Transfer Pricing: Its Interaction with Multinationals' Location, Export and R&D Choices

Inauguraldissertation
zur Erlangung des Grades
Doctor oeconomiae publicae (Dr. oec. publ.)
an der Ludwig-Maximilians-Universität München

vorgelegt von

Hirofumi Okoshi

2020

Referent: Prof. Dr. Andreas Haufler
Korreferent: Prof. Dr. Carsten Eckel
Promotionsabschlussberatung: 22. Juli 2020

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Hirofumi Okoshi
Munich, March 2020

To my love.

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Preface

> *"Transfer pricing is not, in itself, illegal or necessarily abusive. What is illegal or abusive is transfer mispricing, also known as transfer pricing manipulation or abusive transfer pricing"*
>
> Tax Justice Network[1]

In recent years, huge amount of corporate tax bases around the world have been untaxed. As multinational enterprises (MNEs), by definition, locate in several countries and face different corporate tax rates, they have several chances to save their tax payments. One of the well-known methodologies is to concentrate MNEs' profits in low tax countries by manipulating the transfer price of either tangible or intangible intra-firm transactions. According to OECD's estimates, around 4% to 10% of corporate tax revenues disappear because of MNEs' tax avoidance. An article in the *Gurdian* also reports that "by the end of 2017, some of America's most profitable companies, including Apple, . . . had sequestered more than $1tn offshore, using the 'double Irish' to park billions in 'ghost companies.' "[2]

Globalization increases the possibility of the MNE to avoid taxes. First, the reduction in trade costs in any forms such as trade agreements or technological improvement of transportation sector increases the volume of intra-firm transactions (Slaughter (2000), Hanson et al. (2005), Bernard et al. (2010), and Lanz and Miroudot (2011)). Such an increase in intra-firm trade enables MNEs to transfer more profits even if the level of transfer prices keeps constant. Second, the use of tax havens is facilitated as globalization progresses. According to Zucman (2014), the percentage of the U.S. firms' profits reported in tax havens grew over years. Hence, collecting tax revenue from MNEs has become more difficult and becomes a serious problem around the

[1] Source: `https://www.taxjustice.net/topics/corporate-tax/transfer-pricing/`

[2] See `https://www.theguardian.com/technology/2020/jan/01/google-says-it-will-no-longer-use-double-irish-dutch-sandwich-tax-loophole`.

world.

Naturally, these trends have alerted governments to take necessary steps to keep MNEs from international tax planning. Through the Organization for Economic Co-operation and Development (OECD), countries have cooperatively dealt with tax avoidance by enhancing the tax enforcement level. The most important rule in fighting tax avoidance is the arm's length principle (ALP). The central idea of the ALP is that the transfer price should be equal to arm's length price of comparable transaction. To evaluate the effects of the ALP, some papers explicitly introduce this principle in their model (e.g. Bauer and Langenmayr (2013), Choe and Matsushima (2013), and Choi et al. (2019)).

This dissertation explores MNEs' profit shifting behaviour in the wider context of MNEs' overall strategies. Traditionally, research in this field has focused on how MNEs manipulate transfer price, and studied the impact of various policies on optimal transfer pricing. However, since tax avoidance decisions interact with other international strategies of MNEs, ignoring these other decision margins of MNEs may lead to biased conclusions. Therefore, incorporating other relevant decisions of MNEs is critical to design or evaluate the right policies against profit shifting.

As a first example, an MNE's location decision is influenced by tax factors such as the level of corporate tax rate, or the tax enforcement level (Peralta et al. (2006)). Therefore, designing policies that are based on an exogenously fixed MNEs' location may be pointless, because it is straightforward that MNEs which seek ways of tax saving can change their global production or operation network in response to these policy changes.

The interrelation with international trade rules is another important link to consider since transfer prices are basically export prices. This interdependence is overlooked so far in academic works. Among trade policies, rules of origin (ROO) of free trade agreements (FTAs) are highly related to export price. Reuter (2012) points out that "Most of rules of origin are on a percent-of-value basis. . . . By overinvoicing the value added, the MNE can more easily meet a rule-of-origin test and qualify for duty-free entry for its products into another country in the free trade areas." This implies that MNEs' transfer pricing may be motivated by not only tax avoidance but also tariff reduction.

The implementation of the ALP causes another interaction between transfer pricing and research and development (R&D) activities. The ideal way of implementing the ALP is to compare the transfer price with an arm's length price under similar conditions which includes the characteristics of products and used technologies. This generates a hypothesis that tax avoidance incentivizes MNEs to conduct R&D to facilitate profit shifting. Indeed this hypothesis is supported by empirical research which provides robust evidence that profit shifting is frequently observed in R&D intensive sectors or firms (Belz et al. (2017)).

Given the above discussions, all chapters in this dissertation consider MNEs' profit shifting from different angles: location choice, transfer pricing with a tariff avoidance motive and innovation. All chapters are based on stand-alone papers and can be read separately. In the followings, I will briefly give an overview of the lines of discussion developed in each chapter.[3]

Chapter 1 studies the impact of the ALP on an MNE's location choice. Traditional empirical evidence shows that a low corporate tax rate attracts foreign direct investment. However, this chapter shows the possibility that an MNE prefers locating one of its affiliates in a high tax country in the absence of the ALP. This is because geographically separated location of related entities makes profit shifting possible and thus the MNE has a chance to transfer profits from other businesses as well. As this incentive is stronger when the corporate tax gap between countries becomes larger, such a separate location is profitable when the tax gap is sufficiently large. The result is in line with the empirical result of Overesch (2009). Overesch (2009) concluded that the investment level of subsidiaries in high-tax Germany is positively influenced by a rising tax rate differential between Germany and the owner's home country. In the presence of the ALP, however, this location pattern disappears due to impossibility of price discrimination in intra-firm and inter-firm transactions. Hence, the model shows that the ALP is able to prevent profit shifting via an MNE's location choice. This paper is based on joint work with Hayato Kato, Osaka University (Kato and Okoshi (2019b)), which is published in *International Tax and Public Finance.*

The second chapter also considers location choices of MNEs production. As globalization proceeds, relocation of MNEs' plants from low tax countries to high tax countries has been observed in reality. To address the relocation trend, the model investigates the impact of a reduction in trade costs on the agglomeration patterns of MNEs' affiliates. With high trade costs, profit shifting through intra-firm trade is inefficient and therefore most MNEs gather their plants in a low tax country. However, this pattern

[3] Some chapters are based on joint work with my co-authors. In all chapters, I use the pronoun "we" in the text, as it is used in the published and working paper versions with gratitude to the co-authors and those who gave me comments.

reverses with low trade costs. This is because a lower transfer price caused by locating a plant in a high tax country makes a manager in a distribution branch in a low tax country more aggressive in the market. This subsequently increases the market share in a low tax country and intra-firm trade, and thus enhances the benefits of profit shifting. Since low trade costs magnify these managerial and tax incentives, the agglomeration of MNEs' plants in a high tax country only takes place when trade costs are low enough. This paper is based on joint work with Hayato Kato, Osaka University (Kato and Okoshi (2019a)).

The third chapter considers multiple roles of transfer pricing for tax avoidance by considering ROO. The value added criterion of ROO requires exporters to add sufficiently high value inside an FTA region, which implies that transfer pricing manipulation is restricted as it also affects a value added ratio for a preferential tariff. To understand transfer pricing decisions in a wider perspective, the model in this chapter studies the optimal transfer pricing manipulation and the procurement strategies in the presence of ROO. The results suggest that the value added criterion has an effect to restrict the MNE's abusive transfer pricing via either a change in input procurement or via transfer price adjustments. Thanks to this prevention of tax avoidance, ROO can transform a welfare-reducing FTA into a welfare-improving FTA. This chapter is based on joint work with Hiroshi Mukunoki, Gakushuin University (Mukunoki and Okoshi (2019b)).

Chapter 4 analyzes MNEs' incentives to invest in product differentiation in the presence of profit shifting. Recent empirical research provides evidence that transfer mispricing is intensively observed in differentiated product categories (Bernard et al. (2006), Davies et al. (2018), and Liu et al. (2019)). An explanation for this stylized fact is that such firms are likely to own intangible assets such as patents which are easy to relocate to low tax countries, which provides them with more chances to engage in profit shifting. This chapter, however, considers another possibility. I argue that investment in differentiation makes it less costly for MNEs to conduct tax avoidance because the ALP is difficult to apply. I incorporate an MNE's decision in product differentiation investment which affects the cost of tax avoidance. The model shows that MNEs have a stronger incentive to engage in product differentiation in the presence of profit shifting, which benefits consumers and the MNEs, but reduces tax revenue. Hence, it gives a new reason why transfer price manipulation is observed in R&D intensive firms.

The common novelty of the studies in the four chapters is to analyze MNEs' tax avoidance behaviour by considering various forms of imperfect competition. By considering imperfect competition, we can investigate the interaction with other decisions of MNEs. For example, the model in Chapter 3 analyzes the interaction of tax avoidance with a trade policy by assuming a monopolistic MNE. Chapter 1 and Chapter 4 build on duopoly environments and explore links of profit shifting with location and R&D decisions, respectively. Chapter 2 employs a monopolistic competition with footloose capital, also known as "new economic geography" model, to see the impact of transfer pricing on MNEs' agglomeration.

Traditionally, research in the public finance literature focuses on perfect competition although markets in the globalized world are frequently characterized as international oligopolies. Hence, results derived in each chapter reflect such realistic market structure. Moreover, most chapters overlap with other research fields, such as International Economics, Industrial Organization, and Economic Geography. All chapters in this dissertation study the MNEs' tax avoidance decision in combination with other strategic choices. Our results therefore highlight that both researchers and policy makers should pay more attention to the overall decisions setting in which MNEs operate.

Chapter 1

Production Location of Multinational Firms under Transfer Pricing: The Impact of the Arm's Length Principle

1.1 Introduction

The manner in which multinational enterprises (MNEs) organize their production structure is essential for their international strategy. As MNEs can substantially benefit from the opportunity to locate their affiliates in several countries, their location decisions depend on country-specific characteristics, such as the extent of competition and policies in host countries. Considerable research has been undertaken to investigate the determinants of MNEs' locations from both theoretical and empirical standpoints.[1] Among other factors affecting the location choice, the corporate taxation prevalent in both the host and parent countries is known to have a significant

This chapter is based on joint work with Hayato Kato (Kato and Okoshi, 2019b).

[1]For comprehensive surveys, see Markusen (2004); Navaretti and Venables (2004); and Blonigen (2005).

impact.[2]

When considering a firm with a single plant, the consequence of corporate taxation is straightforward; the firm locates its production in a country with a lower tax rate to save taxes. However, the impact of taxation on MNEs' location choice is not this simple. The striking difference between MNEs with multiple plants and single-plant firms is that MNEs' transactions may take place within their organization across borders. This means that MNEs can partly control prices of intermediate goods for foreign affiliates, which are known as *transfer prices*, through intra-firm trade in order to reduce global tax payments. Thus, it is possible that using such a transfer pricing strategy, MNEs locate their production in a high-tax country, while exporting inputs to their affiliates located in a low-tax country.

The relationship between corporate tax rates and the location choice of MNEs using transfer pricing is not just a theoretical curiosity, but is of great importance to the modern economy. Along with the progress of economic integration, intra-firm trade has grown dramatically in recent years, which provides MNEs room for tax manipulations through transfer pricing.[3][4] Recently, the OECD launched a project involving over 80 countries to address the tax avoidance behavior of MNEs, including transfer pricing.[5] According to the OECD, revenue losses from tax avoidance by MNEs are estimated to be between 4% and 10% of global corporate income tax revenues.[6] Despite the growing concern globally, limited work has been done on the interaction between MNEs' location choice and their transfer pricing strategy. The first aim of this paper is to examine how corporate tax rates affect the production location decision of MNEs

[2]Hebous et al. (2011) show that lower corporate tax induces inflows of foreign capital irrespective of the type of investment, such as greenfield foreign direct investment and cross-border mergers and acquisitions. Voget (2011) finds that one percentage point decline in foreign effective tax rate augments the likelihood of headquarters' relocation by 0.22 percentage point. Karkinsky and Riedel (2012) and Griffith et al. (2014) investigate the link between corporate taxation and patent location.

[3]Bernard et al. (2010) show that over 46 percent of U.S. imports composed of intra-firm transactions in 2000. Lanz and Miroudot (2011) report that U.S. imports of intermediate products score around 50 percent in 2009. See also Slaughter (2000) and Hanson et al. (2005) for the importance of intra-firm trade.

[4]For (in)direct evidence on transfer pricing, see Swenson (2001); Bartelsman and Beetsma (2003); Clausing (2003); Bernard et al. (2006); Cristea and Nguyen (2016); Gumpert et al. (2016); Guvenen et al. (2017); and Davies et al. (2018).

[5]The project is called "Base Erosion and Profit Shifting." Further details can be found at https:// www.oecd.org/g20/topics/taxation/beps.htm, accessed on 17 March 2017.

[6]See http://www.oecd.org/ctp/oecd-presents-outputs-of-oecd-g20-beps-project-for-discussion-at-g20-finance-ministers-meeting.htm, accessed on 17 March 2017.

using transfer pricing.

From the government's perspective, there is no doubt that steps preventing MNEs from tax manipulations are indispensable for collecting tax revenues. Many countries adopt a transfer pricing tax system to infer whether MNEs avoid tax payments. The key idea to appropriate the transaction price for related affiliates is the arm's length principle (ALP) which is set out in Article Nine of the OECD Model Tax Convention. The principle points out that conditions (e.g., price, markup or profit) of controlled transactions between related firms should be similar to those of independent transactions.

