

Essays on Corporate Taxation and Foreign Direct Investment

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To my family

Preface

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1 Introduction

Multinational enterprises (MNEs) are a special type of firms. They are firms, which consist of affiliated entities located in at least two different jurisdictions. The MNEs generally have their home in the jurisdiction, where their headquarters is located. Their cross-border investments in other jurisdictions, which are then the hosts of their affiliated firms, are denoted as foreign direct investment (FDI).

There has been an extraordinary increase in the magnitude of the activities of MNEs since the 1980s, which can be seen in Figures 1 and 2. Figure 1 provides an overview of the developments of FDI outflows and FDI out-stock for the time period from 1980 to 2016. Figure 1 shows that both of these measures for the magnitude of MNE activity are steadily increasing over time, with some exceptions after economic crises such as the international financial crisis in 2008. Figure 2 shows us the relative changes of four economic indicators over the same time period, 1980–2016, where the year 1980 is taken as the base year and its values are normalised to 100. All of the changes in the four economic indicators are computed with respect to the base year 1980 and multiplied by 100. The magnitudes of all four variables, which are world GDP (gross domestic product), world exports of goods and services, world FDI outflows, and world FDI out-stock, have increased over the time period of consideration relative to the year 1980. However, the relative changes in the two variables concerning the developments of FDI, world FDI out-stock and world FDI outflows, have increased considerably stronger than the other two variables thus underlying the increasing importance of FDI for the world as a whole.

The developments of FDI, depicted in Figures 1 and 2, indicate a steady increase in the economic importance of the multinational firms worldwide. This is why in the present doctoral dissertation we are interested in studying the activities of the multinational firms, especially with respect to their interactions with corporate tax policy. After all, tax policy consists of policy instruments, which the respective jurisdictions can change relatively fast, for example in order to make themselves more attractive for the activities of MNEs in their respective jurisdictional boundaries.

The scope and boundaries of the multinational firms are determined, among others, by the underlying environment, where these firms are active in. One important determinant of multinational-firm activity, which is the central point of analysis in the present doctoral dissertation, is corporate taxation. Corporate taxation determines the monetary payments that the MNEs or their entities need to pay to the respective jurisdiction, where they have operations in. Taxes are thus perceived by the MNEs as additional cost, for instance for the right to operate in these jurisdictions and to use their infrastructure. This implies that tax policy has an impact on the MNEs operational decisions.

Given that the MNEs often have entities, which operate in different jurisdictions and thus potentially in different tax environments, the MNEs have incentives and, more importantly,

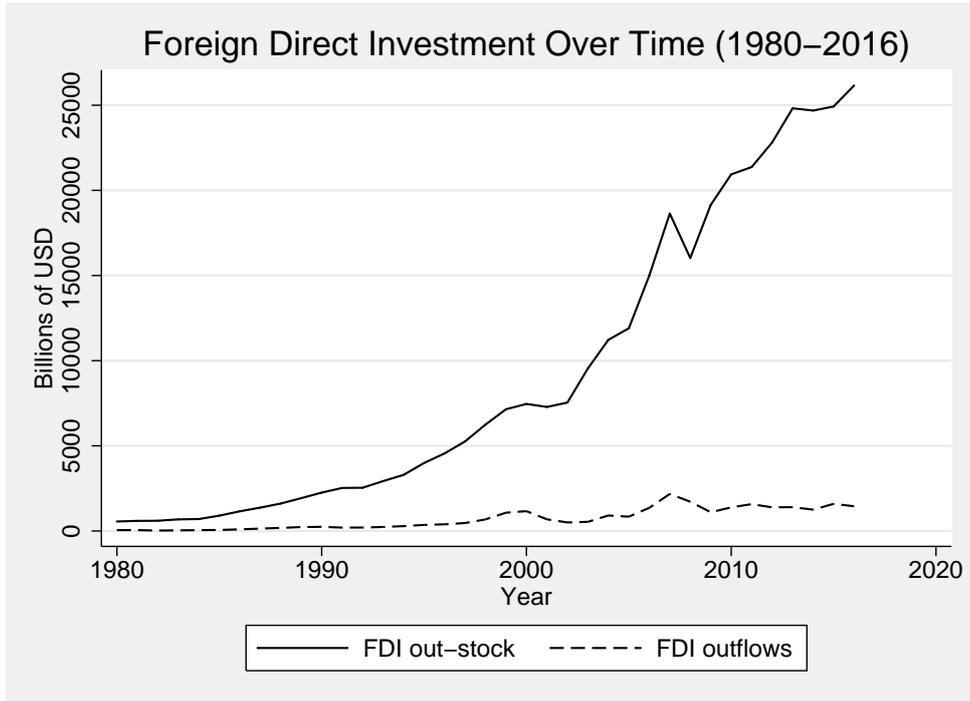


Figure 1: FDI over time

Notes: Development of FDI (foreign direct investment) over time. *Sources:* See the Appendix.

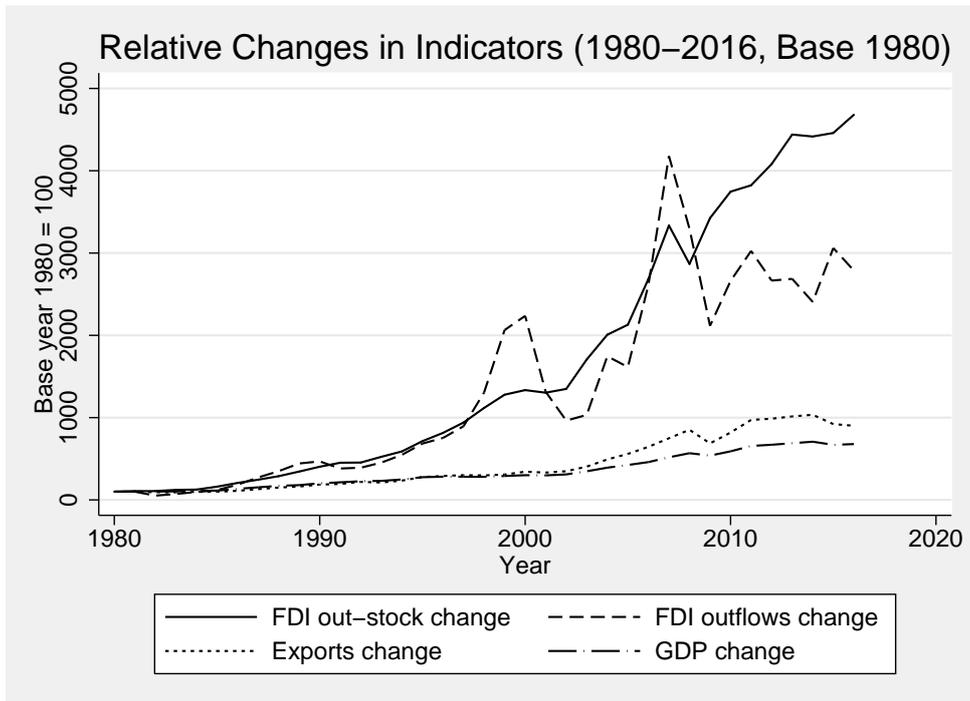


Figure 2: Relative changes of economic indicators

Notes: Relative changes of economic indicators over time with respect to the year 1980, which is the base year and multiplied by 100. *Sources:* Based on own calculations of the author. Inspired by Figure 1.1. in Barba Navaretti and Venables (2006, Chapter 1). The data sources for each economic indicator are presented in the Appendix.

potentially also the possibility to arrange their international network of affiliates in a tax-minimising manner. They can furthermore make their affiliates even specialise in the provision of specific services within the MNE group also with the goal to minimise their overall tax payments. Thus the MNEs might have an incentive to locate specific tasks in jurisdictions, where these tasks are taxed relatively less, compared to locating them in other jurisdictions. This constitutes a way for the MNEs to cost-efficiently arrange their worldwide operations also with tax considerations in mind. This is an important prerequisite for the survival of the particular MNE in the specific markets, where it operates in. It is important to note, that the MNEs are able to achieve worldwide tax minimisation even by using only not necessarily prohibited means of tax minimisation, such as through the registration of their intellectual property in relatively low-tax jurisdictions. All of this allows the MNEs to remain competitive enough, when facing fierce competition by other MNEs and also by national firms. We consider the national firms to be firms, which consist of only one entity or which consist of a group of affiliated firms, where all of these firms are located in the same jurisdiction. The national firms are thus expected to be highly specialised to the operational environment of their particular home jurisdiction. Consequently, the MNEs would also need to have some competitive advantage in order to successfully compete with the other firms.

The analyses made in the present doctoral dissertation can be seen in the light of the OLI (ownership, location, and internalisation) paradigm as proposed in Dunning (1988; 2000). The OLI paradigm provides a framework for explaining the activities of firms, which are active internationally and thus undertake foreign direct investment. According to the OLI paradigm in order to successfully be active in international markets, the MNEs need to possess some comparative advantage relative to other MNEs and national firms, with which they might compete in these markets. In the economic analyses, which we do in the present doctoral dissertation, we focus on the implications of different tax policy instruments for the three OLI components of multinational firm activity.

The first component of OLI, the letter O, denotes the comparative advantage of an MNE stemming from the ownership of some productive asset. This could be, for example, the possession of intangible assets such as patents and trademarks by the MNE in question (Dunning, 2000). The analysis, which we do in Chapter 4, focuses mainly on this aspect of the OLI paradigm. There we explicitly study the decision of the MNE, depending on its financial situation, where to locate its intangible assets for tax-minimising purposes. Thus the MNE can obtain an additional comparative advantage from the ownership of its intangibles. More specifically, this comparative advantage stems from the location of the intangible assets, which can be chosen by the MNE in such a way as to achieve overall tax minimisation. This tax-minimisation option is not available to the purely national firms and is furthermore not available to all MNEs, depending potentially on their financial situation, as discussed in Chapter 4.

The second component of OLI, the letter L, denotes the advantage, which an MNE possesses due to a particular location of its worldwide activities (Dunning, 2000). This advantage could stem from the MNE having production plants in jurisdictions, where the factors of production, which are important for the MNE, are relatively abundant, thus relatively cheap, and also of relatively good quality compared to other jurisdictions. Another aspect implied by the location advantage could be the presence of a relatively big market for the final products of the MNE in the jurisdiction, where its production plants are located in. This would allow the MNE to save on transport costs, when it provides its customers with its products. Another aspect, concerning the location advantage and which is analysed in more detail in Chapter 3, is the impact of the location of the MNE's headquarters in a jurisdiction implementing an IP (Intellectual Property) Box regime on its investments in other jurisdictions. The IP Box regime provides the income of the MNE generated by its intangible assets with lower corporate taxation. Thus, as discussed in Chapter 3, an IP Box regime in force at the jurisdiction, where the MNE's headquarters is located, compared to when there is no such regime in place in that jurisdiction, provides the MNE with higher overall after-tax profits. Consequently, the tax implications of the IP Box regime allow the particular MNE to consider investing also in relatively high-tax jurisdictions. This implies that the MNE has a locational advantage compared to its market competitors stemming from the IP Box regime in the jurisdiction of its headquarters.

The third aspect of the OLI paradigm, the letter I, denotes the advantages of an MNE stemming from the internalisation of its activities as compared to engaging in arm's-length transactions with other market participants instead (Dunning, 2000). This implies that the MNE will operate as an MNE in order to cope with the existence of potential transaction costs, stemming, for example, from the potential existence of market inefficiencies (Coase, 1937; Dunning, 2000). Multinational firms would prefer to internalise their activities if in that way they could benefit from the creation and internal use of intangible assets (Dunning, 2000). Furthermore, in that way they could potentially benefit from the use of transfer pricing, the setting of the prices on the intra-firm transactions between the different MNE's affiliates, in order to shift profits from relatively high-tax to relatively low-tax jurisdictions (Dunning, 1988). The implications of transfer pricing are discussed in more detail in Chapter 5. There we focus on the impact of the degree of firm heterogeneity for the capabilities of the different MNEs to engage in profit shifting. We show that when firm heterogeneity in an industry is increased so are the possibilities of the MNEs to undertake profit shifting by the use of their transfer prices.

As noted in Gresik and Osmundsen (2008), the tax authorities use different indicators, such as financial ratios, in order to compare the declared profitability of the different firms relative to their market competitors. The tax authorities use the firms in the middle 50% of the empirical distribution of the respective indicator as a benchmark for firms, which are not likely to engage in profit shifting. When assessing the declared transfer prices, the

tax authorities especially focus on the firms in the first quartile, first 25%, of the empirical distribution of the respective economic indicator. They do stricter audits of the firms from the first quartile as they would show relatively low profitability, which could be indicative for profit-shifting activities of these firms. When the degree of firm heterogeneity changes, so does also the relevant range of the middle 50% of the firms. In Chapter 5 we show that an increase in firm heterogeneity in terms of firm productivity in a certain industry, jurisdiction, and year, decreases the declared firm profitability due to increased profit shifting opportunities of the MNEs via the setting of their transfer prices. We further show that there are different possibilities of profit shifting for the different MNEs, which depends on their different productivities. More productive MNEs have more profit-shifting possibilities as they have a larger potential scope in declaring their transfer prices, with which they could shift profits and be still in the relevant range of permitted transfer prices by the tax authorities.

In the present doctoral dissertation we study different aspects of the interaction between corporate taxation and foreign direct investment. There are different levels of interaction, on which we focus. In Chapter 3 we start our analysis by studying the MNE's decision, where to locate its new foreign affiliate in manufacturing. At that decision level the MNE thus constructs its network of affiliates, among others also with respect to the aspects covering the issue of corporate taxation. When the MNE's network is created, then in a next step, at another decision level, the MNE decides where to locate important assets for its operations, such as patents and trademarks, which constitute important intangible assets. This decision of the MNE is analysed in Chapter 4. There we consider the financial situation of the MNE in question also to play a role in the location choice for its intangible assets. With this choice the MNE thus potentially also decides on a specialisation of its affiliates on the provision of a specific service for the whole MNE group, given the already determined international network of affiliates that the MNE has. Then Chapter 5 provides an analysis at another decision level, which concerns the operations of the MNE. There we study the profit-shifting and efficiency effects of MNE activity on the expected tax base of a relatively high-tax jurisdiction. So for a given network of affiliates, which are already specialised in the provision of some specific services among each other, we then analyse the intra-firm transactions between the different MNE's entities with respect to corporate taxation. Due to potential differences in the corporate income tax rates between the different jurisdictions, where the MNE has affiliates in, the MNE group as a whole has incentives to engage in profit shifting. Profit shifting from relatively high-tax to relatively low-tax jurisdictions is facilitated due to the existence of firm heterogeneity and thus the difficulties of the respective tax authorities to control for profit shifting via the use of transfer pricing by the MNEs.

We provide a more detailed overview of the three main chapters of the doctoral dissertation in what follows. Each of these chapters focuses on a specific analysis of the interaction

between corporate taxation and foreign direct investment. The chapters are structured generally in the following way. We begin each chapter by providing an overview of the specific research area. Each chapter then includes a theoretical and an empirical parts, where we present our theoretical and empirical analyses respectively. Finally, we provide concluding remarks on the findings of the respective analysis. In the theoretical parts of each analysis we develop a theoretical model, then derive and summarise its theoretical predictions. In the respective empirical parts we choose and describe specific empirical methods, which are suitable for the particular research question, analysed in each of these chapters. We then describe the data, which we use in our empirical analyses, and then test the theoretical predictions empirically. The data, which we use in our analyses, comes from the ORBIS database compiled by Bureau van Dijk. The time period of our analyses is from the year 2004 to the year 2014. Each chapter ends with a summary of the results of each analysis and provides an overview of the implications of the respective findings for future academic research, or for the decision-makers in the respective jurisdictions, or for policy in general.

In Chapter 3 we analyse the impact of an IP Box regime in force in one jurisdiction on new investments by multinational enterprises in other jurisdictions. For this purpose we focus on the effect of an IP Box regime in force in the jurisdiction of the MNEs' headquarters on the location choice for their new foreign affiliates in manufacturing. Our theoretical model shows that the presence of an IP Box regime with its favourable treatment of income generated by a firm's intangible assets provides the MNE with higher overall after-tax profits. Thus the IP Box regime makes the MNE consider also investing in relatively high-tax jurisdictions, which it would have found to be less attractive otherwise. In the empirical part we use a sample containing data from the ORBIS database compiled by Bureau van Dijk for the period 2004–2014. We find that there is heterogeneity in the impact of the corporate income tax rate of the potential new locations on the MNE's location choice irrespective of the existence of an IP Box regime. Furthermore, we find that the IP Box regime in force at the MNE's headquarters indeed decreases the negative effect of the corporate income tax rate for the MNEs' location decision. Our results remain robust with respect to the implementation of a variety of multinomial models. The decision-makers should consider these effects when introducing, reforming, or abolishing an IP Box regime.

Chapter 4 studies the location of intangible assets of multinational enterprises for tax-minimisation purposes. The presented theoretical model analyses both the use of tax havens, or simply low-tax jurisdictions, for the location of intangible assets by some MNEs as well as the observed use of relatively high-tax jurisdictions in the location of intangibles by other MNEs. Additionally, the analysis distinguishes between financially constrained and financially not constrained firms. In the financially constrained case the MNE is hindered in locating its intangibles at a low-tax jurisdiction by its external financial partner

as the gains from doing so remain with the MNE, whereas the costs are shared between the MNE and the partner. This points to the existence of market mechanisms, which are able to deter the MNEs in locating their intangible assets at low-tax jurisdictions. In the corresponding empirical part, we estimate finite-mixture models with two components, implying the potential existence of two groups of MNEs. The estimates for the effect of the corporate income tax rates on the amount of intangible assets located in a particular jurisdiction indeed differ across the two groups, where a tax-optimising group and a non tax-optimising group of MNEs are shown to exist. The probability of belonging to the non tax-optimising group compared to the tax-optimising group is found to be lower when the multinational firm is less financially constrained, which is in line with our theoretical model.

Chapter 5 explores the implications of an increase in firm heterogeneity with respect to firm productivity on the expected tax base of a high-tax jurisdiction hosting multinational enterprises (MNEs). In the developed theoretical model the MNEs can set their transfer prices in the range given by the distribution of firm productivity without any consequences and use the transfer prices to shift profits between their different entities. Thus profit shifting can occur even if MNEs apply transfer prices, the prices set for their intra-firm transactions, conform to the ones allowed by the tax authority. An increase in firm heterogeneity increases profit shifting, however, it also contributes to a reallocation of market shares from less efficient to more efficient firms. Still, the overall effect on the high-tax jurisdiction's expected tax base is negative thus highlighting the need to better control for the MNEs' transfer prices. In the empirical part of Chapter 5 we estimate quantile regressions, where we in turn use two different measures for firm profitability as the dependent variable. Our estimates for the profit-shifting and the efficiency effects of MNE activity are found to be stronger for more profitable MNEs compared to less profitable MNEs. This implies that the tax authorities should concentrate on the more productive and thus on the more profitable MNEs as they have more possibilities to use their transfer prices for profit shifting.

The doctoral dissertation is structured as follows. Chapter 2 provides a general literature review on the interactions of corporate taxation and foreign direct investment with a focus on the topics analysed in Chapters 3, 4, and 5. Then Chapter 3 presents the analysis on the impact of IP Box regimes on the MNEs' location choice for their new foreign affiliates in manufacturing. The analysis on the role of financial constraints on the location decision for the MNEs' intangible assets is presented in Chapter 4. Then Chapter 5 presents the analysis of the effects of transfer pricing by the MNEs, when firms are heterogeneous with respect to their productivity. Chapter 6 provides concluding remarks related to the analyses made in Chapters 3, 4, and 5. The Appendix provides information on the sources of the data used in the graphs in Chapter 1, which is the chapter providing the introduction of the present doctoral dissertation.

2 Literature Review

There are different ways, in which corporate taxation and foreign direct investment interact. Importantly, corporate taxation potentially consists of many tax policy instruments.

Perhaps the most prominent tax policy instrument is the statutory corporate income tax rate. It is the tax rate, which is well visible for the firms and thus easily comparable among different jurisdictions. It is also the tax rate, which applies for more profitable investment projects (Devereux et al., 2002). The statutory corporate income tax rate is furthermore relevant if the firms in question do not make use of any depreciation allowances or in the case of MNEs' entities located in relatively low-tax jurisdictions and thus potentially used for profit-shifting purposes (Overesch and Wamser, 2009). Due to its visibility, the developments in the statutory corporate income tax rate could be indicative for the degree of competition among the different jurisdictions in order to make themselves relatively more attractive as hosts of FDI. After all, MNEs are active internationally and could, for example, simply choose to locate their new foreign affiliate in a jurisdiction with a relatively low corporate income tax rate compared to other jurisdictions, when, for example, all of these jurisdictions are perceived as otherwise similar by the MNEs.

Although, on the one hand, FDI is characterised by a lasting interest of the cross-border investment made by the MNEs in a certain jurisdiction according to the OECD (Organisation for Economic Co-operation and Development) (OECD, 2008, p. 17). On the other hand, the MNEs are also characterised as footloose (Barba Navaretti and Venables, 2006, Chapter 1) thus being able to change the locations of their international activities relatively fast. This could happen, among others, if the MNEs see a better tax environment in other jurisdictions, where, for example, the corporate income tax rates are lower. The different jurisdictions, especially the relatively high-tax ones, are consequently indirectly facing competition among themselves with respect to the setting of their corporate income tax rates in order to maintain their relative attractiveness for foreign direct investments.

In this respect, a study by Devereux et al. (2002) shows that the corporate income tax rates fell for the 16 jurisdictions in their sample, comprised of the G7 countries and the then EU (European Union) member-countries, during the 1980s and 1990s. At the same time, however, there was an accompanying tax-base broadening, which took place in these jurisdictions. These developments might be a way of the different jurisdictions to minimise the effects of the potentially present so-called race-to-the-bottom in the setting of their corporate income tax rates (Devereux et al., 2002). Haufler and Wooton (2010) provide descriptive statistics of the development of the corporate income tax rates in OECD member-countries for the period between 1985 and 2005. They distinguish between relatively large and relatively small countries with respect to their population size. The statutory corporate income tax rates fell on average for both groups of countries, with a steeper fall for the group of the relatively small countries. Still, the corporate income

tax rates in 2005 were nevertheless relatively high on average regardless of the countries' population size. Furthermore, a study by Clausing (2007) finds an ambiguous effect of changes in the corporate income tax rate on the ratio of the corporate tax revenue to the gross domestic product of 29 OECD countries for the period 1979–2002. This implies that the corporate income tax rate is not the only or perhaps not necessarily the main tax policy instrument used by the different jurisdictions in order to compete for FDI.

It is interesting to note that the setting of the corporate income tax rates might differ among the different jurisdictions depending on their goals and the economic environment present there. Table 1 from the study by Gordon and Li (2009) provides an overview of the relative importance, among others, of the tax revenues coming from corporate income taxation for countries of different income levels. The share of the corporate income taxes as part of all the tax revenues of the different countries is shown to be much larger for the developing countries compared to the other countries. This could be explained by difficulties in the collection of other taxes, for instance due to the presence of large informal sectors in these jurisdictions (Gordon and Li, 2009). Thus the tax revenues collected from the firms, perhaps especially from the multinational firms, are very important for the developing countries.

Although the statutory corporate income tax rate can be considered the main tax policy instrument, other tax policy instruments can be also very important for the MNEs and consequently for FDI. For example, the IP Box regimes constitute an important and a relatively new tax policy instrument, which aims at taxing firms' income accruing from their intellectual property at often significantly lower corporate income tax rates than the tax rates implemented in the taxation of the firms' other income (Evers et al., 2015). We analyse the effects of the IP Box regimes on MNEs' new foreign investments in Chapter 3 of the present doctoral dissertation. One of the stated goals of the IP Box regimes is the stimulation of local R&D (research and development) (Bradley et al., 2015). Still, economic analyses do not necessarily find such effects of the IP Box regimes being present (Bradley et al., 2015). This could partly be explained by the different designs of the IP Box regimes, where some of these regimes also allow foreign developed IP to qualify for the tax benefits, which they offer (Schwab and Todtenhaupt, 2016). Such a design of an IP Box regime implies that the so-called nexus requirement for the IP in question to qualify for the respective tax benefits is not imposed (Alstadsæter et al., 2015).

IP Box regimes also differ with respect to the firm's intellectual property, which qualifies for the tax benefits of the particular IP Box regime. Importantly, patent income generally qualifies for the preferential tax treatment under various IP Box regimes (Evers et al., 2015). In addition, some IP Box regimes only allow for self-developed IP to qualify for the respective tax benefits, whereas other IP Box regimes allow also for acquired IP to directly qualify or to qualify at least after this acquired IP has been further developed to a certain degree in the respective jurisdiction of the IP Box regime (Evers et al., 2013). Thus

the specific design of the underlying IP Box regime seems to play a role for its expected implications on economic activity. In Chapter 3 we focus our analysis on the implications of the presence of an IP Box regime in force in the jurisdiction of the MNEs' headquarters for the location decision for the MNEs' new foreign affiliates in manufacturing. We find that an IP Box regime leaves the MNEs with higher overall after-tax profits. This consequently allows the MNEs to consider investing also in relatively high-tax jurisdictions, which they would have considered less attractive for investments otherwise. This implies that IP Box regimes could have effects not only on the jurisdictions implementing them but also for other jurisdictions. These cross-border spillover effects of the IP Box regimes could be transmitted within the networks of affiliates of the MNEs. This is shown in Chapter 3 for the IP Box regimes in general and also in Schwab and Todtenhaupt (2016) for the IP Box regimes when the IP Box regimes do not impose a nexus requirement for the underlying IP to qualify for the preferential tax treatment, which they offer.

MNEs have a potential competitive advantage compared to the national firms with respect to their capabilities of engaging in profit-shifting activities. Thus investing in relatively high-tax jurisdictions could be still attractive for the MNEs as they could arrange a way to shift profits out of these jurisdictions towards relatively low-tax jurisdictions, where they might have affiliates in (Gumpert et al., 2016). This can be achieved simply by organising the activities within the MNE group in a tax-minimising manner. For instance, by locating important intellectual property such as patents in relatively low-tax jurisdictions (Dischinger and Riedel, 2011; Karkinsky and Riedel, 2012). In this way the license fee payments for the use of these intangible assets by MNEs' affiliates located in relatively high-tax jurisdictions will accrue at the respective affiliates located in the relatively low-tax jurisdictions, which would be the legal owners of these assets, and consequently be taxed less there. It should be noted that in this way tax minimisation can be achieved even without manipulation of the prices for the intra-firm transactions set by the MNEs.

However, the process of relocating existing IP can be complex and costly for the MNEs (Walpole and Riedel, 2014). For this reason the MNEs often use contract R&D or cost-sharing arrangements in order to achieve the legal registration of their created intangible assets, such as patents, in relatively low-tax jurisdictions (Griffith et al., 2014). When contract R&D is undertaken, there is one affiliate of the MNE, located in a relatively low-tax jurisdiction. This affiliate contracts another affiliate of the MNE located in a different jurisdiction. The jurisdiction of the second affiliate potentially offers tax incentives for R&D or at least provides for relatively cheap factors of production, which are also of relatively good quality, and which are necessary for the underlying R&D activity. The MNE affiliate in the low-tax jurisdiction finances the uncertain R&D activity and in case of its success receives the legal rights over the new invention, which could be a new patent. With a cost-sharing agreement the goal of the MNE is similar. However, the financing of

the uncertain R&D project is shared between different affiliates of the MNE, potentially located in relatively low-tax jurisdictions, and then consequently the rights over the new invention are also shared accordingly among them.

The location of intellectual property by the MNEs for tax-minimising reasons, when they are financially constrained or not financially constrained, is analysed in Chapter 4. Still, the empirical literature on the location of intangibles by the MNEs does not find that all MNEs locate their intangibles at relatively low-tax jurisdictions (Karkinsky and Riedel, 2012; Heckemeyer et al., 2015). In Chapter 4 of the present doctoral dissertation we develop a theoretical model, which can provide a potential explanation on why some MNEs use low-tax jurisdictions for the location of their intangible assets whereas other MNEs do not. We find both theoretically and empirically that the financial situation of the particular MNE plays an important role for this decision. More specifically, financially constrained MNEs cannot locate their intangibles in low-tax jurisdictions if they want to receive external financing. We show that the potential financial partner of the MNE does not benefit from the tax minimisation done by the MNE, as the potential tax savings accrue only to the MNE, whereas the additional cost connected to the tax minimisation of the MNE are shared between the MNE and its financial partner. Thus the external financial partner has higher incentives to provide the MNE with the necessary financing in the case when the intangible assets of the MNE are located in the relatively high-tax jurisdiction, which we also assume to be the location of the MNE's headquarters.

When the different tasks are allocated among the MNEs' affiliates, including the decision on the location of the MNEs' intangibles with some of the affiliates, then the MNE can use the intra-firm prices for the provision of intra-firm services for profit shifting. The United Nations Conference on Trade and Development (UNCTAD) provides information on the activities of MNEs in its World Investment Reports (WIRs). Figure IV.14. and Box IV.3. in UNCTAD (2013) provide estimates for the volume of exports of goods and services worldwide, including estimates on the intra-firm trade of multinational enterprises, in the year 2010. According to Figure IV.14. in UNCTAD (2013, p. 135) the global intra-firm trade of MNEs is estimated at around 6.3 trillion US (United States) dollars in 2010, whereas the volume of the overall trade in goods and services is estimated at around 19 trillion US dollars in 2010. As indicated in Box IV.3. in UNCTAD (2013, p. 136) this implies that on average intra-firm trade makes around 30% of a country's exports, however, with considerable variations across the different countries. This implies that a significant part of world trade takes place within the boundaries of MNE groups. The focus of the analysis in Chapter 5 of the present doctoral dissertation lies on the implications of firm heterogeneity on the setting of the MNEs' transfer prices for the cross-border transactions between their different entities.

Furthermore, UNCTAD (2015, p. 75) provides information on the intra-firm trade of US MNEs. According to UNCTAD (2015, p. 75) 22% of total US exports in 2012 were

undertaken as part of MNEs' intra-firm trade. Interestingly, 73 billion US dollars, which equals to half of the amount of the intra-firm trade in services of the US MNEs in 2012, was attributed to intra-firm charges for the use of IP (UNCTAD, 2015, p. 75). This should not be very surprising as MNEs are often active in relatively high R&D-intensive industries (Barba Navaretti and Venables, 2006, Chapter 1) but could also be explained with the MNEs' IP, such as patents, potentially being used for tax-minimising purposes by the MNEs. In the analysis, which we do in Chapter 4, we study the location choice for the MNEs' intangible assets. We show that the MNEs could locate their intangibles in a relatively low-tax jurisdiction for tax-minimisation purposes, but that this tax-minimisation option is not available to all of the MNEs.

The MNE has incentives to artificially declare higher cross-border transfer prices than it would have actually done without tax differences being present across the different jurisdictions, when the direction of payment of the transfer price is towards its affiliates in relatively low-tax jurisdictions. Similarly, the MNE has incentives to set lower cross-border transfer prices for intra-firm transactions going towards its affiliates in relatively high-tax jurisdictions. The different jurisdictions are aware of the incentives and capabilities of the MNEs to use their transfer prices for tax-minimising purposes. In this respect, among others, the OECD countries have proposed the so-called arm's-length principle to be implemented by the MNEs when they set the prices for their intra-firm transactions (OECD, 2010, p. 32). According to this principle the MNEs' transfer prices are to be compared to similar transactions undertaken between unrelated parties in order to assess them. However, difficulties of the assessment of the transfer prices are acknowledged as there might be no other similar transactions taking place among unrelated parties (OECD, 2010, p. 31). This is especially the case when the transaction in question involves the amount of the license fees payments or royalties payments for the use of firm-specific intangible assets by the different entities of the MNEs.

It should be noted that the MNEs have some scope to declare their transfer prices within a certain range of transfer prices permitted by the tax authorities. This is due to firm heterogeneity being present and the consequent difficulties of finding a correct transfer price for the intra-firm transactions, as described in Gresik and Osmundsen (2008) and as analysed in Chapter 5 of the present doctoral dissertation. Thus the tax-minimising effects stemming from the strategic location of the MNE's entities in particular jurisdictions and from their intra-firm specialisation in the provision of particular services within the MNE group could be increased by the setting of the transfer prices for profit-shifting purposes. Thus the setting of the transfer prices constitutes one important channel, which the MNEs could use for profit shifting from relatively high-tax to relatively low-tax jurisdictions (Clausing, 2003; Heckemeyer and Overesch, 2017).

It is interesting to note that profit shifting can occur even among the OECD member-countries (Bartelsman and Beetsma, 2003). This is because the strictness of enforcement

of the guidelines on transfer pricing can differ among the different jurisdictions for various reasons. On the one hand, this could stem from the difficulty of finding a comparable arm's-length price as a benchmark for comparison of a particular intra-firm transaction (OECD, 2010, p. 31). On the other hand, this could also be due to the potential willingness of the different jurisdictions to employ the strictness of their control over profit shifting as a separate tax policy instrument. For instance, a potentially less strict control over the profit shifting activities of the MNEs could be able to indirectly compensate the MNEs for the relatively high corporate income tax rate present in the particular jurisdiction, where they have affiliates in (Peralta et al., 2006; Amerighi and Peralta, 2010).

