta_k} - 1)$ (see Cameron and Trivedi, 2005).

have a significant negative and tax treaties a positive and significant effect on foreign investment in a given host country, but are not informative about the extent to which these tax instruments affect the location decision of firms (i.e., the *extensive margin* of MNE activity) or the outcomes of firms conditional on location in a host country (i.e., the *intensive margin* of MNE activity). To shed light on this matter, we turn to the results of the two-part model in Tables 3.3 and 3.4. Table 3.3 reports the probit estimates of the effect of the tax variables of interest on the probability of a firm to set up an affiliate in a host country (the extensive margin), and Table 3.4 shows their effect on the extent of a positive outcome (the intensive margin) by means of a Poisson QML regression, i.e., conditional on the firm to having set up an affiliate in host country j in year t or before that. All dependent variables are once-lagged and all regressions include firm-host and firm-year fixed effects.

The probit estimates in Table 3.3 suggest that the statutory tax rate of the host country deters lumpy foreign investment there. On the other hand, the conclusion of a DTT has indeed a positive and significant effect on the probability of a firm to set up an affiliate in the host country. All of that is in line with our expectations from a theoretical point of view. There is no significant (indirect) effect of depreciation allowances in the host country on investment there.

Table 3.4 reports the results of the Poisson QML model which – unlike in Table 3.2 – is run on the subsample observations with a positive outcome y_{ijt}. As said before, the corresponding parameter estimates reflect the effect of the tax variables of interest and the other covariates on firm outcomes

Table 3.3: Estimation results of two-part models I

	Probit
$TAX_{j,t-1}$	-0.627***
	(0.085)
$DTT_{j,t-1}$	0.025**
	(0.010)
$DEP_{j,t-1}$	-0.070
	(0.047)
$GDP_{j,t-1}$	0.425***
	(0.052)
$SKILL_{j,t-1}$	0.239***
	(0.020)
$KLRAT_{j,t-1}$	-0.013
	(0.022)
$STR_{ij,t-1}$	-0.001***
	(1.67e-04)
$SAE_{ij,t-1}$	1.7e-05***
	(2.6e-06)
Marginal Effects	
$TAX_{j,t-1}$	-0.039***
	(0.005)
$DTT_{j,t-1}$	0.002**
	(0.001)
Wald	11,288
p-value	0.000
Log.L.	-235,100
Obs.	1,485,711
Groups	332,714

Notes: All regressions include firm-host and firm-year fixed effects. Robust standard errors clustered by firm-host pair reported in parentheses. All explanatory variables are lagged once. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively. The lower third of the table reports the Wald (χ^2) test statistic for joint significance of the regressors and its p-value, the value of the log-likelihood function, the number of observations, and the number of groups (firm-host pairs). Marginal effects evaluated at the sample mean.

Table 3.4: Estimation results of two-part models II

	Poisson QML			
	$affiliates$	$employees$	FDI	$assets$
$TAX_{j,t-1}$	0.069	-1.526**	-2.277**	-3.221**
	(0.075)	(0.615)	(1.005)	(1.424)
$DTT_{j,t-1}$	-0.003	0.077	0.130	0.149*
	(0.011)	(0.070)	(0.080)	(0.089)
$DEP_{j,t-1}$	-0.173*	0.075	0.575	0.372
	(0.095)	(0.401)	(0.770)	(0.823)
$GDP_{j,t-1}$	-0.024	-0.552	1.065	-0.132
	(0.079)	(0.500)	(0.778)	(0.978)
$SKILL_{j,t-1}$	-0.028	0.352*	0.130	0.339
	(0.026)	(0.196)	(0.288)	(0.429)
$KLRAT_{j,t-1}$	0.073**	-0.046	0.019	0.035
	(0.031)	(0.156)	(0.294)	(0.344)
$STR_{ij,t-1}$	-4.1e-04***	-3.2e-03***	-3.6e-03***	-4.3e-03**
	(1.5e-04)	(1.0e-03)	(1.2e-03)	(1.8e-03)
$SAE_{ij,t-1}$	-2.3e-06**	4.0e-05*	-1.5e-05***	-2.5e-05***
	(1.2e-06)	(2.1e-05)	(3.8e-06)	(3.8e-06)
Marginal Effects				
$TAX_{j,t-1}$	0.075	-251.885*	-322.999*	-301.849*
	(0.081)	(103.750)	(142.210)	(132.940)
$DTT_{j,t-1}$	-0.003	12.417	17.610*	13.180*
	(0.012)	(11.030)	(10.370)	(7.535)
Wald	158	769	626	554
p-value	0.000	0.000	0.000	0.000
Log.L.	-68,259	-13,435,736	-14,432,744	-13,588,531
Obs.	63,496	63,496	63,496	63,496
Groups	14,940	14,940	14,940	14,940

Notes: All regressions include firm-host and firm-year fixed effects. Robust standard errors clustered by firm-host pair reported in parentheses. All explanatory variables are lagged once. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively. The lower third of the table reports the Wald (χ^2) test statistic for joint significance of the regressors and its p-value, the value of the log-likelihood function, the number of observations, and the number of groups (firm-host pairs). Marginal effects evaluated at the sample mean.

conditional on them being positive (i.e., conditional on the firm running at least one affiliate in host country j and year t). As in Table 3.2, we find a negative effect of statutory tax rates on the level of firm activity which is statistically significantly different from zero after conditioning on positive investment. The semi-elasticities for the parameter of $TAX_{j,t-1}$ lie in the same range as those reported in Table 3.2. However, we do not generally find a significant effect of DTTs on outcome any more. Only when using the volume of fixed assets as outcome is the parameter estimate of $DTT_{j,t-1}$ positive and significantly different from zero at conventional levels. Hence, it seems that DTTs affect the outbound activity of German MNEs mainly through their effect on the extensive margin of investment.

As in Table 3.2, we report not only semi-elasticities but also marginal effects of $TAX_{j,t-1}$ and $DTT_{j,t-1}$ in Tables 3 and 4. Except for the intensive margin of the number of foreign affiliates in Table 3.4, the sign of the semi-elasticities as well as the marginal effects is the same in Tables 3 and 4 as in Table 3.2. However, the marginal effects of the two tax instruments are much larger in absolute value than they were in Table 3.2. The reason for the latter is that the semi-elasticities are not much different between Tables 3.2 and 3.4, but we condition on positive outcome in Table 3.4. Notice that the positive marginal effect of $DTT_{j,t-1}$ is significantly different from zero for FDI stocks as an outcome even though the semi-elasticity is not. The latter has to do with the non-linearity of the model.

In Table 3.5, we summarize further insights for a counterfactual change from no DTT to a DTT if there was any. Again, we summarize the results by

Table 3.5: COUNTERFACTUAL EFFECTS OF DTTS

	Poisson QML (whole sample)			
	affiliates	*employees*	*FDI*	*assets*
Predicted $E(y_{ijt}\|.)$	0.047	7.809	6.715	4.545
Counterfactual				
$E(y_{ijt}\|., DTT_{j,t-1} = 0)$	0.044	6.679	5.362	3.574
$E(y_{ijt}\|., DTT_{j,t-1} = 1)$	0.047	8.029	6.902	4.681
%-change	6.3%	20.2%	28.7%	31%
	Probit			
Predicted $Pr(I_{ijt} = 1\|.)$	0.043			
Counterfactual				
$Pr(I_{ijt} = 1\|., DTT_{j,t-1} = 0)$	0.041			
$Pr(I_{ijt} = 1\|., DTT_{j,t-1} = 1)$	0.043			
%-change	5.13%			
	Poisson QML conditional on positive investment			
	affiliates	*employees*	*FDI*	*assets*
Predicted $E(y_{ijt}\|., I_{ijt} = 1)$	1.094	182.727	157.121	106.338
Counterfactual				
$E(y_{ijt}\|., I_{ijt} = 1, DTT_{j,t-1} = 0)$	1.097	171.001	139.767	93.064
$E(y_{ijt}\|., I_{ijt} = 1, DTT_{j,t-1} = 1)$	1.094	184.781	159.245	107.998
%-change			13.93%	16.04%

Notes: % change reported only for outcomes where the estimated effect of DTT is significant at the 15% level.

computing averages across all cross-sectional units and years. We do so for all models we report results for in Tables 2, 3 and 4. For each model, we report first the mean of the predicted outcome based on observed data and $DTT_{j,t-1}$. Moreover, we report the mean of the prediction after setting all DTTs first to zero, and then to one. We also report the corresponding %-

change for all outcomes where the estimated effect of DTT was significantly different at 15 percent. At the top of Table 3.5 we report the effect of DTTs on the mean of the predictions for the model where we do not condition on positive outcome. The effect ranges from 6.3% (on the expected number of affiliates) to 31% (on the expected volume of fixed assets). Below, we see how DTTs affect the extensive and intensive margins separately. The predicted probability of setting up an affiliate is 5.13% higher after setting all DTTs to one. Conditioning on positive outcome, the effect of a change of $DTT_{j,t-1}$ from zero to one on the expected stock of FDI and volume of fixed assets is 13.93% and 16.04% respectively.

All effects reported in Table 3.5 are average effects. The non-linearity of the models implies that the effect of $DTT_{j,t-1}$ depends on the value of the regressors. It is therefore interesting to evaluate the effect of DTTs and statutory tax rates together. In Figures 3.1 to 3.3 we show the effect of $DTT_{j,t-1}$ on the whole distribution of $TAX_{j,t-1}$. We plot the effect of $TAX_{j,t-1}$ on the predicted outcome for the two values of $DTT_{j,t-1}$. The difference between the two curves is the marginal effect of $DTT_{j,t-1}$.