Among several methods the application of the ALP follows in practice, we focus on the comparable uncontrolled price (CUP) method, which compares the price charged for goods in a controlled transaction with the price charged for comparable goods in an uncontrolled transaction, called the *arm's length price*.[7][8] According to the OECD guideline on transfer pricing, the CUP method is to be preferred if this and other methods can be applied in an equally reliable manner (OECD, 2017, para. 2.3). The second aim of this paper is to investigate the impact of the ALP on MNEs' tax avoidance and production location choice.

We present a simple two-country model with a vertically-related MNE and a local downstream firm. The MNE has a headquarters in the parent country and a downstream affiliate in the host country. It locates an upstream affiliate in either the parent or the host, which provides inputs to both the two downstream firms in the host. The headquarters makes exogenous profits from different business in the parent. Corporate tax rates are exogenous and the parent's tax rate is assumed to be higher than the host's.

We analyze the location pattern of upstream production under the cases with and without the ALP. If the ALP is imposed, the upstream affiliate must set equal prices

[7] The CUP method is applied to tangible assets. The corresponding method for intangible assets is called the comparable uncontrolled transaction (CUT) method. There are other methods such as cost-plus method, resale price method, and profit split method. See OECD (2017, ch.2) for details.

[8] The uncontrolled transaction includes both a transaction of an MNE with an independent firm ("internal comparables") and a transaction between other independent firms ("external comparables"). Our framework captures the internal comparable transaction.

to the two downstream firms.[9] We show that without the ALP, the MNE may locate an upstream affiliate in the high-tax parent country. With the ALP, however, the MNE simply locates it in the low-tax host country. There exist tax rates for which the imposition of the ALP changes the location pattern. This location change leads to smaller tax revenues in the host country, but greater revenues globally.

At first glance, it seems surprising that the upstream affiliate may be located in the high-tax country. The key is that the transfer price can be used as a *profit shifting* device if the upstream and downstream affiliates are separately located. The upstream affiliate located in the high-tax parent may set the transfer price low so as to shift the headquarters' exogenous profits to the low-tax host. The larger international tax difference gives more room for profit shifting, likely leading to geographical separation of affiliates. The introduction of the ALP limits the ability to manipulate the transfer price, so that the MNE simply prefers to locate its upstream affiliate in the low-tax host.

It is not surprising that the imposition of the ALP removes the opportunity of profit shifting and thus increases global tax revenues. However, even though the ALP encourages the co-location of affiliates in the host country, the host's tax revenues decrease. The ALP makes the transfer price of inputs higher, leading the downstream affiliate to produce less. The reduction in the downstream affiliate's profits is so huge that the host country earns less tax revenues. Our result indicates that the ALP is certainly an effective measure against worldwide profit shifting, but may cause a conflict of interest between countries.

[9] In our setting, the arm's length price is the price that the upstream affiliate charged to the local downstream firm. As MNEs are usually not price takers, the AL price in an internal comparable transaction is more or less an MNEs' choice variable and thus is subject to manipulation (Cristea and Nguyen (2016)). Although tax authorities recognize this possibility of manipulation (see e.g., IRS§1.482–1(d)(4)(iii)), they have to refer to internal comparable transactions in some cases due to limited information available. One recent example of such case is the transfer pricing case of Medtronic, a medical device company based in the US, v. the Internal Revenue Service (IRS) (see for details *Global Tax Alert (News from Transfer Pricing)*, 21 June 2016: `http://www.ey.com/gl/en/services/tax/international-tax/alert--us-tax-court-imposes-a-proper-arms-length-allocation-method-for-transfer-pricing`, accessed on 2 June 2018). Medtronic US gave license to its Puerto Rican affiliate for production. The affiliate purchased components from Medtronic US, manufactured finished medical devices, and sold them to the Puerto Rican market. Whereas the IRS accused Medtronic US of profit shifting for the years at issue, 2005-06, Medtronic US argued that the royalty rates charged to the Puerto Rican affiliate, which are a sort of transfer price of inputs, were the AL royalty rates in light of the CUT method. The AL royalty rates calculated by Medtronic US came from several internal comparable transactions, including a license agreement between Medtronic US and Siemens (German conglomerate company). In 2016, the US Tax Court accepted the royalty rates proposed by Medtronic US with small adjustments. See Avi-Yonah (2007) for other applications of the CUP/CUT method.

Our contribution is to examine the location choice of MNEs using transfer pricing, to which most of the studies in the literature have provided limited attention. Their main interest is in how transfer prices are affected by international differences in, e.g., corporate tax rates, tax systems, and trade barriers.[10] Nielsen et al. (2003) examine how different corporate tax systems, separate accounting and formula apportionment, affect transfer prices differently. Kind et al. (2005) ask the same question in a tax competition framework and also look at the impact of a reduction in trade barriers. However, the production location choice of MNEs is outside the scope of these papers.

There are a few papers that address the choice of organization structure of MNEs with profit shifting motives. Nielsen et al. (2008) analyze the impact of different decision structures on transfer prices; i.e., the decision on production is made either by the headquarters of MNEs (centralization) or by the local affiliate (decentralization). Unlike our model, their model fixes the location of affiliates. Using the property-rights approach, Bauer and Langenmayr (2013) and Egger and Seidel (2013) investigate the organization decision on whether to integrate local suppliers or import inputs from independent foreign suppliers. Keuschnigg and Devereux (2013) ask the same question in a model with financial frictions. While they focus on sourcing decisions *across* the boundaries of MNEs ("make or buy" inputs), we emphasize production location decisions *within* the boundaries of MNEs.[11] Closer to the interests of our study, Yao (2013) analyzes the impact of the ALP on MNEs' location choice in a spatial competition model à la Hotelling. In his model, MNEs choose *where* to locate *within a host country*, that is, they choose a point on the "linear-city," whereas in our model an MNE chooses *whether* to locate *in a host or parent country.*[12]

Although the location choice of internationally-mobile firms is at the core of the literature on tax competition,[13] the role of the transfer pricing and/or the ALP has not been addressed there. Haufler and Wooton (1999) consider tax competition between potential host countries for a single MNE (or its affiliate) without profit shifting mo-

[10]Earlier contributions include Copithorne (1971); Horst (1971); Samuelson (1982); and Kant (1988b). In addition to the profit-shifting motive of transfer pricing mentioned in the text, studies such as Elitzur and Mintz (1996); Schjelderup and Sørgard (1997); and Zhao (2000) point out a *strategic motive*. The strategic motive comes from MNEs' incentive to make their downstream affiliates competitive against rival firms. See Section 1.4.4. for more on this point.

[11]In a related context, Choi et al. (2018a) find a possibility of dual sourcing where an MNE buys inputs from both independent suppliers and related subsidiaries.

[12]The role of the ALP on transfer prices is also studied by Gresik and Osmundsen (2008); Bauer and Langenmayr (2013); Choe and Matsushima (2013); and Keuschnigg and Devereux (2013). However, they do not consider the location choice of MNEs.

[13]See Keen and Konrad (2013) for a comprehensive survey.

tives.[14] Based on their framework, Ma and Raimondos (2015) allow the MNE to use transfer pricing and examine the effect of the market size of potential host countries. They simplify the vertical structure within the MNE, and are thus unable to analyze the impact of the ALP. In contrast, we take corporate taxes as given, and describe the vertical structure more precisely to address the ALP issue.

The rest of the paper is organized as follows. Section 1.2 describes the setup of the model. The main analysis is presented in Sections 1.3 and 1.4 where the equilibrium outcomes in the benchmark (no-ALP) and the ALP cases are derived. Section 1.5 analyzes the impact of the ALP on tax revenues. Section 1.6 concludes the paper.

1.2 Basic Setting

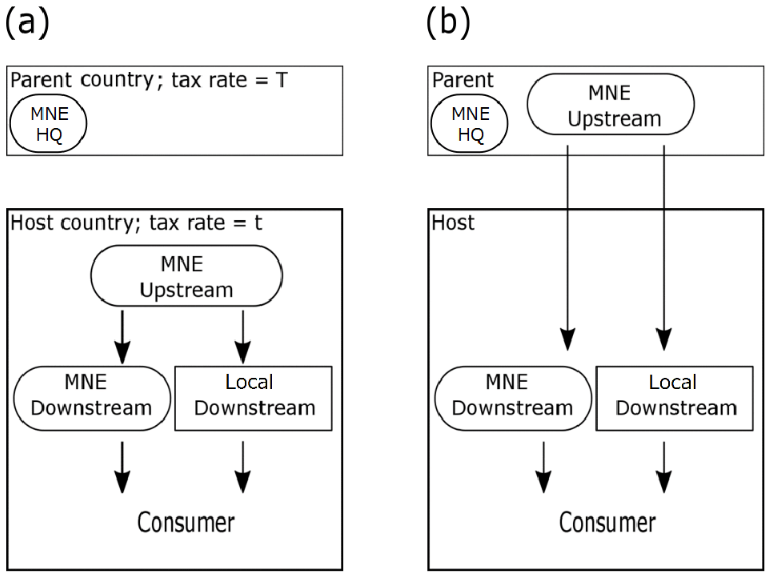
The economy consists of two countries, a host and a parent, with two vertically-linked industries, an upstream industry (intermediate input) and a downstream industry (final good). Our focus is on the host country, where the consumption and production of final goods take place. The headquarters of the MNE is located in the parent country and makes exogenous profits $\overline{\pi}$. In the host country, there are a downstream affiliate of the MNE and a local downstream firm. The two firms produce totally differentiated goods.

The MNE locates an upstream affiliate in either the parent country with tax rate T or the host country with tax rate $t\,(< T)$. If the upstream affiliate is established in the host together with the downstream affiliate, termed as a *co-location scheme*, it produces and sells inputs to both the related and unrelated downstream firms. The price for the related affiliate is called an *internal price* and the price for the independent local firm is called an *arm's length price.* By contrast, if the upstream affiliate is established in the parent separate from the downstream affiliate, termed as a *separate-location scheme*, it produces in the parent and exports to the two downstream firms. The internal price under this scheme can also be called a *transfer price* due to the cross-border transactions. The two schemes are illustrated in Figure 1.1.

The timing of the game is as follows. First, the MNE chooses the location of upstream production (Figure 1.1 (a) or (b)). Second, it sets input prices to maximize the total

[14] For subsequent development in the literature on bidding for a firm, see, e.g., Bjorvatn and Eckel (2006); Haufler and Wooton (2006); Ferrett and Wooton (2010); and Furusawa et al. (2015).

Figure 1.1: Model structure: (a) co-location scheme; (b) separate-location scheme



post-tax profit, which is the sum of the post-tax profits of the upstream and the downstream affiliates. Third, the downstream affiliate and the local firm choose outputs to maximize their own profits.[15] We proceed by analyzing in turn the case where the MNE is free from the arm's length principle (ALP) and the case where it obeys the ALP.

1.3 Benchmark Case

We first consider the case where the ALP is not imposed: the upstream affiliate can sell to the related downstream affiliate and the independent firm at different prices. The equilibrium outcomes are derived in both the co-location and the separate-location schemes. Comparing the equilibrium profits under the two schemes, we analyze in which country the MNE locates the upstream affiliate, given the tax rates of the host and the parent countries.

[15]We consider a decentralized decision structure where the MNE leaves quantity choice to the downstream affiliate.

1.3.1 Co-location Scheme

Given the location of upstream production, the MNE first chooses input prices and then the two downstream firms source the inputs to produce final goods. We solve the problem backward.

The two downstream firms choose quantities to maximize their own pre-tax profits. Let π and π_* be respectively the pre-tax profits of the downstream affiliate and the local firm; the maximization problems are formulated as

$$\begin{aligned} &\max_{q}\ \pi = (p-g)q, \\ &\max_{q_*}\ \pi_* = (p_* - g_*)q_*, \\ &\text{where}\ \ p = 1-q, \\ &\qquad\quad p_* = 1-q_*. \end{aligned}$$

p (p_*) is the final good's price of the downstream affiliate (the local firm) and q (q_*) is the quantity produced by the downstream affiliate (the local firm). The downstream firms use linear production technology, resulting in a one-to-one transformation from intermediate to final goods. g is the price of the intermediate inputs for the downstream affiliate, called the internal price, and g_* is the price for the local firm, called the arm's length price. Solving the maximization problems gives

$$q = \frac{1-g}{2} \tag{1.1}$$

$$q_* = \frac{1-g_*}{2}. \tag{1.2}$$

Taking into account these demand schedules, the MNE sets input prices for the two downstream firms. Letting π_u be the pre-tax profits of the upstream affiliate and Π be the total post-tax profit of the MNE, the MNE faces the following problem:

$$\begin{aligned} \max_{g,g_*}\ \Pi &= (1-T)\bar{\pi} + (1-t)(\pi_u + \pi) \\ &= (1-T)\bar{\pi} + (1-t)[(g-c)q + (g_*-c)q_* + (p-g)q], \end{aligned}$$

where T and t are respectively the parent's corporate tax rate and the host's. It is assumed that $t < T$ throughout the analysis.[16] $c \in [0, 1)$ is the constant marginal cost of the upstream production. $\bar{\pi}$ is constant profits earned (from different business) in the parent market.[17]

Deriving the two first-order conditions (FOCs) from the MNE's problem ($d\Pi/dg = 0$; $d\Pi/dg_* = 0$) and solving the system of equations for (g, g_*), we obtain

$$g = c, \tag{1.3}$$

$$g_* = \frac{1+c}{2}, \tag{1.4}$$

where the second-order conditions (SOCs) trivially hold. The equilibrium input prices are independent of tax rates because both the upstream and downstream firms co-locate in the host country and face the same tax rate. The MNE exercises monopoly power against the local firm by setting g_* greater than the marginal cost c. By contrast, it adopts marginal cost pricing for the downstream affiliate to avoid losses from inefficient markups.