Furthermore, Peralta et al. (2006) point out that the different jurisdictions would tend to control more strictly the profit shifting out of their respective jurisdiction compared to the profit shifting into their jurisdiction. In addition, the degree of the control of profit shifting can influence the firm's decision on how to serve a foreign market via exports or through local production by engaging in FDI. Amerighi and Peralta (2010) show in their theoretical model that when profit shifting is very strict then the firm can choose to minimise its overall taxes by locating its economic activities in a relatively low-tax jurisdiction and serving a relatively high-tax jurisdiction by exporting. The impact on the mode of market entry of the different firms in an international setting could be a third reason why the strictness of the control of profit shifting potentially differs even among relatively similar countries, as shown in the case of the OECD member-countries (Bartelsman and Beetsma, 2003).

Lohse and Riedel (2013) provide an empirical analysis on the impact of differences in the strictness of the transfer-pricing legislation on the reported profits of firms. The authors find that stricter transfer pricing regulations decrease the profit-shifting activities of the MNEs. Still, even with stricter regulation of transfer pricing some firms would still be able to shift profits out of relatively high-tax jurisdictions to relatively low-tax jurisdictions as long as they set such intra-firm prices, which are conform to the range of accepted transfer prices by the respective tax authority. In Chapter 5 of the present doctoral dissertation we present an analysis, which considers this possibility for profit shifting by the MNEs.

As already mentioned, one reason for the difficulty of finding an arm's-length price for comparison with the MNEs' transfer prices is the presence of firm heterogeneity with respect to firm productivity even among firms operating in the same economic sector. According to the paper by Helpman et al. (2004) firm heterogeneity is an important determinant for the existence of multinational firms in the first place. According to their theoretical model firms have different productivity parameters, which have an implication on their profitability. After all, investing abroad, for instance by undertaking a cross-border investment such as building a new production plant by a firm located in one jurisdiction in another jurisdiction and thus becoming multinational, is costly. The cost of building the new plant but also the cost of acquiring the necessary information about the new market

and the local legal environment constitute sunk costs for the firms. This implies that a particular firm would need to be profitable enough in order to be able to cover for this initial cost of opening up its new foreign affiliate and thus engaging in FDI. Thus only the most productive firms would become multinational. In addition, Raff et al. (2012) argue that among the firms, which engage in FDI, firm heterogeneity with respect to the estimated firm productivity could further influence the pattern of FDI. The authors show that more productive firms have a higher probability to make a greenfield investment in a wholly-owned subsidiary compared to acquiring an existing foreign firm instead.

All of this underlines the importance of firm heterogeneity and further provides a potential explanation for the difficulties of the tax authorities to follow the so-called arm's-length-principle when assessing the transfer prices set by the MNEs. The reason is that the underlying firm productivity of the MNE's entities is unknown to outside parties and the tax authority thus needs to find some approximations, which could serve as a benchmark for comparison of the different transfer prices and their consequential assessment. In Chapter 5 of the present doctoral dissertation we analyse the impact of an increase in firm heterogeneity with respect to firm productivity on the expected tax base of a relatively high-tax jurisdiction. In this respect we identify two potentially opposing effects of MNE activity. On the one hand, there is a profit-shifting effect as MNEs have an incentive to declare such transfer prices, with which they can shift profits out of the high-tax jurisdiction. This effect is increased with higher firm heterogeneity. On the other hand, there is also an efficiency effect of MNE activity as higher firm heterogeneity implies higher degree of competition and thus the allocation of market shares from firms with lower productivity to firms with higher productivity. This effect is also increased with higher firm heterogeneity. We find the two effects to be stronger for more productive MNEs compared to less productive MNEs. This implies that the tax authorities should concentrate on the activities of the more productive firms as they have more possibilities to use their transfer prices for profit shifting.

The literature review provided in this chapter has shown that there are many ways, in which corporate taxation and foreign direct investment interact. The analyses done in the present doctoral dissertation can be seen in the light of the OLI paradigm. In Chapter 4 we analyse the MNE's location choice for its intangible assets. The main focus of the analysis in Chapter 4 lies on the O, ownership, component of the OLI paradigm, where also the L, location, and I, internalisation, components are of importance. In Chapter 3 we study the location choice for the MNE's new foreign affiliate in manufacturing when the MNE's headquarters is located in a jurisdiction implementing an IP Box regime. The main focus of the analysis in Chapter 3 lies on the L, location, component of OLI, with the O, ownership, and the I, internalisation, components also being of importance. In Chapter 5 we focus our analysis on the effects of an increase in firm heterogeneity on the expected tax base of a relatively high-tax jurisdiction. In Chapter 5 the main focus of

the analysis lies on the I, internalisation, component of OLI, but the O, ownership, and L, location, components are also of importance. The three analyses are presented in the following chapters.

3 The Impact of IP Box Regimes on the Location Choice for Multinational Firms' New Affiliates in Manufacturing¹

3.1 Introduction

Intellectual Property (IP) Box regimes are a relatively new tax policy instrument. IP Box regimes are implemented mainly in European countries but also in China, and mostly after the year 2006, and have different design features (Alstadsæter et al., 2015, p. 30, Table 2). Still, it is common that the IP Box regimes offer firms significantly lower corporate tax rates for the taxation of their income generated by intellectual property, such as patents and in some cases trademarks registered in the jurisdiction implementing the IP Box regime (Evers et al., 2013; 2015). The study in Alstadsæter et al. (2015) summarises the different features of the IP Box regimes and provides estimations of their impact on fostering domestic innovative activity, measured by the number of registered patents in the jurisdiction implementing the IP Box regime. Furthermore, Bradley et al. (2015) and Schwab and Todtenhaupt (2016) analyse potential external effects of the IP Box regimes on jurisdictions different from the one implementing them, such as with respect to the attraction of foreign-developed patents or whether or not there is an increase in foreign-developed patents within the same group of multinational enterprises (MNEs). In the present analysis we also focus on externalities of IP Box regimes on other jurisdictions transmitted through the activity of multinational firms.

More specifically, we are interested in the effect of an IP Box regime in force in one jurisdiction on real investments in other jurisdictions. For this purpose we examine whether there is a difference in a multinational firm's location choice for its new foreign affiliate in manufacturing, when the jurisdiction where its headquarters is located implements an IP Box regime compared to when not. The MNE will consider investing in jurisdictions where it finds it to be profitable enough to do so. Thus by ordering the jurisdictions according to their investment attractiveness there is a cut-off jurisdiction, potentially different for each MNE, where the profits that the MNE would require in order to undertake an investment are equal to its then realised profits. The IP Box regime with its favourable treatment of the income generated by intellectual property allows the MNE to have higher overall after-tax profits. Thus the existence of an IP Box regime in force moves the cut-off jurisdiction for each MNE and increases the number of jurisdictions potentially interesting for investments by the MNE compared to the case of non-existence of the IP Box regime. This implies that the jurisdiction, which offers the MNE the benefits of an IP Box regime, in a way subsidises the firm's investments in jurisdictions which the MNE would find to be

¹This chapter is based on Tonev (2018c).

otherwise not profitable enough for investments, perhaps due to the existence of relatively high corporate income tax rates in these jurisdictions. The decision-makers should consider these external effects when introducing, reforming, or abolishing an IP Box regime.

Evers et al. (2015) note that IP Box regimes might be used by the jurisdictions, among others, as a new means for corporate tax competition for investments by internationally active firms. With barriers to trade and international capital flows falling internationally due to the initiatives of the World Trade Organisation (WTO) and the economic integration process in Europe, the Single Market Initiative of the European Union (EU), it is easier for firms to become multinational and seize market opportunities also abroad. These developments have thus facilitated the emergence and expansion of multinational enterprises, which are firms that have affiliates in at least two different jurisdictions. Studies have found that firms which become multinational have a systematically higher productivity than the firms from the same cohort, the ones which are established in the same year, but that have affiliates only in one jurisdiction or consist of only one entity and thus remain national (Delgado et al., 2002; Fariñas and Ruano, 2005).

There are different possibilities of becoming a multinational enterprise, for example through the acquisition of an existing foreign firm (mergers and acquisitions, M&A), through the establishment of a completely new firm (greenfield investment), whereas this could be done jointly with a partner firm (joint venture) or undertaken completely alone (wholly-owned subsidiary, WOS). In an analysis on the role of firm productivity on the choice of a particular strategy for entering a foreign market, Raff et al. (2012) show that more productive firms are more likely to choose the WOS option relative to the M&A option.

Having this in mind, it seems logical from the point of view of the different decision-makers to try to attract foreign firms to become active in their respective jurisdiction with the hope that this would benefit their jurisdiction. An important reason why jurisdictions might be interested in attracting multinational firms is the expected increase in their tax revenues when they host MNEs. This comes as a direct implication of the MNEs' relatively high productivity which in turn is expected to be reflected in relatively high profits, which the MNEs would generate in the jurisdiction where they are active in. However, it is not clear if this would necessarily be the case as MNEs could shift profits out of relatively high-tax jurisdictions.

There are various strategies, which the MNEs employ in order to shift profits out of a relatively high-tax jurisdiction into a relatively low-tax jurisdiction. For instance, the MNEs could achieve this by the setting of the transfer prices used for the transactions, which take place between the different entities of the same MNE operating in different jurisdictions (Clausing, 2003). After all, it is often difficult if not impossible to find comparable arm's-length prices for intra-firm transactions. This is especially the case if the transaction in question involves some kind of intangible assets, such as patents or

trademarks, for the right of use of which one affiliate pays royalties to another affiliate, which is the legal owner of the respective intangible assets. Even if transfer prices would not be used for profit shifting, the location of the MNE's intangible assets in a relatively low-tax jurisdiction could in itself be used as an instrument for tax minimisation for the MNE group as a whole, as shown in Chapter 4 of the present doctoral dissertation.

Chapter 5 of the present doctoral dissertation furthermore shows that with higher heterogeneity of the productivity of firms active in a particular industry in some jurisdiction, it is easier for the MNEs to shift their profits out of this jurisdiction by setting their transfer prices accordingly. Chapter 5 analyses two potentially opposing effects being at play. On the one hand, there is an efficiency effect of MNE activity, which is increased when there is more firm heterogeneity present, as the more productive firms gain market shares from the less productive ones. However, at the same time profit shifting by the MNEs takes place and is also increased by the increase in firm heterogeneity. Profit shifting takes place through the use of the prices the multinational firms set for the cross-border transactions between their different entities. As a result of the profit-shifting effect the MNEs minimise their reported earnings in the relatively high-tax jurisdiction.

Next to the macroeconomic factors describing the economic situation of a particular jurisdiction and the relative quality of the institutions of that jurisdiction, tax policy, on which lies the main focus of the following analysis, also plays a crucial role for the decision of an MNE with respect to the location for its new affiliates (Barrios et al., 2012; Merlo et al., 2016). After all, an MNE is often operating in many jurisdictions, which might differ among each other, for instance with respect to the statutory corporate income tax rates imposed on firms' realised profits. Differences in the corporate income tax rates provide the MNE with incentives to shift profits from relatively high-tax to relatively low-tax jurisdictions, where it has affiliates in.

This implies that the same tax policy instruments might have different effects on the location choice decision of MNEs for their new affiliates. This is why in our theoretical and some of the estimated empirical models we explicitly allow for heterogeneity of the impact of the corporate income tax rates on the MNEs' location choices. After all, the corporate income tax rates are an important explanatory variable to which the different multinational firms might respond differently. The empirical analysis of the present chapter furthermore focuses not only on the statutory corporate income tax rates but analyses the impact of a variety of variables, the majority of which are tax policy instruments, on the location choice of multinational firms for their new foreign affiliate operating in a manufacturing sector.

For our analysis we use the ORBIS database compiled by Bureaus van Dijk for the years 2004–2014. In the empirical analysis we implement a variety of multinomial models, compare the signs and statistical significance of the estimated coefficients in these models, and also compare the goodness-of-fit of the estimated results with respect to the actual

data as in Cameron and Trivedi (2010, Chapter 17) and Fiebig et al. (2010). We begin our analysis by estimating a conditional logit model as in Barrios et al. (2012), where the authors analyse the impact of corporate income tax rates on the location decision for new European affiliates of MNEs. The present chapter continues with the estimation of a mixed logit model, which takes into account potential correlations between different choice alternatives as in Merlo et al. (2016), where the authors are interested in the location decision for new affiliates of German MNEs with respect to the rules regarding interest deductions from the respective firms' tax bases. Then we estimate three generalized multinomial logit (G-MNL) models, which are the S-MNL, the G-MNL-I, and the G-MNL-II models, which are proposed by Fiebig et al. (2010) in order to capture potential heterogeneity in the estimated coefficients with respect to the different MNEs. G-MNL models are used in Behrendt and Wamser (2017) for the estimation of the effect of corporate income tax rates and double taxation treaties on the location choice for new affiliates of MNEs. In the present analysis we further provide graphical representations of the estimated individual-level coefficients as in Keane and Wasi (2013). In all of the empirical models, which we estimate, the signs of the estimated coefficients and their statistical significance at conventional significance levels are quite similar, which implies robustness of our empirical results.

The chapter is structured as follows. Section 3.2 presents a literature review on the IP Box regimes. Section 3.3 presents the theoretical model and its predictions, which we later test empirically. Then Section 3.4 elaborates on the empirical models, the different types of multinomial models, implemented in the present analysis. Section 3.5 presents the data and the empirical results. Section 3.6 then concludes. The Appendix, Appendix 3.7, provides information on the explanatory variables used in the empirical analysis and also on their sources.

3.2 Literature review

In their working paper and the consequent paper Evers et al. (2013; 2015) provide a description of the various aspects of the IP Box regimes and their implications for the taxation of the MNEs' corporate income. The main common feature of the IP Box regimes implemented in the different jurisdictions is that they offer preferential taxation of the corporate income of firms, which is generated by the firms' intellectual property registered at the respective jurisdiction. All of these regimes allow income from firms' patents to benefit from the lower tax rates. These regimes differ, however, with respect to other types of intellectual property, such as trademarks and designs, which could also potentially be covered by them and thus be eligible to benefit from the reduced corporate tax rates. There are further important differences concerning the eligible intellectual property. According to some IP Box regimes only IP, which has been self-developed by the firm can be offered

the preferential tax rate. Other IP Box regimes are more generous and allow also for acquired IP to be eligible for the IP Box benefits or only require some further development of the acquired intangible property in the jurisdiction of the IP Box regime. Importantly, the income from royalties resulting from the IP are generally allowed to benefit from the preferential tax rates in the jurisdictions, which implement IP Box regimes.

According to Evers et al. (2015) important reasons why jurisdictions offer such generous tax treatment on the income generated by a firm's IP is to stimulate local innovation, to attract or at least to retain already developed IP. This implies that, on the one hand, potentially there might be effects only on the jurisdiction where the IP Box regime is in force, and on the other hand, that there might also be effects on other jurisdictions, which are different from the one with the IP Box regime in place. As pointed out in Evers et al. (2015) MNEs could use the so-called contract R&D (research and development) arrangements to undertake R&D in a jurisdiction, which offers tax stimuli for R&D, and then to register the resulting IP in a jurisdiction offering generous tax treatment of the IP income, such as the tax benefits offered by the IP Box regimes.²

The paper by Alstadsæter et al. (2015) provides a summary of the characteristics of IP Box regimes and also analyses the implications of IP Box regimes on the jurisdictions, which implement them. The authors find a positive effect of the existence of IP Box regimes on the number of patents of multinational firms located in these jurisdictions. They furthermore find that more valuable patents show a stronger, more sensitive, reaction to the IP Box regimes. Interestingly, there is also some, although relatively small, heterogeneity of the MNEs with respect to their reactions to the IP Box regime, which also depends on the industry to which they belong. Their paper also shows that without an explicit condition that the patents have been previously developed in the jurisdiction of the IP Box regime, there are no positive effects on local R&D to be expected. Whereas with a development condition in place, the authors find positive effects to be present there. This implies that the particular design of an IP Box regime can be crucial to whether the IP Box regimes stimulate local innovative activity or provide incentives for the registration of patents in these jurisdictions only for tax purposes.

A study by Bradley et al. (2015) is also interested in the impact of IP Box regimes on fostering local innovation. Their paper furthermore focuses on the potential cross-border effects of IP Box regimes on the location of patents. The authors specifically distinguish whether the jurisdictions, where the inventors of the patent are located, and the jurisdiction of the application for registration of the patent are the same or different. In the first case the authors assume that there has been no cross-border registration of the patent, whereas in the second case they assume that there has been a cross-border registration.

²Importantly, for the jurisdictions, which are members of the European Union, the European law generally does not impose that the IP is developed in the jurisdiction, where it is legally registered, in order to be eligible for the tax benefits of an IP Box regime (Evers et al., 2015).

Bradley et al. (2015) show that IP Box regimes have indeed a positive effect on the number of patents registered in the jurisdiction implementing the IP Box regime. Their findings suggest that the positive effect of the IP Box regimes on the number of new patent applications in the respective jurisdictions results primarily from the registration of patents, which were also developed there. However, they stress that it is possible that these new patent applications are the result of previously not patented intellectual property, which the firms then patent in order to make it eligible for the benefits of the IP Box regime.

There are further studies on the effects of the IP Box regimes on the jurisdictions implementing them. Chen et al. (2016) study the real economic effects of IP Box regimes on the jurisdictions, which have these tax policies in place. They find an increase in employment but not in investments in fixed assets by MNEs operating in jurisdictions with IP Box regimes. In a follow-up study to the one in this chapter of the doctoral dissertation, Tonev (2018b), we find that jurisdictions with IP Box regimes in force have a higher probability to be chosen as the location for the MNEs' headquarters than jurisdictions, which do not have these tax policies in place.

Schwab and Todtenhaupt (2016) concentrate their analysis on the spillover effects of an IP Box regime on patenting abroad. These spillover effects are transmitted within the different groups of MNEs, which have affiliates active in these jurisdictions. They argue that the existence of an IP Box regime in one jurisdiction, where an MNE has an affiliate in, has a positive effect on the R&D activity of an affiliate of the same MNE group, which is located in a jurisdiction not implementing an IP Box regime. The authors find this positive effect only in the cases, where the IP Box regime does not require that the IP was previously developed in the jurisdiction with the IP Box regime in place. This is the case when there is no nexus requirement for the IP in question to be eligible for the IP Box benefits. The authors compare these positive externalities of IP Box regimes to the effects, which tax havens are found to have on the investments of MNEs in non-haven jurisdictions, elaborated on in Hong and Smart (2010). In the no-nexus-requirement case, the lower corporate income tax rate of the IP Box regime allows the MNEs to register their foreign-developed IP for tax purposes in the respective jurisdiction implementing the IP Box regime. However, this international tax minimisation with respect to the taxation of the income, generated by the MNEs' IP, implies that also R&D projects with lower expected returns would still be realised by the MNEs. As a result the authors find that the average quality of patents developed in the jurisdictions without the IP Box regime in place is lowered. Thus the IP Box regime in force in one jurisdiction increases the quantity but not necessarily the quality of the IP developed abroad within the same MNE group, and which is then registered in the jurisdiction with the IP Box regime in force.

In the present analysis we also focus on the spillover effects of IP Box regimes on other jurisdictions, which are transmitted within MNE groups. However, we are not interested in the external effects on patenting in these jurisdictions as Schwab and Todtenhaupt (2016)

are, but more generally in the potential spillover effects on the real economic activity of the MNEs there. For this purpose we analyse the impact of the existence of an IP Box regime in the jurisdiction of the MNE’s headquarters on the location choice for the MNE’s new foreign affiliate in manufacturing. More specifically, we are interested in the impact of the IP Box regime on the estimated effect for the corporate income tax rate of the jurisdictions from the MNE’s choice set for the location of its new foreign affiliate in manufacturing. The economic mechanism, which we find to exist both theoretically and empirically, is that the presence of the IP Box regime allows the MNE as a whole to have higher overall after-tax profits as it needs to pay less taxes. This thus makes it more probable for the MNE to consider investing also in jurisdictions, which implement relatively high corporate income tax rates. The IP Box regimes consequently increase the probability that the MNE considers investing in such jurisdictions, where it would have found it to be less profitable to do so in the case without an IP Box regime in force at the jurisdiction where its headquarters is located in. This argument is similar to the one elaborated on in the studies of Desai et al. (2006) and Hong and Smart (2010) on the positive effects of the existence of MNEs’ tax-haven affiliates on the investments by these MNEs in high-tax jurisdictions.

3.3 Theoretical model

The theoretical model of the present analysis is inspired by the theoretical part in Gumpert et al. (2016), which focuses on MNE’s tax haven investments. We have taken the initial equation from there and have adapted it to the context of our study.³ More precisely, we model the variable costs of the firm differently, introduce royalties withholding taxes, normalise the fixed costs of the firm to zero, and give a new interpretation to the variable denoting the transaction between the affiliate and the headquarters. In the present analysis we assume this transaction to be made of a royalties payment between the two MNE’s entities.

Thus in the present analysis the profits before taxes of an affiliate of a multinational firm are given by the following equation:

$$\Omega = R - \rho - \frac{\rho^2}{2a}, \quad (1)$$

where R denotes the realised profits and ρ denotes a royalties payment for the right of use of some intellectual property, which is legally registered at the jurisdiction of the MNE’s headquarters (HQ). We assume the MNE’s HQ to be located in a jurisdiction, which is different from the one of the affiliate. The last term denotes the cost of justifying

³The equation describing the reported profits of a firm, which is part of a multinational group, in the theoretical model in Gumpert et al. (2016) is similar to the one in the theoretical part of Hines and Rice (1994), whereas the focus of the analyses of these two papers differs from one another.

the royalties payment. Due to the often specific, even firm-specific, nature of intellectual property it might be the case that comparable arm's-length prices for the underlying royalties payment do not exist. Thus also in the case when the royalties payment is not used for profit shifting, the MNE would still have some costs of justifying the amount of its royalties payment in front of the tax authorities. These cost are assumed to differ among different firms with respect to the parameter a , as for example different firms might have different R&D intensity. This implies that it would be easier for R&D-intensive firms, firms with larger values of a , to claim that the magnitude of the royalties payment between the affiliate and the headquarters is as they declare it to be in front of the tax authorities.

The overall after-tax profits of the whole MNE, which we assume consists only of the headquarters and the one foreign affiliate, are given as:

$$\Pi = (1 - t)(1 - w)\rho + (1 - t^*) \left(R - \rho - \frac{\rho^2}{2a} \right), \quad (2)$$

where the first term represents the after-tax profits of the headquarters, which consist of the royalties payment after a royalties withholding tax at rate w , with $0 < w < 1$, and also after the corporate income tax of the HQ' jurisdiction, given by the tax rate t , have been paid. The second term denotes the after-tax profits of the MNE's foreign affiliate, where t^* is the corporate income tax rate in force in the jurisdiction, where the MNE's affiliate is located in.

It is important to note that the HQ' corporate income tax rate can take two different values. This depends on whether or not there is an IP Box regime in force there, such that $t \in \{t_{IP}, t_{nIP}\}$ and $t_{IP} < t_{nIP}$, with t_{IP} being the relatively low IP Box corporate income tax rate, which applies to the income generated by the intellectual property of the MNE, and t_{nIP} being the corporate income tax rate, if there is no IP Box regime in force in the respective jurisdiction. In order to be profitable for the MNE to locate its intangible assets at the HQ' location, we assume that both of its potential corporate income tax rates are lower than the foreign corporate income tax rate, such that $0 < t < t^* < 1$ and more specifically that $0 < t_{IP} < t_{nIP} < t^* < 1$.

The MNE will have an affiliate only in such jurisdictions, where its overall after-tax profits Π , given in Eq. (2), are larger than or equal to some required level Π_{min} , such that $\Pi_{min} \leq \Pi$. Thus Eq. (1) gives the before-tax profits of an MNE's affiliate located in a jurisdiction, for which the requirement $\Pi_{min} \leq \Pi$ is fulfilled.

The first-order condition (FOC) of Eq. (2) with respect to the amount of the royalties payment, ρ , is given by the following expression:

$$\frac{\partial \Pi}{\partial \rho} = (1 - t)(1 - w) - (1 - t^*) \left(1 + \frac{\rho}{a} \right) \stackrel{!}{=} 0. \quad (3)$$

Rearranging Eq. (3) gives us the optimal royalties payment:

$$\rho = \frac{a}{(1-t^*)} [(t^* - t) - w(1-t)]. \quad (4)$$

Having a positive royalties payment, $\rho > 0$, implies that the expression in the square brackets in Eq. (4) is positive, such that $(t^* - t) - w(1-t) > 0$. This thus implies that:

$$\frac{t^* - t}{1-t} > w, \quad (5)$$

which gives the condition ensuring that the royalties payment, ρ , is positive. We can extend the condition, given in Expression (5), to get the following chain of inequalities: $1 > (t^* - t)/(1-t) > w > 0$, where the first inequality is fulfilled due to $t^* < 1$ and the last inequality is fulfilled due to $0 < w < 1$.

In a next step, we provide some comparative statics of the optimal royalties payment from Eq. (4):

$$\frac{\partial \rho}{\partial a} = \frac{1}{(1-t^*)} [(t^* - t) - w(1-t)] > 0, \quad (6)$$

which implies that the optimal royalties payment is increasing with a , meaning that when it is relatively more easy for the MNE to justify its royalties payment it will make use of this. Furthermore:

$$\frac{\partial \rho}{\partial t} = -\frac{a}{(1-t^*)}(1-w) < 0, \quad (7)$$

which implies that ρ is lower with higher taxation at the HQ' jurisdiction. Thus a more favourable taxation of income generated by intellectual property at the HQ' jurisdiction, given by the lower corporate income tax rate t_{IP} compared to the other corporate income tax rate, t_{nIP} , favours a larger royalties payment towards the HQ' jurisdiction. In addition:

$$\frac{\partial \rho}{\partial w} = -\frac{a}{(1-t^*)}(1-t) < 0, \quad (8)$$

which implies that higher royalties withholding taxes also make it less attractive for the MNE to make high royalties payments between its two entities. And also:

$$\frac{\partial \rho}{\partial t^*} = \frac{a}{(1-t^*)^2}(1-t)(1-w) > 0, \quad (9)$$

which implies that higher corporate taxation at the jurisdiction of the MNE's affiliate induces the MNE to increase the amount of its royalties payment and thus pay a larger amount of royalties to the HQ' jurisdiction.

Still, the amount of royalties, which the MNE will be able to pay most, is determined by the condition of having non-negative profits at its foreign affiliate, $\Omega \geq 0$ in Eq. (1). In order to compute the non-negative-profits constraint for the MNE's affiliate, we plug in

the optimal value for ρ , given in Eq. (4), into the equation for the before-tax profits of the foreign affiliate, given by Eq. (1), then rearrange and simplify the expression to get the following inequality:

$$R \geq \frac{a}{2} \left[\left(\frac{(1-t)(1-w)}{(1-t^*)} \right)^2 - 1 \right], \quad (10)$$

which implies that the realised profits, R , thus need to be sufficiently high. The realised profits R , given in Expression (10), are positive due to the term in the square brackets in Expression (10) being positive:

$$\left(\frac{(1-t)(1-w)}{(1-t^*)} \right)^2 - 1 > 0. \quad (11)$$

Expression (11) is positive because it can be simplified to: $(t^* - t)/(1 - t) > w$. This inequality is fulfilled as it is equal to the condition ensuring that $\rho > 0$, given in Expression (5).

Using the expression for the optimal royalties payment from Eq. (4), the overall after-tax profits of the MNE, given in Eq. (2), can be rewritten as:

$$\Pi = (1 - t^*)R + \frac{a}{2(1 - t^*)} [(t^* - t) - w(1 - t)]^2. \quad (12)$$

Comparative statics of the overall after-tax profits Π from Eq. (12) with respect to the firm-heterogeneity parameter a give us the following relationship:

$$\frac{\partial \Pi}{\partial a} = \frac{1}{2(1 - t^*)} [(t^* - t) - w(1 - t)]^2 > 0, \quad (13)$$

which implies that firms which can more easily justify their royalties payments, whose parameter a is relatively large, have higher overall after-tax profits. This is because they face a lower cost of profit shifting from the high-tax to the low-tax jurisdiction compared to the other firms, whose parameter a is relatively small. This lower cost is implied by the lower cost of justifying the royalties payment in front of the tax authorities, which is given by the magnitude of the respective parameter a . The parameter a is the channel, through which firm heterogeneity has an impact on the overall firm profitability in the present model.

In a further step, we compare the overall after-tax profits of an MNE without an IP Box regime and with an IP Box regime in force at the HQ' location, $\Pi_{nIP} \geq \Pi_{IP}$:

$$\begin{aligned} (1 - t^*)R + \frac{a}{2(1 - t^*)} [(t^* - t_{nIP}) - w(1 - t_{nIP})]^2 &\geq \\ &\geq (1 - t^*)R + \frac{a}{2(1 - t^*)} [(t^* - t_{IP}) - w(1 - t_{IP})]^2, \end{aligned} \quad (14)$$

which simplifies to $t_{IP} < t_{nIP}$ and implies that $\Pi_{nIP} < \Pi_{IP}$. Thus having its HQ located

at a jurisdiction with an IP Box regime, which provides for preferential tax treatment of income generated by intellectual property, provides the MNE with higher overall after-tax profits and thus higher overall profitability. This then implies that the MNE will find it profitable to invest also in jurisdictions, where it wouldn't have done so if there were no IP Box regime in force at the HQ' location in the first place.

The existence of the IP Box regime is thus increasing the number of jurisdictions, where the MNE will still find it profitable enough to invest in, compared to the case when there is no IP Box regime in place. We thus have that $\Pi_{min} \leq \Pi_{nIP} < \Pi_{IP}$.

Propositions 1 and 2 summarise the results, which follow from our theoretical model and which we test in the empirical part of the present analysis:

Proposition 1 *The probability that a jurisdiction is chosen for the location of the MNE's new foreign affiliate in manufacturing is: (i) Decreasing with a higher corporate income tax rate present in the particular jurisdiction; (ii) Increasing when the MNE's HQ is located in a jurisdiction with an IP Box regime; (iii) Decreasing with higher royalties withholding tax rates applied between the two jurisdictions.*

Proposition 2 *There is heterogeneity with respect to the location decision for the MNEs' new foreign affiliates in manufacturing, where some MNEs will be able to consider also relatively high-tax jurisdictions as locations for their new foreign affiliates in manufacturing whereas others will not.*

3.4 Multinomial models

In this section we present the empirical models, which we estimate in the next section. In our analysis we study the location choice decision of an MNE. More precisely, this is the choice of an MNE for one jurisdiction out of a set of possible jurisdictions for the location of its new foreign affiliate. In the empirical analysis we estimate empirical models, which account for the multinomial nature of the location choice of the MNE for its new foreign affiliate as the MNE chooses one jurisdiction out of potentially many alternatives, which comprise its choice set.

In the following we adapt the notation used in Chapter 15 in Cameron and Trivedi (2010) and in Fiebig et al. (2010) when writing down the multinomial models. For convenience in the used notation, we drop the time index n , with $n = 1, \dots, N$, which denotes the different time periods.

In a multinomial model the probability that a firm i chooses a specific jurisdiction j , conditional on the observed realisations of the control variables \mathbf{x}_i , is given by the following expression:

$$p_{ij} \equiv \Pr(y_i = j | \mathbf{x}_i) = F_j(\mathbf{x}_i, \boldsymbol{\theta}), \text{ for } i = 1, \dots, I \text{ and } j = 1, \dots, J;$$

where $\boldsymbol{\theta}$ is a vector of parameters, which are to be estimated, and where the vector of

coefficients β is a part of this vector, in such a way as to maximise the likelihood of the given data realisations to be observed. The maximisation procedure is undertaken on the logarithm of the underlying likelihood function, thus the so-called log-likelihood function is maximised.

Measures, which allow the comparison of the goodness-of-fit of the different multinomial models, include the value of the maximised log-likelihood (LL), Akaike's information criterion (AIC), and Schwarz's Bayesian information criterion (BIC).⁴ These three goodness-of-fit measures are provided in the present analysis after each estimation, where larger values of LL and smaller values of both AIC and BIC imply better model fit.

The utility, which firm i gets from the choice of alternative j , is given by:

$$U_{ij} = \mathbf{x}'_{ij}\beta + \epsilon_{ij}, \quad (15)$$

where the explanatory variables are denoted by \mathbf{x}'_{ij} and they make up the deterministic part of utility, and ϵ_{ij} denotes the random part. In our analysis we are interested in the specific characteristics, especially in terms of the tax policy instruments, of the different jurisdictions and their impact on the location choice of the various MNEs. Alternative j is chosen if it yields the highest utility for firm i .

In our empirical analysis we first estimate conditional logit (Clogit) models. The Clogit model implies that:

$$p_{ij} = \frac{\exp(\mathbf{x}'_{ij}\beta)}{\sum_{k=1}^J \exp(\mathbf{x}'_{ik}\beta)}, \text{ for } j = 1, \dots, J; \quad (16)$$

where \mathbf{x}'_{ij} denotes the explanatory variables.