Figure 3.1 plots the predicted probability of a firm setting up an affiliate in a host country as a function of the host country statutory tax rate. The marginal effect of $DTT_{j,t-1}$ (the difference between the two curves) decreases with the statutory tax rate. The probability that a firm will set up an affiliate in a host country after the conclusion of a DTT is greater for countries with lower statutory tax rates. In Figures 3.2 and 3.3 we repeat the exercise for the conditional mean of FDI stock and volume of fixed assets respectively.

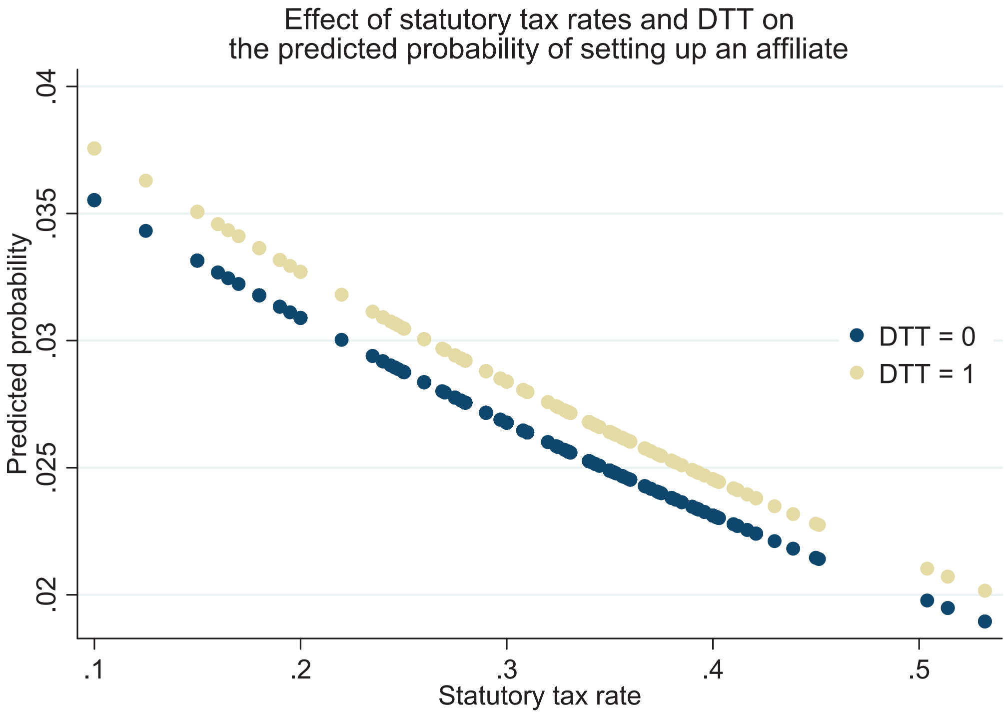

Figure 3.1: Effect of statutory tax rates and DTT on the predicted probability of setting up an affiliate

Again, the increase in the expected outcome associated with a change in $DTT_{j,t-1}$ is larger for countries with lower statutory tax rates. In Figure 3.3, the marginal effect of $DTT_{j,t-1}$ on the expected average volume of fixed assets of a firm in a host country ranges from about 0.7 mn Euro at a statutory tax rate of 0.53 to 2.8 mn at a tax rate of 0.10%.

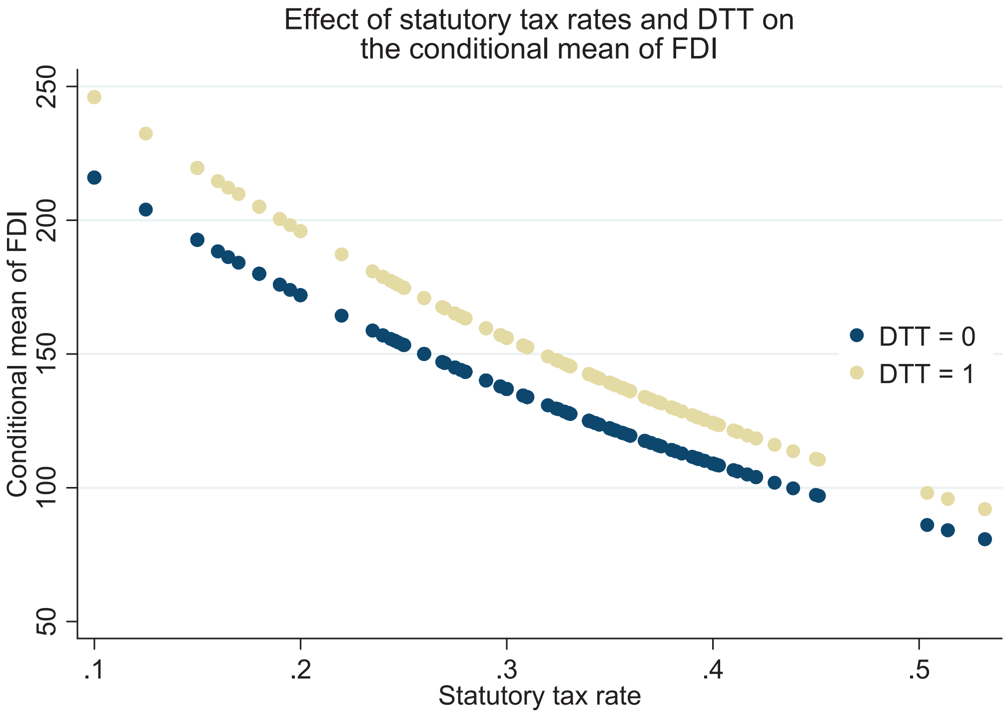

Figure 3.2: Effect of statutory tax rates and DTT on the conditional mean of FDI

3.5 Conclusions

This paper proposes estimating two-part empirical models for an assessment of the impact of profit tax policy instruments on outcome measuring bilateral multinational activity at the firm level. At the bilateral level, outcome of the activity of multinational enterprises (MNEs) is characterized by numerous zeros in the data, since MNEs tend to set up affiliates in only a small number of countries. From an empirical point of view this generates data on bilateral

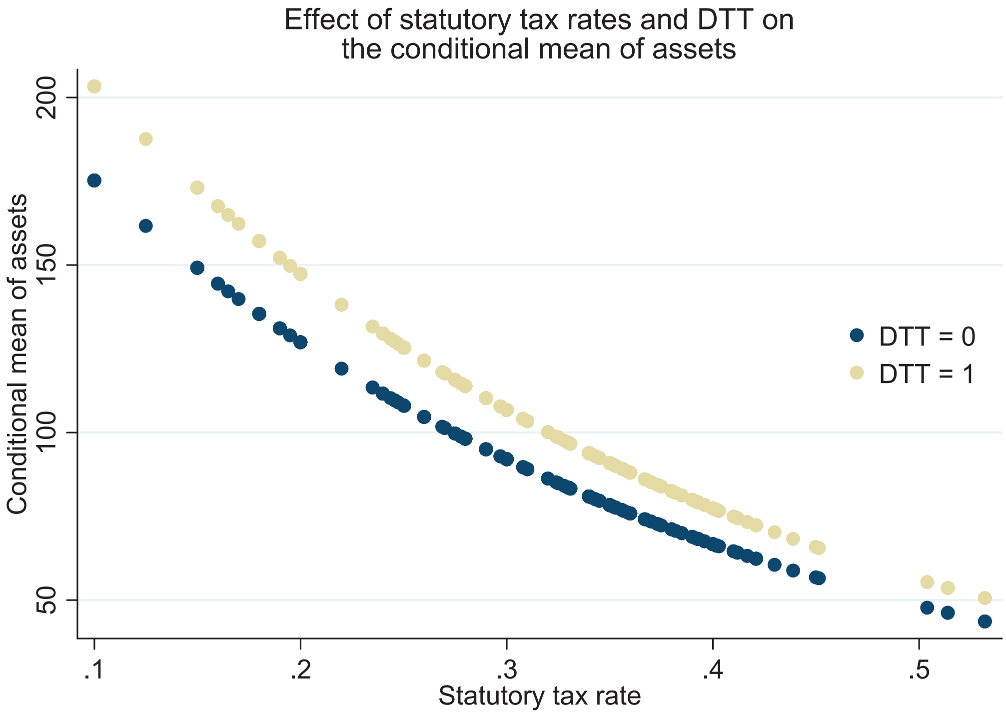

Figure 3.3: Effect of statutory tax rates and *DTT* on the conditional mean of *assets*

firm-level MNE activity with numerous zeros and a much smaller number of positive outcome about numbers of affiliates, employment abroad, stocks of FDI, or total assets abroad per host country. Accordingly, it is impossible for simple nonlinear models such as non-linear least squares or the Poisson quasi-maximum likelihood estimator (Poisson QMLE) to cope with the numerous zeros in the data appropriately. However, the empirical economist can improve tremendously on empirical model performance by resorting to a two-part modeling strategy, where one part is binary and about the extensive margin (zero versus positive outcome per firm and host country) and the other part is continuous and about the intensive margin. The latter can be estimated by ordinary least squares, nonlinear least squares, or Poisson QMLE. An advantage of the Poisson QMLE is that it is robust against misspecification of the error term if a log-transformation of the model is not appropriate (see Santos Silva and Tenreyro, 2006).