Using equilibrium choices, the total post-tax profit Π is re-expressed as

$$\Pi = (1-T)\bar{\pi} + \frac{3(1-t)(1-c)^2}{8}. \tag{1.5}$$

1.3.2 Separate-location Scheme

In the separate-location scheme, where the upstream affiliate is located in the parent country, the two downstream firms behave similarly to the co-location scheme. Suppose the superscript S denotes variables in the separate-location scheme. From Eqs.

[16]If $t \geq T$, the upstream affiliate is always located in the low-tax parent country (separate location) in both the benchmark and ALP cases. Thus, our focus is on the range of $t < T$, where the imposition of the ALP may change the location pattern.

[17]It is common in the literature to assume exogenous profits or profits independent of transfer price (Schjelderup and Sørgard, 1997; Nielsen et al., 2003, 2008; Haufler and Mardan, 2014). In these studies, the tax-manipulation effect, which we will define shortly, is so strong that the price-cost margin (and thus profits) can be negative as in our analysis. To isolate the tax-manipulation effect as clearly as possible, we follow the convention of the literature. In Appendix A.8, we endogneize it by introducing a local downstream firm in the parent country.

(1.1) and (1.2), the outputs of final goods can be written as

$$q^S = \frac{1 - g^S}{2},$$
$$q_*^S = \frac{1 - g_*^S}{2},$$

where g and g_* have been replaced with g^S and g_*^S in Eqs. (1.1) and (1.2), respectively. Given these demand schedules, the MNE chooses input prices to maximize the following total post-tax profit:

$$\begin{aligned}\max_{g^S, g_*^S} \Pi^S &= (1-T)(\bar{\pi} + \pi_u^S) + (1-t)\pi^S \\ &= (1-T)[\bar{\pi} + (g^S - c)q^S + (g_*^S - c)q_*^S] + (1-t)(p^S - g^S)q^S.\end{aligned}$$

Our focus is on a certain range of tax rates where the maximization problem has a unique interior solution:

$$\begin{aligned} t > \underline{t} &\equiv \max\{0,\ t^a,\ t^b\}, \qquad \text{(A1)} \\ \text{where } t^a &\equiv 2T - 1, \\ t^b &\equiv [(3+c)T - (1+c)]/2. \end{aligned}$$

If t and T satisfy (A1): $t > \underline{t}$, equilibrium outputs and prices of intermediate and final goods are positive, and the SOCs hold in all cases of the following analysis.[18] The regularity condition (A1) is assumed throughout the analysis.

The equilibrium input prices are given by

$$g^S = c + \underbrace{\frac{(1-c)(t-T)}{t - 2T + 1}}_{\text{Tax-manipulation effect}}, \qquad (1.6)$$

$$g_*^S = \frac{1+c}{2}, \qquad (1.7)$$

where the SOCs are satisfied and $t - 2T + 1 > 0$ holds under (A1). The second term of g^S involves the tax difference, which is termed as a *tax-manipulation effect* of transfer price. Its sign depends on the tax difference. If both countries had the same tax rate ($t = T$), it would hold that $g^S = c\ (= g)$, meaning no room for tax manipulation.

[18] More precisely, $q^S > 0$ requires $t > t^a$, while $p^S > 0$ does $t > t^b$.

Under our assumption that $t < T$, the second term of g^S is negative and $g^S < c$ holds. By making upstream profit negative, the MNE shifts exogenous profits from the high-tax parent to the low-tax host country. A larger tax difference ($t << T$) brings more room for profit shifting and thus lowers g^S more.[19]

It is also noted that the arm's length price g_*^S is equal to the one in the co-location scheme, and does not depend on tax rates. This is again because g_*^S is used solely for exploiting market power against the local firm.

The total post-tax profit evaluated at the equilibrium choices is given by

$$\Pi^S = (1-T)\left[\bar{\pi} + \frac{(1-c)^2(t-4T+3)}{8(t-2T+1)}\right], \tag{1.8}$$

where the second term in the square bracket is positive under (A1): $t > \underline{t}$.

1.3.3 Location Choice

Comparing the total post-tax profits in the two schemes, the MNE chooses a location for upstream production. From Eqs. (1.5) and (1.8), the profit difference can be calculated as

$$\Pi - \Pi^S = \frac{(1-c)^2(3t-4T+1)(T-t)}{8(t-2T+1)},$$

where $t - 2T + 1 > 0$ holds under (A1). As the denominator is positive, the sign of the difference is determined by the numerator.

It can be seen that $\Pi - \Pi^S = 0$ holds at $t \in \{t^*, T\}$, where t^* is defined by

$$t^* \equiv (4T-1)/3 \, (< T). \tag{1.9}$$

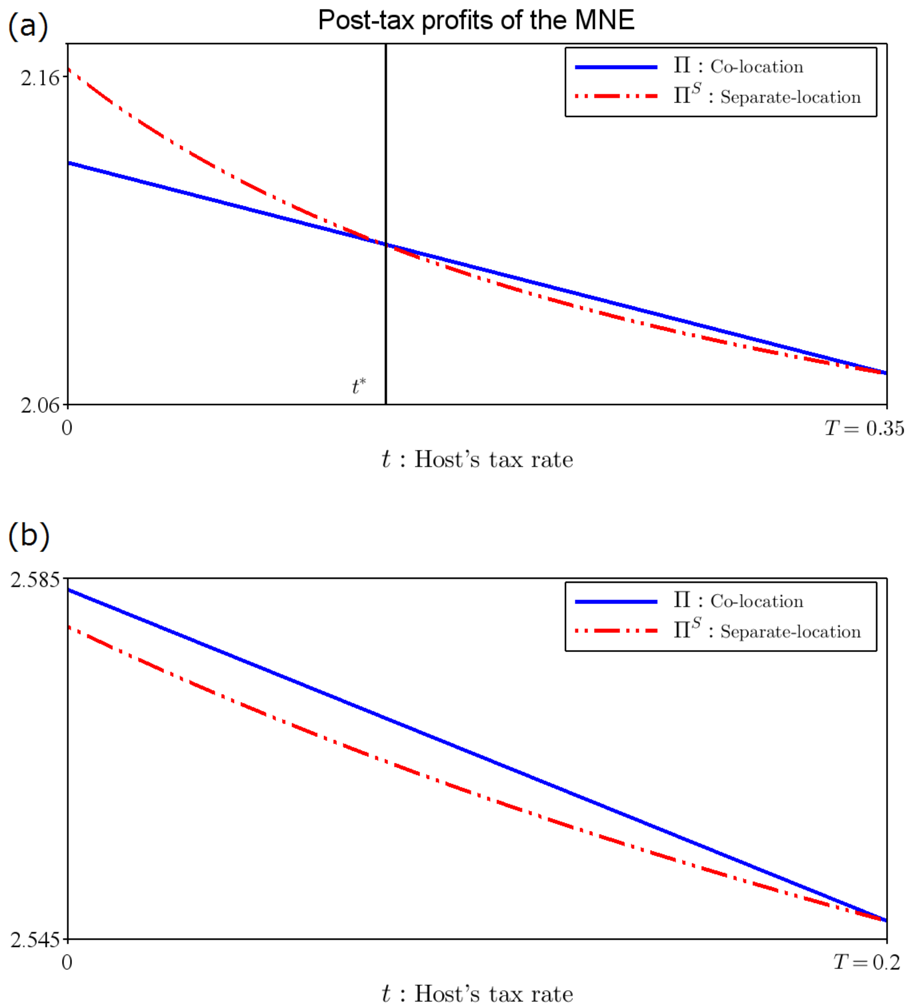
t^* is positive if the parent's tax rate is sufficiently high, i.e., $T > \overline{T} \equiv 1/4$.

The profits under the two schemes are illustrated in Figure 1.2.[20] If the parent's tax rate is low ($T \leq \overline{T}$: Figure 1.2 (b)), t^* becomes negative and $\Pi - \Pi^S > 0$ holds

[19] Clausing (2003) empirically supports this result: she finds that MNEs in the U.S. tend to set lower export prices, as tax rates in the trading partners are lower.

[20] These figures are derived using the following parameter values: $c = 0.3$; $\bar{\pi} = 3$; (a)$T = 0.35$; (b)$T = 0.2$. In this numerical example, $\underline{t} = 0$ holds. We note that the qualitative results stated in Proposition 1.1 do not depend on these particular parameter values.

Figure 1.2: Production location choice in the benchmark case: (a) high T and (b) low T



for $t < T$. The MNE always co-locates the upstream affiliate with the downstream affiliate in the host country.

If the parent's tax rate is high ($T > \overline{T}$: Figure 1.2 (a)), the location choice is more complex. $\Pi - \Pi^S > 0$ holds if t is close to T (i.e., $t \in (t^*, T)$), while $\Pi - \Pi^S \leq 0$ holds if t is far below T (i.e., $t \in (\underline{t} = 0, t^*]$). The MNE chooses the co-location scheme, if the two countries have similar tax rates. Otherwise, it prefers the separate-location scheme.

If the two countries had equal tax rates, the tax manipulation effect would disappear so that the location choice would not matter, i.e., $\Pi = \Pi^S$ at $t = T$. Consider then a marginal decrease in the host's tax rate from $t = T$. The MNE naturally benefits from this reduction, but the degree of benefit varies from scheme to scheme. Indeed, we can confirm

$$-\left.\frac{d\Pi}{dt}\right|_{t=T} > -\left.\frac{d\Pi^S}{dt}\right|_{t=T}.$$

The marginal profit in the co-location scheme is higher than that in the separate-location scheme. Having an upstream affiliate in the parent is beneficial to the MNE trying to manipulate tax payments, but it comes at a cost of the higher tax rate in the parent. Under small international tax differences, there is little room for manipulating tax payments. Thus, the low-tax host becomes more profitable for upstream production than the high-tax parent.

Under fairly large tax differences, however, this is not necessarily the case. Let us assume $T > \overline{T}$ and look at the marginal effects of taxes on the total post-tax profit at $t = t^* > 0$, where $\Pi = \Pi^S$ holds. We can confirm

$$-\left.\frac{d\Pi}{dt}\right|_{t=t^*} < -\left.\frac{d\Pi^S}{dt}\right|_{t=t^*}.$$

In contrast to the previous case of $t = T$, a reduction in t increases total post-tax profit in the separate-location scheme more than in the co-location scheme. A larger tax difference strengthens the tax-manipulation effect and thus allows more profit shifting. To exploit the profit-shifting opportunity, the upstream affiliate is separately located from the downstream affiliate for $t \leq t^*$.

These results are summarized as follows.

Proposition 1.1 *(No-ALP case).*
Suppose the MNE can set different input prices for its downstream affiliate and the local firm, and assume $t < T$ and the regularity condition (A1): $t > \underline{t}$. Two cases may arise:

(i) Suppose the parent country's tax rate is sufficiently high ($T > \overline{T}$). If the host country's tax rate is not low enough ($t \in (t^*, T)$), the MNE locates an upstream affiliate in the low-tax host country ("co-location"). On the other hand, if it is low enough ($t \in (\underline{t}, t^*]$), the upstream affiliate is located in the high-tax parent country ("separate location").

(ii) Suppose the parent country's tax rate is not sufficiently high ($T \leq \overline{T}$). For any host's tax rate ($t \in (\underline{t}, T)$), the MNE always locates an upstream affiliate in the low-tax host country ("co-location").

1.4 Arm's Length Principle (ALP) Case

Let us turn to the case where the MNE follows the ALP. It now sets equal prices to both the downstream affiliate and independent local firm.[21]

1.4.1 Co-location Scheme

We first solve the third stage game, where the downstream firms choose quantities, and then solve the second stage game, where the MNE chooses input prices. Maximization problems facing the downstream firms are exactly the same as in the benchmark (no-ALP) case, except that both the affiliate and the local firm source inputs at the same price, $\tilde{g}$, where the tilde ($\tilde{}$) represents the variable in the ALP case. Replacing g and g_* with $\tilde{g}$ in Eqs. (1.1) and (1.2) gives

$$\tilde{q} = \tilde{q}_* = \frac{1-\tilde{g}}{2}.$$

Noting the MNE is unable to discriminate prices, its maximization problem is formulated as

$$\begin{aligned}\max_{\tilde{g}} \widetilde{\Pi} &= (1-T)\overline{\pi} + (1-t)(\tilde{\pi}_u + \tilde{\pi}) \\ &= (1-T)\overline{\pi} + (1-t)[2(\tilde{g}-c)\tilde{q} + (\tilde{p}-\tilde{g})\tilde{q}].\end{aligned}$$

The profits from selling inputs, $2(\tilde{g}-c)\tilde{q}$, are doubled because prices and quantities for the two downstream firms are the same.

From the FOC with respect to $\tilde{g}$, the following optimal input price is obtained:

$$\tilde{g} = \frac{1+2c}{3}, \qquad (1.10)$$

where the SOC trivially holds. Comparing this with the input prices under the co-location scheme in the benchmark case, g and g_* defined in Eqs. (1.3) and (1.4), we find $g < \tilde{g} < g_*$. In the benchmark case, the MNE exercises market power against the local firm and sets the arm's length price higher than the marginal cost ($g_* > c$).

[21] We assume that the ALP applies to both cross-border transactions (i.e., separate location) and domestic transactions (i.e., co-location). Article Nine and the OECD guidelines are fully or partly applicable to domestic transfer pricing in some member countries of the OECD such as the U.K., Norway and Canada (Wittendorff, 2012).

For the downstream affiliate, the MNE sets the internal price to the marginal cost ($g = c$) so as to avoid inefficient markups between affiliates. The ALP, however, does not allow for price discrimination so that the unique price reflects the two opposing motives. Therefore, the input price in the ALP case falls between the two prices in the benchmark case.