Then we estimate a random-parameters logit model, also called mixed logit (Mixlogit) model, which relaxes the assumption of the Independence of Irrelevant Alternatives (IIA) present in the case of the Clogit model. The IIA assumption implies that the choice between any two alternatives is independent of the other alternatives and that this choice can thus be interpreted as the probability given by a binary logit model for these two alternatives. The Mixlogit model allows the inclusion of alternatives, which are similar to already existing alternatives, to decrease the probability that these alternatives are chosen relative to other existing alternatives, to which the new alternative is not similar. This is not the case under the IIA assumption, where the relative probabilities of any two alternatives are unchanged by the inclusion of a new alternative, even when it is similar to one of them. The error terms across the alternatives are not correlated in the Clogit model, which is not the case in the Mixlogit model. In order to relax the IIA assumption, it is assumed that the error term contains an additional unobservable part coming from

⁴For instance, the two information criteria, AIC and BIC, are used in Fiebig et al. (2010). Furthermore, AIC and BIC, as well the value of the maximised log-likelihood, LL, are used in Cameron and Trivedi (2010, Chapter 17) for comparisons of the goodness-of-fit of different estimated models.

the explanatory variables.

In the Mixlogit case utility is given by the following expression:

$$U_{ij} = \mathbf{x}'_{ij}\boldsymbol{\beta}_i + \epsilon_{ij} = \mathbf{x}'_{ij}\boldsymbol{\beta} + \mathbf{x}'_{ij}\boldsymbol{\eta}_i + \epsilon_{ij}, \quad (17)$$

where it is assumed that the regressors contain not only a deterministic part, which applies in the same way to all firms, as in the Clogit case but also a random part, which can vary across the different firms. The additional unobservable, random, component is given by $\mathbf{x}'_{ij}\boldsymbol{\eta}_i$.

The Mixlogit model implies:

$$p_{ij}|\boldsymbol{\eta}_i = \frac{\exp(\mathbf{x}'_{ij}\boldsymbol{\beta} + \mathbf{x}'_{ij}\boldsymbol{\eta}_i)}{\sum_{k=1}^J \exp(\mathbf{x}'_{ik}\boldsymbol{\beta} + \mathbf{x}'_{ik}\boldsymbol{\eta}_i)}, \text{ for } j = 1, \dots, J; \quad (18)$$

where the explanatory variables are denoted by \mathbf{x}'_{ij} . In the Mixlogit model from above the error term is not simply ϵ_{ij} as in the Clogit case but is: $\mathbf{x}'_{ij}\boldsymbol{\eta}_i + \epsilon_{ij}$, which implies that it is correlated across alternatives in order to relax the IIA assumption. The distribution of the random part $\boldsymbol{\eta}_i$ is assumed to be multivariate normal, $\text{MVN}(\mathbf{0}, \boldsymbol{\Sigma})$, where $\boldsymbol{\Sigma}$ is further assumed to be a diagonal matrix. In the case where the variances of the vector $\boldsymbol{\eta}_i$ are all zero, then the Mixlogit model would collapse to the Clogit model.

There is no closed-form solution for the log-likelihood function $p_{ij} = F_j(\mathbf{x}_i, \boldsymbol{\theta})$ of the Mixlogit model, so the log-likelihood is estimated by simulations. The Mixlogit and the following G-MNL estimations, which we do in our empirical analysis, are all based on maximum simulated likelihood estimations of Halton sequences with 500 draws.

Fiebig et al. (2010) expand the multinomial models by allowing for different forms of scale heterogeneity. Fiebig et al. (2010) propose that the error term ϵ_{ij} has a variance or scale, denoted by σ , which was previously implicitly normalised to 1 in order to achieve identification of the multinomial models. However, this variance may vary across the different firms i . The utility of firm i , given in Eq. (15), can thus be transformed by multiplying the whole equation by σ_i and Eq. (15) thus becomes:

$$U_{ij} = \mathbf{x}'_{ij}\boldsymbol{\beta}\sigma_i + \epsilon_{ij},$$

which is denoted by S-MNL for the model with scale heterogeneity.

A similar transformation for firm i 's utility can be done also for Eq. (17), where Fiebig et al. (2010) explicitly distinguish two specific cases. The first case is given by:

$$U_{ij} = \mathbf{x}'_{ij}\boldsymbol{\beta}\sigma_i + \mathbf{x}'_{ij}\boldsymbol{\eta}_i + \epsilon_{ij},$$

which is denoted by G-MNL-I and where the scale parameter σ_i has an effect only on the deterministic part of the regressors, given by $\boldsymbol{\beta}$. The second case is given by:

$$U_{ij} = \mathbf{x}'_{ij}\boldsymbol{\beta}\sigma_i + \mathbf{x}'_{ij}\boldsymbol{\eta}_i\sigma_i + \epsilon_{ij},$$

which is denoted by G-MNL-II and where the scale parameter σ_i proportionately affects both the deterministic and the random parts of the regressors, given by: $\boldsymbol{\beta} + \boldsymbol{\eta}_i$.

The proposed generalized multinomial model, G-MNL, by Fiebig et al. (2010) can be written in the following form:

$$U_{ij} = \mathbf{x}'_{ij}\boldsymbol{\beta}\sigma_i + \mathbf{x}'_{ij}\boldsymbol{\eta}_i\gamma + \mathbf{x}'_{ij}\boldsymbol{\eta}_i\sigma_i(1 - \gamma) + \epsilon_{ij}, \quad (19)$$

where the parameter γ lies between 0 and 1, $\gamma \in [0, 1]$. It is this parameter, which determines whether we have one of the two specific cases described above. With $\gamma = 1$ we have the G-MNL-I case. With $\gamma = 0$ we have the G-MNL-II case. There might also be some mixture of these two cases.

The G-MNL model implies:

$$p_{ij}|\boldsymbol{\eta}_i = \frac{\exp[\mathbf{x}'_{ij}\boldsymbol{\beta}\sigma_i + \mathbf{x}'_{ij}\boldsymbol{\eta}_i\gamma + \mathbf{x}'_{ij}\boldsymbol{\eta}_i\sigma_i(1 - \gamma)]}{\sum_{k=1}^J \exp[\mathbf{x}'_{ik}\boldsymbol{\beta}\sigma_i + \mathbf{x}'_{ik}\boldsymbol{\eta}_i\gamma + \mathbf{x}'_{ik}\boldsymbol{\eta}_i\sigma_i(1 - \gamma)]}, \text{ for } j = 1, \dots, J; \quad (20)$$

which, as the Mixlogit model denoted in Eq. (18), is estimated by simulations.

In order to ensure that the scale parameter σ_i is positive Fiebig et al. (2010) assume that it is log-normally distributed, where its mean is equal to 1 and its standard deviation is equal to τ , $\text{LN}(1, \tau^2)$. The parameter τ is estimated for the three types of the G-MNL model, which are the S-GML, the G-MNL-I, and the G-MNL-II models. In case that it is statistically significantly different from zero, this would imply that individual-specific scale heterogeneity plays a role in the estimations. Otherwise the G-MNL model would collapse to the Clogit or Mixlogit model, depending then on the statistical significance of the estimated standard deviations for the explanatory variables, which are assumed to have also random parts.

A summarised overview of the estimated individual-level coefficients for the different multinomial models, which we implement in the present analysis, is presented in Table 1. With the exception of the Clogit model, all other models explicitly allow for heterogeneity across the estimated coefficients for the different firms. The existence of this heterogeneity is in line with our theoretical analysis from the previous section and captures in a way the implications of the parameter a from our theoretical model for the different multinational firms.

Table 1 shows that the estimated coefficients in the Clogit model are the same for all firms and they are equal to the constant part $\boldsymbol{\beta}$. In the Mixlogit model heterogeneity is modelled in an additive way, by adding the random part $\boldsymbol{\eta}_i$ to the constant part $\boldsymbol{\beta}$. In the S-MNL model heterogeneity in the estimated individual-level coefficients is modelled in a multiplicative way and comes from the scale parameter σ_i , with which the constant

Table 1: Summary of the individual-level coefficients

Model	Coefficients	Prerequisites
Clogit	$\beta_i = \beta$	$\text{Var}(\boldsymbol{\eta}_i) = \mathbf{0}; \text{Var}(\sigma_i) = 0$
Mixlogit	$\beta_i = \beta + \boldsymbol{\eta}_i$	$\text{Var}(\boldsymbol{\eta}_i) \neq \mathbf{0}; \text{Var}(\sigma_i) = 0$
G-MNL	$\beta_i = [\beta\sigma_i + \boldsymbol{\eta}_i\gamma + \boldsymbol{\eta}_i\sigma_i(1 - \gamma)]$	$\text{Var}(\boldsymbol{\eta}_i) \neq \mathbf{0}; \text{Var}(\sigma_i) \neq 0; \gamma \in [0, 1]$
G-MNL-I	$\beta_i = \beta\sigma_i + \boldsymbol{\eta}_i$	$\text{Var}(\boldsymbol{\eta}_i) \neq \mathbf{0}; \text{Var}(\sigma_i) \neq 0; \gamma = 1$
G-MNL-II	$\beta_i = (\beta + \boldsymbol{\eta}_i)\sigma_i$	$\text{Var}(\boldsymbol{\eta}_i) \neq \mathbf{0}; \text{Var}(\sigma_i) \neq 0; \gamma = 0$
S-MNL	$\beta_i = \beta\sigma_i$	$\text{Var}(\boldsymbol{\eta}_i) = \mathbf{0}; \text{Var}(\sigma_i) \neq 0$

Notes: Inspired by Figure 1 in Fiebig et al. (2010).

part β is multiplied. The G-MNL model provides for combinations of the two ways for the modelling of heterogeneity. For instance, in the G-MNL-II model the scale parameter affects proportionately both the constant and the random parts of the estimated individual-level coefficients, whereas in the G-MNL-I model only the constant part is affected by the scale parameter and the random part is then added to the multiplicative term of the constant part and the scale parameter.

3.5 Data and empirical analysis

3.5.1 Data

In the empirical part of the present analysis we use firm data from the ORBIS database compiled by Bureau van Dijk for the years 2004 to 2014. We are interested in the location choice of multinational firms for their new affiliate, which they locate in a jurisdiction different from the one of the global ultimate owner (GUO) in that period. Thus we are interested in the location of new foreign affiliates by multinational firms. In our analysis we assume the global ultimate owner, as defined by Bureau van Dijk, to be also the MNE's headquarters. We thus assume the jurisdiction where the GUO is located to be the jurisdiction where the MNE's HQ is located. We only consider GUOs which open only one new foreign affiliate in manufacturing in our sample. As shown in more detail in Table 2 the vast majority of the MNEs in our sample, almost 85%, have opened only one new foreign affiliate operating in a manufacturing sector in the period 2004–2014.

In the present analysis we focus on the impact of IP Box regimes in force in the jurisdiction of the MNE's headquarters as we expect important IP for the functioning of the MNE's new foreign affiliate to be registered there. Thus the potential royalties payments from the new foreign affiliate in manufacturing will consequently accrue to the MNE's headquarters and will be taxed according to that jurisdiction's tax policy. The existing literature on the location of intangible assets within MNEs' network of affiliates points out that there is a considerable headquarters bias in the location of intangible assets,

Table 2: Data on the number of new affiliates per GUO in the sample

New affs per GUO	Number of GUOs	Rel. freq. of GUOs, in %	New affs per GUO	Number of GUOs	Rel. freq. of GUOs, in %
1	6,781	84.35	2	683	8.50
3	234	2.91	4	109	1.36
5	59	0.73	6	41	0.51
7	39	0.49	8	26	0.32
9	16	0.20	10	14	0.17
11	9	0.11	12	5	0.06
13	6	0.07	14	3	0.04
15	2	0.02	16	3	0.04
17	3	0.04	18	1	0.01
20	1	0.01	22	2	0.02
24	1	0.01	25	1	0.01
Total: 8,039 GUOs					

Notes: Abbreviations: affs – affiliates; GUO – global ultimate owner; GUOs – plural of GUO; Rel. freq. – relative frequency; in % – in percent.

such as patents and trademarks, which in our case would be a bias towards the GUO location, although there are MNEs which also make use of relatively low-tax jurisdictions for the location of their intangible assets (Heckemeyer et al., 2015). Furthermore, the use of intangible assets, such as patents, is particularly important in the case of manufacturing firms, which are the MNEs’ affiliates on which the present analysis focuses.

In the empirical analysis we consider the GUO of the MNE group, metaphorically speaking, to be an umbrella under which its affiliates operate. We consider only new affiliates, which are opened in a jurisdiction different from the one of the respective GUO, thus new foreign affiliates of MNEs. In addition, we are interested only in such new affiliates, which operate in a manufacturing sector, having NACE Rev. 2 2-digit core codes from 10 to 33, thus MNEs’ new foreign affiliates in manufacturing. So we include all 24 manufacturing sectors in our analysis, as defined by the respective NACE Rev. 2 classification codes. As already mentioned, we only consider multinational firms, which open only one new foreign affiliate in manufacturing during the whole sample period. This is actually the case for the majority, around 85%, of the GUOs in the sample as can be seen in Table 2. This further allows us to have better comparability among the GUOs in our analysis. In addition, in this way we can better focus on the potential differences of the estimated coefficients for the impact of the corporate income tax rates on the location decision for the new affiliate of the different GUOs, depending on whether the GUOs are located in jurisdictions with an IP Box regime compared to the case when they are located in jurisdictions without an IP Box regime in place.

Our basic sample is comprised of the GUO and its location, the new affiliate’s jurisdiction

Table 3: Jurisdictions of the new foreign affiliates

ISO-3 code of the respective jurisdiction									
ARG	AUS	AUT	BEL	BGR	BIH	BLZ	BRA	CHL	CHN
COL	CZE	DEU	DNK	DZA	ECU	EGY	ESP	EST	FIN
FRA	GBR	GRC	HRV	HUN	IND	IRL	ISL	ITA	JPN
KAZ	KOR	LTU	LUX	LVA	MAR	MDA	MEX	MKD	MLT
MNE	NLD	NOR	NZL	PER	PHL	POL	PRT	ROU	RUS
SGP	SRB	SVK	SVN	SWE	TUR	TWN	UKR	USA	VEN
ZAF									
Overall: 61 jurisdictions									

Notes: The table presents the ISO-3 code of the respective jurisdiction, where at least one new foreign affiliate in manufacturing is established in our sample.

and the year of its incorporation, which should be among the years from 2004 to 2014. Table 3 provides information on where the new foreign affiliates of the MNEs are located in, whereas Table 4 shows where the GUOs which open new affiliates of interest for our analysis are located in. On a first glance, it can be noticed that there are much less jurisdictions chosen for the location of a new foreign affiliate in manufacturing of a multinational firm than there are jurisdictions where the GUOs of the MNEs are located in. This implies that potentially there is much more heterogeneity in the location of the GUOs, the MNEs' headquarters, than in the locations of the MNEs' affiliates from manufacturing.⁵ Still, the current analysis focuses on the location of these new affiliates of MNEs as we assume them to be connected to real economic activity and potentially to economic benefits for the jurisdictions, which would be the hosts of these affiliates of the MNEs.

In a next step, we enlarge the sample by all possible year and location choices for a particular GUO. The goal is to produce the potential choice set, which we assume was available to all of the GUOs in each year. Finally, we merge information on the different jurisdictions, including information on the corporate income tax rates present there. This provides the explanatory variables for the present location choice analysis for the MNE's new affiliate in manufacturing, which is located in a jurisdiction different from the one of the respective GUO. We further include explanatory variables, which contain bilateral information, meaning that they are potentially specific to the different pairs of jurisdictions, of the particular GUO and the jurisdictions from the MNEs' choice set. More specifically, we provide information on the royalties withholding tax rates for payments from the potential jurisdiction for the new foreign affiliate to the GUO's jurisdiction, which are to be applied in a particular year.

⁵In a follow-up analysis, Tonev (2018b), we study the location choice for the MNE's HQ and find that this decision is influenced, among others, by policy instruments regarding the taxation of intellectual property of the firms.

Table 4: Jurisdictions of the GUOs of the new affiliates

ISO-3 code of the respective jurisdiction									
ABW	AIA	ALB	AND	ARE	ARG	ARM	AUS	AUT	AZE
BDI	BEL	BGD	BGR	BHR	BHS	BIH	BLR	BLZ	BMU
BRA	BRB	CAN	CHE	CHL	CHN	CIV	COL	CRI	CUW
CYM	CYP	CZE	DEU	DMA	DNK	DZA	ECU	EGY	ESP
EST	ETH	FIN	FRA	GBR	GEO	GIB	GRC	GTM	GUY
HKG	HRV	HUN	IDN	IND	IRL	IRN	IRQ	ISL	ISR
ITA	JOR	JPN	KAZ	KNA	KOR	KWT	LBN	LIE	LKA
LTU	LUX	LVA	MAR	MCO	MDA	MEX	MHL	MKD	MLT
MNE	MUS	MYS	NCL	NLD	NOR	NZL	OMN	PAK	PAN
PER	PHL	POL	PRK	PRT	PRY	QAT	ROU	RUS	SAU
SGP	SLV	SMR	SRB	SVK	SVN	SWE	SYC	SYR	THA
TUN	TUR	TWN	UKR	URY	USA	UZB	VCT	VEN	VGB
VNM	WSM	ZAF							

Overall: 123 jurisdictions

Notes: The table presents the ISO-3 code of the respective jurisdiction, where at least one of the GUOs of the new foreign affiliates in manufacturing from our sample is located in.

In addition, we generate a dummy variable, denoted as IP Box dummy, which is equal to one if there is an IP Box regime in force in the jurisdiction of the GUO in the specific year and is equal to zero otherwise. We then create an interaction term of the IP Box dummy with the corporate income tax rate at the different jurisdictions from the choice set. The main interest of the present empirical analysis lies on the estimated coefficient of the statutory corporate income tax rate in the respective jurisdiction from the choice set and also on the estimated coefficient of the interaction term of the corporate income tax rate variable and the IP Box dummy.

We furthermore provide information on the specific royalties withholding tax rates, which apply for royalty payments from a particular jurisdiction in the choice set to the GUO's jurisdiction. Other explanatory variables, which we include in the empirical analysis, are the following: the number of double tax treaties (DTTs) and bilateral investment treaties (BITs) in force in the respective jurisdiction and year, the logarithm of the GDP (gross domestic product) and the GDP per capita in the jurisdiction, and estimates for the control of corruption present there. Furthermore, we also include information on the number of contact entries in the Ernst & Young (EY) Worldwide Corporate Tax Guides (WCTGs) provided for each jurisdiction. We use this control variable as a proxy for both the complexity of the tax system in the respective jurisdiction and at the same time also for the intensity of the economic activity taking place there. The EY WCTGs contact entries could further capture additional jurisdiction-specific aspects, which could play a role for the MNE's location choice. We also include two other tax policy instruments,

Table 5: Summary statistics – Location choice analysis

VARIABLE	Obs.	Mean	Std. dev.	Min.	Max.
aff_citr	315,301	0.2604	0.0807	0	0.41
guo_ipboxdummy	315,301	0.1366	0.3434	0	1
guoip_affcitr	315,301	0.0344	0.0915	0	0.41
aff_roywith	315,301	0.1077	0.0964	0	0.3955
aff_dtts	315,301	52.8655	25.0632	3	123
aff_bits	315,301	45.8968	26.9508	0	134
aff_eyempl	315,301	39.7796	101.6097	1	922
aff_lc_back	315,301	3.4089	17.5533	0	100
aff_lc_forward	315,301	41.6725	45.3587	0	100
ln_aff_gdp	315,301	26.1252	1.7600	21.4524	30.4886
ln_aff_gdppercap	315,301	9.4862	1.1798	6.4624	11.6666
aff_cc	315,301	0.5930	1.0764	-1.2431	2.5527

Notes: Summary statistics for the variables used in the estimations with the most control variables. Abbreviations: Obs. – observations, gives the number of observations; Std. dev. – standard deviation; Min. – minimum; Max. – maximum; aff – affiliate and as a prefix indicates the values for the potential jurisdictions of the new affiliates; guo – global ultimate owner (GUO) and as a prefix indicates the values for the jurisdictions of the GUOs; citr – statutory corporate income tax rate; ipboxdummy – dummy variable, which is equal to 1 if there is an IP (Intellectual Property) Box regime in effect in the respective jurisdiction and 0 otherwise; guoip_affcitr – interaction term between the IP Box dummy for the GUO location, guo_ipboxdummy, and the corporate income tax rate at the affiliate location, aff_citr; roywith – royalties withholding tax rate; dtts – number of double tax treaties; bits – number of bilateral investment treaties; eyempl – number of contact entries provided for a specific jurisdiction in the Ernst & Young (EY) Worldwide Corporate Tax Guides (WCTGs); lc – loss carry; ln – as a prefix denotes the natural logarithm of the respective variable; gdp – gross domestic product (GDP); gdppercap – GDP per capita; cc – estimate for the control of corruption. The variables ln_gdp and ln_gdppercap are originally given in US (United States) dollars. The variable aff_citr has a minimum at 0 and a maximum at 0.41, which implies that its minimum is at 0% and its maximum is at 41%. The variable aff_roywith has a minimum at 0 and a maximum at 0.3955, which implies that its minimum is at 0% and its maximum is at 39.55%. The estimates for the control of corruption variable, cc, range between approximately -2.5 and 2.5 with higher values indicating better control of corruption. The variables for the loss carry back and loss carry forward provisions are given in years with the number 100 denoting infinity. *Sources:* See Appendix 3.7.

namely the number of years of loss carry back and loss carry forward provisions available in a particular jurisdiction, where we take the number 100 to represent the cases of infinity, infinite amount of time periods, for such provisions as it seems to be a plausibly large number.

Table 5 provides summary statistics of the explanatory variables, which we include in the empirical analysis. The descriptive statistics are given for the sample used in the estimations with the most explanatory variables, which are presented in Column (4) of Table 6 and in all four columns of Table 7. The sources of the explanatory variables are given in Appendix 3.7.

It is interesting to note that although the span of the corporate income tax rates is very similar to the span of the royalties withholding tax rates, the mean of the withholding tax

rates is more than two times smaller than the mean of the corporate income tax rates. The reason is that the withholding tax rates, imposed on royalties payments, as a whole are pretty low even in cases where there is no DTT in effect, which would be expected to be a prerequisite for the imposition of relatively low withholding tax rates between the particular pair of jurisdictions. It is even possible that perhaps due to some tax reforms the withholding tax rate on royalties imposed on non-treaty partners, where there is no DTT in effect, is smaller than the withholding tax rates agreed on previously in DTTs, which then potentially still remain in effect.

Another point worth mentioning is that in our sample there are on average more DTTs in effect than BITs. This might indicate that the avoidance of double taxation of the profits of multinational firms is an important issue for the different jurisdictions, even among jurisdictions of similar status with respect to their economic development. In contrast, although less in numbers, the BITs would be more prevalent in the case where the treaty partners differ much more from one another with respect to the degree of their economic development. However, the spans of the variables, which denote the number of DTTs and BITs in effect of a jurisdiction, are very similar. Still, there are jurisdictions, which do not have any BITs in force in a year at all, whereas the minimum number of DTTs in effect in a certain year is three.

The number of contact entries provided for a particular jurisdiction in the EY Worldwide Corporate Tax Guides is very skewed. On average there are about 40 contact entries, whereas there are a few cases where the number is larger than 100. The maximum values for this variable in our sample are found for the USA.

As some loss carry back and loss carry forward provisions are given for an infinite amount of time periods, years, we have assumed for these cases the amount of years to be given by the number 100. This implies that the mean values of these two variables imply that it is much more common that jurisdictions allow loss carry forward provisions for an infinitely large amount of years than it is the case for the loss carry back provisions.

As in Dischinger et al. (2014a), we also use the logarithm of GDP and of GDP per capita at the different jurisdictions to control for the macroeconomic situation in the respective jurisdictions and furthermore include a control variable for corruption. In our analysis we include an estimate for the control of corruption present in the jurisdictions of the MNEs' choice set. The values of the control of corruption variable range from approximately -2.5 to 2.5 with higher values denoting stronger control of corruption. The mean of this variable is about 0.6, which is positive, thus implying that the MNEs tend to choose jurisdictions with better control of corruption as the locations for their new foreign affiliates in manufacturing.

3.5.2 Empirical analysis

We begin our empirical analysis by estimating a Clogit model as in Barrios et al. (2012). The estimated results are presented in Table 6. Then we continue the analysis by estimating multinomial models, which relax the IIA assumption of the Clogit model and which account for heterogeneity of the estimated individual-level coefficients such as the Mixlogit model as in Merlo et al. (2016) and three different G-MNL models as proposed by Fiebig et al. (2010). Our results for these estimations are presented in Table 7. In every estimation our dependent variable is a binary variable equal either to one or to zero. When it is equal to one this denotes that the particular jurisdiction is chosen in that year by an MNE as the location of its new foreign affiliate in manufacturing and when it is equal to zero this denotes that the particular jurisdiction is not chosen by the MNE. The estimated models thus analyse the location choice made by the different MNEs.

Furthermore, in all of the estimations in Table 6 and Table 7 the estimated standard errors are clustered at the GUO-level. In addition, in all of the estimations we provide information on the estimated values for LL and the two information criteria, AIC and BIC. In order to have a better comparison across the estimated models, we use the same explanatory variables and explore how the different model specifications affect the sign and statistical significance of the coefficient estimates of our central variables of interest.

We begin by elaborating in more detail the results presented in Table 6, in which we estimate four different Clogit models. First, in Column (1) we estimate our basic model specification. As in all of the specifications, which we estimate, we include our two central explanatory variables. These are the corporate income tax rate at the potential affiliate jurisdictions and the interaction term of the IP Box dummy, for whether there is an IP Box regime in force at the jurisdiction of the GUO or not, and the corporate income tax rate at the potential jurisdictions for the location of the new affiliate. Furthermore, we add the two macroeconomic variables and the control of corruption variable. The estimated coefficients for the two explanatory variables, which are of central interest to the underlying analysis, are both statistically significant at the 1% significance level and have the signs implied by our theoretical model. The estimated coefficient for the corporate income tax rate has the expected negative sign. The interaction term has the expected positive sign and is smaller in magnitude than the coefficient for the corporate income tax rate. This implies that the overall effect of the tax rates on MNEs with GUOs located in IP Box jurisdictions is still negative but of smaller magnitude compared to when there is no IP Box regime in force. The IP Box regime dampens the negative effect of the corporate income tax rates on the location choice for the new affiliate of the MNEs.

Depending on the types of FDI (foreign direct investment), being either horizontal or vertical, there would be different theoretical predictions for the expected signs of the two macroeconomic control variables, which we include in our analysis. We are thus only

interested in having the GDP and the GDP per capita of a particular jurisdiction in logs as control variables in our estimations. The same is the case with the last explanatory variable, which we have in the different empirical models, about the estimated values for the control of corruption prevalent in the specific jurisdiction. Even in the case when the jurisdiction in question has relatively low values of the control of corruption variable, an MNE might still invest and open up a new affiliate in that jurisdiction if at the same time the particular jurisdiction has relatively vast networks of DTTs and BITs in force with other jurisdictions. In that way the provisions of the DTT or BIT could provide the MNE with better protection of its investment and provide it with a better planning horizon due to the potential existence, for instance, of agreements regarding the issues of double taxation. In later estimations we include these two variables, the number of DTTs and BITs, as further controls.

We continue with the elaboration of our estimated results of Columns (2), (3), and (4) of Table 6, where we keep our basic explanatory variables and stepwise include additional control variables. Importantly, in all of these three additional specifications the signs and statistical significance of the estimated coefficients for our two central explanatory variables in the estimated Clogit models are not changed.

In Column (2) we add the royalties withholding tax rates for payments of royalties from the potential new location to the MNE's headquarters location. The withholding tax rates on royalties constitute a bilateral tax policy instrument. These tax rates apply to the payments of royalties or license fees for the right of use of intangible assets such as patents or trademarks. These intangibles might be needed in the production of manufacturing goods at the new affiliate and might be registered at the GUO location, most probably due to favorable tax conditions there or due to the avoidance of other costs by the MNE, as analysed in Chapter 4 of the present doctoral dissertation. The potential royalties payments thus could originate from the new affiliate and accrue to the GUO. The estimated coefficient for the royalties withholding tax rate is negative and statistically significant at the 1% significance level. This implies that the higher the royalties withholding tax rates, which apply between the potential jurisdiction of the new affiliate and the jurisdiction of the MNE's HQ, the lower is the probability that this jurisdiction is chosen by the MNE for the location of its new affiliate. Our theoretical model has a similar prediction for the estimated sign of the royalties withholding tax rates. In the theoretical part of the present analysis, we have shown in comparative statics that the MNE's optimal royalties payments decline with higher royalties withholding tax rates. The negative sign and statistical significance of the royalties withholding tax rates remain unchanged in the following two specifications in Table 6, given in Columns (3) and (4).

In Column (3) we furthermore add as explanatory variables the number of DTTs and BITs in force in the respective jurisdiction in a certain year. These two variables could be of interest to the MNEs. After all, when a jurisdiction has a larger network of DTTs

and BITs, then a larger number of the MNEs' already existing affiliates could be located in a jurisdiction, which is itself part of the network of DTTs and BITs of the particular jurisdiction. In that way the MNE group as a whole could benefit from the provisions of the particular DTTs and BITs. Thus perhaps not surprisingly, the existence of a larger number of DTTs in force between the potential jurisdiction of the new affiliate and other jurisdictions increases the probability that this jurisdiction is chosen by the MNE. This is indicated by the positive and highly statistically significant coefficient of the number of DTTs. After all, a DTT generally determines the method of double taxation avoidance imposed on the MNE's repatriated profits (Davies, 2004), which could be of interest to the MNE. The coefficient of the number of BITs in force is also positive and highly statistically significant. We should keep in mind though that BITs are potentially more prevalent between developed and developing jurisdictions, whereas developed jurisdictions might not need to have a BIT in force with another developed jurisdiction. The estimated coefficients on the number of DTTs and BITs remain positive and statistically significant at the 1% significance level also in the following specification, given in Column (4).

In Column (4) of Table 6 we also control for the number of EY contact entries and the number of years for the loss carry back and loss carry forward provisions. We use the variable denoting the number of EY contact entries as a proxy for the complexity of the particular tax system but also for the intensity of economic activity taking place there. A larger number of contact entries thus implies both a potentially relatively more complex tax system and also a potentially higher economic intensity in the particular jurisdiction. The MNEs could appreciate the existence of potential external consultants who might have specific knowledge on the functioning of the tax system of the respective jurisdiction or they could prefer jurisdictions with less economic activity implying potentially less competition present there. In addition, firms might be interested in the loss carry back and loss carry forward provisions as a precautionary measure. Still, these provisions might not be relevant for a newly established firm or affiliate of an MNE. As with the two macroeconomic variables, the logarithm of GDP and of GDP per capita, and the control of corruption variable, we are only interested in having the EY contact entries and the two types of loss carry provisions as control variables in our estimations.

It is useful to make a comparison of the three goodness-of-fit measures for the models presented in Table 6. We can see that from Column (1) to Column (4) the model fit improves. This is shown by the values of LL, which are getting larger, and at the same time from the values of AIC and BIC, which are getting smaller. Thus the inclusion of the additional explanatory variables is improving the overall model fit. The model specification in Column (4) is favoured by the three goodness-of-fit measures, which we implement in our analysis.

The estimated Clogit models are a good starting point for our analysis. Still, we should keep in mind the characteristics and the structure of our data, and also the IIA assumption

Table 6: Location choice analysis – Clogit models

VARIABLES	(1) Clogit	(2) Clogit	(3) Clogit	(4) Clogit
aff_citr	-9.7000*** (0.1965)	-7.5902*** (0.2118)	-6.0210*** (0.2776)	-5.9861*** (0.3639)
guoip_affcitr	2.2374*** (0.4838)	2.0325*** (0.4717)	3.2914*** (0.6359)	3.3166*** (0.6613)
aff_roywith		-6.8723*** (0.1915)	-6.0020*** (0.2285)	-5.8774*** (0.2453)
aff_dtts			0.0048*** (0.0010)	0.0059*** (0.0021)
aff_bits			0.0276*** (0.0009)	0.0279*** (0.0009)
aff_eyempl				-0.0004 (0.0003)
aff_lc_back				-0.1218 (0.1190)
aff_lc_forward				-0.0001 (0.0005)
ln_aff_gdp	0.7075*** (0.0098)	0.6395*** (0.0095)	0.2918*** (0.0138)	0.3057*** (0.0207)
ln_aff_gdppercap	0.2103*** (0.0229)	0.1054*** (0.0227)	0.4606*** (0.0262)	0.4220*** (0.0269)
aff_cc	-0.5673*** (0.0232)	-0.5880*** (0.0226)	-1.0432*** (0.0291)	-0.9709*** (0.0363)
Observations	330,775	323,877	323,877	315,301
LL	-20966	-20298	-19165	-18719
AIC	41942	40608	38345	37460
BIC	41995	40673	38431	37577

Notes: Location choice analysis for a multinational firm's new foreign affiliate in manufacturing. Standard errors adjusted for clustering at the GUO-level in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, 1% significance level respectively. LL – log-likelihood; AIC – Akaike's information criterion; BIC – Schwarz's Bayesian information criterion. See Table 5 and Appendix 3.7 for a description of the explanatory variables.

of the Clogit models. Thus we continue the analysis by estimating multinomial models, which relax the IIA assumption, and multinomial models, which allow for heterogeneity in the estimated individual-level coefficients. We present the new estimations in Table 7, where we use all of the explanatory variables from Column (4) of Table 6 as this was the model specification among the Clogit models with the best model fit. Furthermore, by using the same explanatory variables and only changing the model which is estimated, we can also better compare the different multinomial models and their results with each other.