We apply Poisson QMLE with a two-part modeling strategy to firm-level data about the activity of German MNEs abroad. In particular, we focus on the the role of statutory corporate tax rates abroad and of double taxation treaties (DTTs) signed by Germany on the number of affiliates, total employment, stocks of foreign direct investment, and total assets in the host country. We employ panel data with annual frequency for the decade between 1996 and 2005 as made available by the Deutsche Bundesbank through its *MiDi* database.

We find that higher statutory tax rates in a potential host country reduce the probability of setting up the first affiliate by a German MNE there significantly. The latter relates to the extensive margin of investment by German MNEs. Also, higher statutory tax rates reduce the activity at the intensive margin, i.e., they tend to reduce the number of affiliates (beyond the first one), the number of employees, the value of FDI stocks, and the value of foreign assets. DTTs tend to raise the incentive of a first investment and, if having any effect at the intensive margin, they raise outbound FDI and foreign assets. However, the role of DTTs in absolute value is much smaller than the one of foreign statutory tax rates.

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Chapter 4

Unobserved Profit Shifting – A Finite Mixture Approach

Abstract

This paper investigates the tax responsiveness of multinationals' investment decisions in foreign countries, distinguishing firms that are able to shift profits (*shifters*) from those that are not (*non-shifters*). From a theoretical point of view, the tax responsiveness of firms crucially depends on this distinction. Empirically, however, a firm's ability to shift profits is inherently unobserved. To address this problem, we use a finite mixture modeling approach which allows us to distinguish shifters from non-shifters stochastically from a mixture of distributions of the two types of firms. Using a panel data-set of 38,705 foreign affiliates of the universe of German multinationals over the years 1996 to 2007, we find that shifters do not respond to host-country profit taxes at all, as expected, while taxes affect the investment decision of non-shifters. More specifically, a one-percentage-point increase in the statutory corporate profit tax rate of a host country is associated with a reduction of the fixed assets of non-shifters in the host country by 1.85%.

4.1 Introduction

A vast amount of empirical research on the profit-tax responsiveness of foreign direct investment (FDI) suggests a robust negative impact of profit taxation on the location and size of foreign investments. In a meta-analysis on the matter, De Mooij and Ederveen (2003) find that the median semi-elasticity amounts to −3.3. Hence, a one-percentage-point increase in a host country's (corporate) profit tax rate triggers, ceteris paribus, a decline of (bilateral) FDI by about 3.3% there.[1] However, the same study by De Mooij

[1] A more recent study of De Mooij and Ederveen (2006) finds a somewhat smaller median semi-elasticity of −2.1. Hines (1999) suggests an average profit tax elasticity of FDI of about −0.60.

and Ederveen (2003) also documents a big variance of the estimated profit tax elasticities of FDI across studies. Common explanations for the latter are the differences in the applied empirical specifications and the data used. Yet differences in tax elasticities may also be rationalized by the specific responses of heterogeneous firms.

Differences in the characteristics of multinational firms – such as their geographical affiliate pattern, their financial flexibility, their specialization pattern, firm size, etc. – may not only explain why some firms enter a specific market. Such characteristics crucially determine whether and to what extent a multinational can reduce its overall tax burden by shifting profits from high-tax to low-tax countries and, hence, a firm's responsiveness to profit taxes. In a recent paper, Egger, Eggert, and Winner (2010) investigate whether foreign plant ownership involves lower tax payments than domestic plant ownership. They find that tax payments of foreign-owned firms are lower than those of domestic firms in high-tax countries but higher in low-tax countries, which is consistent with the presumption that multinationals shift income. Of course, national firms are not able to shift income to other countries at all, but neither are all multinational firms necessarily capable of shifting profits to an arbitrary extent.

Which multinationals are able to shift profits, rendering them fairly insensitive to profit taxation? How big is their fraction in all firms? By how much differ shifters and non-shifters of profits in their tax responsiveness? Those appear to be questions of vital interest to economists and policy makers for the following reasons. First, with a coexistence of *shifting* multinationals (i.e.

unresponsive to taxes) and *non-shifting* multinationals (i.e. highly responsive to taxes), knowledge of an average rate of response of aggregate FDI is not informative about important margins at the firm level. In particular, it conceals effects on the distribution of the two types of firms. Second, to the extent that possible shifters and non-shifters differ with regard to economic characteristics such as average employment or their location within countries, knowledge of heterogeneous responses of these types of firms may allow us to draw conclusions for the responsiveness of specific economic (regional) aggregates to tax policy changes.

This paper sheds light on the impact of taxes on the investment decision of foreign affiliates of the universe of German multinationals by allowing for distinct responses of inherently unobserved shifters and non-shifters of profits. The logic is straightforward: a firm which is capable of shifting at least part of its tax base should be less affected by (i.e., less responsive to) changes in profit taxes with regard to its foreign investment decisions than others. By the same token, non-shifters should face higher costs of capital and, in turn, lower levels of investment in high-profit-tax host countries than shifters of profits. These arguments are consistent with theoretical work emphasizing that restrictions on the opportunities for tax planning may result in adverse consequences for multinationals' investment in high-tax countries, which subsequently may reinforce tax competition (see, for example, Keen, 2001; Janeba and Smart, 2003; Peralta, Wauthy, van Ypersele, 2006; Bucovetsky and Haufler, 2008; Haufler and Runkel, 2008).

The major challenge in analyzing empirically the different tax responsiveness of shifters and non-shifters is that profit shifting of multinational firms itself is inherently unobservable. We approach this issue by using a finite mixture model to estimate the different tax responsiveness of latent profit shifters and non-shifters. Finite mixture models are a semiparametric approach to modeling unobserved heterogeneity. The population of interest – in our case, all investments of the universe of German multinational firms – is assumed to be composed of a finite number of distinct but unidentified latent classes or population components – here, profit shifters and non-shifters. The density of all units (investments) is modeled as an additive mixture of the subpopulations. Any randomly drawn observation has a given a priori probability of belonging to one of the groups – shifters and non-shifters of profits. The unknown prior probability of belonging to either one of the classes is estimated along with the other parameters. That prior probability is assumed either constant and equal to the proportion of firms in that group, or it is parameterized and modeled as a function of observables which vary across observations.

Finite mixture models have been introduced in the econometrics literature by Heckman and Singer (1984) and have recently gained popularity in the health economics literature, where most studies use cross-sectional data (see Deb and Trivedi, 1997, 2002; Smith Conway, and Deb, 2005; Ayyagari, Deb, Fletcher, Gallo, and Sindelar, 2009a,b). Finite mixture models have been applied to panel data by Bago d'Uva (2005, 2006) or Deb and Trivedi (2011). In this paper we fit finite mixture models to a panel of foreign affiliates of German multinational firms, and account for affiliate-specific unobserved effects by modeling the conditional mean of the unobserved effects following the approach of Mundlak (1978) as popularized by Chamberlain (1984) and Wooldrige (2002).

To the best of our knowledge, this is the first paper to investigate whether and to which extent the investment decisions of multinational firms in host countries depend on their unobserved ability to shift profits or not. We identify two groups of firms which differ in their average investment levels and react differently to corporate profit taxation. The larger group of firms, associated with a lower average investment, is not able to shift profits and reacts negatively to corporate tax rates. The estimated tax semi-elasticity of these firms ranges from -1.85 to -2.32, magnitudes in line with previous findings. However, there is a smaller group of firms, which is characterized by a higher average investment, that displays no significant response to corporate taxes.

In our preferred specification, a one-percentage-point increase in the statutory profit tax rate is associated with a 1.85% lower stock of fixed assets of a *non-shifting* foreign affiliate. This effect amounts to 68,000 Euro for the average affiliate of that kind with an average investment of 3.65 million Euro in fixed assets. The average *shifting* affiliate has a much higher investment in fixed assets of about 155 million Euro. If such an affiliate were prevented from shifting profits and were to respond to corporate tax rates in the same way as the average *non-shifting* affiliate, the estimated semi-elasticity would imply an effect of 2.88 million Euro of fixed assets per percentage point tax increase.

The findings carry implications for tax policy. The consequences for a given country of introducing measures to prevent profit shifting will depend on the composition of affiliates investing in that country. To the extent that a considerable proportion of a country's foreign investments are carried out by firms that shift profits, the adoption of a policy to restrict profit-shifting opportunities would expose them to tax competition with other countries over the *shifting* firms' investments. The country would have to lower corporate profit tax rates significantly in order to prevent a significant relocation of plants and capital of investment projects from its jurisdiction.

The remainder of the paper is organized as follows. Section 4.2 discusses the empirical literature on profit taxation and multinational firms. Section 4.3 presents a very simple model, briefly demonstrating that the tax elasticity of capital depends on the extent to which a firm is able to shift income. Section 4.4.1 describes the econometric model applied. Section 4.4.2 presents the data we use for the empirical investigation. The results are discussed in Section 4.5. Finally, Section 4.6 concludes.