The total post-tax profit in equilibrium is given by

$$\widetilde{\Pi} = (1 - T)\bar{\pi} + \frac{(1-t)(1-c)^2}{3}. \tag{1.11}$$

1.4.2 Separate-location Scheme

The quantities that the downstream firms choose are the same as in the co-location scheme:

$$\tilde{q}^S = \tilde{q}^S_* = \frac{1 - \tilde{g}^S}{2},$$

where the superscript S represents the separate-location scheme as before. Given these demand schedules, the MNE chooses an input price to maximize the total post-tax profit:

$$\max_{\tilde{g}^S} \widetilde{\Pi}^S = (1 - T)[\bar{\pi} + 2(\tilde{g}^S - c)\tilde{q}^S] + (1 - t)(\tilde{p}^S - \tilde{g}^S)\tilde{q}^S.$$

Solving the FOC yields the equilibrium input price:

$$\tilde{g}^S = \frac{1+2c}{3} + \underbrace{\frac{2(1-c)(t-T)}{3(t-4T+3)}}_{\text{Tax-manipulation effect}}, \tag{1.12}$$

where the SOC is satisfied and $t - 4T + 3 > 0$ holds under the regularity condition (A1): $t > \underline{t}$. The second term of $\tilde{g}^S$ captures the tax-manipulation effect as seen in g^S defined in Eq. (1.6). Its sign depends only on the tax difference. The above input price can be reduced to the one under the co-location scheme ($\tilde{g}^S = \tilde{g}$) at $t = T$. For $t < T$, the second term becomes negative, implying that the MNE reduces the input price to bring more profits to the downstream affiliate in the low-tax host country. Comparing

$\tilde{g}^S$ with g^S reveals that the tax-manipulation effect is smaller in $\tilde{g}^S$ than in g^S.[22] The input price is no longer an effective device for shifting profits. As in the co-location scheme, the input price in the ALP case falls between the transfer price and the arm's length price in the benchmark case, i.e., $g^S < \tilde{g}^S < g^S_*$.

The equilibrium total post-tax profit is calculated as

$$\widetilde{\Pi}^S = (1-T)\left[\bar{\pi} + \frac{(1-c)^2(1-T)}{t-4T+3}\right]. \tag{1.13}$$

1.4.3 Location Choice

From Eqs. (1.11) and (1.13), the profit difference is given by

$$\widetilde{\Pi} - \widetilde{\Pi}^S = \frac{(1-c)^2(t-3T+2)(T-t)}{3(t-4T+3)},$$

where $t - 3T + 2 > 0$ and $t - 4T + 3 > 0$ hold under (A1). The profits under the two schemes are illustrated in Figure 1.3.[23] The sign of the profit difference depends only on $T - t$. Under our assumption that $t < T$, it holds that $\widetilde{\Pi} - \widetilde{\Pi}^S \geq 0$ and thus the MNE always prefers the co-location scheme. In contrast to the benchmark case, the separate-location scheme is never optimal even if T is much higher than t. The input prices can neither be effectively used to exercise market power against the local firm, nor to shift profits, thereby reducing the benefit of choosing the separate-location scheme.

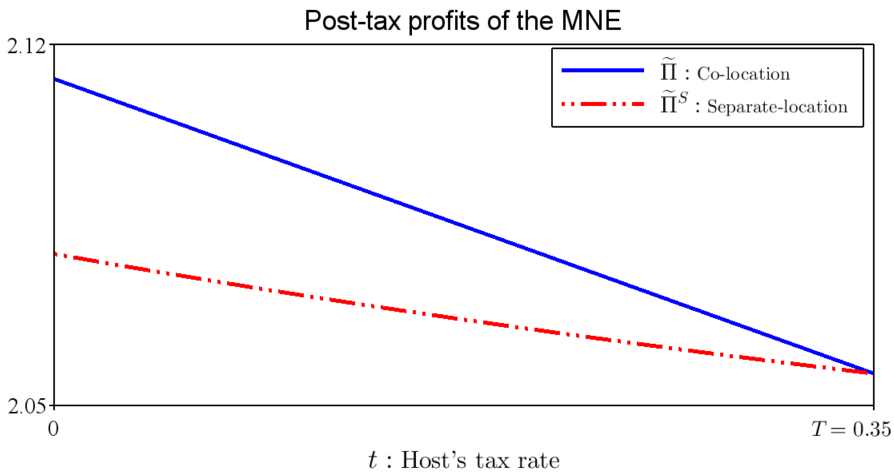
Proposition 1.2 *(ALP case).*
Suppose the MNE sets equal input prices for its downstream affiliate and the local firm, and assume $t \leq T$ and the regularity condition (A1): $t > \underline{t}$. For any host's tax

[22] To see this formally, we calculate the difference between the coefficient of $t - T$ in $\tilde{g}^S$ and that in g^S:

$$\frac{\partial \tilde{g}^S}{\partial(t-T)} - \frac{\partial g^S}{\partial(t-T)} = \frac{2(1-c)}{3(t-4T+3)} - \frac{1-c}{2(t-2T+1)}$$
$$= -\frac{(t-8T+7)(1-c)}{12(t-4T+3)(t-2T+1)} < 0.$$

[23] The parameter values are the same as those in Figure 1.2 (a): $c = 0.3$; $\overline{\pi} = 3$; $T = 0.35$. We note that the qualitative results stated in Proposition 1.1 do not depend on these particular parameter values.

FIGURE 1.3: Production location choice in the ALP case



rate ($t \in (\underline{t}, T)$), the MNE always locates an upstream affiliate in the low-tax host country ("co-location").

1.4.4 Extensions and Robustness

We have seen that the upstream affiliate may be located in the parent country (separate location) even if the parent's tax rate is higher than the host's (Proposition 1.1), and the imposition of the ALP may change the separate-location scheme to the co-location scheme (Proposition 1.2). One may wonder these results crucially depend on our simplified structure, where the intermediate inputs are supplied only by the upstream affiliate, and there is only one local firm in the downstream market. We briefly discuss the robustness of the results against three extensions: (i) imperfect substitutability between the two final goods, (ii) a local upstream firm, and (iii) many downstream firms.

Substitutability of the Final Goods. We allow for the two final goods to be substitutable. The transfer price has then a strategic effect as well as the tax-manipulation effect. As the strategic effect reduces the transfer price to make the downstream affiliate competitive, it works in the same direction as the tax-manipulation effect.

Let $b \in (0, 1)$ denote the degree of substitutability of the goods. If b is so high that competition in the downstream industry is tough, the MNE prevents the local firm from doing business by stopping selling inputs to it. Unless such input foreclosure occurs, we obtain the qualitatively same results as in Propositions 1.1 and 1.2. See our working paper (Kato and Okoshi, 2017) for details.

A Local Firm in the Upstream Industry. We add a local upstream firm in the host country. The upstream firm has the same marginal cost of c, supplies the same type of intermediate inputs as the upstream affiliate, and competes with it in prices. Bertrand competition with homogeneous products leads both the two upstream firms to set their prices equal to or lower than their marginal cost. The upstream firm cannot set its price lower than the marginal cost in order to earn non-negative profits. On the other hand, the upstream affiliate, if located in the parent country, can do so because its negative profits are compensated by the profits from different business $\bar{\pi}$. Thus, the MNE locates the upstream affiliate in the high-tax parent country as in Proposition 1.1.

In the ALP case, if the MNE were to set the input price lower than the marginal cost for the downstream affiliate, the price would also be applied to the local firm and thus lead to negative profits from it. The introduction of ALP makes the separate-location scheme less profitable than before and may change the location pattern as in Proposition 1.2. See Appendix A.3 for details.

As we assume the two upstream firms produce the same type of inputs and have the same marginal cost, the arm's length price is uniquely identified. In practice, however, tax authorities may observe multiple uncontrolled comparable prices. The OECD guideline suggests that the arm's length price might be pinned down by statistical tools to narrow the price range such as the interquartile range or other percentiles (OECD, 2017, para. 3.57). In Appendix A.7, we allow for the differentiation of inputs and analyze the case where the arm's length price takes a range of values.

Many Local Firms in the Downstream Industry. We allow for many local downstream firms, each of which produces a differentiated variety of products. A greater number of downstream firms yields more input sales. This implies that the downstream affiliate's profits relative to profits from local downstream firms become less important in the MNE's total profits. The MNE now lays less emphasis on the role of transfer prices and relies more on input sales from many local firms. Thus, it tends to prefer the co-location scheme simply for the low tax rate of the host country. However, if the number of downstream firms is not too large, Propositions 1.1 and 1.2 still hold. See Appendix A.4 for details.

Furthermore, we extend our analysis to include (iv) extra costs of international trade, (v) extra costs of transfer pricing, and (vi) endogenous profits in the parent market. In these generalized settings, we obtain the qualitatively similar results to those of

Propositions 1.1 and 1.2. The detailed analysis can be found in the Appendix.

1.5 The Impact of the ALP on Tax Revenues

It has been shown that the imposition of the ALP may change the location of upstream production from the parent to the host country. At first glance, this location change seems to enhance production in the host and bring larger tax revenues. However, this is not true.

It can be verified that for $t \in (\underline{t}, t^*)$, tax revenues under the separate-location scheme in the benchmark case, denoted by TR_H, are greater than those under the co-location scheme in the ALP case, denoted by $\widetilde{TR}_H$:[24]

$$\begin{aligned} &\widetilde{TR}_H < TR_H, \\ &\text{where } \widetilde{TR}_H = t(\tilde{\pi}_u + \tilde{\pi} + \tilde{\pi}_*) \\ &\qquad\qquad = t \cdot 2(\tilde{p} - c)\tilde{q}, \\ &\qquad TR_H = t(\pi^S + \pi_*^S) \\ &\qquad\qquad = t[(p^S - g^S)q^S + (p_*^S - g_*^S)q_*^S], \end{aligned}$$

where it is noted that $\tilde{p} = \tilde{p}_*$ and $\tilde{q} = \tilde{q}_*$. The tax base in the benchmark case consists of the profits of the two downstream firms $(\pi^S + \pi_*^S)$, while in the ALP case the tax base includes the profits of the upstream affiliate $(\tilde{\pi}_u)$ as well as the two profits $(\tilde{\pi} + \tilde{\pi}_*)$. In the benchmark case, the transfer price is set lower than the true marginal cost. As a result, the downstream affiliate significantly expands and more goods are produced than in the ALP case, i.e., $q^S + q_*^S > 2\tilde{q}$.[25] In fact, the imposition of the ALP helps the local firm expand $(\tilde{q}_* = \tilde{q} > q_*^S)$, but discourages the production of the

[24] For t^* (defined in Eq. (1.9)) to be positive, we assume a sufficiently high T such that $T > \overline{T} = 1/4$.

[25] To see this formally, we have

$$\begin{aligned} &q^S + q_*^S - 2\tilde{q} = [2\tilde{g} - (g^S + g_*^S)]/2 > 0, \\ &\rightarrow t < (4T + 1)/5 \equiv t^q. \end{aligned}$$

There exists t satisfying the above inequality because it holds that $t^a < t^q < t^*$ and $t > \underline{t} \equiv \max\{0, t^a, t^b\}$ from (A1): $t > \underline{t}$.

downstream affiliate ($\tilde{q} < q^S$) and reduces the price-cost margin ($\tilde{p} - \tilde{g} < p^S - g^S$).[26] The contraction of host production combined with the narrower price-cost margin results in smaller tax revenues.

In contrast, it can be verified that in most cases, the location change induced by the ALP *increases* tax revenues globally:

$$\widetilde{TR}_W > TR_W,$$

$$\begin{aligned} \text{where } \widetilde{TR}_W &= T\bar{\pi} + t(\tilde{\pi}_u + \tilde{\pi} + \tilde{\pi}_*) \\ &= T\bar{\pi} + t \cdot 2[(\tilde{p} - \tilde{g}) + (\tilde{g} - c)]\tilde{q}, \\ TR_W &= T(\bar{\pi} + \pi_u^S) + t(\pi^S + \pi_*^S) \\ &= T[\bar{\pi} + (g^S - c)q^S + (g_*^S - c)q_*^S] + t[(p^S - g^S)q^S + (p_*^S - g_*^S)q_*^S]. \end{aligned}$$

where tax revenues in the parent country are now included. In the benchmark case, the upstream affiliate sets the transfer price lower than the marginal cost ($g^S < c$), and earns negative profits. The host country benefits from larger tax revenues at the expense of the parent country, but the benefit of the host does not exceed the loss of the parent. By imposing the ALP, the internal price is set higher than the marginal cost ($\tilde{g} > c$), which brings positive profits to the upstream affiliate in the host country and leads to greater tax revenues globally.

These results are summarized as follows (see Appendix A.2 for the proof).

Proposition 1.3 *(Tax revenues).*
The imposition of the ALP changes the location of upstream production from the parent to the host country (from "separate location" to "co-location") if the international tax difference is large ($t \in (\underline{t}, t^*)$). This location change decreases tax revenues in the host country, but increases those globally.

Considering the fact that countries adopt transfer pricing taxation to raise their tax revenues, the implementation of the ALP may give rise to an unintended consequence for countries with low corporate tax rates. Proposition 1.3 also suggests a conflict

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[26]Noting that $g^S < g_*^S$ and $\tilde{g} > g_*^S$, we have

$$\tilde{q} - q_*^S = (g_*^S - \tilde{g})/2 > (g_*^S - g)/2 > 0.$$

Combining this result with $q^S + q_*^S > 2\tilde{q}$ gives $\tilde{q} < q^S$. This also implies that the price-cost margin is smaller in the ALP case than in the benchmark case: $\tilde{q} = \tilde{p} - \tilde{g} < p^S - g^S = q^S$.

of interest in the ALP between low-tax and high-tax countries.[27] In Appendix A.9, we show that the results generally apply to social welfare. The ALP limits the use of transfer price and thereby leads to higher prices of final goods, which reduces consumer surplus in the host country. Thus the location change caused by the ALP would lower not only tax revenues, but also social welfare (consumer surplus and profits as well as tax revenues) in the host country. For a full analysis on welfare in a related model but without location choice, we refer independent works by Choi et al. (2018a); and Ishikawa et al. (2017).