We relax the IIA assumption of the Clogit model by estimating a Mixlogit model.⁶ As in all of the multinomial models, which we estimate, we have an MNE, which chooses one jurisdiction out of a choice set. We assume that this choice set is available to all of the MNEs in all of the years in our sample. In order to relax the IIA assumption, in the Mixlogit estimations we further assume that the different choice alternatives are correlated with respect to the two central variables of interest of our analysis. These variables are the corporate income tax rate of the different jurisdictions and the interaction term of the corporate income tax rate with the IP Box dummy variable. The estimated results of the Mixlogit model are shown in Column (1) of Table 7.

As can be seen in Column (1) of Table 7, the estimated standard errors for the variables, which we assumed the alternatives to be correlated over, representing the corporate income tax rate and the interaction term, are in all cases statistically significantly different from zero. This implies that there is also an unobserved random component η_i , which influences the effects of these two control variables on the probability of the location choice by the MNE. This further implies that the Mixlogit model does not collapse to the Clogit model estimated in Column (4) of Table 6.

We have chosen to estimate these two variables as having random effects because of the predictions of the theoretical part of the present analysis. Our theoretical predictions focus on the differences for the perception of the corporate income tax rate by an MNE, depending on whether or not there is an IP Box regime in force in the jurisdiction of the MNE's headquarters. After all, the MNE might perceive the jurisdictions, which have similar prevalent statutory corporate income tax rates, as closer substitutes relative to other jurisdictions. Furthermore, we take these two variables to represent perhaps the most relevant tax policy instrument, which might be of interest for the MNE's location choice, which we are examining here.

In their study Dudar and Voget (2016) implement a similar empirical strategy. In their Mixlogit estimations they also have a control variable and an interaction term of this

⁶For the estimation of the Mixlogit model and of the three G-MNL models, which are the S-MNL, the G-MNL-I, and G-MNL-II models, we use the Stata user-written command `gmn1` (SJ14-3: st0301_2) by Hole, Gu, and Knox. A note on the estimated output with this command is that the sign of the estimated coefficients for the standard deviations of the variables, assumed to have a random part, is irrelevant and that their estimated sign is to be interpreted as being positive.

control variable with a dummy variable. They do this in order to analyse, whether there are differences in the impact of the corporate income tax rates with respect to the location of patents and trademarks. Thus in their case the dummy variable is used to distinguish between these two types of intellectual property. For this purpose they estimate a Mixlogit model where, among others, they use as explanatory variables the corporate income tax rate at the different jurisdictions. In addition, they include an interaction term between the corporate income tax rate and a dummy variable, which is equal to one when the specific intellectual property of the firm is a trademark and is equal to zero in the case of patents. Dudar and Voget (2016) find the two types of IP to react differently to the corporate income tax rate, with trademarks being more sensitive than patents.

Our estimations in Column (1) of Table 7 show that our main findings on the sign and statistical significance of the corporate income tax rate and the interaction term remain unchanged. Thus the higher the corporate income tax rate in a jurisdiction, the lower is the probability that this jurisdiction is chosen as the location for the MNE's new foreign affiliate in manufacturing. However, this negative effect is decreased in the case when the HQ of the MNE is located in a jurisdiction with an IP Box regime in force. The estimated coefficient for the royalties withholding tax rate is also highly statistically significant, at the 1% significance level, and has a negative sign as implied by our theoretical model. The estimated coefficients for the number of DTTs and BITs in effect in the respective jurisdiction are also highly statistically significant and have a positive sign. This implies that the MNEs prefer jurisdictions with large networks of DTTs and BITs for the location of their new affiliate.

In a next step, we consider additional ways of modelling the potential existence of heterogeneity of the estimated effects across the different economic agents, the different GUOs, in the estimations of the multinomial models. For this purpose we estimate an S-MNL, scale multinomial model, and two types of generalized multinomial models, the G-MNL-I and the G-MNL-II models, all three of which are proposed by Fiebig et al. (2010). The results of these estimations are provided in Columns (2), (3), and (4) of Table 7. For the two G-MNL estimations we allow the corporate income tax rate and its interaction term to have random effects at the same time, as we did in the estimation of the Mixlogit model. The signs and the statistical significance of our estimated results for the variables of central interest of our analysis, the corporate income tax rate and the interaction term with the IP Box dummy, are as in our previous estimations. This underlines the robustness of our estimated results. The estimates for the royalties withholding tax rates and for both the number of DTTs and BITs in force remain also unchanged with respect to their sign and statistical significance among the different estimations.

In all three G-MNL models shown in Table 7, the estimated values for τ , which is important for the existence of scale heterogeneity in these models, are statistically different from zero. This implies that the G-MNL models estimated in Table 7 do not collapse to the

Mixlogit model presented in Column (1) of Table 7. Furthermore, in both the G-MNL-I and G-MNL-II models the estimated standard errors of the two random variables, the corporate income tax rate and the interaction term, are also statistically different from zero. This implies that these two models also do not collapse to the S-MNL model.

We continue by comparing the model fit of our estimates from Column (4) in Table 6 with our estimates in Table 7. These five model specifications have the same explanatory variables and are estimated with the same sample, which can be seen from the same number of observations for each one of them. The only difference among them is with respect to the different assumptions made on modelling the potential heterogeneity with respect to the estimated effects of the two central variables of interest. The different ways, in which the estimated individual-level coefficients of the different multinomial models are modelled, are elaborated on in the end of Section 3.4 and we have further presented them in a summarised way in Table 1.

We first compare the Clogit model with the most explanatory variables, presented in Column (4) of Table 6, to the Mixlogit model, presented in Column (1) of Table 7. Our three goodness-of-fit measures imply that the Mixlogit model is favoured by LL and AIC, whereas the value of BIC is the same. This, in addition to the statistical significance of the estimated standard deviations for the two variables, which we allow to have random parts, implies that the Mixlogit model is preferred to the Clogit model. Furthermore, when we compare the estimated results in Columns (1) to (4) in Table 7 with each other, we can see that the S-MNL model has a better model fit than the Mixlogit model, that both the G-MNL-I and the G-MNL-II models have a better model fit than the S-MNL model, and that the G-MNL-II model has a better model fit than the G-MNL-I model. Thus according to the values of LL, AIC, and BIC as well as the statistical significance of the estimated standard deviations of the two variables, which are allowed to have also random parts, and the estimated standard deviation of the parameter τ , our analysis implies that the G-MNL-II model, presented in Column (4) of Table 7, has the best model fit among all of our estimated models. This further implies that the assumptions of the G-MNL-II model apply best to the data in our sample. However, we need to keep in mind that the improvement in the model fit among the Clogit model estimated in Column (4) in Table 6 and the different multinomial models estimated in Table 7 is not that big. Especially when we compare it to the increase in the goodness-of-fit when adding additional explanatory variables in the estimations of the four different Clogit models in Table 6.

Nevertheless, even if the differences in model fit given by LL, AIC, and BIC are not that big, the estimated individual-level coefficients of the different models, specifically for the control variables, which we have specified to have also random parts, differ from each other. Figures 3, 4, 5, and 6 present a visualisation of the estimated individual-level coefficients of the Mixlogit and the three G-MNL models for the impact of the corporate income tax rate for the cases with and without an IP Box regime in force at the jurisdiction of the GUO. As

Table 7: Location choice analysis – Mixlogit and G-MNL models

VARIABLES	(1) Mixlogit	(2) S-MNL	(3) G-MNL-I	(4) G-MNL-II
aff_citr (MEAN)	-5.7593*** (0.4047)	-5.9903*** (0.3852)	-5.7436*** (0.4087)	-5.7108*** (0.4097)
aff_citr (SD)	4.6308*** (0.8408)		4.6984*** (0.7420)	5.2375*** (0.6460)
guoip_affcitr (MEAN)	3.8163*** (0.7353)	3.8970*** (0.8104)	4.4558*** (0.8658)	4.5833*** (0.8602)
guoip_affcitr (SD)	5.2356*** (1.2238)		5.5657*** (1.1844)	6.2008*** (1.1626)
aff_roywith	-5.9234*** (0.2460)	-6.3263*** (0.3244)	-6.3233*** (0.3117)	-6.4016*** (0.3207)
aff_dtts	0.0064*** (0.0022)	0.0072*** (0.0015)	0.0077*** (0.0016)	0.0079*** (0.0015)
aff_bits	0.0279*** (0.0009)	0.0305*** (0.0019)	0.0301*** (0.0017)	0.0306*** (0.0018)
aff_eyempl	-0.0007*** (0.0002)	0.0000 (0.0002)	-0.0003 (0.0002)	-0.0003* (0.0002)
aff_lc_back	-0.1469 (0.1244)	-0.2020*** (0.0715)	-0.2250*** (0.0747)	-0.2356*** (0.0687)
aff_lc_forward	0.0001 (0.0006)	0.0005 (0.0006)	0.0007 (0.0006)	0.0008 (0.0006)
ln_aff_gdp	0.3245*** (0.0194)	0.2695*** (0.0208)	0.2937*** (0.0216)	0.2961*** (0.0211)
ln_aff_gdppercap	0.4429*** (0.0276)	0.5160*** (0.0578)	0.5257*** (0.0512)	0.5490*** (0.0572)
aff_cc	-0.9884*** (0.0360)	-1.1002*** (0.0873)	-1.1019*** (0.0793)	-1.1349*** (0.0890)
τ		0.3735*** (0.0882)	0.3512*** (0.0844)	0.3965*** (0.0879)
γ			1	0
Observations	315,301	315,301	315,301	315,301
LL	-18706	-18706	-18692	-18688
AIC	37438	37436	37413	37404
BIC	37577	37564	37562	37553

Notes: Location choice analysis for a multinational firm's new foreign affiliate in manufacturing. Standard errors adjusted for clustering at the GUO-level in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, 1% significance level respectively. All four models computed by simulations with 500 Halton draws. MEAN – mean; SD – standard deviation; LL – log-likelihood; AIC – Akaike's information criterion; BIC – Schwarz's Bayesian information criterion. The sign of the estimated standard deviations of the variables with a random part, aff_citr (SD) and guoip_affcitr (SD), by the Stata user-written command **gmnl** (SJ14-3: st0301_2) is irrelevant and is to be interpreted as being positive. See Table 5 and Appendix 3.7 for a description of the explanatory variables.

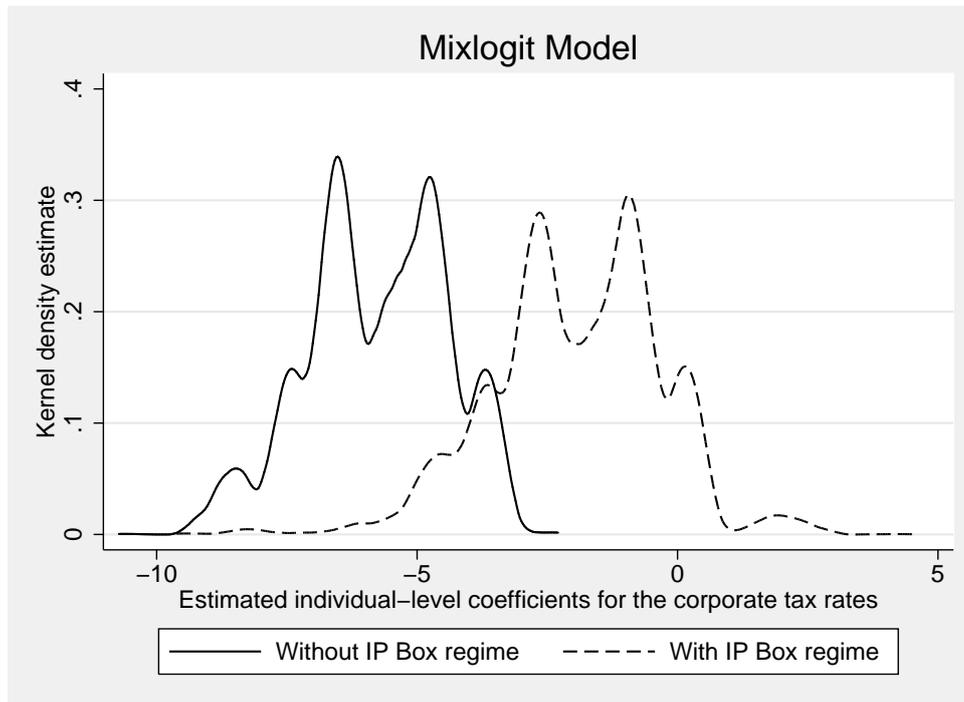


Figure 3: Mixlogit model

Notes: The graph is based on a maximum simulated likelihood estimation with 500 Halton draws.

can be seen in these graphs, the distribution of the estimated individual-level coefficients for the corporate income tax rates when the MNE's HQ is located in a jurisdiction with an IP Box regime in force, given by the dashed line in each graph, is to the right of the one for the case when there is no IP Box regime in force at the MNE's HQ' location, given by the solid line in each graph. This visualises the estimated results and further strengthens the predictions of the theoretical model. The IP Box regime allows the MNE to have higher overall after-tax profits and thus decreases the negative effect of the corporate income tax rate on the location choice for its new foreign affiliate in manufacturing. In the graphs of the Mixlogit, the G-MNL-I, and the G-MNL-II models, a part of the distribution of the coefficients for the case with an IP Box regime in force even becomes positive, which further underlines the mechanism described in the theoretical part of the present analysis. The different assumptions underlying the four different multinomial models imply also differences, which we can see in the forms of the graphs. Still, even if there are some quantitative differences, qualitatively all four graphs present the same argument, which underlines the robustness of our results with respect to the different specifications of the multinomial models, which we estimate.

3.6 Concluding remarks

In the present chapter we have analysed economic spillover effects from an IP Box regime in force in one jurisdiction on other jurisdictions. For this purpose we have focused on

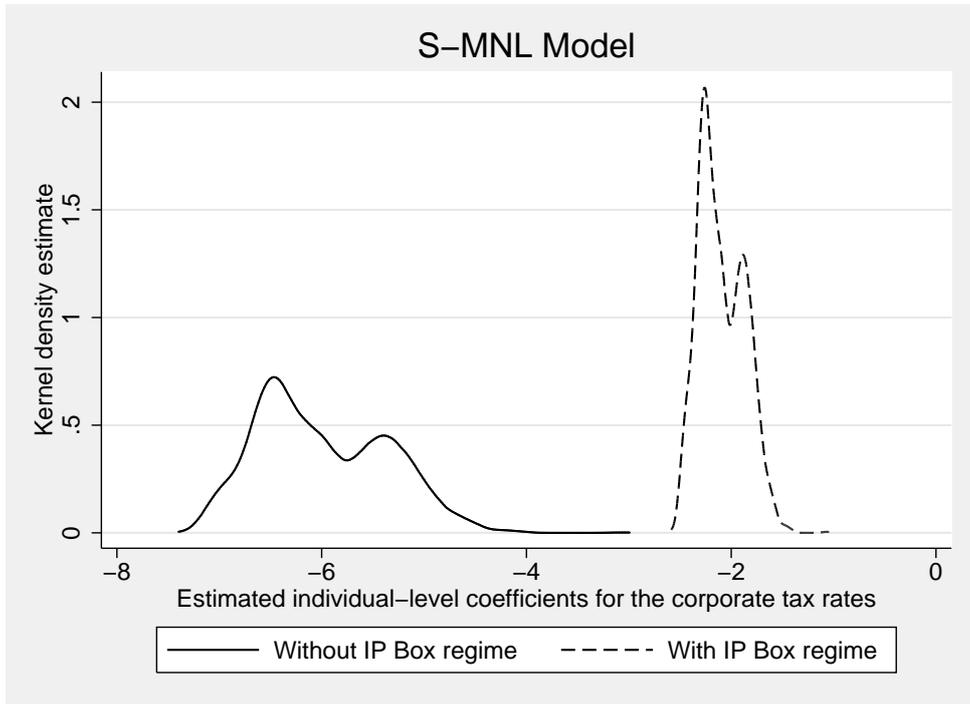


Figure 4: S-MNL model

Notes: The graph is based on a maximum simulated likelihood estimation with 500 Halton draws.

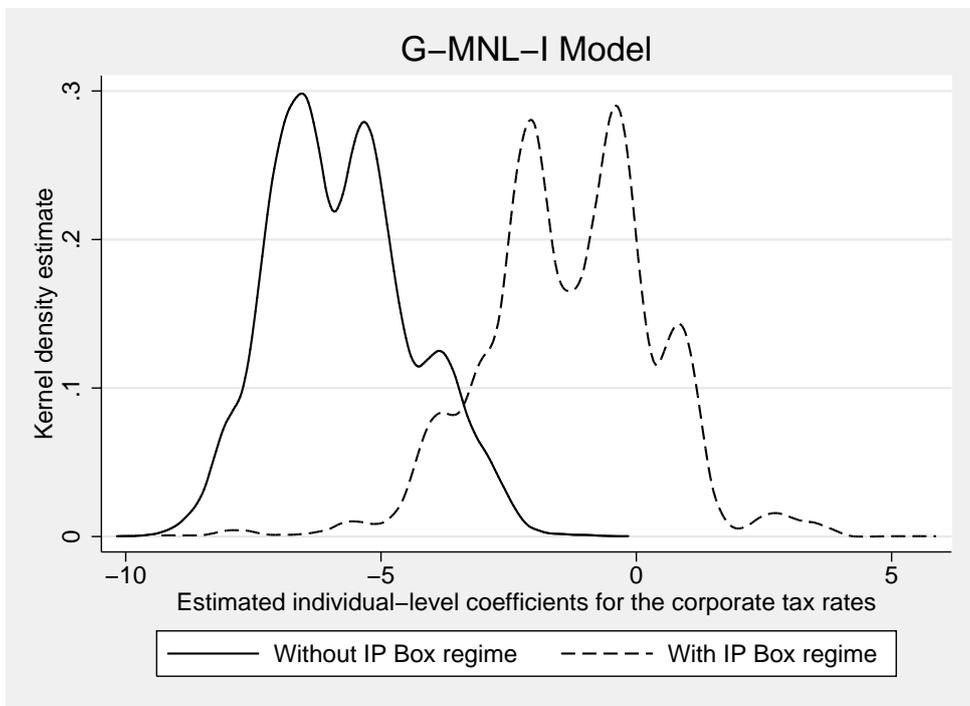


Figure 5: G-MNL-I model

Notes: The graph is based on a maximum simulated likelihood estimation with 500 Halton draws.

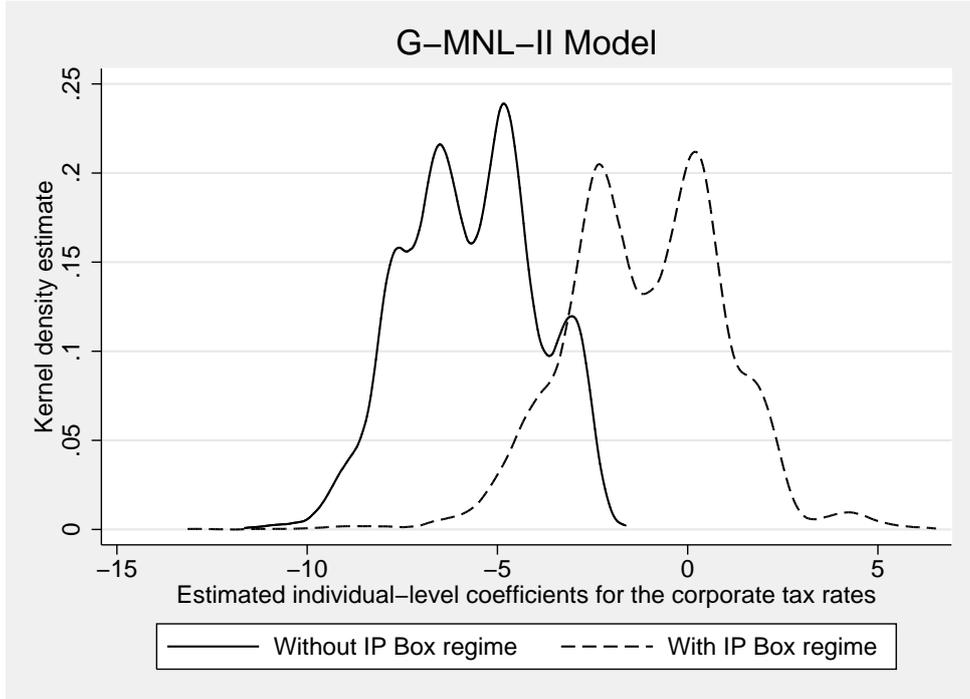


Figure 6: G-MNL-II model

Notes: The graph is based on a maximum simulated likelihood estimation with 500 Halton draws.

the choice made by MNEs when deciding on the location of their new foreign affiliate in manufacturing. We provide a theoretical model, which implies that the existence of an IP Box regime in force at the jurisdiction of the MNE’s HQ allows the MNE to have higher after-tax profits compared to the case when no IP Box regime is present there. This makes the MNE consider investing also in relatively high-tax jurisdictions, which it would otherwise have found to be not profitable enough. We have furthermore tested our model predictions empirically. In the empirical part of the present chapter we have estimated a variety of multinomial models, in which we include a variety of explanatory variables.

Our empirical results are in line with our theoretical predictions. We find that the higher is the corporate income tax rate at the particular jurisdiction, the lower is the probability that this jurisdiction is chosen by the MNE for the location of its new foreign affiliate in manufacturing. However, the existence of an IP Box regime in force at the jurisdiction of the MNE’s HQ is found to decrease the negative effect of the corporate income tax rate, which is shown by the positive sign of the interaction term of the corporate income tax rate with the IP Box dummy. In all of the estimations the signs and high statistical significance of the two explanatory variables of central interest, the corporate income tax rate and the interaction term of the corporate income tax rate with the IP Box dummy, remain unchanged. We have furthermore compared the results of each model that we estimate with respect to three different goodness-of-fit measures, which are the values of the maximised log-likelihood and the AIC and BIC information criteria. According to

our goodness-of-fit measures, we find that the G-MNL-II model has the best model fit compared to the other multinomial models, which we estimate. The improvement in model fit is not that large so that we also provide graphical representations of the estimated individual-level coefficients of the different models. The graphs provide a visualisation of our empirical results and further underline the robustness of our findings with respect to the different model specifications, which we estimate.

In addition to the two central explanatory variables of our analysis, our theoretical model has also a prediction for the effect of the royalties withholding tax rate for payments of royalties from the potential affiliate jurisdiction to the jurisdiction of the MNE's HQ, which we assume to be given by the jurisdiction of the GUO. In line with the prediction of the theoretical model, our empirical results find a negative and statistically significant effect of the royalties withholding tax rate on the probability that a jurisdiction is chosen as the location for the MNE's new foreign affiliate in manufacturing. This result furthermore shows that in their location decision the MNEs consider not only tax policy instruments that are valid only in one jurisdiction, that are unilaterally set, but also bilateral tax policy instruments. The royalties withholding tax rate, which applies between two different jurisdictions, is such a bilateral tax policy instrument, whose value furthermore might be specific to the two particular jurisdictions and the direction of the underlying royalties payments. This implies that the different jurisdictions could also consider bilateral tax policy instruments in order to make themselves more attractive as a location for new affiliates of MNEs. The importance of bilateral policy instruments for the MNEs is also underlined by our findings of the positive and statistically significant effects of the number of DTTs and the number of BITs in effect at the different jurisdictions for the probability that these jurisdictions are chosen by the MNEs as the location of their new foreign affiliate in manufacturing.

Our analysis contributes to the literature on IP Box regimes and on location choices made by multinational firms. We find that an IP Box regime present at the jurisdiction of the MNEs' HQ has positive external effects for real investments of the MNEs in other jurisdictions. The economic mechanism underlying our findings concerning the IP Box regimes is similar to the one concerning the effects of tax havens on other jurisdictions elaborated on in Desai et al. (2006) and Hong and Smart (2010). Schwab and Todtenhaupt (2016) also find a positive external effect of IP Box regimes on other jurisdictions. Their findings of a positive effect on the number of patents developed abroad within the same MNE group, however, apply only for the case when the IP Box regime allows also foreign-developed IP to benefit from its favourable tax provisions. Our results on the effect of IP Box regimes on the location choice for MNEs' new foreign affiliates in manufacturing do not depend on specific characteristics of the IP Box regimes but only on the existence of an IP Box regime in force. It is thus important for the decision-makers to consider the external effects of IP Box regimes, which we have found to exist and analysed in the

present chapter, when introducing, reforming, or abolishing an IP Box regime.

3.7 Appendix

About the explanatory variables:

aff_citr denotes the statutory corporate income tax rates at the different jurisdictions from the choice set for the location of the new affiliates, this data is from Ernst & Young (EY) and it was kindly provided by Prof. Dr. Georg Wamser from the University of Tübingen, Germany.

guo_ipboxdummy denotes a dummy variable, which is equal to one if there is an IP (Intellectual Property) Box regime in force at the GUO jurisdiction and is zero otherwise, taken from Table 2 on p. 30 in Alstadsæter et al. (2015), where there are 14 jurisdictions listed as having an IP Box regime in force in some year.

guoip_affcitr denotes an interaction term of the variables **guo_ipboxdummy** and **aff_citr**.

aff_roywith denotes the royalties withholding tax rates, which apply for royalty payments from the affiliate jurisdiction to the GUO jurisdiction, collected by the author from the EY Worldwide Corporate Tax Guides (WCTGs).

aff_dtts denotes the number of Double Tax Treaties (DTTs) in force in a specific jurisdiction, collected by the author from the EY WCTGs.

aff_bits denotes the number of Bilateral Investment Treaties (BITs) in force in a specific jurisdiction, collected by the author from the UNCTAD (United Nations Conference on Trade and Development) Investment Policy Hub.

aff_eyempl denotes the number of contact entries provided for a specific jurisdiction in the EY WCTGs, collected by the author from the EY WCTGs.

aff_lc_back denotes the number of years of a loss carry back provision in a specific jurisdiction, where infinity is denoted by the number 100, collected by the author from the EY WCTGs.

aff_lc_forward denotes the number of years of a loss carry forward provision in a specific jurisdiction, where infinity is denoted by the number 100, collected by the author from the EY WCTGs.

ln_aff_gdp denotes the natural logarithm of the GDP (gross domestic product) in a specific jurisdiction, originally given in current US (United States) dollars, taken from the World Bank Group's World Development Indicators (WDI).

ln_aff_gdpperpcap denotes the natural logarithm of the GDP per capita in a specific jurisdiction, originally given in current US dollars, taken from the World Bank Group's WDI.

aff_cc denotes the estimate for the control of corruption in a specific jurisdiction, which ranges between approximately -2.5 and 2.5 with higher values indicating stronger control

of corruption, taken from the World Bank Group's World Governance Indicators (WGI).

4 Financial Constraints and the Location of Intangible Assets by Multinational Firms⁷

4.1 Introduction

Multinational enterprises (MNEs) are firms, which have affiliates in at least two different jurisdictions. A core characteristic of the MNEs is that they hold relatively more knowledge capital, for example embedded in their intangible assets, and are relatively more R&D-intensive compared to the purely national firms (Barba Navaretti and Venables, 2006, Chapter 2). Intangible assets, such as patents, trademarks, registered designs, databases, are important strategic assets of the firm (Hall, 1992). They support the firm's position in the market relative to its competitors and investing in R&D activities increases the probability that the firm stays in the market (Long et al., 2011). From a theoretical point of view the intangible assets of the firm have public good features, once created they can be used across the different entities, of which the firm might be comprised, without much difficulty (Barba Navaretti and Venables, 2006, Chapter 2). For a multinational enterprise, a firm which has subsidiaries located in different jurisdictions, this implies that it could assign the legal ownership of its intangible assets, which can be protected by law such as patents and trademarks (Hall, 1992), to an affiliate located in a specific jurisdiction for strategic reasons without much impediment to its overall activities.

It should be noted, however, that the monopoly of exploitation of the patent is granted to a firm only for a limited period of time, after which it is going to be made available to everybody (Hall, 1992). This furthermore explains why it is worth for the firms to engage in tax planning especially for the location of their most valuable intangible assets. In practice such tax planning is done through contract R&D or cost-sharing arrangements (Griffith et al., 2014), where a subsidiary in a low-tax jurisdiction finances the whole or at least a part of an uncertain R&D project, thus bearing the financial risk involved with the project and in case of success is then awarded the rights to the new invention. Other ways of relocating the intangible assets such as selling these assets from subsidiaries in high-tax jurisdictions to subsidiaries in low-tax jurisdictions or the relocation of the whole R&D unit with all of the people involved in the R&D process in a low-tax jurisdiction might be economically less favourable for the MNEs.

In theory, we might expect that the MNEs would tend to locate all of their intangible assets in the lowest tax jurisdictions. However, empirical studies have shown that this is not necessary the case. More precisely, for patents this is shown in the study by Griffith et al. (2014) and for trademarks this is shown in the study by Heckemeyer et al. (2015). Griffith et al. (2014, p. 13) document that patent ownership at tax havens is rarely observed. Although there are indeed MNEs that extensively use low-tax jurisdictions for the location

⁷This chapter is based on Tonev (2018a).

of their intangible assets, empirically a considerable “parent bias”, “home bias” also called “headquarter bias” in the MNEs’ decision on the location of their intangibles is observed (Karkinsky and Riedel, 2012, p. 184; Heckemeyer et al., 2015, p. 4 and p. 12). Importantly, tax havens are often jurisdictions with good quality institutions, which are in place for a relatively long time (Dharmapala and Hines, 2009), so that in principle these jurisdictions could be suitable for the location of important IP (intellectual property) by the MNEs. Furthermore, it is interesting to note that whereas taxation has generally a negative impact on both the number of trademarks and patents registered in a certain jurisdiction, trademarks are found to be more sensitive to changes in their taxation compared to patents (Dudar and Voget, 2016).

The present chapter studies the location choice of multinational enterprises with respect to their intangible assets. There are empirical studies on the impact of taxation on the location choice of firms’ intangible assets, among others Evers et al. (2013), Griffith et al. (2014), Alstadsæter et al. (2015), Dudar et al. (2015). The present chapter develops a theoretical model, which underlines the importance of the financial situation of an MNE for the location of its intangible assets. The model captures the trade-off an MNE faces when deciding whether to locate its intangibles in a relatively low-tax jurisdiction, such as a tax haven, or locate its intangible assets in a relatively high-tax jurisdiction. In the theoretical model we furthermore assume the relatively high-tax jurisdiction to be also the jurisdiction where the MNE’s headquarters is located. The trade-off, which the MNE faces, is between a lower marginal cost of production when making use of the headquarters’ jurisdiction and fixed corporate tax savings when making use of the tax haven, due to the tax rate differential between the two jurisdictions. The location decision further depends on the financial situation of the MNE.

This implies that not all MNEs could make use of the tax-minimising option of locating their intangibles, for example patents or trademarks, in relatively low-tax jurisdictions in the same way and actually locate them in the jurisdiction of the MNE’s headquarters. Though, this jurisdiction might still provide the income of a firm’s IP with a preferential tax treatment. For instance, such tax treatment is offered by IP Box regimes to IP income, which qualifies for the tax benefits of the respective IP Box regime. In this respect Tonev (2018b) shows that jurisdictions implementing an IP Box regime have a higher probability of being chosen as the MNEs’ headquarters location compared to jurisdictions which do not have an IP Box regime in force. It seems, however, that tax considerations are not the only ones of importance for the MNEs’ decision on the location of their intangible assets.

The analysis, which we do in the present chapter, considers the financial situation of the particular MNE to play an important role for the decision on the location of its intangible assets. We develop a theoretical model, in which we consider two cases. In the first case, the MNE is not financially constrained and can freely maximise its overall expected after-tax profits by making use of different locations for its intangible assets.

In that case tax considerations play an important role in the location decision for the intangibles. In the second case, the MNE is financially constrained and needs to find a partner to provide it with additional financing. In that case the MNE cannot freely decide on the location of its intangibles. We show that the partner's expected profits are higher when the intangibles are located in the high-tax jurisdiction, which we assume to be the jurisdiction of the MNE's headquarters. The partner would thus prefer the headquarters jurisdiction for the location of the MNE's intangible assets in order to provide the MNE with financing. This is because the partner does not receive the tax benefits when the MNE makes use of the low-tax jurisdiction but is only left with the higher production costs when the MNE's intangible assets are registered at the low-tax jurisdiction.