4.2 State of the Literature – Empirical Research on Profit Taxes and Multinational Firms

Our study is related to the empirical literature on the consequences of profit taxation on multinational firm behavior, which is basically organized along three lines of interest. First, some work focuses on the role of profit taxes for the location decision of firms' lumpy investments (for example, Devereux and Griffith, 1998; Devereux and Griffith, 2003; Büttner and Ruf, 2007; Barrios, Huizinga, Laeven, Nicodème, 2008; Becker, Egger and Merlo, 2009). A second line of research is concerned with the question of how taxes affect a firm's level of foreign investment or assets held abroad (for a review and meta-studies of empirical work see De Mooij and Ederveen, 2003, 2006, 2008). A third line of work is interested in the extent of tax avoidance through profit shifting, debt shifting, or transfer pricing (Grubert and Mutti, 1991; Hines and Rice, 1994; Swenson, 2001; Clausing, 2003; Huizinga and Laeven, 2008; Huizinga, Laeven and Nicodème, 2008; Buettner and Wamser, 2009; Weichenrieder, 2009; Egger, Eggert, Winner, 2010; Egger, Eggert, Keuschnigg, Winner, 2010). While Grubert and Mutti (1991), Hines and Rice (1994), Huizinga and Laeven (2008) and Weichenrieder (2009) focus on the allocation of profits, other work investigates specific strategies that are used to shift income to low-tax countries. For instance, Huizinga, Laeven and Nicodème (2008) and Büttner and Wamser (2009) examine how tax-rate differentials affect the use of debt. Swenson (2001) and Clausing (2003) investigate how firms manipulate internal transfer prices to reduce taxation.

Other studies analyze how investment decisions of firms are affected by tax-planning strategies. Hines (1996) investigates foreign investment in the U.S. distinguishing between investors from countries that exempt foreign income and investors from countries that grant foreign tax credits. He shows that investors operating under tax-credit systems exhibit a lower tax sensitivity than investors from countries with tax-exemption regimes. Overesch (2009) draws indirect conclusions from country characteristics that might determine the opportunities to shift profits. In particular, investment in a host country may depend on the tax rate at the location of the direct owner and, hence, given that firms shift profits, the cost of capital in the host country may increase in the tax rate at the direct owner's location. Overesch and Wamser (2009) show that the profit tax responses of multinational firms depend on firm characteristics, which may be related to profit-shifting opportunities.

The studies just mentioned suggest that tax bases may be unbundled from real economic activity, at least to some extent. This has major implications for decisions of multinational firms. For instance, profit taxes have a limited relevance for location and investment decisions. In particular, the ability to shift profits should reduce the profit-tax responsiveness of firms' investments. However, although some observed characteristics of multinational firms facilitate tax-planning activities, for the most part, whether and to what extent firms shift profits is unobserved. To the best of our knowledge, this is the first paper to investigate how the investment decisions of multinational firms in host countries depend on their unobserved ability to shift profits.

4.3 Profit Shifting and the Tax Responsiveness of Capital

To see how firms' investments may differ with respect to their tax elasticities, consider a very simple model of foreign investment of a multinational firm.

The multinational maximizes profits Π of a foreign subsidiary i. To keep the analysis simple, let us assume that capital K_i is the only factor of production. Output is determined by the production function $F(K_i)$, which has standard properties such as $F'(K_i) > 0$ and $F''(K_i) < 0$. We further denote the cost of capital by r_i. The profit function is then defined as

$$\Pi_i \quad = \quad F(K_i) - \tau F(K_i)(1 - \phi_i) - r_i K_i, \tag{4.1}$$

where τ denotes the local tax rate. The tax base (profit) is determined by production $F(K_i)$. Without any profit shifting, total tax payments amount to $\tau F(K_i)$. The parameter ϕ_i, $0 \leq \phi_i \leq 1$, captures the degree of profit shifting (by using transfer pricing, debt shifting, or royalty payment strategies). If $\phi_i = 1$, the firm is able to shift all profits and effectively pays no taxes, i.e., $\tau F(K_i) - \tau \phi_i F(K_i) = 0$. The case without profit shifting is described by $\phi_i = 0$. Differentiating this simple problem with respect to K_i yields

$$F'(K) = \frac{r_i}{1 - \tau(1 - \phi)}. \tag{4.2}$$

Given the usual properties of $F(K_i)$, this directly implies that non-shifters with $\phi_i = 0$ require a higher marginal product of capital than shifters. In contrast, in the extreme case with $\phi_i = 1$, the marginal decision does no longer depend on τ. In view of this, the tax elasticity of K_i can then be written as

$$\frac{dK_i}{d\tau} = \frac{(1 - \phi)F'(K_i)}{F''(K_i)[1 - \tau(1 - \phi)]} < 0. \tag{4.3}$$

Assuming that a firm is able to reduce its tax base to zero by shifting all profits, equation (4.3) implies that the tax elasticity of K_i is zero, i.e., the subsidiary will not respond to changes in τ. For all positive values of $\phi_i < 1$, the tax response of a firm is smaller (less negative) compared with the case of no profit shifting with $\phi_i = 0$.

4.4 Empirical Approach

4.4.1 A Finite Mixture Model

We are interested in the tax elasticity of the fixed assets of foreign affiliates of German multinational firms. We expect tax responses of foreign affiliates that are able to shift taxable income between different locations (*shifters*) to differ from those of affiliates which can not shift profits (*non-shifters*). In particular, non-shifters are expected to be affected by corporate profit taxation, and thus have higher costs of capital and lower levels of fixed assets than shifters at positive tax rates. However, whether an affiliate shifts profits or not is unobserved. One way to approach this problem empirically is in terms of a latent class analysis: the population of affiliates is considered to be composed of two underlying latent classes or population components (see Aitkin and Rubin, 1985). We use a finite mixture model to estimate the different tax responsiveness of two latent classes of affiliates, profit shifters (s) and non-shifters (ns). In this model, the whole sample of affiliates is seen as a probabilistic mixture from two subpopulations with different densities.[2]

Let y_{it} denote the stock of fixed assets of affiliate $i = 1, \ldots, N$ in period $t = 1, \ldots, T$. The outcome y_{it} is characterized by one of two different densities f^ℓ, $\ell = \{s, ns\}$, with the same distributional form but different parameters $\boldsymbol{\theta}^\ell$, depending on whether affiliate i is able to shift profits in period t or not. Let $\mathbf{x}_{it}$ be a $1 \times K$ vector of affiliate- and country-specific explanatory variables, and c_i a time-invariant affiliate-specific effect. The following density defines a two-component finite mixture

$$\begin{aligned} f(y_{it}|\mathbf{x}_{it}, \boldsymbol{\theta}^s, \boldsymbol{\theta}^{ns}, c_i, \pi^{ns}) &= \pi^{ns} f^{ns}(y_{it}|\mathbf{x}_{it}, \boldsymbol{\theta}^{ns}, c_i) \\ &+ (1 - \pi^{ns}) f^s(y_{it}|\mathbf{x}_{it}, \boldsymbol{\theta}^s, c_i), \end{aligned} \tag{4.4}$$

where $0 \leq \pi^{ns} \leq 1$. π^{ns} is the fraction of affiliates that can not shift profits in period t. Their outcome y_{it} is characterized by $f^{ns}(y_{it}|\mathbf{x}_{it}, \boldsymbol{\theta}^{ns}, c_i)$. The fraction $\pi^s = (1 - \pi^{ns})$ of affiliates is able to shift profits and is characterized by the density $f^s(y_{it}|\mathbf{x}_{it}, \boldsymbol{\theta}^s, c_i)$.

While the fraction π^{ns} is unknown, it can be estimated along with the parameters we are interested in, $\boldsymbol{\theta}^\ell$. In principle, we could treat the probability π^{ns} of belonging to the group of non-shifting affiliates as an unknown constant. But since we observe characteristics of the affiliates which have an influence on that probability, we may parameterize π^{ns} by using, e.g., a logistic func-

[2] The densities differ in their moments but have the same distributional form.

tion and allow it to depend on observable characteristics. For this, let us write

$$\pi^{ns} = \frac{exp(\mathbf{z'}_{it}\boldsymbol{\delta})}{[1 + exp(\mathbf{z'}_{it}\boldsymbol{\delta})]}, \tag{4.5}$$

where $\mathbf{z}_{it}$ is a $1 \times Q$ vector of observed characteristics that determine the probability of profit shifting.