1.6 Conclusion

We have analyzed how corporate tax rates affect the production location choice of MNEs. One may think that internationally-mobile firms locate their production in low-tax countries, but this simple reasoning may not hold true for MNEs with multiple affiliates. MNEs attempt to reduce tax payments globally by manipulating transfer prices for intra-firm trade. Thus, they have an incentive to locate their upstream and downstream affiliates separately to exploit international tax differences. Contrary to the conventional wisdom, this paper shows that the upstream affiliate is likely to be located in the high-tax parent country, if its tax rate is much higher than that of the host country where the downstream affiliate is located.

With a view to preventing tax manipulation, the transfer pricing tax system requires MNEs to follow the ALP, where MNEs should not set different prices for related affiliates and unrelated firms. We have also analyzed the impact of the ALP on the location choice of MNEs. With the ALP, MNEs are unable to fully utilize intra-firm transactions across borders for profit shifting. The ALP makes the transfer pricing strategy less effective, and thus may change the location pattern from a separate-location to a co-location of upstream and downstream affiliates. This location change seems to bring greater tax revenues to the country hosting the two affiliates, but we have demonstrated that this is not true. In contrast to a separate location, a co-location in the host country does not provide the scope of profit shifting from the parent country, which leads to the loss of tax base in the host. Owing to this, the host government may hesitate to implement the ALP strictly, although the ALP may increase global tax revenues.

[27]Similar results can be found in Yao (2013) in a different setting mentioned in the Introduction.

We conclude by proposing possible extensions worth investigating. One extension is to allow taxes to be endogenously chosen by governments. In addition, one can think of many other policies to attract MNEs such as production and entry subsidies. Considering the importance of international tax planning, further analysis on different national tax systems is also needed such as the impact of a change from the separate accounting system to the formula apportionment system, or the role of the advance pricing agreement. These issues are left to future research.

Chapter 2

Economic integration and agglomeration of multinational production with transfer pricing

2.1 Introduction

Continuing economic integration in the last few decades brought more international mobility to multinational enterprises (MNEs) and allowed them to diversify activities across subsidiaries in different countries. Considering the complexity of multinational activities, governments today need to carefully design policies to attract MNEs. Among many factors, corporate taxation is one of the essential determinants of foreign direct investment (FDI) (Navaretti and Venables, 2004, Ch.6; Blonigen and Piger, 2014).[1] One naturally expects that countries with a low corporate tax rate will succeed in hosting more FDI inflow than those with a high tax rate.

However, the type of MNE activities that operate in such low-tax countries is not obvious. Governments lower taxes with an aim of hosting production plants, which contribute to local employment and tax revenues.[2] Contrary to host governments'

This chapter is based on joint work with Hayayo Kato (Kato and Okoshi, 2019a).

[1]As other determinants of MNEs' location decision, recent studies highlight agglomeration economies arising from affiliates (Mayer et al., 2010) and financial development in the host country (Bilir et al., 2019).

[2]The Irish government, for example, has explicitly stated its commitment to the low corporate tax rate for attracting FDI. See the 2013 Financial Statement by the Minister for Finance: `http://www.budget.gov.ie/Budgets/2013/FinancialStatement.aspx`, accessed on 19 June 2019.

expectations, MNEs reportedly establish affiliates in low-tax countries to save taxes and do not engage in production (Horner and Aoyama, 2009).[3]

We can illustrate this point by looking at the profits and manufacturing activities of U.S. affiliates in Europe. In Figure 2.1, we take U.S. affiliates in twelve European countries and draw the share of their profits from two low-tax countries, Ireland and Switzerland, over the last 15 years (thick line).[4] The profit share of low-tax countries is disproportionately large for their size and doubled from 17% in 1997 to 34% in 2012. The manufacturing employment share of low-tax countries (dotted line), on the other hand, has been less than their profit share, indicating that U.S. affiliates there rely more on non-production activities such as distribution, than those in the other countries. Although both the profit and manufacturing employment shares increased over time, there is no clear sign of convergence between the two.

The diverging shares of profits versus manufacturing employment in low-tax countries may be explained by profit shifting of MNEs. MNEs allocate their activities between low-tax and high-tax countries and transfer profits by controlling prices for intra-firm trade, known as *transfer prices*.[5] For example, headquarters in high-tax countries makes profits by producing goods and sells them to affiliates in low-tax countries by setting low transfer prices to inflate the affiliates' profits. As intra-firm trade enhanced by economic integration makes profit shifting easy, the geographical separation of production and profits may continue to rise.

When firms can shift profits and relocate between countries with different tax rates, it is no longer clear how MNEs optimally set up their firm structure. To answer the question, we extend a two-country spatial model developed by Martin and Rogers (1995) and Pflüger (2004) to incorporate MNEs with profit-shifting motives.

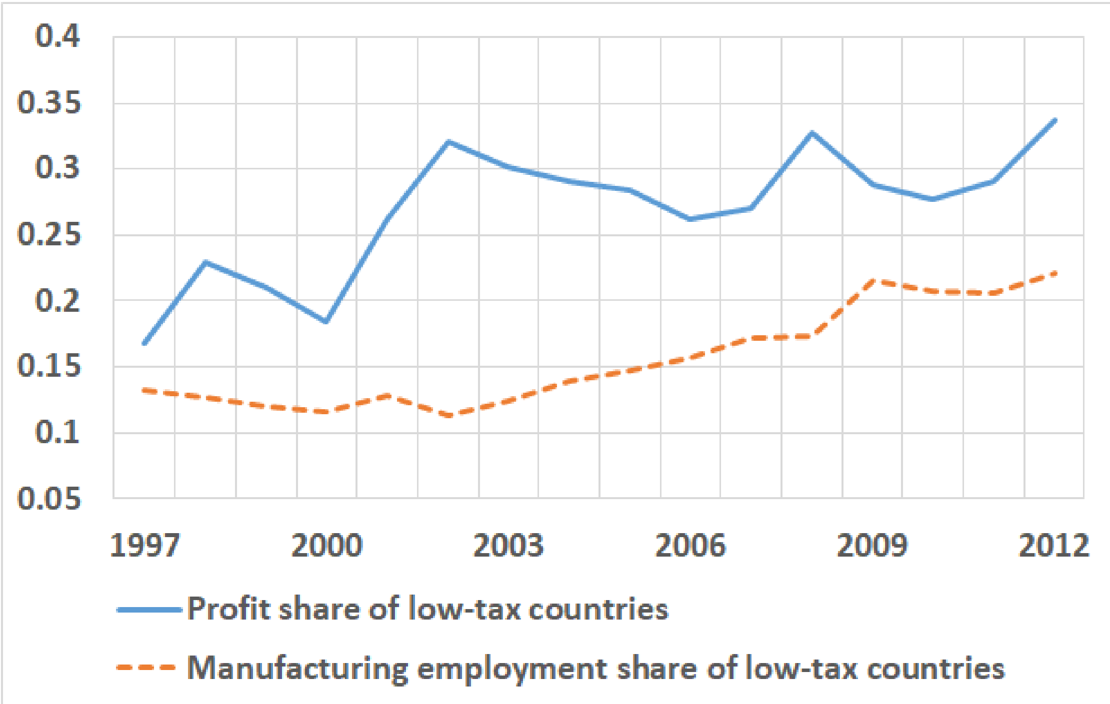
Specifically, we investigate in which country, the low-tax or the high-tax one, multinational production is agglomerated and how the location pattern changes as trade

[3]Horner and Aoyama (2009) provide a list of Irish company relocations, with several examples indicating that MNEs move production from Ireland—with the world's lowest corporate tax rate at the time—abroad while maintaining non-production activities such as service centers and marketing. This implies that low-tax countries do not necessarily retain multinational production.

[4]As noted in the caption of Figure 2.1, data on profit are from Zucman (2014), who relies on the Bureau of Economic Analysis (BEA). Because recent studies point out that the BEA data may overstate profits aboard (Blouin and Robinson, 2019), the figure should be interpreted with caution.

[5]Empirical evidence on transfer pricing can be found in many studies. See Swenson (2001); Bartelsman and Beetsma (2003); Clausing (2003); Bernard et al. (2006); Cristea and Nguyen (2016); Gumpert et al. (2016); Guvenen et al. (2017); Bruner et al. (2018); and Davies et al. (2018).

Figure 2.1: Profit share and manufacturing employment share of low-tax countries in U.S. affiliates in Europe



Sources: The U.S. Bureau of Economic Analysis (the BEA) and Zucman (2014).
Notes: Data on profit are from Zucman (2014) ("U.S. Direct Investment Abroad, Direct Investment Income Without Current-Cost Adjustment"), who compiles data originally from the BEA. Either Ireland or Switzerland had the lowest or the second lowest corporate tax rates among the sample countries for most of the period from 1997 to 2012: the average rates are 17.5% (Ireland), 23.3% (Switzerland), and 30.3% (overall) (source: OECD tax database). Data on employment are also from the BEA ("Employment of Affiliates, Country of UBO by Industry of Affiliate"). Because the BEA reports employment data for only selected countries, we take twelve countries in Europe with consistent reporting for 1997-2012: Belgium, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Spain, Sweden, Switzerland, and the U.K.

costs fall. There are monopolistically competitive firms producing different varieties that compete for consumers in two countries. A set of these firms are (the headquarters of) MNEs that can decide where to locate their production plants. Part of the produced output will be sold in the country where the variety is produced, and some in a different country through a foreign affiliate that the MNE opens. With a foreign affiliate present, the MNE can engage in intra-firm trade and use the transfer price for profit shifting. However, due to trade costs, shipping goods from one country to another will be costly. Trade costs change the volume of intra-firm trade and thus the effectiveness of profit shifting, which in turn affects MNEs' location choice.

Our findings are as follows. In the beginning of economic integration marked by high trade costs, the low-tax country attracts a higher share of multinational production than the high-tax country. When high trade costs hamper intra-firm trade and thereby limit the profit shifting opportunity, MNEs can sell little to their foreign affiliate. With most of the profits made in the country where goods are produced, they simply prefer to locate production in the low-tax country.

A further reduction in trade costs, however, reverses this location pattern, i.e., production plants agglomerating in the high-tax country. This result seems surprising, but it is indeed consistent with MNEs' optimal location choice. The MNE with production in the high-tax country *lowers* the transfer price to shift its domestic plant's profits to its foreign affiliate in the low-tax country. The lowered transfer price reduces the affiliate's marginal cost, which allows it to lower the price of goods and to gain competitiveness against local plants. On the other, the MNE with production in the low-tax country *raises* the transfer price to shift profits from its foreign affiliate in the high-tax country back to its domestic plant. Due to the high transfer price, the affiliate sells goods at a high price and loses competitiveness against local plants. The direction of profit shifting from the plant in the high-tax country to the affiliate in the low-tax country makes the MNE competitive in both markets. When trade costs are so low that this effect is significant, all MNEs choose to locate production in the high-tax country.

These results may explain the fact that U.S. affiliates in low-tax European countries engage disproportionately more in non-production activities than those in high-tax European countries do, as Figure 2.1 shows. In addition, Overesch (2009) provides supporting empirical evidence. He finds that multinationals in high-tax Germany increase real investments as the cross-country corporate tax difference between their home country and Germany is larger.

The agglomeration of multinational production in the high-tax country, however, does not necessarily bring greater tax revenues there, since a large portion of profits are shifted to the foreign affiliates in the low-tax country. Amid growing concerns about tax base erosion, the OECD recently reported that the estimated revenue losses from MNEs' tax avoidance is at most 10% of global corporate income tax revenues.[6] Our finding may justify the concern about low-tax countries attracting affiliates that receive shifted profits from high-tax countries.

The basic framework is further extended to consider tax competition between two unequal-sized countries. The main result goes through that profit shifting makes more likely production agglomeration in the (large) high-tax country. We also find that profit shifting makes tax competition tougher by reducing the large country's tax rate.

These results echo existing studies on tax competition in agglomeration economies, telling that large countries set a higher tax rate, while keeping production agglomeration (Baldwin and Krugman, 2004; Borck and Pflüger, 2006).[7] If transfer pricing can be used, however, the large country may still keep the agglomeration, but set a lower tax rate than it would if transfer pricing is impossible. A bigger tax difference would bring more opportunities to manipulate transfer prices. To prevent an erosion of taxable profits, the large country is forced to lower its tax rate.

Relation to the literature. This paper fits into the literature on transfer pricing pioneered by Copithorne (1971) and Horst (1971). The literature points out that MNEs use transfer prices to make affiliates competitive as well as for shifting profits. The former is called a strategic effect and the latter a tax manipulation effect. Earlier studies examining the strategic use of transfer pricing include those by Elitzur and

[6]See `http://www.oecd.org/ctp/oecd-presents-outputs-of-oecd-g20-beps-project-for-discussion-at-g20-finance-ministers-meeting.htm`, accessed on 20 February 2019. To tackle this issue, the OECD set up a project called "Base Erosion and Profit Shifting" (BEPS), involving over eighty countries. See `http://www.oecd.org/tax/beps`, accessed on 20 February 2019.

[7]See also Kind et al. (2000); Ludema and Wooton (2000); Andersson and Forslid, 2003; and Ottaviano and van Ypersele, 2005 for earlier contributions. Recent studies in the literature allow for heterogeneity among firms (Davies and Eckel, 2010; Haufler and Stähler, 2013; Baldwin and Okubo, 2014), forward looking behavior by governments (Han et al., 2014; Kato, 2015), and lobbying by firms (Ma, 2017; Borck et al., 2012; Kato, 2018). See also Section 3.5.3 of Keen and Konrad (2013).