We test empirically the predictions of our theoretical model. For this purpose we estimate a variety of two component finite-mixture models as in Egger et al. (2014b). The analysis in Egger et al. (2014b) is focused on the impact of the corporate income tax rates on the amount of fixed assets of the foreign affiliates of German MNEs. In our empirical estimations we use the ORBIS database compiled by Bureau van Dijk. Our dependent variable is the level of intangible fixed assets of firms belonging to an MNE group. The explanatory variable of central interest to our analysis is the estimate for the effect of the corporate income tax rates present in the particular jurisdiction. In this respect we find that there are two groups of firms. The first group, denoted Group 1, consists of observations coming from entities of MNEs, which generally experience a positive and statistically significant effect of the corporate income tax rates on the amount of the intangibles which they hold. The second group, denoted Group 2, on the contrary, is made of observations from entities of MNEs, which experience a negative and statistically significant impact of the corporate income tax rates on the amount of their intangible assets. The probability of belonging to Group 1, the non tax-optimising group, decreases with a better financial situation of the MNE in question. Thus the two groups of firms from the theoretical model are found to exist also empirically. Our results are robust with respect to the choice of a proxy for financial constraints, for which we use four different ones. In addition, the two estimated tax rate coefficients for each of the two components are different from each other in all of our estimations. This is shown by the rejection of the null hypothesis of the respective Wald tests for coefficient equivalence at the 1% significance level.

The analysis is organised as follows. Section 4.2 provides a literature review on multinational firms' intangible assets and the impact of financial constraints on profit shifting. Section 4.3 presents the theoretical model, which distinguishes the two cases of interest, when the multinational firm does not face financial constraints and when it is financially constrained. After that, Section 4.4 describes the empirical strategy and the implemented data, and then presents the estimated results. Section 4.5 concludes. The Appendix of the present chapter, Appendix 4.6, provides information on the variables implemented in

the empirical analysis and on their sources.

4.2 Literature review

The different entities of an MNE can interact with each other. For instance some affiliates may make payments for the use of intangible assets, such as patents, to another affiliate of the same MNE, which is the legal owner of these assets. This implies that this affiliate earns profits, which are made up of the royalties received from the other affiliates. Due to the potential differences in the tax environment, which the different affiliates face, the MNE has an incentive to register its intangibles at a low-tax jurisdiction so that it can minimise its overall expected tax payments (Dischinger and Riedel, 2011; Karkinsky and Riedel, 2012; Griffith et al., 2014). This would allow the profits generated by the intangible assets to accrue to an affiliate located at a low-tax jurisdiction and to be taxed at the low tax rate there. In the present analysis we consider only the location of the intangibles as a tax-minimising option and assume that the prices for the intra-firm transactions, the royalty payments, between the MNE's entities are accepted by the tax authorities.

From a theoretical point of view we would expect the MNEs to use tax havens, or at least relatively low-tax jurisdictions, for the location of their intangible assets. Still, in reality it seems not that easy for a firm to locate its intangible assets for tax-minimisation purposes, as the process of relocating intangible assets can be in itself complex from a legal and logistical point of view (Walpole and Riedel, 2014). If the firm anticipates its R&D activity to bring about a high-quality outcome, it might be worthwhile to plan where the then generated profits from this outcome can be taxed less. This explains the findings in Ernst et al. (2014) that jurisdictions with low tax rates on a firm's income derived from patents tend to attract patents with an above average earnings potential. After all, the royalty payments or the license fee payments that the other entities of the multinational firm pay for the right to use the intangible assets, such as patents, then accrue to a subsidiary facing a low tax rate relative to other potential locations. These profits will be consequently taxed in a relatively low-tax jurisdiction and thus the MNE can lower its overall tax payments. In this respect, using data from the OECD database on trade in services Dudar et al. (2015) find a negative impact of taxes on bilateral royalty flows, the royalty flows between two jurisdictions.

Jurisdictions react to the tax-minimisation strategies of the MNEs with respect to their intangible assets. Some jurisdictions, mainly in Europe, have introduced special policies known as Intellectual Property (IP) Box regimes, also known as Patent Boxes, although they might be applicable to other types of intangible assets such as trademarks as well. The IP Box regimes offer substantially lower tax rates for the taxation of the income accruing to the intellectual property of a firm, which they deem to qualify for the preferential tax treatment (Evers et al., 2013 and 2015; Griffith et al., 2014; Alstadsæter et al., 2015). The

preferential tax treatment offered by these regimes applies to the income generated by a firm's IP, like patents, registered in the respective jurisdiction, in some cases regardless of whether the IP was actually created there in the first place. In this respect, Alstadsæter et al. (2015) show that the imposition of a local development condition for a patent to qualify for the preferential tax treatment of a jurisdiction's Patent Box regime implies a higher probability for more R&D (research and development) activities to be undertaken in the particular jurisdiction.

Although tax directors and managers of MNEs, who were the respondents of the interviews conducted in Walpole and Riedel (2014), agree that policies such as the Patent Boxes increase the attractiveness of a jurisdiction for being the location of their intellectual property, they still see their IP as geographically bound to where they operate, generate their sales, and can find skilled employees. Furthermore, Heckemeyer et al. (2015) show that jurisdictions implementing a Patent Box regime are hardly chosen as the location of trademarks by US and European firms considered in their sample. Still, Alstadsæter et al. (2015) and Bradley et al. (2015) find a positive effect of the existence of IP Box regimes on the number of patents of multinational firms located in these jurisdictions. Although Bradley et al. (2015) note that this could be due to the patenting of existing IP and not necessarily be the result from additional R&D activities of the firms. Overall, this implies that not all firms have the same possibilities to locate their intangible assets for tax-minimising purposes.

The MNEs are not a homogenous group, i.e. they have a different number of affiliates, they operate in different jurisdictions and face different financial circumstances.⁸ This implies that some firms are facing financial constraints. Keeping in mind the additional costs, which the relocation of the intangible assets potentially brings with itself, financially constrained firms might not be able to make use of low-tax jurisdictions, such as tax havens, in the same manner as not financially constrained firms might do. An empirical study by Dyreng and Markle (2014) indeed finds that more financially constrained US multinationals shift less profits from the United States to foreign jurisdictions than less financially constrained ones do. Although the authors do not focus on a particular profit-shifting channel the MNEs might be using. An empirical study by Alexander et al. (2016) which uses data on US firms from Compustat, shows that financially constrained firms do less tax avoidance during economic downturns in order to more easily obtain external financing. However, they also do not explicitly analyse particular tax-avoidance strategies used by the firms.

In this respect in a further empirical study on US firms, Hasan et al. (2014) find that firms, which engage in tax avoidance receive external financing at less favourable conditions

⁸For a study of the decisions of MNEs for the allocation of internal funds by borrowing between their different entities when these entities are to a different degree financially constrained and when taking into account tax and non tax reasons, see Egger et al. (2014a).

compared to the other firms. For example, these firms are facing higher costs, such as higher interest rates on loans, and stricter requirements for collateral. This makes tax avoidance less attractive when the firms are in need of external financing. Furthermore, Hasan et al. (2014) argue that debt holders have asymmetric payoffs compared to the firm's shareholders as they are exposed to the risk of repayment, where tax avoidance is perceived as a risky activity of the firms, but do not necessarily benefit from the tax savings from this risky activity as the shareholders might do. The authors further note that the debt holders perceive tax avoidance as risky because with higher levels of tax avoidance the audit probability by the respective tax authority is increased. This in turn increases the potential direct costs, such as the costs for the firm's defense in front of the tax authority and the potential penalty fees to be paid to the tax authority, and indirect costs, such as an increased probability of audits in the future, for the firm engaging in tax avoidance. The debt holders consider all of these aspects to have negative implications for the financial situation of the particular firm and thus for the probability that the firm repays its loan. In the theoretical part of the present analysis we formally model this asymmetry of the payoffs between the shareholders and the debt holders, where we take the costs of the MNE's tax avoidance strategy to be shared between the MNE and its financial partner but not the benefits from the tax avoidance activity, which constitute tax savings only for the multinational firm. We focus on the location of the MNE's intangible assets for tax reasons as the specific tax-minimisation strategy implemented by the MNE, which we then further examine empirically.

Chen (2014) also studies financially constrained firms, which possess intangible assets, but the analysis there is concentrated on the differences in the firm dynamics, the firm size and growth, between firms with different shares of intangible assets to total assets. In Chen (2014) firms with relatively more intangible assets face tighter financial constraints but at the same time have higher growth opportunities and eventually have higher market values per unit of assets than firms, which have relatively more tangible assets. In the present analysis we abstract from such kind of firm dynamics and only concentrate on the location choice for the intangible assets of a given MNE. It is important to note that due to their firm-specific nature the value of the intangible assets is hard to be measured and it is thus not easy for the firm to make use of its intangibles as collateral in order to obtain external financing (Harnhoff, 2009; Chen, 2014).

4.3 Theoretical model

4.3.1 The model setup

The model considers a multinational firm with intangible assets of size g . The intangible assets can be registered in a relatively high-tax jurisdiction or in a relatively low-tax jurisdiction, which can also be a tax haven. We assume the high-tax jurisdiction to be the

jurisdiction of the MNE's headquarters (HQ) where also the MNE's manager is located. Furthermore, we assume that the MNE already has an affiliate in the low-tax jurisdiction. The location choice of the MNE can be interpreted as the MNE having already developed some IP and then choosing a jurisdiction where to officially register this IP, potentially for tax-minimising reasons. This is similar to the argument in Bradley et al. (2015) about the patenting of existing IP by firms done potentially for tax reasons.

Using the intangible assets requires efforts e , which are unobservable for third parties. The cost of using the assets is given by θ . Locating the intangible assets in the low-tax jurisdiction as compared to locating them at the jurisdiction of the headquarters leads to a higher cost of use with parameter $\hat{\theta}$, such that $\hat{\theta} > \theta$. This difference can be understood as additional variable cost of coordinating the use of the intangible assets across potentially large geographic distances and across potentially different time zones where the MNE's entities might be located. Furthermore, Mudambi and Navarra (2004) note that the location of the MNE's intangible assets at a specific entity of the MNE increases the intra-firm bargaining power of the specific entity, though looking at the intra-firm arrangements by the different entities of the MNE goes beyond the scope of the present analysis.⁹

The MNE possesses funds of size E , which we take as exogenous, that can be used for a new investment project. The multinational firm has an investment option and the size of the investment is endogenous and denoted by x . The payoff generated by the investment is uncertain and depends on the size of the investment, x , and on the efforts, e , of the manager to utilise the firm assets for this project. The efforts of the firm manager are neither observable nor verifiable and thus also not contractible with a partner outside of the firm. We assume the investment option of the MNE to be a greenfield investment in a foreign jurisdiction, but in principle this could be also some other type of investment.

An investment of size x generates a minimum payoff, denoted by the function $f(x, e)$, where $f(\cdot, 0) = 0$ and $f(0, \cdot) = 0$. The respective first and second derivatives of the payoff function, denoted by the respective subscripts, are given as $f_x, f_e > 0$ and $f_{xx}, f_{ee} < 0$. While $f(x, e)$ is the lower bound of payoffs, the probability that the realised payoff z is less than or equal to some value y is given by the cumulative distribution function of the Pareto distribution with $\delta > 1$:

$$\Pr(z \leq y) = \begin{cases} 1 - \left(\frac{f(x, e)}{y}\right)^\delta & \text{if } y \geq f(x, e), \\ 0 & \text{if } y < f(x, e). \end{cases}$$

From the Pareto distribution it follows that the expected project payoff is given by $Af(x, e)$, where $A \equiv \delta/(\delta - 1)$.

We assume the payoff function to be of the Cobb-Douglas type: $f(x, e) = x^\alpha e^\beta$, where

⁹In addition, we could interpret the difference of the cost of use of the intangible assets as the MNE's HQ potentially already having experience with this kind of activity, whereas the MNE's affiliate in the low-tax jurisdiction not or not yet having such experience.

$0 < \alpha < 1$; $0 < \beta < 1$; and $0 < \alpha + \beta < 1$.

In the model we focus on the location choice for the intangible assets between a high-tax jurisdiction, where also the MNE's headquarters is located, and a low-tax jurisdiction, which can be a tax haven. We abstract from any tax incentives for the new investment project. In particular, we assume that the corporate income tax rates do not differ between the jurisdiction of the headquarters and the jurisdiction of the potential new affiliate and that they are both equal to t . However, the corporate income tax rate in the low-tax jurisdiction, denoted by t^* , is lower than the one in the high-tax jurisdiction, such that $0 < t^* < t < 1$. The corporate income tax rate in the low-tax jurisdiction can be very close to zero but is still positive. However, tax havens are not excluded from our analysis as firms might still need to pay fees to the tax haven jurisdictions when being active in these jurisdictions.

Although the intangible assets are a public good within the firm, the multinational firm has discretion in charging its subsidiaries royalties or license fees for their provision. These are costs in addition to the cost of utilising the assets. We assume that the maximum amount of royalties for the right of use of the intangibles, which is accepted by the tax authorities, is equal to ρ . Furthermore, we assume that the MNE will optimally make use of this by claiming the maximum amount of royalties still accepted by the tax authorities in the case of using the tax haven as the location of its intangibles. In this way the MNE will be able to shift as much profits to the relatively low-tax jurisdiction from the relatively high-tax jurisdiction as permitted by the tax authorities. Thus the location of the intangible assets by the MNE is the only tax-minimisation option on which the MNE can decide in the present model.

4.3.2 No financial constraints

We start the analysis with the case of a multinational enterprise that is not financially constrained, such that $E \geq x$. This case will be used as a benchmark for the analysis of the financially constrained multinational. Without financial constraints, the MNE specifies the investment volume x and the efforts e . If the multinational firm has located its intangible assets in the high-tax jurisdiction, the after-tax expected profits are given by:

$$\Pi_n^H(x, e) = (1 - t) (Ax^\alpha e^\beta - rx - \theta e), \quad (21)$$

where the term rx gives the opportunity cost of a project of size x for a given rental rate r . The superscript H denotes the location of the intangible assets as being at the high-tax jurisdiction, where also the MNE's headquarters is located, and the subscript n indicates that the firm is not financially constrained.

If the MNE has located its intangible assets in the low-tax jurisdiction, its overall after-tax expected profits, made up of the profits of the headquarters and of the royalties

profits accruing to the affiliate in the low-tax jurisdiction, are given by:

$$\begin{aligned}\Pi_n^L(x, e) &= (1-t)(Ax^\alpha e^\beta - rx - \hat{\theta}e) - (1-t)\rho + (1-t^*)\rho = \\ &= (1-t)(Ax^\alpha e^\beta - rx - \hat{\theta}e) + \rho(t-t^*),\end{aligned}\quad (22)$$

where the last term, $\rho(t-t^*)$, gives the tax savings from locating the intangible assets in the low-tax jurisdiction compared to the high-tax jurisdiction, and the superscript L denotes the location of the intangibles as being at the low-tax jurisdiction.

We now focus on the situation where the not financially constrained multinational firm has decided to locate its intangible assets in the high-tax jurisdiction. In this case the MNE maximises $\Pi_n^H(x, e)$, given in Eq. (21), over x and e , which leads to optimal investment volume and optimal efforts given by the following first-order conditions (FOCs):

$$\frac{\partial \Pi_n^H}{\partial x} = (1-t)(A\alpha x^{\alpha-1}e^\beta - r) \stackrel{!}{=} 0, \quad (23)$$

$$\frac{\partial \Pi_n^H}{\partial e} = (1-t)(A\beta x^\alpha e^{\beta-1} - \theta) \stackrel{!}{=} 0. \quad (24)$$

Solving for the optimal values of the investment volume and the efforts yields:

$$x_n^H = \left(\frac{A\alpha^{1-\beta}\beta^\beta}{r^{1-\beta}\theta^\beta} \right)^{\frac{1}{1-\alpha-\beta}}, \quad (25)$$

$$e_n^H = \left(\frac{A\alpha^\alpha\beta^{1-\alpha}}{r^\alpha\theta^{1-\alpha}} \right)^{\frac{1}{1-\alpha-\beta}}. \quad (26)$$

Similar expressions hold for the case of the MNE locating the intangible assets at the low-tax jurisdiction, with the only difference being the higher marginal cost of use of the intangibles $\hat{\theta}$ in Eqs. (24), (25), and (26). Due to the higher marginal costs, $\hat{\theta} > \theta$, the optimal values for x and e are smaller in magnitude when the multinational firm uses the low-tax jurisdiction compared to when it uses the high-tax jurisdiction for the location of its intangible assets. Thus the following ranking emerges: $e_n^H > e_n^L$ and $x_n^H > x_n^L$, due to $\theta < \hat{\theta}$.

So the investment volume is lower and also less efforts are exerted when the MNE decides to locate its intangibles at the low-tax jurisdiction compared to locating them at the high-tax jurisdiction. Still, when the MNE makes use of the low-tax jurisdiction it saves on corporate taxes in the amount of $\rho(t-t^*)$ due to the positive tax rate differential, as $t > t^*$.

Plugging in the respective optimal values of the investment volume, x , and the efforts, e , in the respective profit equations, Eqs. (21) and (22), and rearranging gives us the after-tax expected profits of the MNE for the two locations, which are:

$$\Pi_n^H(x, e) = (1 - t) \left[\left(\frac{A\alpha^\alpha \beta^\beta}{r^\alpha \theta^\beta} \right)^{\frac{1}{1-\alpha-\beta}} (1 - \alpha - \beta) \right], \quad (27)$$

$$\Pi_n^L(x, e) = (1 - t) \left[\left(\frac{A\alpha^\alpha \beta^\beta}{r^\alpha \hat{\theta}^\beta} \right)^{\frac{1}{1-\alpha-\beta}} (1 - \alpha - \beta) \right] + \rho(t - t^*). \quad (28)$$

The not financially constrained MNE faces a trade-off between fixed tax savings when using the low-tax jurisdiction and at the same time a larger variable cost of managing the use of the intangibles. Depending on the after-tax expected profits, $\Pi_n^H \geq \Pi_n^L$, the multinational firm then decides where to locate its intangible assets. The location decision has implications for the optimal investment volume and optimal efforts. Comparing the two rearranged profit equations, Eqs. (27) and (28), yields the following expression, which gives the trade-off faced by the not financially constrained MNE:

$$(1 - t) \left(\frac{A\alpha^\alpha \beta^\beta}{r^\alpha} \right)^{\frac{1}{1-\alpha-\beta}} (1 - \alpha - \beta) \left[\left(\frac{1}{\theta^\beta} \right)^{\frac{1}{1-\alpha-\beta}} - \left(\frac{1}{\hat{\theta}^\beta} \right)^{\frac{1}{1-\alpha-\beta}} \right] \geq \rho(t - t^*), \quad (29)$$

where:

$$(1 - t) \left(\frac{A\alpha^\alpha \beta^\beta}{r^\alpha} \right)^{\frac{1}{1-\alpha-\beta}} (1 - \alpha - \beta) > 0$$

is the relative weight of the variable cost differential and ρ is the relative weight of the tax rate differential.

The left-hand-side (LHS) and the right-hand-side (RHS) of Expression (29) are both positive, as $1 > \alpha + \beta$, $\theta < \hat{\theta}$, and $t > t^*$. This allows us to make the following statements:

Proposition 3 *In the case of a not financially constrained multinational firm: (i) For $t = t^*$ then $RHS = 0$ in Expression (29) and $\Pi_n^H > \Pi_n^L$ thus the high-tax jurisdiction is chosen; (ii) For $\theta = \hat{\theta}$ then $LHS = 0$ in Expression (29) and $\Pi_n^H < \Pi_n^L$ thus the low-tax jurisdiction is chosen; (iii) An increasing difference ($\hat{\theta} - \theta$) favours Π_n^H in Expression (29) and thus the high-tax jurisdiction; (iv) An increasing difference ($t - t^*$) favours Π_n^L in Expression (29) and thus the low-tax jurisdiction.*

4.3.3 Financial constraints

The second case is given when the optimal investment size x falls short of the amount of funds, E , of the multinational enterprise.

In the financially constrained case, $x > E$, the MNE needs an external partner to provide it with additional financing. Since efforts are not observable, they cannot be verified by a third party and are not contractible. The multinational firm and its partner decide to share the expected after-tax payoff of the investment. We assume the expected payoff

to be divided according to a sharing rule in which the MNE receives a share ϕ and the partner a share $(1 - \phi)$ of the expected payoff, with $\phi \in (0, 1)$.¹⁰

In the first stage, the multinational firm makes a decision where to locate its intangible assets. In the second stage, the MNE offers a joint project to the partner who is external to the firm. The firm and the partner simultaneously decide upon the efforts provided and on the investment volume respectively. Contracts are incomplete such that efforts e are not contractible. Both the firm and the partner will split the project payoff according to the previously agreed shares ϕ and $(1 - \phi)$ respectively. It should be noted that all costs are sunk, so that the firm will not be able to recover managerial costs, the efforts e in our model, of utilising the intangible assets for the investment project.

The maximisation problem of a financially constrained MNE, denoted by the subscript c , which has located its intangible assets in the high-tax jurisdiction is given by:

$$\Pi_c^H(x, e) = (1 - t) (\phi Ax^\alpha e^\beta - rE - \theta e), \quad (30)$$

and for an MNE, which has located them in the low-tax jurisdiction, it is given by:

$$\Pi_c^L(x, e) = (1 - t) (\phi Ax^\alpha e^\beta - rE - \hat{\theta}e) + \rho(t - t^*). \quad (31)$$

For the case that the intangibles are in the high-tax jurisdiction, the MNE maximises Eq. (30) with respect to e and the FOC is given by:

$$\frac{\partial \Pi_c^H}{\partial e} = (1 - t) (\phi \beta Ax^\alpha e^{\beta-1} - \theta) \stackrel{!}{=} 0. \quad (32)$$

The FOC for the case of the location of the intangibles being the low-tax jurisdiction is similar to the one for the high-tax jurisdiction with the exception of the variable cost of use of the intangible assets being $\hat{\theta}$ instead of θ .

The participation constraint (PC) of the partner, which leaves the partner just indifferent between financing the MNE's project or choosing an outside option, is given by:

$$\Pi_P^H = (1 - t) ((1 - \phi)Ax^\alpha e^\beta - r(x - E)), \quad (33)$$

where the subscript P indicates that these are the partner's after-tax expected profits and the superscript H again denotes the location of the MNE's intangibles as being at the high-tax jurisdiction. In the last term of the PC, given in Eq. (33), the partner's investment part V , where $V = x - E$, has already been substituted for. The PC has the same functional form when the location of the intangibles is the low-tax jurisdiction instead.

The partner maximises the equation of the PC, Eq. (33), with respect to x and the

¹⁰The respective shares can be thought of resulting from a generalised Nash bargaining approach that models sharing the quasi-rent of the project. Though, in the present analysis we take both shares as given.

FOC is given by:

$$\frac{\partial \Pi_P^H}{\partial x} = (1-t) \left((1-\phi) A \alpha x^{\alpha-1} e^\beta - r \right) \stackrel{!}{=} 0. \quad (34)$$

Using the two FOCs, given by Eqs. (32) and (34), yields the new optimal values for x and e , which are given also in comparison to the not financially constrained case given by Eqs. (25) and (26):

$$x_c^H = \left(\frac{A \alpha^{1-\beta} \beta^\beta}{r^{1-\beta} \theta^\beta} \right)^{\frac{1}{1-\alpha-\beta}} \left(\phi^\beta (1-\phi)^{1-\beta} \right)^{\frac{1}{1-\alpha-\beta}} = x_n^H \gamma, \quad (35)$$

$$e_c^H = \left(\frac{A \alpha^\alpha \beta^{1-\alpha}}{r^\alpha \theta^{1-\alpha}} \right)^{\frac{1}{1-\alpha-\beta}} \left(\phi^{1-\alpha} (1-\phi)^\alpha \right)^{\frac{1}{1-\alpha-\beta}} = e_n^H \delta, \quad (36)$$

with

$$\gamma \equiv \left(\phi^\beta (1-\phi)^{1-\beta} \right)^{\frac{1}{1-\alpha-\beta}} > 0,$$

$$\delta \equiv \left(\phi^{1-\alpha} (1-\phi)^\alpha \right)^{\frac{1}{1-\alpha-\beta}} > 0.$$

The new values for x and e differ from the ones in the case without financial constraints for the MNE. The same is true for the case when the MNE chooses the low-tax jurisdiction for the location of its intangibles except that then we have $\hat{\theta}$ instead of θ in the expressions for x and e in Eqs. (35) and (36).

Plugging in the respective values for x and e in the profit functions gives us the after-tax expected profits of the MNE in the financially constrained case:

$$\Pi_c^H(x, e) = (1-t) \left[\left(\frac{A \alpha^\alpha \beta^\beta}{r^\alpha \theta^\beta} \right)^{\frac{1}{1-\alpha-\beta}} (1-\beta) \delta - rE \right], \quad (37)$$

$$\Pi_c^L(x, e) = (1-t) \left[\left(\frac{A \alpha^\alpha \beta^\beta}{r^\alpha \hat{\theta}^\beta} \right)^{\frac{1}{1-\alpha-\beta}} (1-\beta) \delta - rE \right] + \rho(t-t^*). \quad (38)$$

When comparing its after-tax expected profits from the two different locations, given in Eqs. (37) and (38), $\Pi_c^H \geq \Pi_c^L$, the MNE faces the following trade-off, which looks similar to the case without financial constraints:

$$(1-t) \left(\frac{A \alpha^\alpha \beta^\beta}{r^\alpha} \right)^{\frac{1}{1-\alpha-\beta}} (1-\beta) \delta \left[\left(\frac{1}{\theta^\beta} \right)^{\frac{1}{1-\alpha-\beta}} - \left(\frac{1}{\hat{\theta}^\beta} \right)^{\frac{1}{1-\alpha-\beta}} \right] \geq \rho(t-t^*), \quad (39)$$

where:

$$(1-t) \left(\frac{A \alpha^\alpha \beta^\beta}{r^\alpha} \right)^{\frac{1}{1-\alpha-\beta}} (1-\beta) \delta > 0$$

is the new relative weight of the variable cost differential and ρ is the relative weight of the tax rate differential as in the case when the MNE does not face financial constraints.

The partner's after-tax expected profits for the two different locations of the MNE's intangible assets are given below:

$$\Pi_P^H = (1 - t) \left[\left(\frac{A\alpha^\alpha \beta^\beta}{r\alpha\theta^\beta} \right)^{\frac{1}{1-\alpha-\beta}} (1 - \alpha)\gamma + rE \right], \quad (40)$$

$$\Pi_P^L = (1 - t) \left[\left(\frac{A\alpha^\alpha \beta^\beta}{r\alpha\hat{\theta}^\beta} \right)^{\frac{1}{1-\alpha-\beta}} (1 - \alpha)\gamma + rE \right]. \quad (41)$$

The MNE's partner also compares the after-tax expected profits from the two locations which are given by Eqs. (40) and (41), $\Pi_P^H \geq \Pi_P^L$. Due to $\theta < \hat{\theta}$ the partner's expected profits are higher when the MNE locates its intangible assets at the high-tax jurisdiction as compared to the low-tax jurisdiction, $\Pi_P^H > \Pi_P^L$. The partner thus has higher incentives to provide the MNE with financing when the intangibles are located in the high-tax jurisdiction, which we have assumed to be also the jurisdiction of the MNE's headquarters.

As the location choice of the intangible assets is observable, it serves as a signal for the potential partner. When the MNE locates its intangible assets at the low-tax jurisdiction compared to locating them at the high-tax jurisdiction, the partner is left only with the larger variable costs, $\hat{\theta}$, but not with the tax benefits of using the low-tax jurisdiction, $\rho(t - t^*)$, which accrue only to the multinational firm. This situation is similar to the argument expressed in Hasan et al. (2014) about the asymmetric payoffs of the firm's shareholders and debt holders when the firm engages in tax avoidance. Thus it would be less likely for the MNE to use the low-tax jurisdiction when deciding on the location of its intangible assets in the financially constrained case as it would have to consider also the after-tax expected profits of the partner, which are higher when the high-tax jurisdiction is chosen.

Conjecture 1 *In the case of a financially constrained multinational firm: It is less likely for the multinational firm to make use of the relatively low-tax jurisdiction as the location of its intangible assets.*

4.4 Empirical analysis

4.4.1 Empirical strategy

In the underlying analysis we are interested in showing that there are two different groups of multinational enterprises with respect to the effect of the jurisdictions' corporate income tax rates on the amount of intangible assets of the MNEs' entities in these jurisdictions. We assume Group 1 to be comprised of the financially constrained MNEs, which cannot locate their intangible assets in an optimal tax-minimising manner. Whereas we assume

Group 2 to be comprised of MNEs, which are not financially constrained and can make use of the location of their intangible assets for tax-minimising purposes.

In order to empirically analyse whether these two groups exist and the MNEs belonging to each one of them behave as we expect them to, we estimate finite-mixture models (FMMs). The FMMs assume that the whole distribution of the variable of interest, in our case the intangible fixed assets (IFAS) of the MNEs' entities, is made up of a finite mixture of groups, which follow the same distributional form but differ in their moments (Cameron and Trivedi, 2010, Chapter 17). More specifically, we estimate FMMs with two components where our dependent variable is the level of the intangible fixed assets of a particular firm, which is part of an MNE group. In addition, we assume the underlying distribution of the IFAS to be negative binomial 2 (NB2) as in the analysis of Egger et al. (2014b) for the case of the fixed assets of the German MNEs' foreign affiliates. In the first two estimations, which we make, we do not explicitly model the probability of an observation to belong to one of the two groups. In the latter estimations, however, we model the probability of an MNE's entity to belong to either of the two groups by a variety of proxies for its financial situation, which is motivated from our theoretical model.

We use the notation from Chapter 17 in Cameron and Trivedi (2010) and from Egger et al. (2014b) to write down the functional form of the finite-mixture models with two components, which we estimate in our empirical analysis. The overall density of the variable IFAS is assumed to be given by a mixture of two components in the following way:

$$f(y_{it}|\mathbf{x}_{it}, \boldsymbol{\theta}_1, \boldsymbol{\theta}_2, \pi_1) = \pi_1 f_1(y_{it}|\mathbf{x}_{it}, \boldsymbol{\theta}_1) + (1 - \pi_1) f_2(y_{it}|\mathbf{x}_{it}, \boldsymbol{\theta}_2), \quad (42)$$

where $\pi_1 \in [0, 1]$ is the fraction of the observations belonging to Group 1 and π_2 is the fraction of the observations belonging to Group 2, for which we have substituted for using the following relationship $\pi_1 + \pi_2 = 1$. We use y_{it} to denote the level of intangible fixed assets of entity i in year t , where $i = 1, \dots, I$ and $t = 1, \dots, T$. Furthermore, \mathbf{x}_{it} denotes the vector of explanatory variables, whereas $\boldsymbol{\theta}_1$ and $\boldsymbol{\theta}_2$ are vectors of parameters, which are to be estimated. From Eq. (42) we can see that the overall distribution of IFAS is a weighted average of the distributions of the two components, weighted by their respective fraction in the whole population. The probability to belong to either one of the two fractions, π_1 and π_2 , can be taken as constant, which we do in our first two estimations. However, this probability can also be estimated by a logistic function, which we then do in the latter eight estimations. Thus the probability of belonging to Group 1 can be estimated by the following expression:

$$\pi_1 = \frac{\exp(\mathbf{z}'_{it} \boldsymbol{\delta})}{1 + \exp(\mathbf{z}'_{it} \boldsymbol{\delta})},$$

with \mathbf{z}_{it} being a vector of explanatory variables, in our case it contains a proxy variable for an MNE being more or less financially constrained, and $\boldsymbol{\delta}$ being a vector of parameters,

which are going to be estimated by the logistic function.

4.4.2 Data

For the present analysis we use data from the ORBIS database compiled by Bureau van Dijk. Our sample comprises the years 2004 to 2014. We include only observations belonging to multinational enterprises. MNEs are defined as firms, which have at least one affiliate which is located in a jurisdiction different from the one of the global ultimate owner (GUO).

Furthermore, we are interested only in observations, which come from the Local GAAP (generally accepted accounting principles) accounting practice. The reason is that the variable of central interest to our analysis is the firm's balance sheet item IFAS (intangible fixed assets). As noted in Dischinger and Riedel (2011) the accounting practice being Local GAAP or IFRS (international financial reporting standards) matters for the item IFAS, which is also central to their analysis. The sample used for the analysis in Dischinger and Riedel (2011) is comprised of only observations coming from Local GAAP. We also include only observations coming from Local GAAP in our analysis. In addition, in order to make sure that we have firms for which the question of the location of their intangible assets is relevant, we only use observations which have positive values for the item IFAS. We also take care of outliers and do not include the largest 1% of the observations for IFAS. In our analysis we consider the variable IFAS in levels and it is given in thousands of US dollars.

The explanatory variable of central interest to our analysis is the corporate income tax rate at the different jurisdictions. In our main specification we further include as explanatory variables two macroeconomic variables. These are the logarithm of the GDP (gross domestic product) and the logarithm of the GDP per capita at the particular jurisdiction. We also include an estimate for the control of corruption present in the different jurisdictions. Similar control variables are also used in the analysis of Dischinger et al. (2014a). In robustness checks we also include a dummy variable, which is equal to one when the specific jurisdiction implements an IP Box regime in the particular year and is zero otherwise. Information on the IP Box dummy is taken from Table 2 on p. 30 in Alstadsæter et al. (2015). We include the IP Box dummy in order to capture potential additional incentives of the MNEs to locate their intangible fixed assets in the particular jurisdiction. However, we include the IP Box dummy only as a robustness check as it is not clear whether or not the particular IFAS qualify for the benefits of the particular IP Box regime. This is because, for example, some IP Box regimes impose a condition that the IP in question had to be developed in the IP Box jurisdiction in the first place in order to qualify for the potential tax benefits of the IP Box regime (Alstadsæter et al., 2015).