We specify an exponential conditional mean model for an affiliate's fixed assets y_{it}, where the unobserved time-invariant affiliate-specific effect c_i enters multiplicatively, so that $E(y_{it}|x_{i1}, \ldots, x_{iT}, c_i) = c_i exp(\mathbf{x'}_{it}\boldsymbol{\beta}^{\ell})$. We follow the approach introduced by Mundlak (1978) and popularized by Chamberlain (1984) and Wooldridge (2002), and allow c_i to be correlated with the individual-specific averages of the regressors across all periods, $\bar{\mathbf{x}}_i = T^{-1}\sum_{t=1}^{T}\mathbf{x}_{it}$. In particular, we specify $E(c_i|x_{i1}, \ldots, x_{iT}) = exp(\gamma^{\ell} + \bar{\mathbf{x}}_i'\boldsymbol{\xi}^{\ell})$, which implies the conditional mean

$$E(y_{it}|x_{i1}, \ldots, x_{iT}) = exp(\gamma^{\ell} + \mathbf{x'}_{it}\boldsymbol{\beta}^{\ell} + \bar{\mathbf{x}}_i'\boldsymbol{\xi}^{\ell}) \tag{4.6}$$

by iterated expectations.[3]

Furthermore, we specify the density $f^{\ell}(y_{it}|\boldsymbol{\theta}^{\ell})$ as a negative binomial with

[3] By the law of iterated expectations,

$$\begin{aligned} E(y_{it}|x_{i1}, \ldots, x_{iT}) &= E[E(y_{it}|x_{i1}, \ldots, x_{iT}, c_i)|x_{i1}, \ldots, x_{iT}] \\ &= E[c_i exp(\mathbf{x'}_{it}\boldsymbol{\beta}^{\ell})|x_{i1}, \ldots, x_{iT}] \\ &= E(c_i|x_{i1}, \ldots, x_{iT}) exp(\mathbf{x'}_{it}\boldsymbol{\beta}^{\ell}) \\ &= exp(\gamma^{\ell} + \mathbf{x'}_{it}\boldsymbol{\beta}^{\ell} + \bar{\mathbf{x}}_i'\boldsymbol{\xi}^{\ell}). \end{aligned}$$

See Wooldridge (2002, chapter 19).

parameters $\mu_{it}^{\ell} = exp(\mathbf{x'}_{it}\boldsymbol{\beta}^{\ell})$ and α^{ℓ}, where $\boldsymbol{\theta}^{\ell} = (\boldsymbol{\beta}^{\ell}, \alpha^{\ell})$, $\ell = \{s, ns\}$.[4] Alternatively, we fit a model to the logarithm of fixed assets $ln(y_{it})$ and specify $f^{\ell}(y_{it}|\boldsymbol{\theta}^{\ell})$ as a normal distribution. The estimation is performed by maximum likelihood.

The posterior probability that observation y_{it} belongs to the group of *non-shifters* is given by

$$Pr(y_{it} \in ns) = \frac{\pi^{ns} f^{ns}(y_{it}|\mathbf{x}_{it}, \boldsymbol{\theta}^{ns}, c_i)}{\pi^{ns} f^{ns}(y_{it}|\mathbf{x}_{it}, \boldsymbol{\theta}^{ns}, c_i) + (1 - \pi^{ns}) f^{s}(y_{it}|\mathbf{x}_{it}, \boldsymbol{\theta}^{s}, c_i)}. \tag{4.7}$$

Equation 4.7 allows us to classify observations into the groups after estimating the model.

4.4.2 Data and Specification

We use the *Microdatabase Direct Investment (MiDi)* provided by Deutsche Bundesbank (the German Central Bank; see Lipponer, 2009, for a docu-

[4] The negative binomial distribution is obtained by assuming that the dependent variable y_{it} follows a Poisson distribution with parameter λ_{it}, and letting $\lambda_{it} = \mu_{it}\nu_{it}$. μ_{it} is in our case $exp(\mathbf{x}'_{it}\boldsymbol{\beta})$ and ν_{it} is a gamma-distributed random unobserved component with parameter $m = 1/\alpha$. The marginal distribution of y_{it} conditional on the deterministic parameters μ_{it} and α is obtained by integrating ν_{it} out, which gives $f(y_{it}|\mu_{it}, \alpha) = \int h(y_{it}|\mu_{it}, \alpha) g(\nu_{it}|\alpha) d\nu = \frac{\Gamma(\alpha^{-1}+y_{it})}{\Gamma(\alpha^{-1})\Gamma(y_{it}+1)} (\frac{\alpha^{-1}}{\alpha^{-1}+\mu_{it}})^{\alpha^{-1}} (\frac{\mu_{it}}{\mu_{it}+\alpha^{-1}})^{y}_{it}$. Letting α be a parameter to be estimated obtains the conditional variance $V[y_{it}|\mu_{it}, \alpha] = \mu_{it}(1 + \alpha\mu_{it})$, which is quadratic in the mean allowing for overdispersion in the data. This version of the model is called negative binomial 2 (NB2). See Cameron and Trivedi (2006) for details. By choosing a negative binomial model, we allow for unobserved heterogeneity within each subpopulation (or latent class).

mentation).[5] This data-set contains annual statistics on virtually all foreign affiliates of German multinationals. All German investors holding 10% or more of shares or voting rights in foreign firms with a balance sheet total of more than 3 million Euro are required by law to report to the Deutsche Bundesbank balance-sheet information as well as information on the sector, legal form, and number of employees of their foreign affiliates. Indirect participating interests are to be reported whenever residents hold more than 50% in a foreign firm and these dependent enterprises themselves hold 50% or more of the shares or voting rights in other foreign enterprises.[6]

Our sample comprises 38,705 foreign affiliates of 9,803 German multinational firms investing in 85 countries over the period 1996 to 2007. Altogether, we have 191,116 observations on the stock of fixed assets of these foreign affiliates.

We are predominantly interested in the effect of the statutory corporate income tax rate of a host country j in year t, $CITR_{jt}$, on the fixed assets of foreign affiliates. As alternative tax measures, we use the effective average tax rate, $EATR_{jt}$, and the effective marginal tax rate, $EMTR_{jt}$. The first one measures the tax effect on the after-tax net present value of investments, and the latter reflects the tax burden on the cost of capital, i.e., the returns on a marginal investment. These two measures consider all rules determining

[5]The data-set is made available only under strict conditions and for clearly defined academic research purposes and can be used exclusively at the Bank's Research Center.

[6]The reporting requirements are set by the Foreign Trade and Payments Regulation. Reporting thresholds have been changed in the past, for details and a documentation on the micro-level data-set *MiDi* see Lipponer (2009).

the tax base (such as depreciation allowances). Previous work suggests that while the relevant tax measure determining the size of an investment – conditional on the location choice – is the effective marginal tax rate, the effective average tax rate is what determines discrete (lumpy) investment decisions and location choice (Devereux and Griffith, 1998, 2003). However, these two alternative tax measures are available only for a subset of the countries in the sample, leading to a loss of almost 40,000 observations. For this reason we include $CITR_{jt}$ in our preferred specification.[7] In any case, we expect a higher tax rate to raise the cost of capital and affect investment in fixed assets negatively to the extent that a foreign affiliate is unable to avoid taxation by shifting profits.

The theory of multinational firms and trade suggests that multinational firm activity depends mainly on market size, skilled labor endowments, capital-labor ratios, factor prices, and trade and investment costs (see Carr, Markusen, and Maskus, 2001; Markusen, 2002; Markusen and Maskus, 2002; Blonigen, Davies, and Head, 2003; and Bergstrand and Egger, 2007; Blonigen and Piger, 2010). This motivates the choice of the remaining variables included in the vector $\mathbf{x}_{it}$. To capture market size, we include GDP_{jt}, the log of real GDP. The tertiary school enrolment rate, $SKILL_{jt}$, and the log capital-labor ratio, $KLRAT_{jt}$, reflect relative factor endowments. The log of real GDP per capita, $GDPPC_{jt}$, is a proxy for labor costs; the local lending interest rate,

[7]Buettner and Ruf (2007) and Overesch and Wamser (2009, 2010) show that the statutory corporate income tax rate is an appropriate alternative to the effective average tax rate. Devereux and Griffith (2003) point out that the effective average tax rate is a weighted average of the effective marginal tax rate and the statutory tax rate, and it converges to the latter as profits rise.

$LEND_{jt}$, and inflation rate, $INFL_{jt}$, reflect capital costs. We also include a corruption perception index, CPI_{jt}, and a measure of banking efficiency, $FINFR_{jt}$, to control for investment costs. Trade costs are usually assumed to be fixed over a short time span as ours and are captured in our application (along with every other time-invariant factor) by the affiliate-specific fixed effect c_i.

The vector $\mathbf{z}_{it}$ includes determinants of the probability of shifting profits. In our case, these are the number of affiliated enterprises in other countries, $NSIS_{it}$, and a variable capturing the affiliate-specific tax incentive to shift profits defined as the average tax rate over all countries *with a lower tax rate* in which the affiliate has other affiliated enterprises, PSI_{it}.[8] A larger number of affiliated enterprises abroad should facilitate profit shifting, so we expect $NSIS_{it}$ to increase the probability of shifting profits. We expect PSI_{it} to have a negative effect on the propensity to shift profits, since a higher average tax rate in other locations of the multinational firm lowers the incentive of that specific affiliate to shift profits. As robustness checks, we use alternative specifications for the probability of shifting profits. We include following variables alternatively: IDR_{it}, the ratio of internal borrowing over capital, OS_{it}, the ownership share of the German parent, and $R\&D_{it}$, a

[8] To be specific, the tax incentive of any affiliate i of multinational firm k in country j in year t arises from the tax rates at other locations including the parent country and is defined as

$$PSI_{it} = \begin{cases} \sum_{m=1}^{M} \tau_{mt}, & \text{if } \tau_{jt} > \tau_{mt,\; m \neq j}, \\ \tau_{jt} & \text{otherwise.} \end{cases}$$

M is the number of countries *other than* j in which multinational firm k holds affiliates (including Germany, the parent country), τ_{mt} is the corporate tax rate in each of these countries.

dummy indicating if the affiliate operates in the R&D sector. We expect a higher internal-debt-to-capital ratio (IDR_{it}) to be an indicator of profit shifting through debt shifting (see, e.g. Desai, Foley and Hines, 2004a). Desai, Foley and Hines (2004b) point out that while partial ownership is associated with coordination costs, whole ownership facilitates worldwide tax planning. Grubert (2003) argues that R&D intensive affiliates have more opportunities to shift profits because they engage in a greater amount of intra-firm transactions.