Mintz (1996); Schjelderup and Sørgard (1997); Zhao (2000); and Nielsen et al. (2003).[8] The literature looks only at profit shifting with a fixed location of each affiliate. Our contribution is to uncover how these two effects of transfer pricing affect the MNEs' location choices.

Recent studies focus on the FDI decision of MNEs with profit-shifting motives; that is, whether MNEs should undertake FDI to manufacture inputs within their firms, or source inputs from independent suppliers, known as the *make or buy* decision (Bauer and Langenmayr, 2013; Egger and Seidel, 2013; Keuschnigg and Devereux, 2013; Choi et al., 2018b).[9] Egger and Seidel (2013), for example, theoretically predict and empirically confirm that larger tax differences are more likely to lead MNEs to engage in FDI, rather than outsourcing. Choi et al. (2018b) find a possibility that MNEs do both FDI and outsourcing to avoid regulations by tax authorities. While these studies fix the supplier's location and look at MNEs' organizational choices, we fix the MNEs' organization form and allow for the endogenous location of production. Our companion study, Kato and Okoshi (2019b), focuses on the location decision within MNEs, though accounts for neither MNEs' various activities (production and distribution), nor trade costs, unlike the present one.

Only a handful of studies examine tax competition for MNEs using profit-shifting motives due to analytical inconvenience (Haufler and Schjelderup, 2000; Kind et al., 2005; Peralta et al., 2006; Stöwhase, 2005, 2013; Ma and Raimondos, 2015).[10] In models with two unequal-sized countries, Stöwhase (2005, 2013) find that introducing profit shifting will *not* generally put downward pressure on tax rates, which is in contrast to our findings. These different results are mainly due to the strategic effect of transfer prices in our model, which strengthens profit-shifting incentives and thereby leads to tougher tax competition.

In terms of setting, the closest studies to ours are Peralta et al. (2006); and Ma and Raimondos (2015), who allow for both trade costs and unequal-sized countries. In

[8]See Nielsen et al. (2008); and Choe and Matsushima (2013) for subsequent development. While these studies (and ours) deal exclusively with tangible assets, recent studies examine intangible assets (Juranek et al., 2018).

[9]For studies on MNEs without profit shifting motives, see Antràs and Yeaple (2014); Section 3.6 of Costinot and Rodríguez-Clare (2014); and Shen (2018).

[10]More recent studies introduce a low-tax country with no production or consumption, calling it a *tax haven* country, and consider tax competition between a home country and the tax haven (Krautheim and Schmidt-Eisenlohr, 2011; Langenmayr et al., 2015; Hauck, 2019). This setting greatly enhances analytical tractability but is not suitable to investigate the MNEs' production location.

a tax-competition game over a *single* MNE's plant, Peralta et al. (2006) show the possibility that the large country may win the plant while setting a higher tax rate, which is similar to our findings. However, the mechanism is crucially different from ours because in their model countries use enforcement policy as well as corporate taxation. Despite its higher tax rate, the large country can attract the plant if it adopts a loose enforcement policy and thus its *effective tax rate* is lower. Moreover, in contrast to our findings, they show that the large, high-tax country may win competition if trade costs are *high*.

Ma and Raimondos (2015) also consider tax competition for a *single* MNE and obtain the similar results.[11] However, because of analytical inconvenience arising from the location discontinuities of a single MNE, their analysis relies heavily on numerical simulations. It is thus unclear whether introducing profit shifting increases or decreases equilibrium tax rates. By contrast, we can obtain sharp predictions in analytical form by employing an economic geography model with a *continuum* of MNEs and focusing on a fully agglomerated situation.

The rest of the paper is organized as follows. The next section develops the model. Section 2.3 characterizes the equilibrium plant distribution in a situation where two countries are equal-sized and taxes are given. It shows how allowing for transfer pricing changes the plant distribution. Section 2.4 analyzes tax competition between two unequal-sized countries and sees how the results change with and without profit shifting. The final section concludes.

2.2 Basic setting

Consumers. We consider an economy with two countries, indexed by 1 and 2, and two goods, homogeneous and differentiated ones. Letting L be the world population, country 1 has a population of $L_1 = s_1 L$, while country 2 has a population of $L_2 = s_2 L = (1 - s_1)L$, where $s_1 \in (0, 1)$ is country 1's share of the world population. Each individual owns one unit of labor.

Following Pflüger (2004), each consumer has an identical quasi-linear utility function with a constant-elasticity-of-substitution (CES) subutility. Consumers in country 1

[11] In some of the numerical examples, they allow for both asymmetry in the leniency of enforcement policy and asymmetric market size, in which case the small country may win the MNE while setting a higher tax rate.

solve the following maximization problem:

$$\max_{\tilde{q}_{11}(\omega),\tilde{q}_{21}(\omega),q_1^O} \quad u_1 = \mu \ln Q_1 + q_1^O,$$
$$\text{where } Q_1 \equiv \left[\sum_{i=1}^{2} \int_{\omega\in\Omega_i} \tilde{q}_{i1}(\omega)^{\frac{\sigma-1}{\sigma}} d\omega\right]^{\frac{\sigma}{\sigma-1}},$$

subject to the budget constraint:

$$\sum_{i=1}^{2} \int_{\omega\in\Omega_i} p_{i1}(\omega)\tilde{q}_{i1}(\omega)d\omega + q_1^O = y_1 + \overline{q}_1^O.$$

$\mu > 0$ captures the intensity of the preference for the differentiated goods. q_1^O and $\overline{q}_1^O$ are the individual demand for the homogeneous good and its initial endowment, respectively. We assume that $\overline{q}_1^O$ is large enough for the homogeneous good to be consumed. $\tilde{q}_{i1}(\omega)$ is the individual demand from consumers in country 1 for the variety $\omega \in \Omega_i$, where Ω_i is the set of varieties produced in country $i \in \{1, 2\}$. Q_1 is the CES aggregator of differentiated varieties with $\sigma > 1$ being the elasticity of substitution over them.

Solving the above problem gives the aggregate demand for the variety ω produced in country $i \in \{1, 2\}$ and consumed in country 1:

$$q_{i1}(\omega) \equiv L_1\tilde{q}_{i1}(\omega) = \left(\frac{p_{i1}(\omega)}{P_1}\right)^{-\sigma} \frac{\mu L_1}{P_1}. \tag{2.1}$$
$$\text{where } P_1 \equiv \left[\sum_{i=1}^{2} \int_{\omega\in\Omega_i} p_{i1}(\omega)^{1-\sigma} d\omega\right]^{\frac{1}{1-\sigma}}.$$

P_1 is the CES price index of the varieties. Although we will mainly present the results for country 1 in the following, analogous expressions hold for country 2. As firms are symmetric, we will suppress the variety index ω for notational brevity.

Homogeneous good sector. The homogeneous good sector uses a constant-returns-to-scale technology. That is, one unit of labor produces one unit of the good. The technology leads to perfect competition, making the good's price equal to its production cost, or the wage rate. Letting w_i be the wage rate of country $i \in \{1, 2\}$, the costless trade of the homogeneous good equalizes the wage rates between countries;

that is $w_1 = w_2$. We choose the good as the numéraire such that $w_1 = w_2 = 1$.

Differentiated goods sector. The differentiated goods sector uses an increasing-returns-to-scale technology. Each MNE needs f units of capital for a production plant in one country and another f units for a foreign affiliate in the other.[12] Supposing the world amount of capital is $2K$, we choose f such that the world has $2K/(2f) = L$ MNEs, or $f = K/L$. We denote the number of production plants located in country 1 (or country 2) by $N_1 = n_1 L$ (or $N_2 = n_2 L = (1 - n_1)L$), where $n_1 \in [0, 1]$ is country 1's share of production plants. Once established, each MNE needs a units of labor to produce one unit of variety.

Consider an MNE with its production plant in country 1. The plant produces quantities q_{11} and sells them at a price p_{11} to domestic consumers. In addition, it produces quantities q_{12} and exports them at a transfer price g_1 to its foreign affiliate in country 2. When exporting, due to iceberg trade costs $\tau > 1$, $1/\tau < 1$ units of quantities melt away, so the plant has to produce τ units to deliver one unit to the affiliate. The affiliate sells the imported goods to consumers in country 2 at a price p_{12}.

MNEs have decentralized decision making. In other words, the headquarters (or the production plant) of the MNE sets the transfer price to maximize global post-tax profits, while the foreign affiliate sets the retail price to maximize its own profits.[13] The idea that the headquarters lets affiliates make decisions for strategic purpose is known as the delegation principle, and is adopted by many studies in the literature (Zhao, 2000; Nielsen et al., 2003, 2008; Kind et al., 2005).[14] In practice, it is sensible to delegate decisions to local managers who are familiar with their local business environments. In many cases, a company's acquisition of a rival often involves the latter receiving divisional autonomy (e.g., Volkswagen's acquisition of Audi, Ford's acquisition of

[12]Similar specifications in the context of transfer pricing can be found in Kind et al. (2005); and Matsui (2012), although they fix the location of plants and affiliates.

[13]In the benchmark analysis, we do not consider the cost of profit shifting as in Nielsen et al. (2003, 2008); Kind et al. (2005); Section 2.1.2 of Keen and Konrad (2013); and Agrawal and Wildasin (2019). Introducing such costs does not affect the qualitative nature of our results. See Appendix B.6.

[14]It is worth noting that the strategic role of transfer pricing *within* multinationals should be distinguished from strategic interactions *across* multinationals. As we employ the monopolistically competitive framework, each plant/affiliate does not set a price strategically against others, leading to the constant mark-up: $\sigma/(\sigma-1)$, which we will see shortly (Matsuyama, 2000). But the transfer price g_i is strategically determined between the plant and its affiliate.

Volvo, and GM's acquisition of Saab).[15] We examine the case of centralized decision making in Appendix B.6 and confirm the robustness of our results.

The timing of actions proceeds as follows. First, each MNE chooses the country in which to locate a production plant and a foreign affiliate, endogenously determining the share of plants n_1. The decision is based on a comparison of the post-tax profits in the two countries. Second, the MNE chooses the transfer price. Third, production plants and foreign affiliates engage in price competition in each country. Finally, production and consumption take place. We solve the game in a backward fashion. For convenience, we refer to the results with fixed capital allocation as a *short-run equilibrium* and refer to the results in the endogenous case as a *long-run equilibrium.* We will examine the two situations in turn.

2.2.1 *Optimal Prices in the Short-run Equilibrium*

Let us derive the optimal prices given the distribution of plants and affiliates. The pre-tax profits of the production plant in country 1 (π_{11}) and those of the foreign affiliate in country 2 (π_{12}) are, respectively,

$$\pi_{11} = \underbrace{(p_{11} - a)q_{11}}_{\text{Domestic profit}} + \underbrace{(g_1 - \tau a)q_{12}}_{\text{Shifted profit}},$$

$$\pi_{12} = (p_{12} - g_1)q_{12},$$

where q_{11} is given by Eq. (2.1) and q_{12} is defined analogously, and a is the unit-labor requirement. The second term in π_{11} represents the profits from intra-firm trade subject to trade costs τ. As we will see shortly, this term captures profit shifting within MNEs. At the third stage of the game, the production plant and the foreign affiliate choose their prices to maximize their own profits. The optimal prices are

$$p_{11} = \frac{\sigma a}{\sigma - 1}, \quad p_{12} = \frac{\sigma g_1}{\sigma - 1}.$$

At the second stage, the MNE with its production plant in country 1 sets the transfer price to maximize the following global post-tax profits:

$$\Pi_1 = (1 - t_1)\pi_{11} + (1 - t_2)\pi_{12},$$

[15] See Ziss (2007) for more on this issue.

where $t_i \in [0,1]$ is the tax rate of country $i \in \{1,2\}$. The optimal transfer price is[16]

$$g_1 = \frac{\sigma\tau a}{\sigma - \Delta t_1}, \quad \text{where } \Delta t_1 \equiv \frac{t_2 - t_1}{1 - t_1}, \tag{2.2}$$

which is positive because $\sigma - \Delta t_1 > 0$. We can check that g_1 decreases with t_1 and increases with t_2. As a higher tax rate in country 1 reduces the post-tax profit of the production plant, the MNE tries to move profits from country 1 to 2 by lowering the transfer price. When the tax rate in country 2 increases, the direction of profit shifting reverses, and the MNE raises the transfer price.

Similarly, the MNE with its production plant in country 2 sets the optimal transfer price as follows:

$$g_2 = \frac{\sigma\tau a}{\sigma - \Delta t_2}, \quad \text{where } \Delta t_2 \equiv \frac{t_1 - t_2}{1 - t_2}, \tag{2.3}$$

which is also positive because $\sigma - \Delta t_2 > 0$.

To see the direction of profit shifting, we assume $t_1 > t_2$ and have $\Delta t_1 < 0 < \Delta t_2$. Using the optimal transfer prices, we can rewrite the profit from intra-firm trade as

$$(g_1 - \tau a)q_{12} = \frac{\tau a \Delta t_1}{\sigma - \Delta t_1} q_{12} < 0 \quad \text{for the MNE with production in country 1,} \tag{2.4-1}$$

$$(g_2 - \tau a)q_{21} = \frac{\tau a \Delta t_2}{\sigma - \Delta t_2} q_{21} > 0 \quad \text{for the MNE with production in country 2.} \tag{2.4-2}$$

The MNE with production in country 1 cuts the transfer price to below the true marginal cost, making negative profits from intra-firm trade. In doing so, the plant shifts profits made in the high-tax country 1 to the foreign affiliate in the low-tax country 2. As for the MNE with production in country 2, the direction reverses: from the affiliate in country 1 to the plant in country 2.