In the first two specifications we do not explicitly model the probability for an observation to belong to one of the two components of the FMM, which we estimate, whereas in the other eight estimations we do this. In these eight estimations we separately use the

Table 8: Summary statistics – Intangible fixed assets analysis

VARIABLE	Obs.	Mean	Std. dev.	Min.	Max.
ifas	783,332	1609.154	6435.335	1	84998
citr	783,332	0.2913	0.0695	0	0.41
ipbox_dummy	783,332	0.2098	0.4072	0	1
ln_gdp	783,332	27.6604	1.3687	21.4524	30.4505
ln_gdppercap	783,332	10.2555	0.7587	6.5806	11.9646
cc	783,332	0.9654	0.9047	-1.4063	2.5527
ln_shfd	711,344	8.1202	2.1071	0	14.0467
ln_cash	735,426	5.8224	2.3553	0	11.3043
ln_tfas	739,769	6.9620	2.4755	0	12.7825
ln_toas	780,691	9.3968	1.7808	0	15.0129

Notes: Abbreviations: Obs. – observations, gives the number of observations; Std. dev. – standard deviation; Min. – minimum; Max. – maximum; ifas – intangible fixed assets; citr – statutory corporate income tax rate; ipbox_dummy – dummy variable, which is equal to 1 if there is an IP (Intellectual Property) Box regime in force in the respective jurisdiction and is equal to 0 otherwise; ln – as a prefix denotes the natural logarithm of the respective variable; gdp – gross domestic product (GDP); gdppercap – GDP per capita; cc – estimate for the control of corruption; shfd – shareholders funds; cash – cash & cash equivalent; tfas – tangible fixed assets; toas – total assets. The variable ifas is given in thousands of US (United States) dollars. The variable citr has a minimum at 0 and a maximum at 0.41, which implies that its minimum is at 0% and its maximum is at 41%. The variables ln_gdp and ln_gdppercap are originally given in US dollars. The estimates for the control of corruption variable, cc, range between approximately -2.5 and 2.5 with higher values indicating better control of corruption. The variables ln_shfd, ln_cash, ln_tfas, and ln_toas are originally given in thousands of US dollars. *Sources:* See Appendix 4.6.

logarithm of the balance sheet items SHFD (shareholders funds), CASH (cash & cash equivalent), TFAS (tangible fixed assets), and TOAS (total assets) as proxies for the MNE’s financial situation. We thus include multinational firms, which have at least some SHFD, CASH, TFAS, and TOAS. We again take care of outliers and do not consider the largest 1% of each of these four control variables when we compute their logarithms. In all of the specifications we include year dummies as in Egger et al. (2014b), the estimates of which are not shown in the respective tables of our empirical results. Table 8 contains summary statistics of the variables used in the present analysis.

4.4.3 Empirical results

Tables 9 to 13 present our empirical results.¹¹ In each table we make two estimations, where the first specification describes our general case and in the second specification we also add the dummy variable on the existence or not of an IP Box regime in a particular jurisdiction. In Table 9 we take the probability of belonging to Group 1 to be given, whereas in the other four tables we explicitly model this probability to depend on firm-specific characteristics. More specifically, we take this probability to depend on variables which we

¹¹For all finite-mixture model estimations we use the Stata user-written command **fmm** by Deb.

assume represent the financial situation of the particular MNE's entity. In all estimations robust standard errors adjusted for clustering at the firm-level are provided in parentheses.

As can be seen in Specification (1) of Table 9 there are indeed two groups of MNEs, when it comes to the effects of the corporate income tax rate on the level of intangible fixed assets registered at the particular firm belonging to an MNE group. Group 2 is the group for which the corporate income tax rates have a negative and highly statistically significant impact. This group behaves as the not financially constrained multinationals from the theoretical part, which can optimally choose the location of their intangibles with respect to the corporate income tax rates. Group 1 on the other hand behaves as the financially constrained multinationals from the theoretical part. This is because the estimated coefficient of the corporate income tax rate for them is positive and statistically significant. It seems that these entities of MNEs cannot locate their intangible assets in a tax-minimising way.

In Specification (2) of Table 9 we add the IP Box dummy to the explanatory variables from Specification 1. This does not change our results qualitatively as we still have two groups of firms, which behave in a different way when it comes to the effect of the corporate income tax rate on the amount of their intangible assets. We have again Group 2, which can optimise with respect to the corporate income tax rate it faces, and Group 1, which cannot. The signs and statistical significance of the estimated coefficients for the corporate income tax rate remain unchanged for the two groups. We should note, however, that the absolute value of the estimated coefficient for the corporate income tax rate for the tax-optimising group is larger in Specification (2) compared to Specification (1), whereas it is smaller for the non tax-optimising group.

Still, the shares of both groups in the whole sample stay almost the same in both specifications. Observations belonging to Group 1 account for around 64% of all observations and the observations belonging to Group 2 account for around 36%. This implies that the tax-optimising group is the smaller of the two groups, which implies that it is not that easy for all firms to locate their intangible assets in a tax-minimising way. The estimations in Table 9 furthermore indicate that there is overdispersion in the data. This is because the estimate for the dispersion in the data, α , given by the estimate for the logarithm of its value, \ln_alpha , is different from zero and it is statistically significant at the 1% significance level. The NB2 model thus does not collapse to a Poisson model. We also perform Wald tests for equivalence of the estimated coefficients for the effect of the corporate income tax rate for the two groups, which are rejected for both specifications at the 1% significance level.

We also provide graphical representations of the predicted values of the variable IFAS for both specifications in Figures 7 and 8. The two groups can be clearly distinguished from each other. The predicted mixture density for Group 1, given by the solid line, lies in the left part of each graph and the predicted mixture density for Group 2, given by the

Table 9: Intangible fixed assets analysis – General estimations

VARIABLES	(1) General case		(2) IP Box dummy case	
	Group 1	Group 2	Group 1	Group 2
citr	1.3981*** (0.2268)	-1.0254*** (0.2310)	0.6461*** (0.2308)	-1.2481*** (0.2335)
ipbox_dummy			0.4286*** (0.0331)	0.3030*** (0.0246)
ln_gdp	0.0267** (0.0117)	0.1681*** (0.0111)	0.0481*** (0.0122)	0.1520*** (0.0114)
ln_gdppercap	0.4280*** (0.0246)	-0.1550*** (0.0237)	0.4212*** (0.0251)	-0.1177*** (0.0239)
cc	0.3204*** (0.0195)	0.3869*** (0.0201)	0.2997*** (0.0195)	0.3405*** (0.0202)
Constant	-1.5147*** (0.2710)	5.0797*** (0.3322)	-1.8313*** (0.2746)	5.2216*** (0.3321)
ln_alpha	0.6377*** (0.0067)	1.0792*** (0.0027)	0.6445*** (0.0069)	1.0775*** (0.0027)
% of the sample	64.08%	35.92%	64.50%	35.50%
Observations	783,332		783,332	

Notes: The dependent variable is the balance sheet item intangible fixed assets (IFAS) in levels, reported by entities of multinational firms and coming from the Local GAAP accounting practice. All estimations include year dummies which are not shown. Robust standard errors adjusted for clustering at the firm-level in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, 1% significance level respectively. \ln_alpha – estimate of the logarithm of the dispersion parameter α of the estimated negative binomial 2 (NB2) two-component mixture density for the dependent variable. Wald tests for equivalence of the estimated coefficients for the variable *citr* of Group 1 and Group 2 indicate rejection of the null hypothesis of coefficient equivalence at the 1% significance level in both specifications. See Table 8 and Appendix 4.6 for a description of the explanatory variables.

dashed line, lies in the central and the right parts of each graph.

In a next step, we separately use four variables as proxies for the firms' financial situation. We use these variables in order to determine whether they have an effect on the probability of MNEs' entities to belong to one of the two groups, which are the group of the tax-optimisers and the group of the non tax-optimisers. The estimation of Specification (1) in Table 10 shows us that firms, which have larger amounts of shareholders funds, have a lower probability of belonging to Group 1, the non tax-optimisers, with respect to the location of their intangible assets. The same result holds also in Specification (2). In both specifications the results on the probability of belonging to Group 1 are highly statistically significant and in line with our theoretical predictions. It should be noted that in Specification (1) the estimated coefficient for the corporate income tax rates is positive and statistically significant whereas in Specification (2) it is not statistically significant. This still shows that the firms belonging to Group 1 do not respond to the corporate

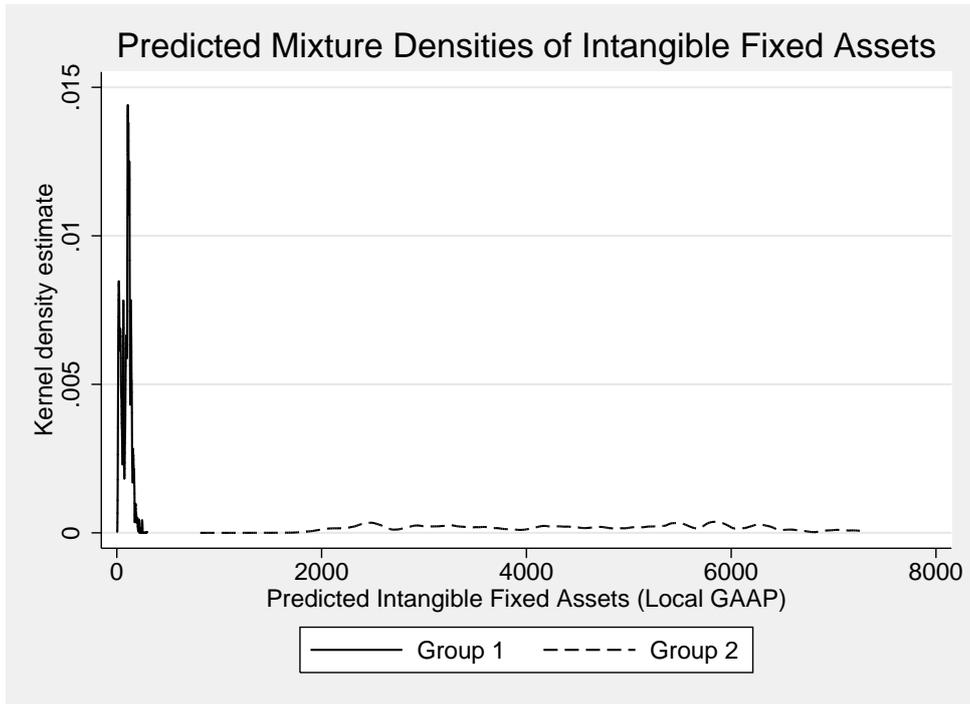


Figure 7: Predicted mixture densities of the two groups – General case

Notes: Estimates from Specification (1) in Table 9.

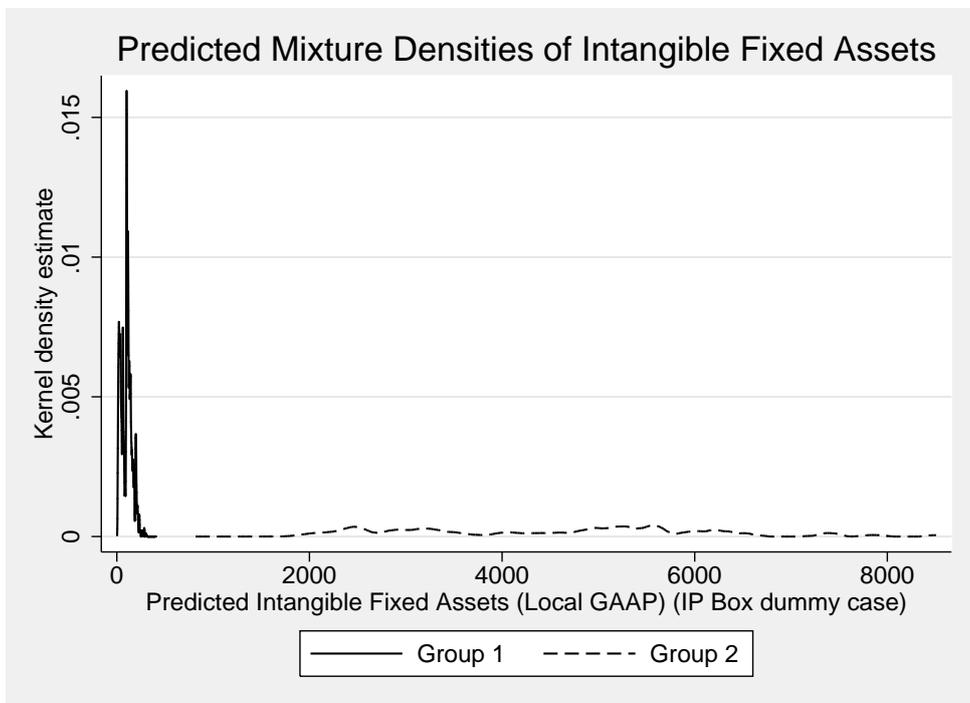


Figure 8: Predicted mixture densities of the two groups – IP Box dummy case

Notes: Estimates from Specification (2) in Table 9.

Table 10: Intangible fixed assets analysis – Shareholders funds

VARIABLES	(1) General case		(2) IP Box dummy case	
	Group 1	Group 2	Group 1	Group 2
citr	0.5612*** (0.2108)	-1.3907*** (0.2384)	-0.2192 (0.2113)	-1.6068*** (0.2420)
ipbox_dummy			0.4537*** (0.0285)	0.3315*** (0.0253)
ln_gdp	0.0305*** (0.0109)	0.1572*** (0.0114)	0.0429*** (0.0111)	0.1350*** (0.0118)
ln_gdppercap	0.6598*** (0.0227)	-0.0127 (0.0238)	0.6773*** (0.0229)	0.0315 (0.0239)
aff_cc	0.1453*** (0.0180)	0.2880*** (0.0204)	0.1084*** (0.0181)	0.2381*** (0.0206)
Constant	-3.3312*** (0.2557)	4.3379*** (0.3432)	-3.6284*** (0.2581)	4.5686*** (0.3433)
ln_alpha	0.7065*** (0.0062)	0.9478*** (0.0038)	0.7095*** (0.0062)	0.9459*** (0.0038)
Observations	711,344		711,344	
Pr(Group 1)				
ln_shfd	-0.6945*** (0.0075)		-0.7045*** (0.0077)	
Constant	6.6956*** (0.0787)		6.7969*** (0.0806)	

Notes: The dependent variable is the balance sheet item intangible fixed assets (IFAS) in levels, reported by entities of multinational firms and coming from the Local GAAP accounting practice. All estimations include year dummies which are not shown. Robust standard errors adjusted for clustering at the firm-level in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, 1% significance level respectively. ln_alpha – estimate of the logarithm of the dispersion parameter α of the estimated negative binomial 2 (NB2) two-component mixture density for the dependent variable. Pr(Group 1) – estimates the probability for an observation to be in Group 1. Wald tests for equivalence of the estimated coefficients for the variable citr of Group 1 and Group 2 indicate rejection of the null hypothesis of coefficient equivalence at the 1% significance level in both specifications. See Table 8 and Appendix 4.6 for a description of the explanatory variables.

income tax rates present in their respective jurisdiction in the same way as the firms in Group 2 do. The estimated coefficients for the effect of the corporate income tax rate for the firms in Group 2 remain negative and statistically significant in both specifications of Table 10.

In Table 11 we use the variable cash & cash equivalent as our proxy for financial constraints. This variable is mentioned in Hadlock and Pierce (2010), where the authors discuss different proxies for financial constraints of firms. In both specifications, the general case and the IP Box dummy case, the probability of a firm belonging to Group 1, the non tax-optimising firms, is lower when the firm in question has higher values of the

Table 11: Intangible fixed assets analysis – Cash & cash equivalent

VARIABLES	(1) General case		(2) IP Box dummy case	
	Group 1	Group 2	Group 1	Group 2
citr	1.4451*** (0.2192)	-1.0106*** (0.2373)	0.6527*** (0.2211)	-1.3124*** (0.2401)
ipbox_dummy			0.4570*** (0.0323)	0.3566*** (0.0260)
ln_gdp	0.0069 (0.0111)	0.1297*** (0.0113)	0.0258** (0.0113)	0.1115*** (0.0118)
ln_gdppercap	0.5726*** (0.0231)	-0.0084 (0.0252)	0.5747*** (0.0234)	0.0331 (0.0256)
cc	0.2012*** (0.0190)	0.2742*** (0.0207)	0.1750*** (0.0191)	0.2196*** (0.0210)
Constant	-2.2656*** (0.2642)	4.7840*** (0.3404)	-2.5915*** (0.2668)	4.9642*** (0.3399)
ln_alpha	0.6562*** (0.0069)	1.0339*** (0.0031)	0.6627*** (0.0070)	1.0313*** (0.0031)
Observations	735,426		735,426	
Pr(Group 1)				
ln_cash	-0.2464*** (0.0039)		-0.2505*** (0.0040)	
Constant	2.1582*** (0.0360)		2.2026*** (0.0371)	

Notes: The dependent variable is the balance sheet item intangible fixed assets (IFAS) in levels, reported by entities of multinational firms and coming from the Local GAAP accounting practice. All estimations include year dummies which are not shown. Robust standard errors adjusted for clustering at the firm-level in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, 1% significance level respectively. ln_alpha – estimate of the logarithm of the dispersion parameter α of the estimated negative binomial 2 (NB2) two-component mixture density for the dependent variable. Pr(Group 1) – estimates the probability for an observation to be in Group 1. Wald tests for equivalence of the estimated coefficients for the variable citr of Group 1 and Group 2 indicate rejection of the null hypothesis of coefficient equivalence at the 1% significance level in both specifications. See Table 8 and Appendix 4.6 for a description of the explanatory variables.

variable cash & cash equivalent. The estimated coefficients for the probability of belonging to Group 1 with respect to our proxy for financial constraints are negative and highly statistically significant in both specifications. Furthermore, in both specifications the estimates for the effect of the corporate income tax rates are again positive and statistically significant for Group 1 and negative and statistically significant for Group 2.

Next, we use the variable tangible fixed assets in the probability estimation of an observation to belong to Group 1. For firms with more tangible fixed assets it would be less likely to have financial constraints. For instance, they would have a higher probability to obtain external financing due to the potentially higher values of collateral which they

Table 12: Intangible fixed assets analysis – Tangible fixed assets

VARIABLES	(1) General case		(2) IP Box dummy case	
	Group 1	Group 2	Group 1	Group 2
citr	1.5385*** (0.2135)	-0.6948*** (0.2479)	0.6855*** (0.2116)	-1.0206*** (0.2516)
ipbox_dummy			0.4961*** (0.0304)	0.3739*** (0.0265)
ln_gdp	-0.0112 (0.0109)	0.1456*** (0.0117)	0.0037 (0.0111)	0.1222*** (0.0122)
ln_gdppercap	0.7169*** (0.0225)	-0.0024 (0.0246)	0.7293*** (0.0228)	0.0443* (0.0247)
cc	0.1442*** (0.0181)	0.3065*** (0.0212)	0.1117*** (0.0182)	0.2546*** (0.0213)
Constant	-3.2357*** (0.2516)	4.1252*** (0.3534)	-3.5401*** (0.2531)	4.3971*** (0.3531)
ln_alpha	0.6481*** (0.0066)	0.9848*** (0.0035)	0.6551*** (0.0066)	0.9814*** (0.0035)
Observations	739,769		739,769	
Pr(Group 1)				
ln_tfas	-0.3906*** (0.0043)		-0.4013*** (0.0044)	
Constant	3.5261*** (0.0436)		3.6277*** (0.0450)	

Notes: The dependent variable is the balance sheet item intangible fixed assets (IFAS) in levels, reported by entities of multinational firms and coming from the Local GAAP accounting practice. All estimations include year dummies which are not shown. Robust standard errors adjusted for clustering at the firm-level in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, 1% significance level respectively. ln_alpha – estimate of the logarithm of the dispersion parameter α of the estimated negative binomial 2 (NB2) two-component mixture density for the dependent variable. Pr(Group 1) – estimates the probability for an observation to be in Group 1. Wald tests for equivalence of the estimated coefficients for the variable citr of Group 1 and Group 2 indicate rejection of the null hypothesis of coefficient equivalence at the 1% significance level in both specifications. See Table 8 and Appendix 4.6 for a description of the explanatory variables.

might have (Egger et al., 2014a). Our results in the two specifications in Table 12 are in line with our expectations that more financially constrained firms will have higher probability to belong to the firms in Group 1. Furthermore, the estimated coefficients for the corporate-income-tax-rate variable in Table 12 are again positive and statistically significant for Group 1 and negative and statistically significant for Group 2.

Hadlock and Pierce (2010) argue that also a firm's size can play a role as a potential proxy for its financial situation. For this reason in our estimations in Table 13 we use the total assets of a firm as our proxy for financial constraints, where entities of multinational firms with higher values of total assets are expected to be less financially constrained.

In both specifications we find indeed that the probability of an observation to belong to Group 1 is smaller, the larger is the value of its total assets. Furthermore, in both specifications, estimated in Table 13, the estimated coefficients for the variable total assets are negative and highly statistically significant. The estimated coefficients for the effect of the corporate income tax rate are negative and highly statistically significant for Group 2 in both specifications. It should be noted, however, that in Table 13 the estimated coefficient for Group 1 for the effect of the corporate income tax rate is positive and statistically significant only in the general case specification, whereas it is negative and statistically significant in the IP Box dummy case. Still, in Specification (2) the magnitude of the estimated effect for Group 1 is more than three times smaller in absolute value than the estimated effect for Group 2, although both estimated coefficients have negative signs. This finding is in line with our main hypothesis that the firms in Group 2 are tax-optimisers and the firms in Group 1 are not, at least not in that amount. Wald tests reject the null hypothesis for equivalence of the estimated coefficients of the corporate income tax rate of the two groups in both specifications at the 1% level of statistical significance.

Our results remain robust across the different two-component FMM estimations.

4.5 Concluding remarks

The analysis made in the present chapter shows that the choice of the jurisdiction for the location of the MNEs' intangible assets can indeed be used as a means for tax minimisation by the MNEs. Still, as the existing literature has already noted, the findings of the theoretical model presented in this chapter indicate that the location of the intangibles for tax-minimising reasons does not exist as an option for all MNEs or at least this tax-minimisation option is not available to all MNEs in the same way. We have shown that for financially constrained multinational firms it is not that easy to make use of relatively low-tax jurisdictions as the location of their intangible assets if they want to secure external financing. In a way the financial partner of the MNE unconsciously acts in favour of the high-tax jurisdiction. As a result of own profit maximisation the partner is able to prevent the multinational firm from locating its intangible assets for tax-minimisation reasons. Thus in order to receive external financing the MNE lets indirectly its financial partner choose the location for its intangible assets.

Our empirical analysis supports the results of our theoretical model. The estimated two-component finite-mixture models show that there are indeed two groups of firms, which react differently to the corporate income tax rate when it comes to the amount of the intangible assets they locate in a particular jurisdiction. Group 2 is found to be the group, which is comprised of firms which do tax optimisation. Firms which cannot optimise with respect to the corporate income tax rates to the same degree or at all are found to belong instead to Group 1. In all model specifications this result remains qualitatively unchanged.

Table 13: Intangible fixed assets analysis – Total assets

VARIABLES	(1) General case		(2) IP Box dummy case	
	Group 1	Group 2	Group 1	Group 2
citr	0.3481*	-1.7624***	-0.6433***	-2.0654***
	(0.2086)	(0.2286)	(0.2075)	(0.2328)
ipbox_dummy			0.5488***	0.3554***
			(0.0277)	(0.0243)
ln_gdp	0.0120	0.1458***	0.0264**	0.1248***
	(0.0106)	(0.0109)	(0.0106)	(0.0113)
ln_gdppercap	0.5570***	-0.0643***	0.5751***	-0.0194
	(0.0223)	(0.0229)	(0.0226)	(0.0231)
cc	0.2200***	0.3281***	0.1782***	0.2745***
	(0.0172)	(0.0197)	(0.0173)	(0.0199)
Constant	-1.9147***	5.1747***	-2.2225***	5.3946***
	(0.2570)	(0.3253)	(0.2590)	(0.3259)
ln_alpha	0.6833***	0.9641***	0.6871***	0.9637***
	(0.0062)	(0.0036)	(0.0061)	(0.0036)
Observations	780,691		780,691	
Pr(Group 1)				
ln_toas	-0.9878***		-1.0103***	
	(0.0081)		(0.0083)	
Constant	10.2466***		10.4834***	
	(0.0895)		(0.0913)	

Notes: The dependent variable is the balance sheet item intangible fixed assets (IFAS) in levels, reported by entities of multinational firms and coming from the Local GAAP accounting practice. All estimations include year dummies which are not shown. Robust standard errors adjusted for clustering at the firm-level in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, 1% significance level respectively. ln_alpha – estimate of the logarithm of the dispersion parameter α of the estimated negative binomial 2 (NB2) two-component mixture density for the dependent variable. Pr(Group 1) – estimates the probability for an observation to be in Group 1. Wald tests for equivalence of the estimated coefficients for the variable citr of Group 1 and Group 2 indicate rejection of the null hypothesis of coefficient equivalence at the 1% significance level in both specifications. See Table 8 and Appendix 4.6 for a description of the explanatory variables.

Furthermore, our four proxies for financial constraints of a particular firm indicate that less financially constrained firms have a higher probability to belong to Group 2, the tax-optimisers, whereas more financially constrained firms have a higher probability of belonging to Group 1, the non tax-optimisers. This result also remains robust throughout our analysis.

This is an important finding. It implies that not all firms have the same means available for tax minimisation with respect to the location of their intangible assets. In the present chapter we analyse how the market interactions of the MNE with a potential financial partner can dampen the MNE's tax planning. There seem to exist market mechanisms,

which are able to deter the tax-minimisation strategies of the multinational firms, at least in the context of the location of their intangible assets for tax reasons. This does not mean that the decision-makers should relax when it comes to the tax planning by multinational firms. Instead, new channels seem to be available to them in order to deter the tax planning of the multinational firms active in their respective jurisdictions. It would be interesting to find similar market mechanisms, which could be able to deter or at least dampen also other tax planning strategies of the MNEs. This is left for future research.

4.6 Appendix

About the variables used in the empirical analysis:

ifas denotes the balance sheet item intangible fixed assets, given in thousands of US (United States) dollars, only observations with positive values considered where the largest 1% of its empirical distribution is not considered, taken from the ORBIS database compiled by Bureau van Dijk (BvD).

citr denotes the statutory corporate income tax rates in the different jurisdictions, this data is from Ernst & Young (EY) and it was kindly provided by Prof. Dr. Georg Wamser from the University of Tübingen, Germany.

ipbox_dummy denotes a dummy variable, which is equal to one if there is an IP (Intellectual Property) Box regime in force at the specific jurisdiction and is zero otherwise, taken from Table 2 on p. 30 in Alstadsæter et al. (2015), where there are 14 jurisdictions listed as having an IP Box regime in force in some year.

ln_gdp denotes the natural logarithm of the GDP (gross domestic product) in a specific jurisdiction, originally given in current US dollars, taken from the World Bank Group's World Development Indicators (WDI).

ln_gdppercap denotes the natural logarithm of the GDP per capita in a specific jurisdiction, originally given in current US dollars, taken from the World Bank Group's WDI.

cc denotes the estimate for the control of corruption in a specific jurisdiction, which ranges between approximately -2.5 and 2.5 with higher values indicating stronger control of corruption, taken from the World Bank Group's World Governance Indicators (WGI).

ln_shfd denotes the natural logarithm of the balance sheet item shareholders funds, originally given in thousands of US dollars, only observations with positive values considered where the largest 1% of its empirical distribution is not considered, taken from the ORBIS database compiled by BvD.

ln_cash denotes the natural logarithm of the balance sheet item cash & cash equivalent, originally given in thousands of US dollars, only observations with positive values considered where the largest 1% of its empirical distribution is not considered, taken from the ORBIS database compiled by BvD.

ln_tfas denotes the natural logarithm of the balance sheet item tangible fixed assets, originally given in thousands of US dollars, only observations with positive values considered where the largest 1% of its empirical distribution is not considered, taken from the ORBIS database compiled by BvD.

ln_toas denotes the natural logarithm of the balance sheet item total assets, originally given in thousands of US dollars, only observations with positive values considered where the largest 1% of its empirical distribution is not considered, taken from the ORBIS database compiled by BvD.

5 Transfer Pricing with Heterogeneous Firms¹²

5.1 Introduction

The falling barriers to international trade (Perez, 2008) as well as the falling restrictions on international capital flows (Troeger, 2013) have provided the firms with the possibilities to more easily and less costly engage in cross-border economic activities. These developments have facilitated the export of firm products and even investments by firms abroad, which are made by the firms in order to have production capacities also in foreign jurisdictions and thus to become multinational. Horstmann and Markusen (1989) argue that for a firm to become a multinational enterprise it has to be productive enough in order to be able to successfully compete in the local markets of its foreign competitors, which might possess better knowledge of their respective home markets and customers. Thus MNEs are firms, which possess some competitive advantage. This competitive advantage mostly stems from their knowledge capital, which is furthermore firm-specific. Thus firm heterogeneity exists among firms, both national and multinational, operating even in the same industry. Helpman et al. (2004) show that the multinational enterprises are the most productive and thus most efficient firms, followed by the exporting firms. With free trade the more efficient firms thus have an incentive to become multinational and seize opportunities also abroad. There are efficiency gains from the reallocation of market shares and of production resources to the more efficient firms, which is the efficiency effect of multinational firm activity (Caves, 1974).

Although Blomström and Kokko (1998) support the argument on the efficiency gains from the activities of multinational enterprises, they nevertheless note shortly that the MNEs might also engage in profit shifting via the use of their transfer prices and shift their profits to other jurisdictions for tax reasons. Multinational firms have to set transfer prices for the various transactions between the different entities of which an MNE group is made of. As often there are no comparable transactions taking place between unrelated parties, the MNEs possess some discretion in setting these prices and the transfer prices can thus be used as a tool to shift profits from a high-tax to a low-tax jurisdiction. In this way the MNEs can minimise their overall tax payments, this is the profit-shifting effect of multinational firm activity. In their meta-study Heckemeyer and Overesch (2017) indeed show that profit shifting via transfer pricing is one of the main channels used for profit shifting by the MNEs.

Other profit-shifting channels, which the MNEs can use, exist, however, they are not part of the present analysis. One such channel is the choice of the location of the MNEs' intangible assets in order to ensure that the concerned royalties and license fees payments will accrue to affiliates located in relatively low-tax jurisdictions and consequently be

¹²This chapter is based on Tonev (2018d).

taxed less (see, among others, Fuest et al., 2013; and the analysis done in Chapter 4 of the present doctoral dissertation). Another profit-shifting channel is the use of debt by MNEs to finance their foreign affiliates in relatively high-tax jurisdictions as the interest payments on loans can be tax deductible and diminish the tax base of these affiliates (see, among others, Schindler and Schjelderup, 2013; Egger et al., 2014a). In the present analysis we concentrate on the role of transfer prices as the MNEs' profit-shifting channel.

If firms in an industry are homogeneous in terms of their productivity, the issue of transfer pricing would in principle not arise. This is because all firms would use the same technology, so the tax authority would eventually be able to learn the true marginal production cost. However, if firms are heterogeneous, this is no longer the case because firms can claim any cost in a reasonable range. Thus firm heterogeneity seems to be crucial for profit shifting via transfer pricing. When assessing the appropriateness of the claimed transfer prices, tax authorities apply the so-called arm's-length standard. The tax authorities thus compare the MNEs' transfer prices to the prices of similar transactions between unrelated parties in order to have some benchmark for orientation. However, with firm heterogeneity present, it can be argued that it might not be possible for the tax authority to find a correct arm's-length price for the intra-firm transactions of the various firms operating in the same industry in order to compare it with the ones claimed by the particular MNE (Bauer and Langenmayr, 2013; Behrens et al., 2014).

The focus of the present analysis is on studying the relationship between firm heterogeneity, in terms of firm productivity, and its effect on the reported profits of multinational firms operating in jurisdictions with different corporate income tax rates. The analysis employs a model of asymmetric information in which production costs are private information of the firms and thus neither known to their rivals nor to the tax authority. We analyse both the efficiency effect resulting from more firm heterogeneity in an industry, due to more competition, and the profit-shifting effect, due to the increased possibilities for the use of transfer pricing for profit shifting, at the same time. In our theoretical model we furthermore allow profit shifting to occur even if the transfer prices claimed by the MNEs are accepted as valid by the tax authority. This is also the case in Bauer and Langenmayr (2013) and Becker and Davies (2014).