Table 4.1: Descriptive Statistics

	Description	Mean	Std. Dev.
Dependent Variable			
$FixedAssets_{it}$	Foreign affiliate's fixed assets in million Euro	19.360	261.407
Independent Variables explaining *Fixed Assets*			
$CITR_{jt}$	Statutory corporate income tax rate	0.325	0.071
$EATR_{jt}$	Effective average tax rate	0.295	0.065
$EMTR_{jt}$	Effective marginal tax rate	0.230	0.079
GDP_{jt}	log(real GDP)	27.505	1.380
$KLRAT_{jt}$	log(capital-labor ratio)	10.574	0.926
$SKILL_{jt}$	Tertiary school enrollment rate	53.547	17.912
$GDPPC_{jt}$	log(real GDP per capita)	9.576	0.991
$LEND_{jt}$	Lending interest rate	8.627	9.875
$INFL_{jt}$	Inflation rate	3.186	5.120
CPI_{jt}	Corruption perception index (0: totally corrupt – 10: corruption free)	6.588	2.004
$FINFR_{jt}$	Financial freedom index (0: repressive – 100: negligible government influence)	69.371	18.378
Independent Variables explaining π^{ns}			
$NSIS_{it}$	Number of affiliated enterprises in other countries	26.916	56.643
PSI_{it}	Profit-shifting incentive	0.276	0.063
IDR_{it}	Internal-debt-to-capital ratio	0.180	0.248
OS_{it}	Ownership share of German parent	0.901	0.204
$R\&D_{it}$	1 if affiliate operates in the R&D sector, 0 otherwise	0.003	0.055
Observations		191,116	

Notes: Panel of 191,116 observations on 38,705 foreign affiliates in 85 countries over the period 1996-2007. The variables *EATR* and *EMTR* are available for 152,660 observations.

Table 4.1 provides descriptive statistics for all variables. All tax data is collected from databases provided by the International Bureau of Fiscal Documentation (IBFD) and tax surveys provided by Ernst&Young, PwC and KPMG. The data on real GDP, capital-labor ratios, [9] tertiary school enrollment and lending interest rate come from the 2009 edition of the World Bank's World Development Indicators. The corruption perception index is published annually by Transparency International and ranks countries from 10 (corruption free) to 0 (almost totally corrupt) according to perceived levels of corruption determined by expert assessments and opinion surveys. The inflation rate is taken from the IMF World Economic Outlook. The financial freedom indicator is published annually by the Heritage Foundation and measures banking efficiency as well as independence from government control and interference in the financial sector, ranking economies from 100 (negligible government influence) to 0 (repressive). The variables $NSIS_{it}$, PSI_{it}, IDR_{it}, OS_{it}, and $R\&D_{it}$ are constructed upon information taken from *MiDi*.

4.5 Results

We provide results of two-component negative binomial mixture models for the effects of corporate taxes on the fixed assets of foreign affiliates, and compare them with estimates from a simple negative binomial regression for the preferred specification. We then provide, as a robustness check, finite

[9] Capital stocks are computed by using the perpetual inventory method as in Bergstrand and Egger (2007).

mixture models with an alternative specification of the probability equation and a two-component normal mixture model for the log of fixed assets.

The first column of Table 4.2 presents the results of a negative binomial regression, disregarding the possibility of latent components in the population of foreign affiliates. There, the estimated effect of the statutory tax rate on the fixed assets of the foreign affiliates in our sample is negative but not statistically significant.[10] The remaining 4 columns show the results of two-component negative binomial mixture models. When we allow for two latent components in the population, we find that the tax responses differ significantly across components. Across all specifications, we identify a larger component associated with a lower conditional mean for fixed assets which reacts significantly to tax rates, and a smaller one associated with a high fixed assets mean which seems to be unaffected by corporate taxation. We associate the first component with the *non-shifter* group and the second one with the *shifter* group. Let us discuss the results for each group in detail.

[10]Note that, while previous research using the same data-set and a similar regression technique do find significant tax effects, they do so for a smaller sample of firms than the one we have here (9,803 parent firms holding 38,705 affiliates in 85 host countries). Egger and Merlo (2011) find a significant tax effect on the fixed assets at the *parent firm* level in a poisson regression including only 6915 parent firms in 51 host countries and excluding indirectly-held affiliates. While there, the exclusion of indirectly-held affiliates was necessary, we explicitly want to have them in this analysis.

Table 4.2: The Impact of Taxes on Non-Shifting and Shifting Firms

	Negative Binomial	2-component Negative Binomial Mixture Model							
		Non-Shifter	*Shifter*	*Non-Shifter*	*Shifter*	*Non-Shifter*	*Shifter*	*Non-Shifter*	*Shifter*
$CITR_{jt}$	-0.653	-1.947***	-0.633	-1.854***	-0.190				
	(0.557)	(0.235)	(0.796)	(0.248)	(0.858)				
$EATR_{jt}$						-1.238***	1.826		
						(0.259)	(1.18)		
$EMTR_{jt}$								-0.236*	0.472
								(0.130)	(0.460)
GDP_{jt}	-0.511**	0.340	-0.825**	0.482*	-0.683	0.267	-0.596	-0.645	-0.718***
	(0.246)	(0.296)	(0.395)	(0.276)	(0.438)	(0.328)	(0.487)	(0.667)	(0.245)
$KLRAT_{jt}$	-0.706**	0.270*	-0.882**	0.358**	-0.860**	0.114	-1.844**	-0.047	-1.971***
	(0.299)	(0.158)	(0.398)	(0.157)	(0.390)	(0.306)	(0.811)	(0.303)	(0.786)
$SKILL_{jt}$	-0.009**	0.003*	-0.010**	0.003**	-0.009*	0.003*	-0.013*	0.002	-0.012
	(0.004)	(0.001)	(0.005)	(0.001)	(0.005)	(0.002)	(0.008)	(0.002)	(0.008)
$GDPPC_{jt}$	2.066***	0.837***	2.833***	0.697**	2.807***	1.933***	4.086***	2.728***	3.755***
	(0.551)	(0.318)	(0.728)	(0.297)	(0.734)	(0.376)	(0.901)	(0.656)	(.912)
$LEND_{jt}$	0.001	0.002	-0.001	0.001	0.000	0.012**	-0.009	0.008	-0.012
	(0.004)	(0.001)	(0.007)	(0.001)	(0.006)	(0.005)	(0.013)	(0.005)	(0.016)
$INFL_{jt}$	-0.008**	-0.005**	-0.009	-0.004*	-0.010	-0.013***	-0.010	-0.012***	-0.005
	(0.004)	(0.002)	(0.008)	(0.002)	(0.006)	(0.005)	(0.015)	(0.005)	(0.022)
CPI_{jt}	-0.035	0.048***	-0.073*	0.048***	-0.063	0.064***	-0.025	0.054***	-0.039
	(0.028)	(0.012)	(0.043)	(0.012)	(0.043)	(0.013)	(0.049)	(0.014)	(0.049)
$FINFR_{jt}$	0.001	0.000	0.001	-0.001	0.001	-0.005***	0.0001	-0.004***	0.001
	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.003)	(0.001)	(0.003)
Pr(*Non-Shifter*)									
$NSIS_{it}$				-0.002***		-0.002***		-0.002***	
				(0.001)		(0.001)		(0.001)	
PSI_{it}				2.308***		3.065***		2.879***	
				(0.464)		(0.500)		(0.434)	
constant		1.694***		1.793***		1.698***		1.545***	
		(0.068)		(0.245)		(0.250)		(0.219)	
Predicted Mean	16.985	3.634	87.263	3.542	77.381	3.531	76.736	3.533	77.267
% of sample		84.47	15.53	89.64	10.36	89.25	10.75	89.35	10.65
Observations	*191,116*	*191,116*		*191,116*		*152,660*		*152,660*	

Notes: The dependent variable refers to the fixed assets of a foreign affiliate. All regressions include time dummies and affiliate-specific effects. Robust and clustered (by affiliate) standard errors reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively. The % of sample classified as belonging to either component is obtained after estimation using the calculated posterior probability of belonging to each component.

The second column shows a model with a constant prior probability of belonging to either component. For the *non-shifters* (84% of the sample), the estimated semi-elasticity of the statutory corporate tax rate amounts to -1.95 and is highly significant.[11,12] For the *shifters*, the smaller population component (about 16% of the sample), the point estimate of the tax variable is also negative, though lower than the estimate for the *non-shifters* and statistically insignificant. In this model, the prior probability of belonging to the *non-shifter* group is specified as constant. Since we have information on characteristics that affect that probability, we may let it depend on observables. The third column shows a model where the probability of being a *non-shifter* depends on the number of affiliated enterprises in other countries, $NSIS_{it}$, and on PSI_{it}, a variable capturing the affiliate-specific tax incentive to shift profits defined as the average tax rate over all countries *with a lower tax rate* in which the firm to which the affiliate belongs has other affiliated entities. As expected, a higher number of affiliated entities abroad lowers the probability of being in the *non-shifter* group, and a higher average tax rate at the location of such affiliated entreprises (a lower incentive to shift profits) increases the probability of being a *non-shifter*. Both effects are highly significant. The *non-shifter* group is somewhat larger than in the previous model (89.4% of the sample) and its tax response remains negative and highly significant. The estimated tax semi-elasticity of -1.85

[11]In any model with an exponential conditional mean $E(y|\mathbf{x}) = exp(\mathbf{x}'\beta)$, the regression coefficients can be interpreted as semi-elasticities since the marginal effect $ME_k = E(y|\mathbf{x}) \times \beta_k$, so $\beta_k = ME_k/E(y|\mathbf{x})$ (see Cameron and Trivedi, 2005).