[16] We can confirm that the second order condition (SOC) is satisfied at the optimal point. The SOC is $\partial^2 \Pi_1 / \partial g_1^2 < 0$, which reduces to $(1-t_2)g_1 - (1-t_1)[(\sigma+1)\tau a - \sigma g_1] < 0$. This inequality holds at $g_1 = \sigma\tau a/(\sigma - \Delta t_1)$.

We can rewrite the post-tax profit as

$$\begin{aligned}
\Pi_1 &= (1-t_1)\pi_{11} + (1-t_2)\pi_{12} \\
&= (1-t_1)\Bigg[\underbrace{\frac{\mu L_1}{\sigma(N_1+\phi\gamma_2 N_2)}}_{\text{Domestic profit}} + \underbrace{\frac{(\sigma-1)\Delta t_1}{\sigma}\cdot\frac{\phi\gamma_1\mu L_2}{\sigma(\phi\gamma_1 N_1+N_2)}}_{\text{Shifted profit}}\Bigg] \\
&\qquad + (1-t_2)\cdot\frac{\phi\gamma_1\mu L_2}{\sigma(\phi\gamma_1 N_1+N_2)}, \qquad (2.5\text{-}1)\\
\Pi_2 &= (1-t_1)\pi_{21} + (1-t_2)\pi_{22} \\
&= (1-t_1)\cdot\frac{\phi\gamma_2\mu L_1}{\sigma(N_1+\phi\gamma_2 N_2)} \\
&\qquad + (1-t_2)\Bigg[\underbrace{\frac{\mu L_2}{\sigma(\phi\gamma_1 N_1+N_2)}}_{\text{Domestic profit}} + \underbrace{\frac{(\sigma-1)\Delta t_2}{\sigma}\cdot\frac{\phi\gamma_2\mu L_1}{\sigma(N_1+\phi\gamma_2 N_2)}}_{\text{Shifted profit}}\Bigg], \qquad (2.5\text{-}2)
\end{aligned}$$

$$\text{where } \phi \equiv \tau^{1-\sigma},\ \gamma_i \equiv \left(\frac{\sigma}{\sigma-\Delta t_i}\right)^{1-\sigma}, \quad \Delta t_i \equiv \frac{t_j - t_i}{1-t_i}, \quad i \neq j \in \{1,2\}.$$

The first and second terms in the square brackets in Π_1 and Π_2 are respectively the profit from domestic market and the profit shifted through transfer pricing. $\phi = \tau^{1-\sigma} \in [0,1]$ is an inverse measure of trade costs, or the freeness of trade. $\phi = 0$ (i.e., $\tau = \infty$) corresponds to a prohibitively high level of trade costs, while $\phi = 1$ (i.e., $\tau = 1$) indicates zero trade costs.

If the tax difference is too large, profit shifting is so excessive that taxable profits can be negative. To ensure positive profits, we assume the condition that $1 + \Delta t_1 > 0$. This simply requires that the tax difference should not be too large. See Appendix B.3 for details.

When the difference in the post-tax profits is positive, i.e., $\Delta\Pi \equiv \Pi_1 - \Pi_2 > 0$, the MNE prefers to locate its production plant in country 1, and vice versa. In the long-run equilibrium, the profit differential is zero and no MNEs are willing to change their allocation of plants/affiliates.

2.3 Equilibrium allocation of production plants

To highlight the role of tax difference, we suppose that the tax rate is higher in country 1 ($t_1 > t_2$), but the two countries are of the same size ($s_1 = 1/2$).[17] By solving the long-run equilibrium condition ($\Delta\Pi = 0$) for the share of production plants in country 1, we obtain interior equilibria $n_1 \in (0, 1)$. If $\Delta\Pi = 0$ does not have interior solutions, then we obtain corner equilibria in which all multinational production takes place in one country, i.e., $n_1 \in \{0, 1\}$.

To see how a reduction in trade costs affects the long-run equilibrium allocation, we consider two extreme cases: prohibitive trade costs ($\phi = 0$) and zero trade costs ($\phi = 1$).

An extremely high level of trade costs does not allow for intra-firm trade, leaving no room for profit shifting.[18] As the MNEs earn profits only from the domestic sales of their production plants, they prefer to locate them in the low-tax country 2. We note that the equilibrium distribution involves a small but positive share of plants in the high-tax country 1, i.e., $n_1|_{\phi=0} \in (0, 1/2)$. Since competition in the domestic market works as a dispersion force, the corner distribution where all plants are in country 2 ($n_1|_{\phi=0} = 0$) cannot be an equilibrium.

Zero trade costs, on the other, allow MNEs to engage in intra-firm trade fully, making profit shifting through transfer pricing effective.[19] In our model, transfer pricing does not just shift profits between domestic plants and foreign affiliates, but also affects the competitiveness of the affiliates. As we showed, MNEs with production in the high-tax country 1 set a low transfer price to shift profits to their affiliates in the low-tax country 2 (see Eqs. (2.2) and (2.4-1)). Due to the low sourcing cost, the affiliates can sell varieties at a low price and become competitive against local plants. By contrast, MNEs with production in the low-tax country 2 set a high transfer price (see Eqs. (2.3) and (2.4-2)), which makes their affiliates in the high-tax country 1 less competitive. They are at a disadvantage in both the domestic and foreign markets. Therefore, MNEs prefer to locate production in the high-tax country so that the direction of profit shifting makes affiliates competitive.

[17] The assumption of symmetric market size is for simplicity and is not crucial for our main result, which we will discuss after Proposition 2.1.

[18] In Eqs. (2.5-1) and (2.5-2), the profits from intra-firm trade and those from the foreign affiliate disappear if $\phi = 0$.

[19] We can confirm that the shifted profit increases with ϕ; that is, $\partial[(g_i - \tau a)q_{ij}]/\partial\phi > 0$ for $i \neq j \in \{1, 2\}$.

From the results of the two polar cases, it is expected that more production plants are in the low-tax country 2 if trade costs are high, whereas they are in the high-tax country 1 if trade costs are low. We can prove that this is the case and summarize the findings as follows (see Appendix B.1 for a proof).

Proposition 2.1 *(Plant distribution).*
Suppose that country 1 has a higher corporate tax rate than country 2. The equilibrium allocation of production plants is as follows:

(i) With high trade costs such that $\phi \in [0, \phi^*)$, the high-tax country 1 hosts a smaller share of plants than the low-tax country 2, i.e., $n_1 < 1/2$.

(ii) With low trade costs such that $\phi \in (\phi^*, 1]$, the high-tax country 1 hosts a greater share of plants, i.e., $n_1 > 1/2$.

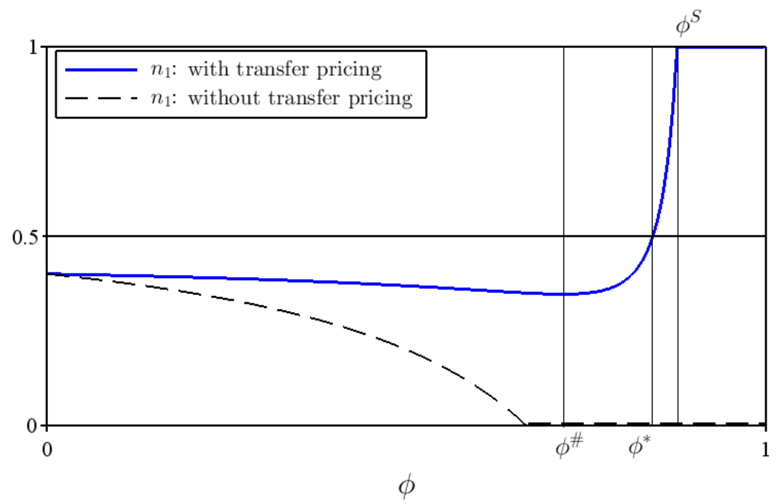
At $\phi = \phi^*$, the two countries have an equal share of plants, i.e., $n_1 = 1/2$.

Figure 2.2 shows a representative pattern of equilibrium plant distribution for different levels of the freeness of trade ϕ (thick curve), along with the equilibrium plant distribution under no profit shifting (dotted line).[20] As ϕ increases from zero, the high-tax country 1 decreases plants in both cases, with and without profit shifting. When high trade costs prevent exporting, MNEs make profits mostly from their domestic plants and thus prefer to locate them in the low-tax country. Along with a further increase in ϕ from $\phi^{\#}$, however, the high-tax country 1 increases plants in the case with profit shifting, whereas it continues to decrease plants in the case without profit shifting. Sufficiently low trade costs expand intra-firm trade and thus the opportunities for profit shifting, leading to a sharp contrast in location patterns.

The result of the high-tax country 1 attracting more multinational plants for low trade costs generally does not depend on the assumption of symmetric market size. If country 1 is larger ($s_1 > 1/2$), then the agglomeration incentive of plants to seek country 1's market is stronger (see also the tax-competition analysis in Section 2.4). If country 1 is smaller ($s_1 < 1/2$), then the agglomeration incentive is weaker but the shifted profits from country 2 to 1 are larger. We can numerically confirm that in both

[20] The parameter values are $\sigma = 5$, $t_1 = 0.8$, $t_2 = 0.7$, $L = 10$, $s_1 = 0.5$, $\mu = 1$, and $a = 1$. The qualitative feature of location pattern explained below (i.e., n_1 first decreases and then increases as ϕ rises) does not depend on specific parameter values. See Appendix B.1.

Figure 2.2: Share of production plants in the high-tax country 1



cases multinational production is concentrated in country 1 for low trade costs if the size asymmetry and the tax difference are not extremely large.

This finding seems consistent with the fact that in the last two decades marked by globalization, U.S. affiliates in Europe make a disproportionate share of profits from low-tax countries compared to manufacturing activities there, as Figure 2.1 shows. Moreover, Overesch (2009) empirically finds that the cross-country tax difference between high-tax Germany and a low-tax home country increases German inbound investments.

Full agglomeration. If ϕ is sufficiently high such that $\phi > \phi^S$, which is called a *sustain point*, then all production plants are located in country 1.[21] It can be checked that ϕ^S decreases with $t_1 - t_2$. A larger tax difference offers more room for profit shifting and thus leads to more aggressive transfer pricing (very low g_1 or very high g_2). This strengthens the competitiveness of MNEs with production in country 1, since they set a much lower price than their rivals in both the domestic and foreign markets, i.e., $p_{11} < p_{21}$; $p_{12} < p_{22}$. Consequently, full agglomeration in country 1 is more likely to occur since the tax difference is larger. We summarize these findings as follows (see Appendix B.2 for a proof).

Proposition 2.2 *(Full agglomeration).*
With sufficiently low trade costs such that $\phi \in [\phi^S, 1]$, all production plants locate

[21]Formally, a sustain point is the level of the freeness of trade above which full agglomeration is sustainable.

in the high-tax country 1: $n_1 = 1$. *As the tax difference increases, the sustain point* ϕ^S *decreases, and thus full agglomeration is more likely to occur.*

Tax revenues. The taxable base in country i consists of profits of production plant $N_i \pi_{ii}$ and those of distribution affiliate $N_j \pi_{ji}$. The tax revenue then becomes

$$TR_1 \equiv t_1(N_1\pi_{11} + N_2\pi_{21}),$$
$$TR_2 \equiv t_2(N_2\pi_{22} + N_1\pi_{12}).$$

Figure 2.3 illustrates country 1's share of tax revenues in the world along with its share of plants.[22] Naturally, with high trade costs ($\phi \simeq 0$), the high-tax country 1 earns greater tax revenues and its revenue share exceeds one-half.

The higher tax rate may not guarantee greater tax revenues, however, with low trade costs ($\phi > \phi^S$) such that production plants are agglomerated in country 1. In the fully agglomerated situation, country 1 (country 2) collects taxes solely from the plants (affiliates). As a result of profit shifting, country 1 cannot fully enforce taxes on the plants, whereas country 2 can tax on shifted profits the affiliates receive. The profit-shifting incentive of MNEs is stronger as a higher elasticity of substitution (high σ) leads to tougher market competition.[23] If σ is high enough such that $\sigma > t_1/(2t_1 - 1)$ and thus the loss from tax-base erosion is huge, country 1's tax revenues are smaller than country 2's.

We can formally prove the above discussion and summarize the findings as follows (see Appendix B.4 for a proof).

Proposition 2.3 *(Tax revenues).*
With high trade costs such that ϕ *is close to zero, the high-tax country 1 earns greater tax revenues than the low-tax country 2. This pattern reverses, however, with low trade costs such that* $\phi \in (\phi^S, 1]$ *and a high elasticity of substitution such that* $\sigma > t_1/(2t_1 - 1)$.

[22] Parameter values are the same as those in Figure 2.2.

[23] Given transfer prices, an increase in σ reduces the good's price: $\partial p_{ii}/\partial\sigma < 0$; $\partial p_{ij}/\partial\sigma < 0$. It also strengthens the profit shifting: $\partial g_1/\partial\sigma = -\tau a \Delta t_1/(\sigma - \Delta t_1)^2 > 0$; $\partial g_2/\partial\sigma = -\tau a \Delta t_2/(\sigma - \Delta t_1)^2 < 0$.