The main research goal of the present analysis is to study the potential efficiency effect of multinational firm activity and the MNEs' profit-shifting effect on the tax base of a high-tax jurisdiction at the same time. In our model transfer pricing is the only channel for profit shifting between the high-tax jurisdiction and the low-tax jurisdiction. For this purpose we study the implications of an increase in firm heterogeneity via a mean-preserving spread in the distribution of the production costs of the MNEs. In our theoretical model this implies also an increase in the range of permitted transfer prices by the tax authority. With an increase in firm heterogeneity the two potentially opposing effects, the efficiency and the profit-shifting effects, are increased. However, our theoretical model shows that the overall

effect of an increase in firm heterogeneity on the high-tax jurisdiction's expected tax base, for given tax rates, turns out to be negative.

We test the implications of the theoretical model empirically. For this purpose we estimate a variety of quantile regressions. The quantile regressions allow us to estimate potentially different magnitudes of the profit-shifting and the efficiency effects for MNEs which are found in different conditional quantiles of firm profitability, which we use as the dependent variable. In the empirical analysis we find the relationship underlined in the theoretical part to hold as well. More specifically, the profit-shifting effect and the efficiency effect are found to be stronger for more profitable MNEs. This indicates that the more productive and thus the more profitable MNEs have more possibilities to engage in profit shifting via the use of their transfer prices.

The remainder of this chapter is organised as follows. Section 5.2 provides an overview of existing literature on profit shifting by MNEs via the transfer pricing channel. Then, Section 5.3 sets up the theoretical model and furthermore discusses the impact of an increase in firm heterogeneity on the high-tax jurisdiction's expected tax base, where the focus of the analysis is on the efficiency and the profit-shifting effects of MNE activity. The empirical analysis is done in Section 5.4, where we first elaborate on the implemented methods, after that describe the data used in the estimations and then provide the results of the respective quantile regressions. Finally, Section 5.5 provides some concluding remarks. The Appendix of the present chapter, Appendix 5.6, provides also information on the variables used in the empirical analysis and on their sources.

5.2 Literature review

Nielsen et al. (2003) analyse the role of transfer pricing in a model with oligopolistic competition but without firm heterogeneity and asymmetric information. They assess the MNEs' profit-shifting incentives under different profit allocation schemes implemented by the jurisdictions' tax authorities such as separate accounting and formula apportionment. In their model the choice of the transfer price has implications for the competitiveness of the MNEs' foreign affiliates and thus can be used for strategic reasons in addition to profit shifting. In our model we do not have this strategic effect of the transfer price as we have centralised decision-making regarding the prices set by the MNEs' entities and as we furthermore want to focus only on the MNE's profit-shifting activities.

Bauer and Langenmayr (2013) and Behrens et al. (2014) both provide theoretical models, which stress that the arm's-length prices used as benchmarks by the tax authorities can be distorted. Thus even when the MNEs correctly adhere to the arm's-length principle, profit shifting can occur. The reason is that the unrelated parties, which do cross-border transactions, are less efficient than the multinational firms, which instead engage in intra-firm transactions. After all, as argued in Horstmann and Markusen (1989) and in Helpman

et al. (2004) the firms choose their MNE structure in order to exploit some comparative advantage, which might then result in the relatively higher productivity of the MNEs compared to the other firms. In our model we take the organisational structure of the firms, being MNEs, as given. In addition, we focus our analysis only on the interactions between different MNEs' entities, which are located in different jurisdictions. There are no other firms in the present theoretical model.

Becker and Davies (2014) provide a theoretical model which focuses on the role of negotiations between the different jurisdictions on determining the transfer prices used by the MNE. In their model profit shifting can take place even if the transfer prices set by the MNE are accepted by the tax authorities of the two different jurisdictions. The two tax authorities can choose a transfer price from a given range, as in our model, but in their case it is the relative bargaining power of the two jurisdictions with respect to each other, which determines the accepted transfer price in this range. In our model we concentrate on the multinational firm's decisions for its transfer prices instead. Furthermore, we focus on the tax authority of the high-tax jurisdiction. After all, it is in the interest of this tax authority to strictly control for the correct application of the transfer prices as the MNEs have an incentive to shift profits out of its jurisdiction to a relatively low-tax jurisdiction (Peralta et al., 2006).

Furthermore, Gresik (2010) considers a tax competition model between two jurisdictions, which includes asymmetric information between each tax authority and the firm. In Gresik (2010) the tax authorities can jointly use a noisy auditing technology, which decides whether the transfer price is acceptable or not. In our model asymmetric information is also present between the tax authority and the respective MNE. Still, the MNEs set transfer prices, which are accepted by the tax authority. As in Gresik (2010) we also assume that there is a range of permitted transfer prices. In our theoretical model the MNEs set their transfer price in accordance to this range.

In this respect Gresik and Osmundsen (2008) elaborate that in practice the tax authorities indeed use a range of permitted transfer prices when assessing the MNEs transfer prices. More specifically, they evaluate the MNEs transfer prices with respect to other firms operating in the same industry by comparing different financial ratios of the respective firms. When the particular MNE is found to have a value of the specific financial ratio, which does not lie within the middle 50% of the empirical distribution of the underlying indicator, then its transfer prices are thoroughly assessed. In the other case, when it lies within the middle 50%, the MNE is not considered suspicious of profit shifting. So being in the lowest 25%, the first quartile, of the empirical distribution or the highest 25%, the fourth quartile, of the empirical distribution of the particular indicator, which can be some financial ratio, is both taken by the tax authority as potentially indicative for profit shifting. Still, in practice it might be the case that the particular tax authority is more concerned when the MNE is found to be in the first quartile as this could be due to profit

shifting out of its jurisdiction, whereas the firms in the fourth quartile could be shifting profits in that jurisdiction, which would then constitute additional tax revenues for the particular jurisdiction (Peralta et al., 2006; Gresik and Osmundsen, 2008).

The issue of profit shifting by MNEs has been analysed empirically. Depending on the available data, the different analyses look either directly at the MNEs intra-firm transactions (i.e. Clausing, 2003) or use a profitability measure, such as EBIT (earnings before interest and taxes), in order to approximate the effect of the corporate income tax rates on the declared firm profitability in a respective jurisdiction (i.e. Lohse and Riedel, 2013; Beer and Loeprick, 2015). Clausing (2003) finds in the US context that the price setting in intra-firm transactions differs systematically from the price setting among unrelated parties in relation to the corporate income tax rate and that this is in line with the profit-shifting incentives of the MNEs. Lohse and Riedel (2013) and Beer and Loeprick (2015) find that firm profitability is sensitive to the corporate income tax rate and that there is a negative relationship between the corporate income tax rate and firm profitability. In the present analysis we also use proxies for firm profitability and find a negative effect of the corporate income tax rate on our profitability measures.

The empirical paper by Maffini and Mokkalas (2011) implements the ORBIS database, as we do. Their analysis focuses on the differences in estimated firm productivity between multinational and national manufacturing firms with respect to changes in the corporate tax rates of the jurisdictions where they are located in. For this purpose they are interested in the estimated sign of an interaction term of the corporate tax rate and a dummy variable of whether the firm is national or it belongs to a multinational group. The sign of the interaction term is negative, as they expect it to be, implying that multinational firms have the possibility to engage in profit shifting from high-tax to low-tax jurisdictions, which is not available to national firms. One such profit-shifting channel used by the MNEs could be the setting of their transfer prices.

A meta-study on the response of MNE's reported before-tax profits to international tax rate differentials is conducted in Heckemeyer and Overesch (2017). In their Figure 1 they show that the estimated coefficients are diminishing in absolute value over time and in their Table 4 they further show that studies, which implement the ORBIS database, as we do in the present analysis, find lower effects than studies using other databases. Calculations in Heckemeyer and Overesch (2017) imply that transfer pricing is indeed an important channel used by the MNEs for profit shifting. In our analysis we also estimate the responses of before-tax firm profitability to corporate income tax rates, where we separately employ two different measures for firm profitability. These computations represent the profit-shifting effect of MNE activity. In addition to that, we also estimate the efficiency effect of MNE activity for a particular jurisdiction.

5.3 Theoretical model

5.3.1 The model setup

We consider a duopoly where two multinational firms are hosted by one jurisdiction, called Home. The establishment of each multinational firm requires a specific factor, which is available only in this jurisdiction, so there will be no competition by other, foreign firms. This specific factor could be a certain skill or an investment, for example in research and development (R&D), which can be successful only in this jurisdiction. Before the firm makes this investment, however, it does not know its productivity, but will learn it only after entry. For example, market entry may warrant an R&D investment, but the outcome of this investment is uncertain, that is, the firm will learn its marginal production cost after entry. We assume that entry costs do not differ and firms draw from the same distribution.¹³ We are not interested in the entry decision, but will focus on the operational decisions of the firms once they have entered.

After entry, the two firms draw their marginal production cost c from a commonly known distribution, where c is element of the set $\{l, h\}$, $c \in \{l, h\}$, and $l < h$. There is a low-cost type firm, which has l as its marginal production cost, and a high-cost type firm, which has h as its marginal production cost. The cost draw is private information of the firm. Therefore, neither its rival nor the tax authority are able to learn this cost. The probability for a low-cost type is r and for a high-cost type is $(1 - r)$, where $0 < r < 1$. This implies:

$$c = \begin{cases} l, & \text{where } \Pr(c = l) = r, \\ h, & \text{where } \Pr(c = h) = 1 - r. \end{cases}$$

The two firms are vertically integrated and serve a foreign market, called Foreign, by foreign direct investment (FDI). The firms compete over quantities. Each firm produces a final good with constant marginal cost c in Home, which we assume to be a low-tax jurisdiction with a corporate income tax rate denoted by t^* , and sells it via its foreign subsidiary in Foreign, which we assume to be a high-tax jurisdiction with a corporate income tax rate denoted by t and where $0 < t^* < t < 1$. Tax havens are not excluded from our analysis. Although it could be the case that the corporate income tax rates of tax havens are zero, firms might still need to pay fees to the tax haven authorities when making use of these jurisdictions, which constitutes costs for the firms. So t^* can in principle be very close to zero but still positive. We take the corporate income tax rates, t and t^* , as given, and it is beyond the scope of the present analysis to evaluate how tax rates may change in response to an increase in firm heterogeneity.¹⁴

¹³For a model with market entry and R&D costs, which determine the range of potential productivities of each firm, see Long et al. (2011).

¹⁴The determination of tax rates in models of tax competition, when firms are heterogeneous, relies often on numerical simulations, see, for example, Krautheim and Schmidt-Eisenlohr (2011) and Haufler and

The output of a firm is z . It is x for the low-cost type and y for the high-cost type. This can be summarised as follows:

$$z = \begin{cases} x, & \text{where } \Pr(z = x) = r, \\ y, & \text{where } \Pr(z = y) = 1 - r. \end{cases}$$

The foreign market inverse demand function is: $p = a - z - m$, where m is the expected per-firm output and is equal to:

$$m = rx + (1 - r)y. \quad (43)$$

Firm profits are taxed only once in the jurisdiction where they occur. Since each firm is vertically integrated, it has some scope to determine the transfer price for the transaction between its two entities, denoted by w . In this case, the net profits of a firm of type c are given by

$$\Pi(c) = (1 - t)(p - w)z + (1 - t^*)(w - c)z. \quad (44)$$

The first term denotes the after-tax profits from sales in the high-tax jurisdiction and the second term denotes the after-tax profits in the low-tax jurisdiction from selling the final good to the foreign affiliate. We assume that the firms do not face any costs of transporting their final goods between the two jurisdictions in order to focus our analysis on the implications of corporate taxation for the MNE activity.

Only the individual firm learns its true cost, but it can claim any cost which is reasonable. As its rival in the market game, also the tax authority cannot observe the true cost, but it has to accept any transfer price in a relevant range. The relevant range is the same as the range of the cost distribution so that each firm is free to set w equal to any value in the range given by $[l, h]$ without any consequences. This decision rule of the tax authority is motivated from the real world, where the tax authority allows for a range of permitted transfer prices. For an overview of the different methods how the tax authority determines whether or not the reported MNEs' transfer prices are acceptable, see Gresik and Osmundsen (2008).

As the after tax profits increase with w , $\partial\Pi(c)/\partial w = z(t - t^*) > 0$, both firms will set $w = h$. Due to the tax rate differential firms have an incentive to shift profits from the high-tax to the low-tax jurisdiction. This can be done by claiming that the cost in the low-tax jurisdiction is higher than the true cost. Only the high-cost firm will thus report its true cost. The profits of the low-cost firm are given by:

$$\Pi(l) = (1 - t)(p - h)x + (1 - t^*)(h - l)x = (1 - t)(a - x - m - h)x + (1 - t^*)(h - l)x. \quad (45)$$

Stähler (2013).

The profits of the high-cost firm can be rewritten as:

$$\Pi(h) = (1-t)(p-h)y + (1-t^*)(h-h)y = (1-t)(a-y-m-h)y. \quad (46)$$

The rearranged first-order condition (FOC) of Eq. (45) with respect to x is:

$$x = \frac{a-h}{2} - \frac{m}{2} + \frac{(1-t^*)(h-l)}{2(1-t)} = \delta - \frac{m}{2} + \phi, \quad (47)$$

where for convenience we define:

$$\delta \equiv \frac{a-h}{2} > 0,$$

where we assume that the market potential, denoted by a , is large enough such that $a > h$ and thus $(a-h) > 0$, and we furthermore define:

$$\phi \equiv \frac{(1-t^*)(h-l)}{2(1-t)} > 0.$$

Analogously the rearranged FOC of Eq. (46) with respect to y is:

$$y = \frac{a-h}{2} - \frac{m}{2} = \delta - \frac{m}{2}. \quad (48)$$

Substituting the expressions for x and y from the two rearranged FOCs, Eq. (47) and Eq. (48), into the equation for m , Eq. (43), and solving for the expected per firm output m yields:

$$m = \frac{2}{3}(\delta + r\phi) = \frac{1}{3} \left[(a-h) + r \frac{(1-t^*)(h-l)}{1-t} \right]. \quad (49)$$

Plugging in the value for m from Eq. (49) into the respective equations for the optimal firm outputs x and y , given respectively by Eq. (47) and Eq. (48), yields:

$$x = \frac{1}{3}(2\delta + (3-r)\phi) = \frac{1}{6} \left[2(a-h) + (3-r) \frac{(1-t^*)(h-l)}{1-t} \right] \quad (50)$$

and

$$y = \frac{1}{3}(2\delta - r\phi) = \frac{1}{6} \left[2(a-h) - r \frac{(1-t^*)(h-l)}{1-t} \right]. \quad (51)$$

The expressions for the expected per-firm output, m , and the output of the low-cost firm, x , are both positive as: $a > h$; $l < h$; $0 < t^* < t < 1$; and $0 < r < 1$. A positive output of the high-cost firm requires the expression in the square brackets in Eq. (51) to be positive. This expression can be rearranged and it then implies that the market potential should be large enough, so that:

$$a > h + r \frac{(1-t^*)(h-l)}{2(1-t)} = h + r\phi.$$

This constitutes a new binding constraint for the parameter a of the present model, as $a > h + r\phi > h$. Comparing the two firms' output quantities, given in Eqs. (50) and (51), shows that the low-cost firm's output is higher than the high-cost firm's output, $x > y$, as $3 > 0$. This furthermore implies that:

$$x = y + \frac{(1-t^*)(h-l)}{2(1-t)} = y + \phi.$$

5.3.2 The effects of firm heterogeneity

This section explores how the tax base in the high-tax jurisdiction changes when the degree of firm heterogeneity increases. This implies that also the range of permitted transfer prices increases, because the tax authority accepts transfer prices only if they are in the range between the value for the production cost of the low-cost and high-cost firms. Furthermore, we do not allow for technological progress on average so that the expected marginal cost does not change. Therefore, an increase in firm heterogeneity is equivalent to a mean-preserving spread (MPS) such that the range between l and h increases while the average marginal cost \hat{c} stays constant. The MPS can be understood as a comparative static analysis.

The average marginal cost is given by the following expression: $\hat{c} = rl + (1-r)h$. The total differential of the average marginal cost is: $d\hat{c} = rdl + (1-r)dh$. An MPS implies that $d\hat{c} = 0$ and thus that:

$$\frac{dl}{dh} = -\frac{1-r}{r}.$$

The implication of an MPS is that there is a new relevant range for the marginal production cost and thus the transfer prices.

The effects of a mean-preserving spread on firm outputs are as follows:

$$\frac{dx}{dh} = \frac{\partial x}{\partial l} \frac{dl}{dh} + \frac{\partial x}{\partial h} = \frac{3(1-r)(1-t^*) + 2r(t-t^*)}{6r(1-t)} > 0, \quad (52)$$

$$\frac{dy}{dh} = \frac{\partial y}{\partial l} \frac{dl}{dh} + \frac{\partial y}{\partial h} = -\frac{(1-t^*) + 2(1-t)}{6(1-t)} < 0, \quad (53)$$

$$\frac{dm}{dh} = \frac{\partial m}{\partial l} \frac{dl}{dh} + \frac{\partial m}{\partial h} = \frac{t-t^*}{3(1-t)} > 0. \quad (54)$$

With the MPS the low-cost firm increases its output while the high-cost firm decreases its output. This is the efficiency effect of increased firm heterogeneity with the MPS. The expected per-firm output m also increases with the MPS.

Proposition 4 *The efficiency effect of MNE activity: With higher firm heterogeneity with respect to firm productivity the low-cost firm increases its output while the high-cost firm decreases its output.*

The overall after-tax profits of the low-cost firm, $\Pi(l)$, are made of its after-tax profits in the high-tax jurisdiction and in the low-tax jurisdiction, such that $\Pi(l) = \Pi_H(l) + \Pi_L(l)$, where the subscript H denotes the high-tax jurisdiction, Foreign, and the subscript L denotes the low-tax jurisdiction, Home.

Plugging in the values for m , x , and y , given by Eqs. (49), (50), and (51), in the first term of the respective profit function, Eq. (45), concerning the taxable profits in the high-tax jurisdiction yields the following expression:

$$\Pi_H(l) = (1 - t)x^2 - (1 - t^*)(h - l)x = (1 - t)x^2 + [-(1 - t^*)(h - l)x]. \quad (55)$$

This expression, $\Pi_H(l)$, denotes the expected after-tax profits of the low-cost firm in the high-tax jurisdiction and it consists of two parts. The first part, which is the first term in $\Pi_H(l)$, represents the efficiency effect of multinational firm activity. From the first part is subtracted the second part, the second term, of $\Pi_H(l)$, which represents the profit-shifting effect of multinational firm activity. We can see that the efficiency effect depends only on the tax rate in the high-tax jurisdiction, whereas the profit-shifting effect depends on the tax rate in the low-tax jurisdiction and on the relative productivity difference, $(h - l)$, between the two firms. After all, the multinational firm would then have to pay taxes on the profits shifted from the high-tax in the low-tax jurisdiction.

As shown in Eq. (55), the low-cost firm has larger incentives to shift profits, the lower is the corporate income tax rate in the relatively low-tax jurisdiction, t^* . Furthermore, Eq. (55) shows us that the profit-shifting effect increases with the difference between the two firm-productivity parameters, l and h , so that the low-cost firm can gain more by declaring an even higher transfer price, which would still lie in the permitted range of transfer prices by the high-tax jurisdiction's tax authority when the range between l and h is increased. This range is increased with the MPS.

The overall firm profits of the low-cost firm from both markets equal the sum of the profits declared in both jurisdictions, $\Pi(l) = \Pi_H(l) + \Pi_L(l)$, where $\Pi_L(l)$ is given by the second term in Eq. (45). Thus $\Pi(l)$ equals:

$$\Pi(l) = (1 - t)x^2 - (1 - t^*)(h - l)x + (1 - t^*)(h - l)x = (1 - t)x^2. \quad (56)$$

This shows us that there is a reallocation of the low-cost firm's profits from the high-tax to the low-tax jurisdiction due to the profit shifting the low-cost multinational firm is doing.

As the high-cost firm is not shifting any profits, its overall profits are equal to the profits realised and declared in the high-tax jurisdiction, where $\Pi(h) = \Pi_H(h)$ as $\Pi_L(h) = 0$. Thus the expression for the expected after-tax profits in the high-tax jurisdiction of the

high-cost firm, which also denotes the overall expected after-tax profits of the high-cost firm, is computed by plugging in the values for m , x , and y , given by Eqs. (49), (50), and (51), in Eq. (46) and after rearranging we have:

$$\Pi(h) = \Pi_H(h) = (1 - t)y^2, \quad (57)$$

which shows that the high-cost firm's expected profits in the high-tax jurisdiction are affected only by the efficiency effect. There is no profit-shifting effect in Eq. (57) as the high-cost firm reports its real cost as its transfer price.

As already mentioned, there are two effects of an MPS on the expected after-tax profits of the low-cost firm in the high-tax jurisdiction. We now separately analyse the implications of the MPS for the efficiency-effect part and the profit-shifting-effect part of Eq. (55). We denote the efficiency-effect part of Eq. (55) by the superscript I , such that: $\Pi_H^I(l) = (1 - t)x^2$, and the respective MPS yields:

$$\frac{d\Pi_H^I(l)}{dh} = \frac{x [3(1 - r)(1 - t^*) + 2r(t - t^*)]}{3r} > 0. \quad (58)$$

We further denote the profit-shifting-effect part of Eq. (55) by the superscript II , such that: $\Pi_H^{II}(l) = -(1 - t^*)(h - l)x$, and the respective MPS yields:

$$\frac{d\Pi_H^{II}(l)}{dh} = -\frac{(1 - t^*)}{r} \left[x + \frac{(h - l) [3(1 - r)(1 - t^*) + 2r(t - t^*)]}{6(1 - t)} \right] < 0. \quad (59)$$

Thus with an MPS the efficiency-effect part of Eq. (55) increases the after-tax profits of the low-cost firm in the high-tax jurisdiction, whereas the profit-shifting-effect part decreases these profits. This implies that also some of the newly generated profits in the high-tax jurisdiction would be shifted to the low-tax jurisdiction.

For completeness, we note that the term denoting the profits of the low-cost firm in the low-tax jurisdiction, Home, is identical, in absolute value, to the one denoting the profit-shifting effect except that it is positive. This implies that the effect for the profits shifted from the high-tax jurisdiction is the same in magnitude but with the opposite sign as the profits are shifted in the low-tax jurisdiction. Thus an MPS implies that $d\Pi_L(l)/dh > 0$.

Proposition 5 *The profit-shifting effect of MNE activity: With higher firm heterogeneity with respect to firm productivity the low-cost firm increases its profit shifting from the high-tax to the low-tax jurisdiction.*

In the case for the high-cost firm, given by Eq. 57, there is only one effect of the MPS, the efficiency effect:

$$\frac{d\Pi_H(h)}{dh} = -\frac{y [(1 - t^*) + 2(1 - t)]}{3} < 0, \quad (60)$$

which is negative. Due to the efficiency effect the high-cost firm decreases its output in

the high-tax jurisdiction, as shown in Eq. (53), and thus its expected after-tax profits decrease.

We are ultimately interested in the overall effect of an MPS on the relatively high-tax jurisdiction's expected tax base. The expected tax base per firm is simply given by the expected per-firm profits. The expected tax base, denoted by T , in the high-tax jurisdiction is thus:

$$T = 2(a - 2m - h)m = (a - Q - h)Q, \quad (61)$$

where $Q \equiv 2m$. The change of the expected tax base, Eq. (61), with an MPS is given by the following expression:

$$\frac{dT}{dh} = (a - 2Q - h) \frac{dQ}{dh} - Q < 0, \quad (62)$$

where $(a - 2Q - h) < 0$ as it can be rewritten as:

$$a - 2Q - h = -\frac{(1-t)(a-h) + 4r(1-t^*)(h-l)}{3(1-t)} < 0;$$

and $dQ/dh > 0$, which follows from Eq. (54), where $dm/dh > 0$; furthermore $Q > 0$ as $m > 0$, which is shown in Eq. (49). All of this implies that the overall effect in Eq. (62) is negative, $dT/dh < 0$. This proves Proposition 6.

Proposition 6 *The change in the expected tax base of the high-tax jurisdiction due to an increase in firm heterogeneity is negative.*

Proposition 6 is one of the main results of the theoretical part of this chapter. The efficiency effect of the increase in firm heterogeneity implies that the low-cost firm, which is the relatively more productive firm, increases its output, whereas the high-cost firm decreases its output, but remains active in the market, as we have assumed earlier. However, at the same time the profit-shifting effect of the increase in firm heterogeneity takes place, which is driven by the low-cost firm's transfer pricing. The overall effect of the MPS on the expected tax base of the high-tax jurisdiction is negative as shown in Eq. (62).

5.4 Empirical analysis

5.4.1 Empirical strategy

In the present analysis, we are interested in the potential differences in the reactions of the multinational firms in the different conditional quantiles, percentiles, of the profitability distribution. There are three central variables of interest to our analysis, which are the corporate income tax rate at a particular jurisdiction, a measure of firm heterogeneity in an industry and year in a particular jurisdiction, and an interaction term between the corporate income tax rate and the firm heterogeneity measure. This is motivated from

our theoretical model, where the low-productivity firm and the high-productivity firm react differently with respect to the corporate income tax rates and to the degree of firm heterogeneity, which is present. These potential differences in the estimated coefficients can be captured by the quantile regression. In the empirical part of the present analysis we thus estimate a variety of quantile regressions. Armstrong et al. (2015) also estimate quantile regressions in their analysis of the effects of differences in firms' governance on these firms' tax avoidance behaviour.

In the following we use the notation from Chapter 7 in Cameron and Trivedi (2010), when we write down the formulas with respect to the quantile regression. The aim of the quantile regression is to minimise the absolute deviations of the realised values from the estimated ones with asymmetric weights for deviations coming from below and above the respective quantile. In this respect only the absolute deviations for the median have the same weights. Thus the estimated coefficients for the q -th quantile minimise the following function, with respective weights:

$$Q(\beta_q) = \sum_{i: y_i \geq \mathbf{x}'_i \beta} q |y_i - \mathbf{x}'_i \beta_q| + \sum_{i: y_i < \mathbf{x}'_i \beta} (1 - q) |y_i - \mathbf{x}'_i \beta_q|,$$

where β_q denotes the estimated coefficients β for a particular quantile q , where $0 < q < 1$, indicating that the estimates can be potentially different among the different quantiles.

The functional form of a conditional quantile regression, which is linear in the \mathbf{x} , is denoted as:

$$Q_q(y_i | \mathbf{x}_i) = \mathbf{x}'_i \beta_q,$$

where in the present analysis y_i is a measure of profitability of firm i , which belongs to a particular manufacturing industry and is located in a specific jurisdiction in a specific year. We use in turn two different measures of firm profitability for the dependent variable, y_i . The control variables are collected in the vector \mathbf{x}_i .

Marginal effects of the quantile regression are given as:

$$\frac{\partial Q_q(y | \mathbf{x})}{\partial x_j} = \beta_{qj},$$

where the respective explanatory variable, x_j , is continuous and the estimated coefficients, β_{qj} , are the same across the individuals in the same quantile. For discrete changes, it is assumed that individual i remains in the respective quantile after the marginal change in the particular regressor (Cameron and Trivedi, 2010, Chapter 7).

5.4.2 Data

For the empirical analysis we use the ORBIS database compiled by Bureau van Dijk for the years from 2004 to 2014. This database provides information on both multinational

and national firms' balance sheet data in a variety of jurisdictions. We are interested in the observations, which show firms' unconsolidated financial reports.

In the present analysis we are interested in the implications of firm heterogeneity with respect to firm productivity in an industry, jurisdiction, and year on multinational firms' declared profitability in that jurisdiction. We consider the multinational firms to be the only ones, which can shift profits abroad via transfer pricing. Thus we expect their reported profitability to react to the corporate income tax rates present in the respective jurisdiction. As a dependent variable in our analysis we use two different measures of firm profitability.

The first measure of firm profitability is denoted as $ebitpta$ and stands for EBIT (earnings before interest and taxes) divided by the total assets of the firm. We compute it by taking the balance sheet item OPPL (operating profits and loss, EBIT) and dividing it by the balance sheet item TOAS (total assets). We consider only firms with positive values of OPPL and TOAS and furthermore consider only observations for $ebitpta$, which lie on the interval between 0 and 1. We do this in order to focus on firms, which have at least some profits to potentially shift abroad, and also in order to take care of outliers. The second firm profitability measure, which we employ, is the logarithm of a firm's sales given by the balance sheet item TURN, which we denote as \ln_turn .

Using EBIT as a dependent variable allows the empirical analysis to focus on the firms' non-financial profit-shifting strategies such as transfer pricing (Lohse and Riedel, 2013; Heckemeyer and Overesch, 2017). Furthermore, Gresik and Osmundsen (2008) note that the tax authorities use, among other measures, also financial ratios, when they evaluate the appropriateness of the transfer pricing by the firms, which in our case is done by the ratio given by $ebitpta$. Lohse and Riedel (2013) also implement the ratio of EBIT to total assets, although in logs, as a dependent variable in some of their specifications. The use of the firms' sales as a second profitability measure is motivated from our theoretical model, where the increase in firm heterogeneity has different effects on the output of the different firms, and where the firms' sales have implications for the firms' profits.

In order to compute a measure of firm heterogeneity with respect to firm productivity, we first estimate firm productivity itself. Most studies, which estimate the productivity of firms, implement data for specific jurisdictions, i.e. Bottazzi et al. (2008) for Italy, Head and Ries (2003) and Raff et al. (2012) for Japan, De Loecker et al. (2016) for India. However, the study of Maffini and Mokkalas (2011) on the reactions of firm productivity to changes in the corporate tax rates of the respective jurisdictions also implements the ORBIS database as we do, although they consider only certain European countries.

As in Maffini and Mokkalas (2011), we also focus only on firms operating in manufacturing. In our case these are firms with NACE Rev. 2 2-digit core codes, which are taken from the first 2 digits of the respective 4-digit core code, between 10 and 33. This implies that we include all 24 manufacturing sectors. We compute the firms' total factor productivity

(TFP) according to the method proposed by Levinsohn and Petrin (2003). This method was also implemented, among others, by Maffini and Mokkas (2011) and Raff et al. (2012).¹⁵

TFP is estimated for both national and multinational firms. We do this because the high-cost MNE in our theoretical model behaves in a way as a national firm as it does not shift any profits between the two jurisdictions. Furthermore, the presence of purely national firms potentially adds heterogeneity in the estimated firm productivities, which might also be used by the MNEs when they set their transfer prices.

We calculate our estimate of TFP following Maffini and Mokkas (2011). We use firm's value added as the dependent variable in the estimation and get it by first subtracting the material costs (MATE from the ORBIS data) from the firm's sales (TURN) and then taking the logarithm of the computed value. In the TFP estimation, we use material costs as a proxy for capital, which we assume to be given by the firm's fixed assets (FIAS from the ORBIS data) and use the number of employees (EMPL in ORBIS) to represent the firm's labour input. All of these variables are taken in logs. The method by Levinsohn and Petrin takes care of endogeneity in the firm's decisions for the use of its inputs, capital and labour, due to some correlation with unobservable firm-specific productivity shocks and extends the method by Olley and Pakes by including new proxies for the firm's inputs (Olley and Pakes, 1996; Levinsohn and Petrin, 2003).

Figure 9 shows the estimated TFP distribution for the whole period for multinational and national firms. In order to take care of outliers the largest 1% of the whole empirical distribution of TFP is not shown. We define multinational firms to be firms belonging to a group of firms, which are located in at least two different jurisdictions. In contrast to this, we define national firms to be firms, which do not belong to any group of firms or all of the firms of the group to which they belong are located in the same jurisdiction. Being part of the same group of firms is implied by having the same GUO (global ultimate owner) as provided in the ORBIS database.

Studies on firm productivity, for instance Helpman et al. (2004), have noted that multinational firms have higher productivity than national firms, which serve foreign markets via exports instead of undertaking FDI there. Figure 9 shows us that the empirical distribution of the estimated productivity for the MNEs, given by the solid line, lies above the one for the national firms, given by the dashed line, for higher levels of estimated TFP, in the central and right parts of the graph. At the same time, the empirical distribution of the estimated TFP for the MNEs lies below the one for the national firms for lower estimated levels of productivity, in the left part of the graph. This implies that there are relatively more MNEs, which have relatively high productivities compared to the national firms. Still, there are also MNEs, which have estimates of TFP similar to the TFP estimates for the national firms.

¹⁵For the estimation of total factor productivity according to the Levinsohn-and-Petrin method we use the Stata user-written command `levpet` (SJ4-2: st0060) by Petrin, Poi, and Levinsohn.