[12]The estimated coefficients of both components are obtained simultaneously through maximum likelihood estimation using the whole sample. The % of the sample classified as *non-shifters* is obtained after estimation using the calculated posterior probability of belonging to that group (see equation 4.7).

is lower than in the previous model, but the confidence intervals overlap. Table 4.3 reports Akaike's and Schwarz's Bayesian information criteria for the 3 models discussed above. The negative binomial mixture model with parametrized probability (FMNB) achieves the smaller values, indicating a better fit. Table 4.3 also reports likelihood ratio tests for the negative binomial (NB) model against both the negative binomial mixture model with constant probability (FMNB-CP) and FMNB, and for the FMNB-CP against the FMNB. In all cases, the null hypothesis of the constrained model being true can be rejected. The FMNB model, displayed in the third column of Table 4.2, is thus the preferred model.

Table 4.3: Satistics for Model Selection

Model	Log-Likelihood	k	AIC	BIC
NB	-604060.60	31	1208183.20	1208498.18
FMNB-CP	-562119.50	63	1124365.00	1125005.12
FMNB	-560587.48	67	1121308.96	1121989.72

Likelihood-ratio Test

Null	Alternative	LR-statistic	d.f	p-value
NB	FMNB-CP	83882.20	32	0.000
NB	FMNB	86946.24	36	0.000
FMNB-CP	FMNB	3064.04	4	0.000

Notes: The statistics refer to the models displayed in the first 3 columns of Table 4.2: the Negative Binomial (NB), the 2-component Negative Binomial Mixture with constant probability (FMNB-CP), and the 2-component Negative Binomial Mixture with parametrized probability (FMNB). k is the number of estimated parameters in each model. AIC is Akaike's information criteria and BIC is Schwarz's Bayesian information criteria. The lower part of the table reports likelihood ratio test for the alternative model against the constrained model.

The two population components differ as well in terms of the parameters of the remaining variables. In our preferred specification, the effect of GDP_{jt} is positive and significant for the *non-shifter* group but insignificant for the *shifters*. The variables $KLRAT_{jt}$ and $SKILL_{jt}$ have opposite significant effects for each group: positive for the larger group of *non-shifters* and negative for the *shifters*. This results are consistent with a prevalence of large-market-seeking horizontal multinationals – producing the same product at home and at the host market – in the *non-shifter* group and a greater presence of vertical multinational firms – producing headquarter services in skill-abundant countries and goods in skill-scarce economies – among the *shifters*. Given that vertically integrated firms may have more opportunities to shift profits through transfer pricing than horizontal firms, this makes sense. The variable $GDPPC_{jt}$, which reflects labor costs, has a positive and significant effect for both groups. Both a higher inflation rate and higher perceived corruption have a negative effect on the fixed assets of the *non-shifter* group but doesn't seem to affect the *shifters*. Table 4.4 reports Wald tests of coefficient equality across components. The null hypothesis that coefficients across components are equal can not be rejected for the parameters of the lending rate, the inflation rate and the financial freedom index. For the rest of the explanatory variables, most importantly in the case of the statutory tax rate, the estimated parameters differ significantly across components.

We can use the predicted posterior probability of belonging to either component to classify the individual observations into *shifters* and *non-shifters*. Table 4.5 reports the means of the dependent and explanatory variables for each component after splitting the sample according to the predictions of our preferred model. The firms classified as *shifters* invest an average amount

Table 4.4: Wald Tests of Coefficient Equality Across Components

Parameter	χ^2 statistic	d.f.	P-value
$CITR_{jt}$	3.90	1	0.048
GDP_{jt}	4.65	1	0.031
$KLRAT_{jt}$	8.52	1	0.004
$SKILL_{jt}$	6.31	1	0.012
$GDPPC_{jt}$	6.78	1	0.009
$LEND_{jt}$	0.02	1	0.896
$INFL_{jt}$	0.68	1	0.411
CPI_{jt}	6.52	1	0.011
$FINFR_{jt}$	0.46	1	0.497
All coefficients	126.07	29	0.000

Notes: Tests based on the regression displayed in the first two columns of Table 4.2. The test of joint equality of all coefficients across components includes the individual means and the year dummies.

of 155 million Euro in fixed assets, while the *non-shifters* have an average investment of just 3.65 million Euro. Even though they constitute only 10% of the sample, *shifters* account for 83% of the total stock of fixed assets held abroad by German multinational firms. *Shifters* have on average 82.6 affiliated enterprises of the same parent in other countries, *non-shifters* only 20.4. The country-specific explanatory variables, especially the tax measures, show no significant difference across groups.

From the third column of Table 4.2, we know that the means of the predicted values of fixed assets amount to 3.54 and 77.38 for *non-shifters* and *shifters*,

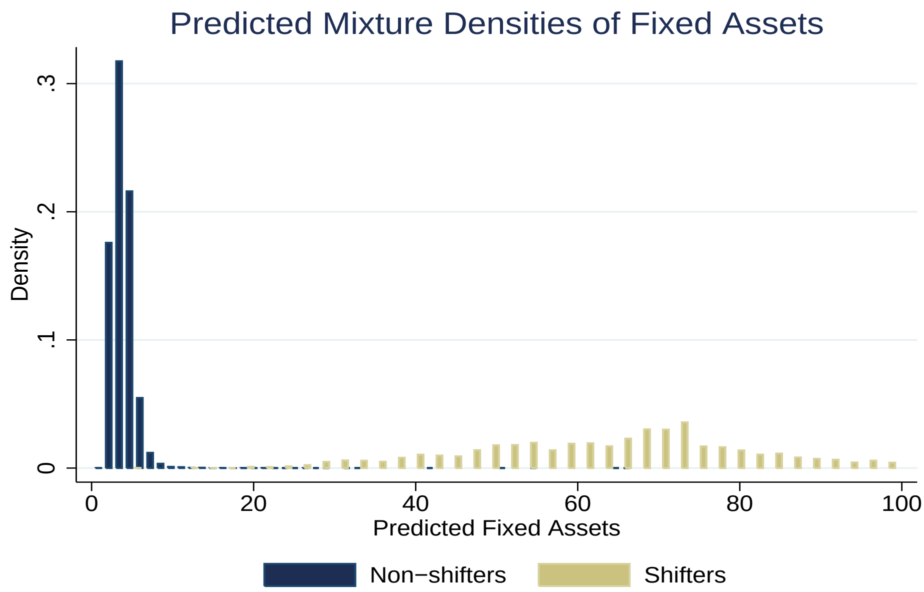

Figure 4.1: Predicted mixture densities of fixed assets

respectively. Figure 4.1 shows the predicted mixture densities, and reveals that the estimated component distributions overlap in a wide range of values. This highlights the fact that the finite mixture model captures latent heterogeneity and improves the assessment of differential tax responses that could be made relying only on a mere grouping of firms according to their investment levels. Figure 4.2 displays the average investment in fixed assets by quantiles of the distribution of the corporate tax rate, for *non-shifters* and *shifters*. Two things strike our attention. First, the differences between average levels of investments across the two components are significant, irrespective of the tax rate. Second, *shifters* seem to invest the most, on average, in high-tax countries.

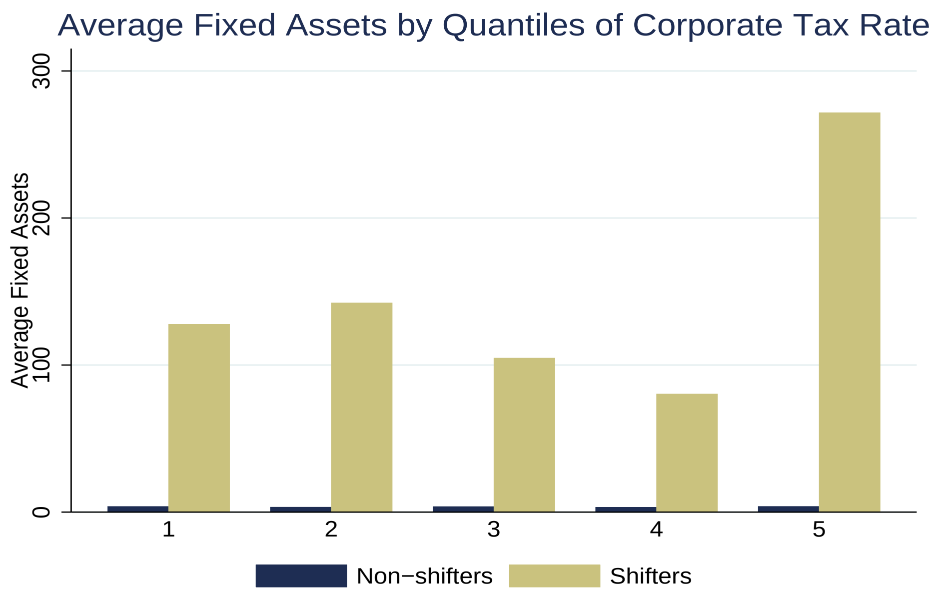

Figure 4.2: Average fixed assets by quantiles of corporate tax rate

The two last regressions presented in Table 4.2 use different tax measures, $EATR_{jt}$, the effective average tax rate, and $EMTR_{jt}$, the effective marginal tax rate. Although the estimated semi-elasticities for the *non-shifters* are lower, the main results remain unchanged. The tax effect is negative and significant for the larger group with the lower conditional mean, and insignificant for the smaller group with the higher mean of fixed assets. Given that we loose observations when using these alternative measures, we prefer the specification with the statutory tax rate $CITR_{jt}$. Table 4.6 presents three models with alternative probability specifications and a normal mixture model for the log of fixed assets. Adding variables to the specification of the probability of being in the *non-shifter* group does not change the results. While a higher internal-debt-to-capital ratio lowers, as expected, the probability of being a *non-shifter*, the ownership share of the German parent and operating in the R&D sector do not seem to have an influence, after controlling for the number of affiliated enterprises and the average tax rate at other locations. Fitting a normal mixture model for the log of fixed assets produces similar results concerning the tax effects. The estimated semi-elasticity for the *non-shifter* amounts here to -2.32 and is highly significant. The tax response of the *shifter* group is now significant at the 10% level, but much lower (-0.65) than that of the *non-shifter* group. The difference between both coefficients is statistically significant at the 2% level.[13] In this model the group of *non-shifters* associated with the lower predicted mean is still larger than the *shifter* group but only marginally (51.56% of the sample). The logarithmic transformation of the dependent variable is to blame. First, in our sample we have firms with zero fixed assets which are dropped. Second, the distribution is shifted to the right and observations with high values are brought closer to each other. Probability mass is shifted from the low-mean group to the high-mean group.

[13]The χ^2 statistic of the wald test for coefficient equality has a value of 5.17. The null hypothesis that both coefficients are equal can be rejected at the 2% level.

Table 4.5: Component Characteristics

	Non-shifter	*Shifter*
Observations	171,325	19,791
Affiliates	35,725	5,272
% Sample	89.64	10.36
% of total fixed assets	16.93	83.07
Component means		
$FixedAssets_{it}$	3.654	155.320
$NSIS_{it}$	20.480	82.630
PSI_{it}	0.277	0.268
IDR_{it}	0.180	0.182
OS_{it}	0.904	0.868
$R\&D_{it}$	0.003	0.005
$CITR_{jt}$	0.324	0.330
$EATR_{jt}$	0.295	0.298
$EMTR_{jt}$	0.229	0.235
GDP_{jt}	27.484	27.684
$KLRAT_{jt}$	10.563	10.672
$SKILL_{jt}$	53.269	55.954
$GDPPC_{jt}$	9.564	9.688
$LEND_{jt}$	8.664	8.313
$INFL_{jt}$	3.210	2.973
CPI_{jt}	6.571	6.738
$FINFR_{jt}$	69.288	70.096

Notes: Classification of observations into non-shifters and shifters according to the posterior probability of belonging to the non-shifter group calculated upon the regression displayed in the third column of Table 4.2. % of total fixed assets refers to the total of fixed assets of all German affiliates abroad over all years in the sample (1996-2007).

Table 4.6: Alternative Specifications

	Negative Binomial Mixture Model						Normal Mixture Model	
	Non-Shifter	*Shifter*	*Non-Shifter*	*Shifter*	*Non-Shifter*	*Shifter*	*Non-Shifter*	*Shifter*
$CITR_{jt}$	-1.851***	-0.230	-1.858***	-0.307	-1.853***	-0.190	-2.316***	-0.648*
	(0.249)	(0.855)	(0.251)	(0.849)	(0.248)	(0.857)	(0.501)	(0.347)
GDP_{jt}	0.472*	-0.668	0.464*	-0.729*	0.482*	-0.683	1.076***	-0.253
	(0.278)	(0.428)	(0.248)	(0.418)	(0.276)	(0.438)	(0.357)	(0.320)
$KLRAT_{jt}$	0.365**	-0.853**	0.319**	-0.839**	0.358**	-0.860**	0.769**	-0.039
	(0.158)	(0.389)	(0.159)	(0.386)	(0.157)	(0.390)	(0.338)	(0.330)
$SKILL_{jt}$	0.003**	-0.009*	0.003**	-0.009*	0.003**	-0.009*	0.003	0.0004
	(0.001)	(0.005)	(0.001)	(0.005)	(0.001)	0.005	(0.003)	(0.002)
$GDPPC_{jt}$	0.703**	2.780***	0.749***	2.737***	0.698**	2.807***	0.424	0.909**
	(0.299)	(0.728)	(0.271)	(0.716)	(0.297)	(0.734)	(0.379)	(0.421)
$LEND_{jt}$	0.001	0.000	0.001	0.000	0.001	0.003	-0.002	0.005*
	(0.001)	(0.006)	(0.001)	(0.006)	(0.001)	(0.006)	(0.004)	(0.003)
$INFL_{jt}$	-0.004*	-0.010	-0.004*	-0.009	-0.004*	-0.010	0.003	-0.012***
	(0.002)	(0.006)	0.002	(0.006)	(0.002)	(0.006)	(0.003)	(0.003)
CPI_{jt}	0.047***	-0.064	0.045***	-0.065	0.048***	-0.063	0.022	0.029*
	(0.012)	(0.043)	(0.012)	(0.043)	(0.012)	(0.043)	(0.022)	(0.017)
$FINFR_{jt}$	-0.001	0.001	-0.001	0.001	-0.001	0.001	-0.00002	0.0001
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)
Pr(Non-Shifter)								
$NSIS_{it}$	-0.002***		-0.002***		-0.002***		0.0002	
	(0.001)		(0.001)		(0.001)		(0.001)	
PSI_{it}	2.337***		2.173***		2.308***		0.444	
	(0.467)		(0.467)		(0.464)		(0.628)	
IDR_{it}	-0.244***							
	(0.056)							
OS_{it}			-0.047					
			(0.127)					
$R\&D_{it}$					-0.042			
					(0.528)			
constant	1.665***		0.257		1.793***		-0.281	
	(0.250)		(0.271)		(0.245)		(0.295)	
Predicted mean	3.517	76.953	3.538	77.523	3.542	77.377	-0.128	1.585
% of sample	89.43	10.57	89.35	10.35	89.64	10.36	51.56	48.44
Observations	*191,116*		*191,116*		*191,116*		*174,651*	

Notes: The dependent variable refers to the fixed assets of a foreign affiliate in the negative binomial mixture models and to the log of fixed assets of a foreign affiliate in the normal mixture model. All regressions include time dummies and affiliate-specific effects. Robust and clustered (by affiliate) standard errors reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively. The % of sample classified as belonging to either component is obtained after estimation using the calculated posterior probability of belonging to each component.

Overall, we find evidence for two different groups of firms which react differently to corporate taxation. The larger group of firms is unable to shift profits and is negatively affected by the corporate tax rate. The estimated tax semi-elasticity for the *non-shifter* group ranges from -1.85 to -2.32, a magnitude in line with previous research. The smaller group of firms is able to shift profits and avoid taxation and shows no significant response to the corporate tax rate. In our preferred specification a one-percentage-point increase in the statutory tax rate is associated with a decrease by 1.85% in the stock of fixed assets of a *non-shifting* foreign affiliate. We can quantify that effect by evaluating it at the sample mean of the component (see Table 4.5). The average affiliate classified as non-shifter invests about 3.65 million Euro in fixed assets. Such an affiliate would reduce its investment in fixed assets by about 68,000 Euro in response to a one-percentage-point increase in the corporate tax rate. We may ask what would happen if countries were able to prevent all profit shifting. Under the assumption that the firms in the shifter group can no longer shift profits and exhibit the same tax elasticity as the non-shifters, the implied effect given the average investment size of the shifters of about 155 million Euro would be 2.88 million Euro per percentage point tax increase.

4.6 Conclusions

This paper investigates the tax responsiveness of multinationals' investment decisions in foreign countries, distinguishing firms that are able to shift profits (*shifters*) from those that are not (*non-shifters*). From a theoretical point of view, the tax responsiveness of firms crucially depends on this distinction. Empirically, however, whether or not a firm is able to shift profits is basically unobserved.

We use a finite mixture model to distinguish the tax responsiveness of investments made by foreign affiliates which are able shift profits and reduce their tax base from that of affiliates which are not able to do so and are thus fully taxed. Using a panel of 38,705 foreign affiliates of German multinationals over the years 1996 to 2007, we show that while *shifters* do not respond to host-country taxes at all, taxes significantly affect the investment decision of *non-shifters*. We identify a larger group of affiliates with a relatively low average investment which is negatively affected by the local corporate tax rate on profits. The estimated tax effect for the latter group amounts to 1.85% less fixed assets, or 68,000 Euro for the average affiliate, per percentage point tax increase. A smaller group of affiliates is able to avoid taxation by shifting its tax base and shows no significant response to corporate tax rates. The affiliates in this group have significatively higher investments in fixed assets, so that, were they to be prevented from shifting profits, the implied effect in Euro of a one-percentage-point change in the tax rate would be 42 times higher.

To the extent that a considerable proportion of a country's foreign investments are carried out by firms that shift profits, the introduction of anti-tax-avoidance measures to restrict profit shifting in the pursuit to cash tax revenue will come at the cost of entering in tax competition with other countries for that firms' investments. In fact, the broadening of the tax base has to be accompanied by a policy of cutting the statutory tax burden to avoid losing real economic activity.

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