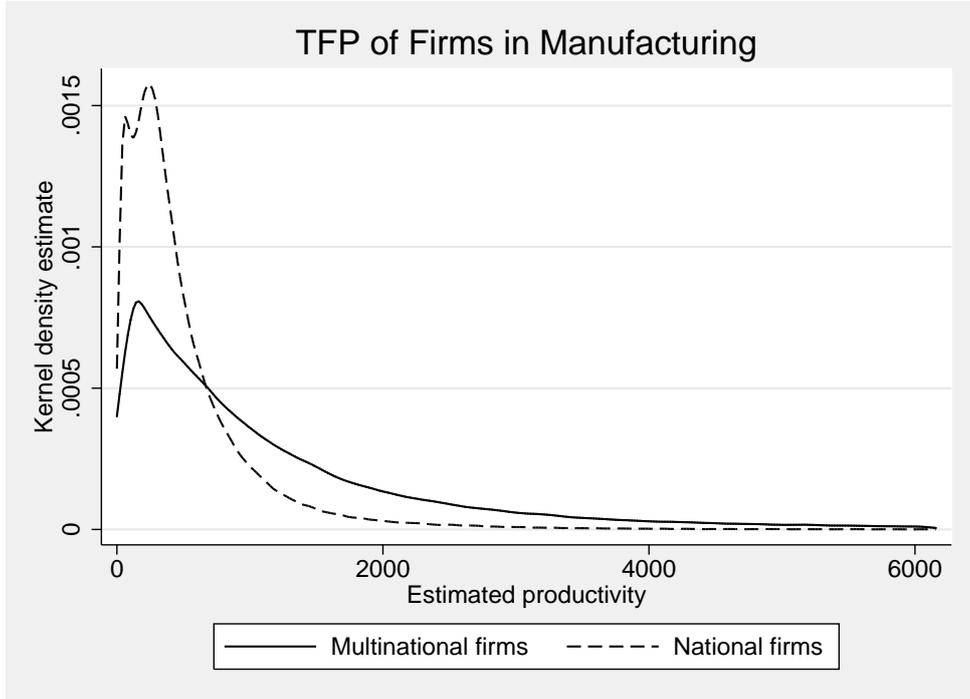


Figure 9: Estimated TFP

Notes: The largest one percent of the whole TFP (total factor productivity) distribution is not shown.

We measure firm heterogeneity as the span of the middle 98% of the empirical distribution of the estimated TFP of all firms, both multinational and national, where we do not include outliers in the smallest and largest 1% of the empirical distribution of TFP. We calculate our heterogeneity measure for each industry in a certain jurisdiction and year. We take this to be the relevant competitive market environment in a year for the firms belonging to a certain industry and operating in a certain jurisdiction. This control variable represents the efficiency effect of MNE activity from the theoretical model. A wider range of the firm heterogeneity measure is expected to imply a more competitive environment. At the same time a narrower range of the span of firm heterogeneity with respect to firm productivity is expected to represent a less competitive market environment, where the competing firms have more similar productivities.

Furthermore, we control for the corporate income tax rates present in the respective jurisdictions. This control variable represents the profit-shifting effect of MNE activity from the theoretical model. Larger tax differences between the jurisdictions, where the MNE operates in, are expected to increase the MNE's incentives to engage in profit shifting. In addition, we add an interaction term between the corporate income tax rate and the firm heterogeneity measure. We expect that larger firm heterogeneity is enforcing the profit-shifting effect as the MNEs would have more opportunities for undetected profit shifting via transfer pricing. This argument is also indicated by our theoretical model, where the range of permitted transfer prices is increased with higher firm heterogeneity

and thus the low-cost firm is enabled to increase its profit shifting via the use of its transfer prices.

As the Levinsohn-and-Petrin method for estimating firms' TFP is generally derived from a Cobb-Douglas production function with capital and labour as the underlying production factors (Olley and Pakes, 1996; Levinsohn and Petrin, 2003), in the present analysis we also control for the use of capital and labour of the respective firm. In the set of control variables, which we implement in the various estimations, we thus include the logarithm of the firm's total assets (TOAS from the ORBIS data) as a proxy for capital and the logarithm of the firm's cost of employees (STAF in ORBIS) as a proxy for labour. Furthermore, we control for the macroeconomic environment in the respective jurisdiction by including the logarithm of the GDP (gross domestic product) and the logarithm of the GDP per capita, both taken from the World Bank Group's World Development Indicators (WDI). In addition, we include a control variable for the control of corruption in the specific jurisdiction. We use estimates for this variable taken from the World Bank Group's World Governance Indicators (WGI), which range between approximately -2.5 and 2.5. Larger values of the control of corruption variable indicate higher control of corruption present in the respective jurisdiction. Similar WDI and WGI variables have also been implemented as control variables in Dischinger et al. (2014b).

Table 14 presents summary statistics of the data used in the empirical estimations.

5.4.3 Empirical results

As noted in Cameron and Trivedi (2010, Chapter 7) the quantile regression is relatively robust to outliers and furthermore can estimate the relationship of the control variables with respect to the whole conditional distribution of the dependent variable. This is relevant to our empirical analysis as in this way we can estimate potential differences in the estimated coefficients of our control variables for different levels of firm profitability. In addition, we can capture some features of the assessment of the appropriateness of transfer pricing by the respective tax authority, as we can focus on the estimated values for particular quantiles of interest. More precisely, we estimate the coefficients for the 20-th percentile, the 50-th percentile, and the 80-th percentile of the conditional distribution of our dependent variable. This implies that we focus on the estimates for a multinational firm, which is in the first quartile, in the median, and in the fourth quartile of the estimated distribution of the dependent variable given the control variables.

According to our theoretical model we expect that there will be differences in the estimated coefficients for the three control variables of interest for multinational firms in different quantiles of the conditional distribution of our dependent variable. This is why after each estimation we also provide the p -values for Wald tests of equivalence of the estimated results between the 20-th percentile and the 50-th percentile, the 50-th percentile and the 80-th percentile, and the 20-th percentile and the 80-th percentile estimates. In

Table 14: Summary statistics – Transfer pricing analysis

VARIABLE	Obs.	Mean	Std. dev.	Min.	Max.
ebitpta	127,164	0.1098	0.3856	4.03e-06	93.2778
ln_turn	166,497	9.8061	1.7195	0	18.3796
citr	166,975	0.2803	0.0700	0.09	0.403
lag_citr	151,459	0.2829	0.0713	0.09	0.403
span_all	157,531	7723.347	11243.29	0	166612.9
lag_span_all	136,162	7712.645	11299.28	0	166612.9
citr_span	157,531	2388.931	3877.499	0	57364.84
lag_citr_span	136,162	2404.798	3905.411	0	57364.84
ln_toas	166,975	9.5969	1.6950	1.3863	17.6987
ln_staf	166,975	8.0122	1.6004	0	15.6638
ln_gdp	166,975	27.2957	1.4241	21.5374	28.9838
ln_gdppercap	166,975	10.1361	0.7520	7.2206	11.6666
cc	166,975	0.7851	0.7920	-1.0924	2.5527
lp_vadded	157,531	1621.502	3389.369	0.0393	202623.7
oppl	127,164	6072.507	32039.54	1	3628127
ln_empl	159,459	4.4164	1.4192	0	11.3691
ln_mate	165,862	8.9934	2.0349	0	18.1797
ln_fias	166,769	8.1786	2.1588	0	17.6268

Notes: Abbreviations: Obs. – observations, provides the number of observations; Std. dev. – standard deviation; Min. – minimum; Max. – maximum; ebitpta – EBIT (earnings before interest and taxes), given by the variable oppl of which only positive values considered, divided by total assets, given by the variable toas; ln – as a prefix denotes the natural logarithm of the respective variable; turn – sales; citr – statutory corporate income tax rate; lag – as a prefix denotes the first lag of the respective variable; span_all – the span of the middle 98% of the empirical distribution of the estimated total factor productivity (TFP) of all firms, both national and multinational; citr_span – an interaction term between the corporate income tax rate, citr, and the span of the estimated TFP of the firms, span_all; toas – total assets; staf – costs of employees; gdp – gross domestic product (GDP); gdppercap – GDP per capita; cc – estimate for the control of corruption; lp_vadded – firm productivity computed by the Levinsohn-and-Petrin method by using value added as a proxy for firm output; oppl – operating profit and loss (EBIT) of which only positive values considered; empl – number of employees; mate – material costs; fias – fixed assets. The variables oppl and toas are given in thousands of US (United States) dollars. The variables ln_turn, ln_toas, ln_staf, ln_mate, and ln_fias are originally given in thousands of US dollars. The variables ln_gdp and ln_gdppercap are originally given in US dollars. The variable citr has a minimum at 0.09 and a maximum at 0.403, which implies that its minimum is at 9% and its maximum is at 40.3%. The estimates for the control of corruption variable, cc, range between approximately -2.5 and 2.5 with higher values indicating better control of corruption. *Sources:* See Appendix 5.6.

many cases the null hypothesis of parameter equivalence can be rejected at conventional levels of statistical significance, the 1%, the 5%, and the 10% significance levels. These tests of equivalence of the estimated coefficients for the different quantiles can furthermore be seen as tests for heteroskedasticity of the data (Cameron and Trivedi, 2010, Chapter 7). The non-equivalence of the estimates among different quantiles of the distribution can be interpreted as heteroskedasticity being present and also that estimating the various quantile regressions is a way to take care of this issue.

We now move to the estimation of the quantile regressions.¹⁶ Our main empirical results are provided in Table 15, where the dependent variable is *ebitpta* computed for multinational firms. The estimates for the effect of the corporate income tax rate on our firm profitability measure are negative and statistically significant for the three quantiles of interest. This implies that with higher corporate income tax rates in the particular jurisdiction the reported firm profitability, as measured by *ebitpta*, is decreasing. Importantly, this effect is larger for higher quantiles. This is indicated by the larger magnitude of the effects in absolute terms for the higher quantiles. Thus more profitable multinational firms react more strongly to increases in the corporate income tax rates than less profitable MNEs. These estimates are in line with our theoretical predictions, where the more productive multinational firm, the low-cost firm, is responsible for the profit-shifting effect as it has a larger scope for profit shifting via its transfer prices compared to the less productive multinational firm, the high-cost firm.

Still, we can interpret this result also from a different perspective. It might well be that there is asymmetric treatment of the MNEs by the respective tax authority. Peralta et al. (2006) note that the tax authority has incentives to be more strict, when the firms shift profits out of its jurisdiction as to when they shift profits in. So firms which pay above average profits enjoy perhaps more freedom of shifting profits out as they pay a lot of taxes anyway or are just not that suspicious to the tax authority in the first place. This is a potential additional explanation to our estimation results for the different effects of the corporate income tax rates for the different quantiles. This interpretation is also in line with our theoretical model as the permitted range by the tax authority in a way favours the more productive firm with respect to its profit-shifting opportunities.

Furthermore, Table 15 shows that the estimates for our firm heterogeneity measure are also highly statistically significant and furthermore have a positive sign. This captures the efficiency effect of MNE activity, which is expected to shift market shares towards the more productive firms from less productive firms when market competition, given by our heterogeneity measure, is increased. As with the profit-shifting effect from the estimates of the corporate income tax rates we can again observe an increase in magnitude of the efficiency effect for firms with higher profitability. Thus more productive firms gain more from increased competition. This is also in line with our theoretical model, where we showed that increased firm heterogeneity allows the more productive firm to increase its output and thus its profits, whereas the effect for the less productive firm is the opposite.

The interaction term between the corporate income tax rate and our firm heterogeneity measure is also highly statistically significant and has a negative sign. This implies that the profit-shifting effect is increased with higher firm heterogeneity present in the respective industry, jurisdiction, and year. The estimated effect is also increasing in absolute value for the firms in the higher quantiles of the conditional distribution of the dependent variable,

¹⁶For these estimations we use the Stata command `sqreg`.

Table 15: Transfer pricing analysis – EBIT per total assets

VARIABLES	(1) ebitpta		
	$q-20$	$q-50$	$q-80$
citr	-0.0515*** (0.0047)	-0.1216*** (0.0073)	-0.1956*** (0.0168)
span_all	6.83e-07*** (1.40e-07)	1.78e-06*** (1.99e-07)	2.80e-06*** (5.42e-07)
citr_span	-2.01e-06*** (4.16e-07)	-5.00e-06*** (5.86e-07)	-7.33e-06*** (1.58e-06)
ln_toas	-0.0063*** (0.0002)	-0.0144*** (0.0003)	-0.0259*** (0.0006)
ln_staf	0.0059*** (0.0002)	0.0119*** (0.0003)	0.0158*** (0.0006)
ln_gdp	0.0019*** (0.0002)	0.0038*** (0.0003)	0.0056*** (0.0007)
ln_gdppercap	-0.0031*** (0.0004)	-0.0154*** (0.0007)	-0.0296*** (0.0016)
cc	0.0076*** (0.0004)	0.0223*** (0.0006)	0.0357*** (0.0010)
Constant	0.0332*** (0.0036)	0.1908*** (0.0072)	0.4573*** (0.0146)
Observations	120,243	120,243	120,243
Test:	$q-20=q-50$	$q-20=q-80$	$q-50=q-80$
<i>p</i> -values:			
citr	0.0000	0.0000	0.0000
span_all	0.0000	0.0001	0.0306
citr_span	0.0000	0.0007	0.0938

Notes: The dependent variable is ebitpta, which denotes the ratio of the balance sheet item EBIT to the balance sheet item total assets of multinational firms' entities. Bootstrapped standard errors computed by 400 repetitions in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, 1% significance level respectively. Wald tests for equivalence of the estimated coefficients are done in the lower part of the table where the respective *p*-values are shown. $q -$ denotes the respective quantile. A description of the explanatory variables is provided in Table 14 and in Appendix 5.6.

which is ebitpta. This further implies that the efficiency effect is decreased with higher corporate income tax rates present in the respective jurisdiction.

Next, we compute Wald tests of equivalence of the estimated coefficients for the different quantiles, which all indicate, at conventional levels of statistical significance, that the estimated coefficients for the different quantiles are indeed different from one another. The respective *p*-values for the Wald tests are shown in the lower part of Table 15.

As a robustness check we redo the estimation presented in Table 15 using the first lag of the corporate income tax rate, of our heterogeneity measure, and of their interaction term.

After all, it might be the case that the MNEs are better informed about the situation from the last period with respect to the values of the three variables of central interest to our analysis than about their values from the respective current period. These estimated results are presented in Table 16.

The estimates for the effect of the corporate income tax rates are again negative and highly statistically significant. The magnitude of the estimated effects is also larger for the higher quantiles. The estimated coefficients for the heterogeneity measure and the interaction term are also highly statistically significant and have the same signs as before. The development of their magnitude with respect to the higher quantiles is also the same. The corresponding Wald tests generally indicate that the estimated coefficients differ among the different quantiles. Exceptions in this respect are the Wald tests for equivalence of the 50-th and 80-th quantiles for the estimated coefficients for the first lag of the heterogeneity measure having a p -value of 0.1044, which is still pretty close to the 10% significance level, and for the estimated coefficients for the first lag of the interaction term. This indicates that our results are robust with respect to the estimation of the first lags of the three variables of central interest to our analysis.

In a further estimation, we use the logarithm of the sales of multinational firms as the dependent variable, denoted by \ln_turn , where the corresponding estimates are presented in Table 17. The estimated coefficients for the corporate income tax rate are again negative and statistically significant at the 1% significance level. However, the hypothesis of the respective Wald test that the estimates for the 20-th and the 80-th quantile are different cannot be rejected at conventional significance levels. All other Wald tests indicate that the estimated coefficients differ among the three quantiles of interest. In this estimation there is an increase in the magnitude of the estimated effect for the corporate income tax rate only between the 20-th and 50-th quantiles. Still, the pattern of increases in the estimated coefficients for the heterogeneity measure and the interaction term is present for all three quantiles. So more profitable MNEs again benefit most from the increased competition and their profit shifting is increased with higher firm heterogeneity.

In a next step, we again use lagged values of the three central explanatory variables of interest. The estimated results for the logarithm of the MNEs' sales as dependent variable and the three different lagged control variables are shown in Table 18. The estimated results for the effects of the corporate income tax rate, the heterogeneity measure, and the interaction term of the corporate income tax rate and the heterogeneity measure are all highly statistically significant. Their estimated signs are as before. They are negative for the corporate income tax rate and the interaction term, and positive for the heterogeneity measure. The pattern of increases in the effects for the larger quantiles is also maintained. However, the hypothesis of the respective Wald tests for equivalence of the estimated coefficients for the first lag of the corporate income tax rate between the 20-th and the 50-th quantiles and for the first lag of the interaction term between the 50-th and 80-th

Table 16: Transfer pricing analysis – EBIT per total assets, lagged variables

VARIABLES	(2) ebitpta		
	$q-20$	$q-50$	$q-80$
lag_citr	-0.0563*** (0.0047)	-0.1246*** (0.0084)	-0.1889*** (0.0172)
lag_span_all	4.05e-07*** (1.48e-07)	1.37e-06*** (2.22e-07)	2.08e-06*** (4.93e-07)
lag_citr_span	-1.24e-06*** (4.28e-07)	-3.91e-06*** (6.43e-07)	-5.47e-06*** (1.49e-06)
ln_toas	-0.0060*** (0.0002)	-0.0141*** (0.0003)	-0.0248*** (0.0006)
ln_staf	0.0057*** (0.0002)	0.0118*** (0.0003)	0.0153*** (0.0007)
ln_gdp	0.0021*** (0.0002)	0.0040*** (0.0004)	0.0056*** (0.0008)
ln_gdpperpercap	-0.0033*** (0.0004)	-0.0150*** (0.0008)	-0.0276*** (0.0017)
cc	0.0076*** (0.0004)	0.0215*** (0.0006)	0.0346*** (0.0012)
Constant	0.0309*** (0.0043)	0.1795*** (0.0085)	0.4326*** (0.0163)
Observations	104,102	104,102	104,102
Test:	$q-20=q-50$	$q-20=q-80$	$q-50=q-80$
<i>p</i> -values:			
lag_citr	0.0000	0.0000	0.0000
lag_span_all	0.0000	0.0006	0.1044
lag_citr_span	0.0000	0.0041	0.2415

Notes: The dependent variable is ebitpta, which denotes the ratio of the balance sheet item EBIT to the balance sheet item total assets of multinational firms' entities. Bootstrapped standard errors computed by 400 repetitions in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, 1% significance level respectively. Wald tests for equivalence of the estimated coefficients are done in the lower part of the table where the respective *p*-values are shown. q – denotes the respective quantile. A description of the explanatory variables is provided in Table 14 and in Appendix 5.6.

quantiles cannot be rejected at conventional levels of statistical significance. Nevertheless, the general pattern of our results is maintained and is, furthermore, in line with the predictions of our theoretical model.

Thus the general pattern in our estimation results remains robust with respect to the different estimation specifications presented in Tables 15, 16, 17, and 18.

Table 17: Transfer pricing analysis – Logarithm of sales

VARIABLES	(3) ln_turn		
	$q-20$	$q-50$	$q-80$
citr	-0.3301*** (0.0548)	-0.4358*** (0.0414)	-0.3270*** (0.0481)
span_all	1.16e-05*** (1.59e-06)	2.24e-05*** (1.58e-06)	2.97e-05*** (1.73e-06)
citr_span	-3.54e-05*** (4.54e-06)	-6.29e-05*** (4.58e-06)	-7.64e-05*** (5.07e-06)
ln_toas	0.4730*** (0.0031)	0.6444*** (0.0023)	0.7623*** (0.0024)
ln_staf	0.5335*** (0.0037)	0.3302*** (0.0028)	0.1912*** (0.0028)
ln_gdp	0.0059** (0.0025)	0.0226*** (0.0020)	0.0110*** (0.0021)
ln_gdpperpercap	0.0705*** (0.0055)	-0.0474*** (0.0041)	-0.1043*** (0.0050)
cc	0.0554*** (0.0036)	0.1208*** (0.0030)	0.1568*** (0.0036)
Constant	-0.2528*** (0.0503)	0.8784*** (0.0367)	2.0798*** (0.0460)
Observations	157,531	157,531	157,531
Test:	$q-20=q-50$	$q-20=q-80$	$q-50=q-80$
<i>p</i> -values:			
citr	0.0476	0.9628	0.0212
span_all	0.0000	0.0000	0.0000
citr_span	0.0000	0.0000	0.0067

Notes: The dependent variable is ln_turn, which denotes the logarithm of the balance sheet item sales of multinational firms' entities. Bootstrapped standard errors computed by 400 repetitions in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, 1% significance level respectively. Wald tests for equivalence of the estimated coefficients are done in the lower part of the table where the respective *p*-values are shown. q – denotes the respective quantile. A description of the explanatory variables is provided in Table 14 and in Appendix 5.6.

5.5 Concluding remarks

The present analysis contributes to the academic research concerning multinational firms' transfer pricing. We have shown that firm heterogeneity with respect to firm productivity plays an important role when it comes to transfer pricing. Due to the presence of asymmetric information, it is hard for the tax authority to enforce the application of the arm's-length principle in transfer pricing and it thus has to rely on approximations, which are represented by the existence of a range of permitted transfer prices. Due to the

Table 18: Transfer pricing analysis – Logarithm of sales, lagged variables

VARIABLES	(4) ln_turn		
	q-20	q-50	q-80
lag_citr	-0.5133*** (0.0557)	-0.4656*** (0.0418)	-0.2908*** (0.0546)
lag_span_all	8.76e-06*** (1.67e-06)	2.17e-05*** (1.55e-06)	2.59e-05*** (2.14e-06)
lag_citr_span	-2.73e-05*** (4.86e-06)	-6.12e-05*** (4.56e-06)	-6.54e-05*** (6.20e-06)
ln_toas	0.4825*** (0.0032)	0.6506*** (0.0025)	0.7677*** (0.0027)
ln_staf	0.5211*** (0.0038)	0.3256*** (0.0029)	0.1891*** (0.0030)
ln_gdp	0.0097*** (0.0026)	0.0221*** (0.0021)	0.0073*** (0.0023)
ln_gdppercap	0.0721*** (0.0058)	-0.0485*** (0.0048)	-0.1044*** (0.0056)
cc	0.0617*** (0.0040)	0.1231*** (0.0032)	0.1559*** (0.0039)
Constant	-0.3081*** (0.0552)	0.8976*** (0.0424)	2.1500*** (0.0557)
Observations	135,684	135,684	135,684
Test:	q-20=q-50	q-20=q-80	q-50=q-80
<i>p</i> -values:			
lag_citr	0.3704	0.0012	0.0005
lag_span_all	0.0000	0.0000	0.0197
lag_citr_span	0.0000	0.0000	0.4243

Notes: The dependent variable is ln_turn, which denotes the logarithm of the balance sheet item sales of multinational firms' entities. Bootstrapped standard errors computed by 400 repetitions in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, 1% significance level respectively. Wald tests for equivalence of the estimated coefficients are done in the lower part of the table where the respective *p*-values are shown. *q* – denotes the respective quantile. A description of the explanatory variables is provided in Table 14 and in Appendix 5.6.

information asymmetry with respect to the real cost of production, the MNEs can always claim a transfer price, which lies within the permitted range, without any consequences. In our theoretical model this allows the low-cost firm, the more productive firm, to claim higher transfer prices than its real ones and thus to shift profits out of the high-tax jurisdiction into the low-tax jurisdiction.

When firm heterogeneity is increased then the range of permitted transfer prices is increased. We have shown that profit shifting by the low-cost MNE is also increased. Still, we have analysed not only the implications of increased firm heterogeneity on the

profit-shifting effect but also on the efficiency effect of MNE activity in the high-tax jurisdiction. The efficiency effect describes the increased market competition, which comes with an increase in firm heterogeneity. Thus, in addition, the low-cost firm increases its output while the high-cost firm decreases it. In our theoretical model the overall effect of an increase in firm heterogeneity on the high-tax jurisdiction's expected tax base turns out to be negative.

In the empirical part of the present analysis we have estimated a variety of quantile regressions. In these estimations we in turn employ two different measures for firm profitability as the dependent variable. Our main explanatory variables are the corporate income tax rate, a measure of firm heterogeneity, and their interaction term. In that way we proxy for the profit-shifting and the efficiency effects of MNE activity. We find that the profit-shifting effect of MNE activity is increased with more firm heterogeneity being present. Furthermore, we find that generally for larger quantiles of the conditional distribution of our dependent variable both the profit-shifting and the efficiency effects are increased. Our empirical results are thus in line with our theoretical predictions. The main pattern in our estimated results remains robust to the different specifications of the estimated quantile regressions. Therefore, the tax authorities, which might have limited resources, should keep their attention especially on the more productive multinational firms active in industries with more firm heterogeneity relative to other industries as they have more possibilities to potentially shift profits out of their respective jurisdictions compared to other firms, which are also active there.

5.6 Appendix

About the variables used in the empirical analysis:

ebitpta denotes EBIT (earnings before interest and taxes), given by the balance sheet item operating profit and loss (OPPL) of which only positive values are considered, divided by total assets, given by the balance sheet item total assets (TOAS), both OPPL and TOAS are given in thousands of US (United States) dollars and are taken from the ORBIS database compiled by Bureau van Dijk (BvD).

ln_turn denotes the natural logarithm of the balance sheet item sales, originally given in thousands of US dollars, taken from the ORBIS database compiled by BvD.

citr denotes the statutory corporate income tax rates in the different jurisdictions, this data is from Ernst & Young (EY) and it was kindly provided by Prof. Dr. Georg Wamser from the University of Tübingen, Germany.

lag_citr denotes the first lag (the value from the previous time period, from the previous year) of the variable **citr**.

span_all denotes the span of the middle 98% of the empirical distribution of the estimated total factor productivity (TFP) of all firms, both multinational and national,

where the smallest and largest 1% of the empirical distribution of TFP are not included in order to take care of outliers.

lag_span_all denotes the first lag (the value from the previous time period, the previous year) of the variable **span_all**.

citr_span denotes an interaction term between the corporate income tax rate, given by the variable **citr**, and the span of the estimated TFP of the firms, given by the variable **span_all**.

lag_citr_span denotes the first lag (the value from the previous time period, the previous year) of the variable **citr_span**.

ln_toas denotes the natural logarithm of the balance sheet item total assets, originally given in thousands of US dollars, taken from the ORBIS database compiled by BvD.

ln_staf denotes the natural logarithm of the balance sheet item costs of employees, originally given in thousands of US dollars, taken from the ORBIS database compiled by BvD.

ln_gdp denotes the natural logarithm of the GDP (gross domestic product) in a specific jurisdiction, originally given in current US dollars, taken from the World Bank Group's World Development Indicators (WDI).

ln_gdppercap denotes the natural logarithm of the GDP per capita in a specific jurisdiction, originally given in current US dollars, taken from the World Bank Group's WDI.

cc denotes the estimate for the control of corruption in a specific jurisdiction, which ranges between approximately -2.5 and 2.5 with higher values indicating stronger control of corruption, taken from the World Bank Group's World Governance Indicators (WGI).

lp_vadded denotes firm productivity computed by the Levinsohn-and-Petrin method by using value added as a proxy for firm output.

oppl denotes the balance sheet item operating profit and loss (EBIT, earnings before interest and taxes) of which only positive values are considered, in thousands of US dollars, taken from the ORBIS database compiled by BvD.

ln_empl denotes the natural logarithm of the balance sheet item number of employees, taken from the ORBIS database compiled by BvD.

ln_mate denotes the natural logarithm of the balance sheet item material costs, originally given in thousands of US dollars, taken from the ORBIS database compiled by BvD.

ln_fias denotes the natural logarithm of the balance sheet item fixed assets, originally given in thousands of US dollars, taken from the ORBIS database compiled by BvD.

6 Conclusion

The present doctoral dissertation has analysed different aspects of the interplay between corporate taxation and foreign direct investment. The presented analyses show that there are many decision layers on which FDI and corporate taxation interact.

We have started with an analysis of the location choice of a firm for its new foreign affiliate in manufacturing depending on whether its headquarters is located in a jurisdiction implementing an IP Box regime or not, which is presented in Chapter 3. The IP Box regime generally provides for a considerably lower taxation of a firm's income generated by its intellectual property. Consequently the IP Box regime provides the firms with higher overall after-tax profits. The IP Box regime thus allows the firms to consider opening up new affiliates, thus undertaking FDI, also in relatively high-tax jurisdictions, which otherwise they would not have considered to be attractive enough for such investments. Having its headquarters located in jurisdiction implementing an IP Box regime provides the particular firms with a comparative advantage relative to other firms. Thus there seem to be cross-border spillover effects stemming from an IP Box regime being in force in one jurisdiction on other jurisdictions. These cross-border effects are transmitted through the activities of MNEs, more precisely they are transmitted among the affiliates belonging to the same MNE group. Our analysis provides new insights on the effects of IP Box regimes, which should be considered by decision-makers when they introduce, reform, or abolish an IP Box regime in their respective jurisdiction. The analysis in Chapter 3 can be furthermore seen in the light of the L, location, component of the OLI paradigm.

In a next step, in Chapter 4, we have analysed the location decision for the MNE's intangible assets, such as patents. In this chapter we focus on the O, ownership, component, of the OLI paradigm, where the MNE has a comparative advantage from the ownership of intangible assets not only for its production process but potentially also for tax-minimisation purposes. The particular MNE faces a trade-off between tax savings, when locating its intangibles at a relatively low-tax jurisdiction, and lower cost of using the intangibles, when they are located in a relatively high-tax jurisdiction, where we assume its headquarters to be also located. The location decision for the intangible assets furthermore depends on the financial situation of the MNE in question. In the case when the MNE is not facing financial constraints, it makes its location decision depending on its own profit maximisation. However, when the MNE faces financial constraints, it needs to find an external partner, who would provide it with additional financing. There is an asymmetric treatment of the cost and benefits of the MNE's tax-minimisation activities. On the one hand, the financial partner does not benefit from the tax saving of the MNE. On the other hand, the cost of the tax-minimisation activities of the MNE are shared between the MNE and its financial partner. Thus as a consequence of own profit maximisation, the external financial partner has higher incentives to provide the MNE with financing, when the MNE

does not engage in tax-minimisation. This implies the existence of a market mechanism, which is able to constrain the MNE from using the location of its intangible assets for tax-minimisation purposes.

Then, in Chapter 5, we have analysed the effects of an increase in firm heterogeneity with respect to firm productivity on the expected tax base of a relatively high-tax jurisdiction, which is hosting affiliates of MNEs. In this chapter our focus is on the I, internalisation, component of the OLI paradigm. In this respect, more productive MNEs have a higher comparative advantage compared to less productive MNEs as they have a larger scope to set their transfer prices in a tax-minimising way. We show that an increase in firm heterogeneity has two potentially opposing effects on the expected tax base of the relatively high-tax jurisdiction. On the one hand, increased firm heterogeneity implies an increased efficiency effect of MNE activity as more productive firms would take more market shares from less productive firms. On the other hand, the profit-shifting effect of MNE activity is also increased as with a higher degree of firm heterogeneity the scope for profit shifting of the firms is increased. The reason is that, as the underlying productivity of the different firms is not observable to anyone but the particular MNE itself, the tax authorities allow the transfer prices to be set within a range of permitted transfer prices. However, with more firm heterogeneity being present also the relevant range of transfer prices is increased, allowing the more productive firms to make use of this and thus profit shifting is increased. Consequently, the tax authorities would need to concentrate their attention especially on the more productive multinational firms. After all, our analysis shows that these are the firms with the highest possibilities to engage in profit shifting via transfer pricing.

The analyses made in the present doctoral dissertation show that tax policy can have an impact on the activities of multinational firms. The corporate income tax rate is not the only tax policy instrument available to the different jurisdictions in this respect. The analysis presented in Chapter 3 points to the importance also of relatively new tax policy instruments such as the IP Box regimes. This tax policy instrument could also allow the particular jurisdiction to maintain a relatively high statutory corporate income tax rate and at the same time provide a specific type of income, firms' income accruing from their intangible assets, with a taxation at a considerably low tax rate. Interestingly, these new tax policies have important cross-border effects, which are transmitted through the networks of affiliates of the different multinational groups of firms. Although it seems difficult to control for the tax-minimisation activities of the MNEs, Chapter 4 is able to describe particular market mechanisms, which are able to deter at least some of the MNEs tax-minimisation strategies with respect to the location of their intellectual property for tax reasons. This implies that market mechanisms, which could have a similar effect with respect to other tax-minimisation strategies of the MNEs, might also exist. However, in Chapter 5 we show that due to the existence of firm heterogeneity the different tax authorities experience difficulties with the assessment of the prices, which the MNEs set

on their cross-border intra-firm transactions. This underlines the strategic benefits, which more productive firms have when keeping their cross-border activities internal, within the boundaries of the MNE group as a whole.

It is important to study the interactions of corporate taxation and foreign direct investment. Multinational firms, the driving forces of FDI, seek to be cost efficient and competitive enough in order to survive in the different markets, where they might have affiliates in. At the same time, the different jurisdictions can use their corporate tax policies in order to make themselves more attractive for FDI. However, they are also interested in keeping as much as possible from the potential benefits of the MNE activity in their respective boundaries, such as the revenues that they could obtain from the taxation of the MNEs. The analyses made in the present doctoral dissertation provide new insights concerning the interactions between corporate taxation and foreign direct investment. These interactions will continue to evolve as the corporate tax policies of the different jurisdictions and the strategies of the multinational firms will continue to evolve as well.

Appendix

About the variables used in the graphs of Chapter 1, which is the chapter providing the introduction of the present doctoral dissertation:

FDI out-stock denotes the world FDI (foreign direct investment) out-stock, given in millions of current US (United States) dollars, taken from the UNCTADstat Data Center (UNCTAD, United Nations Conference on Trade and Development).

FDI outflows denotes the world FDI outflows, given in millions of current US dollars, taken from the UNCTADstat Data Center.

World exports denotes the world exports of goods and services, given in current US dollars, taken from the World Bank Group's World Development Indicators (WDI).

World GDP denotes the world GDP (gross domestic product), given in current US dollars, taken from the World Bank Group's WDI.

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