Figure 2.3: Revenue share and plant distribution

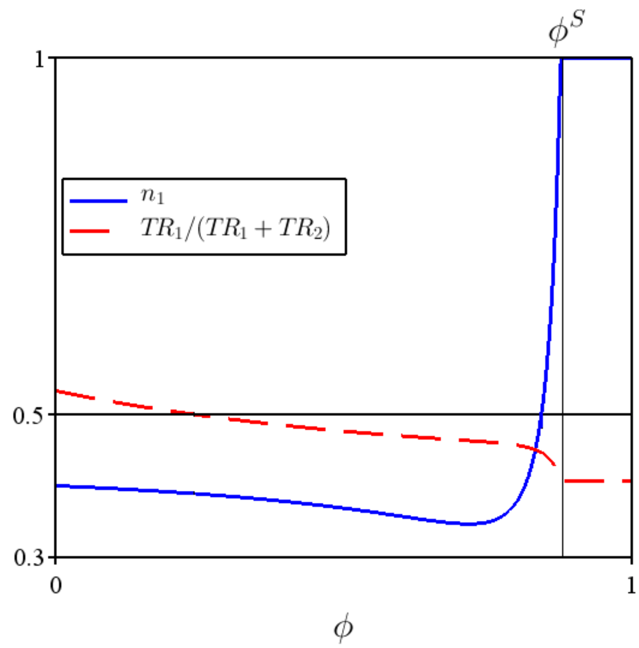


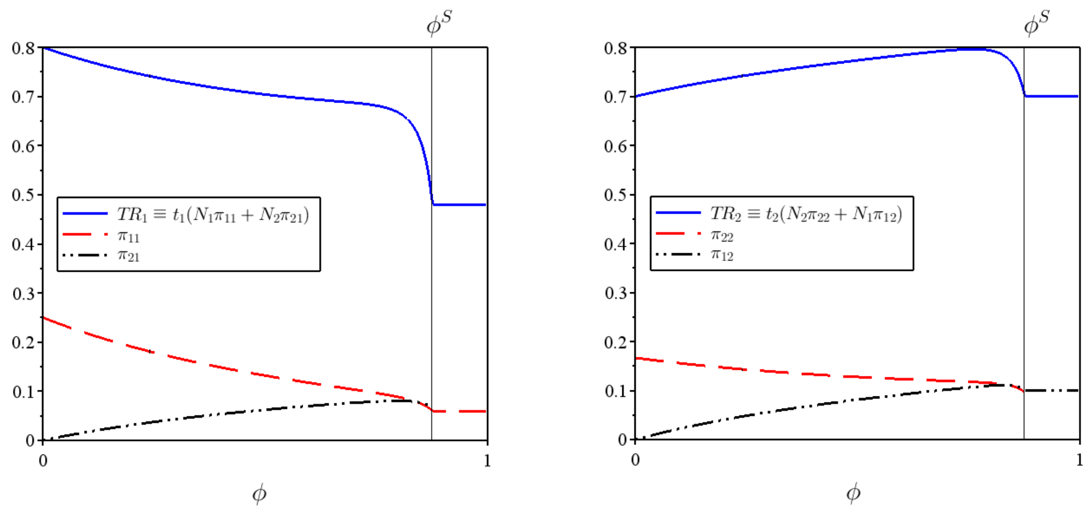
Figure 2.4 shows a further decomposition of tax revenues in each country.[24] Let us first look at profits. The taxable profit, either of plant π_{ii} or affiliate π_{ji}, behaves similarly in both countries. π_{ii} monotonically decreases with ϕ because a rise in ϕ exposes the domestic market to more imports.[25] On the other, π_{ji} exhibits an inverted-U shape in terms of ϕ. As ϕ rises, the affiliate can import goods at a lower cost and thus set a lower selling price. This explains the increasing part of π_{ji}. A further decline in ϕ induces the drastic relocation of plants from country 2 to 1. The massive inflow of plants leads to tougher competition in country 1, reducing π_{21}. The relocated plants in turn export goods at a lower transfer price, making tougher competition in country 2 and thus reducing π_{12}. These explain the decreasing part of π_{ji}.

The overall shape of tax revenues, TR_i, depends on the relative importance of π_{ii} and π_{ji}, which is determined by the plant distribution N_i. Since N_1 gets larger as ϕ approaches ϕ^S, TR_1 and TR_2 are respectively governed by $N_1\pi_{11}$ and $N_1\pi_{12}$. Consequently, TR_1 decreases with ϕ as π_{11} does, while TR_2 exhibits an inverted-U shape in

[24]The parameter values are the same as those in Figure 2.2. For $\phi \geq \phi^S$, π_{21} and π_{22} are not drawn because there are no multinationals with production in country 2, i.e., $N_2 = 0$.

[25]Strictly speaking, π_{ii} consists of the profit from domestic market and the profit from intra-firm trade, which respectively corresponds to the "Domestic profit" term and the "Shifted profit" term in Eqs. (2.5-1) and (2.5-2). The domestic profit decreases with ϕ, while the shifted profit does not necessarily so. Since the shifted profit is discounted by trade costs and is thus smaller than the domestic profit in absolute terms, the overall shape of π_{ii} is determined by that of domestic profit.

Figure 2.4: Profits and tax revenues: Country 1 on the left and country 2 on the right



terms of ϕ as π_{12} does.

Centralized decision making. We assumed that MNEs have decentralized decision making, where foreign affiliates choose prices to maximize their own profits. Our main result holds true if MNEs have centralized decision making, in which the MNE chooses all prices to maximize global profits. Note that the direction of profit shifting does not change depending on the decision making style. That is, foreign affiliates source goods from production plants by paying high (or low) transfer prices if they are in the low-tax country (or the high-tax country). By locating in the low-tax country, foreign affiliates enjoy a higher price-cost margin than those located in the high-tax country ($p_{12} - g_1 > p_{21} - g_2$) and earn larger profits. As in the decentralized decision making case, profit shifting affects the profitability of foreign affiliates asymmetrically, leading to agglomeration of production plants in the high-tax country. See Appendix B.6 for details.

2.4 Tax competition

We here allow countries to choose their tax rate non-cooperatively and compare the results of tax competition with profit shifting to those without profit shifting.

If two countries with equal size compete with each other, they end up with having equal taxes, resulting in the symmetric distribution of plants. To generate different tax rates between countries, we introduce size asymmetry and assume that country 1 is larger than country 2, i.e., $L_1 = s_1 L > (1 - s_1)L = L_2$, or $s_1 > 1/2$. If there were no tax differences, there would exist a sustain point above which level of trade freeness the large country 1 would host all plants (see e.g., Chapter 3 of Baldwin et al., 2003).

Following Baldwin and Krugman (2004), the objective function of the government in each country takes the form of

$$G_i = TR_i - \frac{\beta t_i}{1 - t_i},$$
$$\text{where } TR_i \equiv t_i(N_i \pi_{ii} + N_j \pi_{ji}), \quad i \neq j \in \{1, 2\}.$$

The first term represents tax revenues and the second term is a tax administration cost, where $\beta > 0$ captures its inefficiency.[26] The two governments simultaneously and non-cooperatively decide their tax rates before the location decision of MNEs.

To make our results as comparable as possible to those of prior studies (Baldwin and Krugman, 2004, in particular), we analyze tax competition in the full-agglomerated situation, known as the *core-periphery* situation. We focus on the situation where ϕ is higher than a sustain point and country 1 hosts all plants ($n_1 = 1$) before tax competition.

No-transfer-pricing case. As a benchmark, we first derive the equilibrium tax rates when transfer pricing is not allowed. The inability to manipulate transfer prices implies that $g_i = \tau a$, resulting in zero profits from intra-firm trade: $(g_i - \tau a)q_{ij} = 0$ for $i \neq j \in \{1, 2\}$. Government i maximizes

$$G_i = \frac{\mu L_i t_i}{\sigma} - \frac{\beta t_i}{1 - t_i}.$$

Notice that G_i does not depend on trade freeness ϕ, which can be explained as follows. The taxable base, $N_i \pi_{ii} + N_j \pi_{ji}$, is proportional to the sales of plant and affiliate located in the country, $N_i p_{ii} q_{ii} + N_j p_{ji} q_{ji}$. The sales must be in turn equal to the country's

[26] Tax administration cost is well recognized as an important determinant of raising revenues (OECD, 2017; Profeta and Scabrosetti, 2017). OECD (2017) states that "Even small increases in compliance rates or compliance costs can have significant impacts on government revenues and the wider economy." (p.5) In addition, this objective function in general captures the fundamental conflicts governments face: they attempt to raise tax revenues while maintaining a low tax rate, which is thought of as a reduced-form objective that either selfish or benevolent government adopts (Baldwin and Krugman, 2004). See also Borck and Pflüger (2006); Han et al. (2014); and Kato (2015) for similar specifications.

expenditure, μL_i, which is independent of ϕ.[27]

Solving the first-order condition gives the unique equilibrium tax rate in country $i \in \{1, 2\}$:

$$\widehat{t}_i = 1 - \sqrt{\frac{\beta\sigma}{\mu L_i}}, \tag{2.6}$$

at which the government objective is positive: $G_i(t_i = \widehat{t}_i) > 0$. To exclude non-positive taxes, we will assume that $\widehat{t}_i > 0$, or $\beta < \overline{\beta} \equiv \mu L_2/\sigma$. It can be verified that the large country 1 sets a higher tax rate than the small country 2, i.e., $\widehat{t}_1 > \widehat{t}_2$, because its larger market size generates taxable agglomeration rents. This is in line with the results in the literature (Baldwin and Krugman, 2004).

The equilibrium taxes are indeed consistent with the core-periphery situation. That is, there exists the sustain point $\widehat{\phi} \in (0, 1)$ above which level of ϕ plants are fully agglomerated in country 1:

$$\begin{aligned} \widehat{\phi}^S &= \frac{1 - s_1}{s_1} \frac{1 - \widehat{t}_2}{1 - \widehat{t}_1} \\ &= \sqrt{\frac{1 - s_1}{s_1}}, \end{aligned} \tag{2.7}$$

which lies in between zero and one.

These results are summarized as follows (see Appendix B.5 for a proof).

Lemma 2.1 *(Tax competition without transfer pricing).*
Assume that $\beta < \overline{\beta} \equiv \mu L_2/\sigma$. Consider tax competition in the core-periphery situation without transfer pricing: $\phi \in [\widehat{\phi}^S, 1]$; $n_1 = 1$. The large country 1 maintains the full agglomeration of production despite its higher tax rate: $\widehat{t}_1 > \widehat{t}_2$.

Transfer-pricing case. We will see how the above results change if MNEs can use transfer pricing. As in the previous case, we consider tax competition in the range of trade freeness above the sustain point, where country 1 hosts all plants. The objective

[27] The constant mark-up pricing implies that $\pi_{ii} = (p_{ii} - a)q_{ii} = p_{ii}q_{ii}/\sigma$ and $\pi_{ji} = (p_{ji} - \tau a)q_{ji} = p_{ji}q_{ji}/\sigma$. From the manufacturing good's market clearing condition in country i, we have $N_i p_{ii} q_{ii} + N_j p_{ji} q_{ji} = \mu L_i$ or $N_i \pi_{ii} + N_j \pi_{ji} = \mu L_i/\sigma$.

functions become

$$G_1 = \frac{\mu t_1}{\sigma}\left[L_1 + \underbrace{\frac{(\sigma-1)\Delta t_1}{\sigma}L_2}_{\text{Erosion of taxable profits}}\right] - \frac{\beta t_1}{1-t_1},$$

$$G_2 = \frac{\mu L_2 t_2}{\sigma} - \frac{\beta t_2}{1-t_2}.$$

Country 1's objective now involves the tax difference, i.e., the second term in the square bracket of G_1, since plants in the high-tax country 1 move their profits to the low-tax country 2. If country 1 keeps its tax rate as high as it does in the no-transfer-pricing case, then it earns less tax revenues. Thus, country 1 has an incentive to lower its tax rate to prevent the erosion of taxable profits. On the other, as country 2 does not have any plants that receive shifted profits, its tax revenue is the same as in the no-transfer-pricing case.[28]

From the first-order conditions, we obtain the unique equilibrium tax rates:

$$t_1^* = 1 - \sqrt{\frac{\beta\sigma^2 + (\sigma-1)\sqrt{\beta\sigma\mu L_2}}{\mu L(\sigma - s_2)}}, \tag{2.8-1}$$

$$t_2^* = 1 - \sqrt{\frac{\beta\sigma}{\mu L_2}} \quad (= \widehat{t}_2), \tag{2.8-2}$$

which are positive and give positive government payoffs under $\beta < \overline{\beta} \equiv \mu L_2/\sigma$.[29] As expected, we can check that introducing profit shifting pushes downward country 1's

[28] In the transfer-pricing case, the taxable profit in country $i \in \{1, 2\}$ is

$$N_i\pi_{ii} + N_j\pi_{ji} = \frac{\mu L_i}{\sigma} + \frac{(\sigma-1)\Delta t_i}{\sigma}\frac{\phi\gamma_j N_j}{\sigma(N_i + \phi\gamma_j N_j)}\mu L_j,$$

where the first term in the right hand side is the taxable base in the no-transfer-pricing case. The second term is zero when $N_j = 0$.

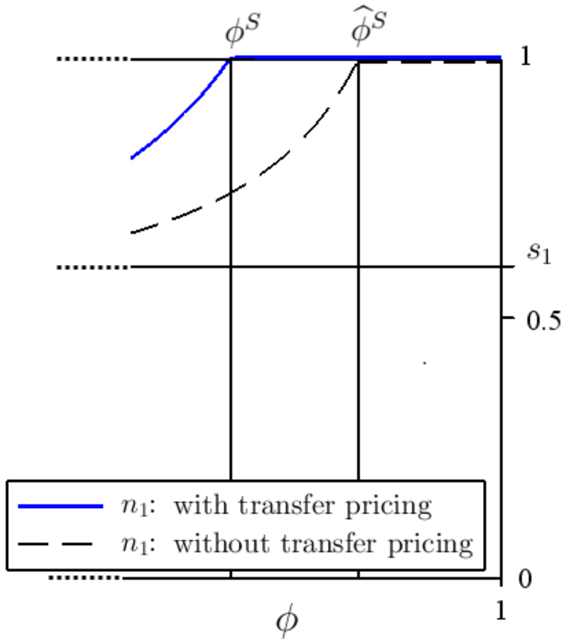
[29] The condition for $t_1^* > 0$ reduces to

$$\sigma^2\beta + (\sigma-1)\sqrt{\sigma\mu L_2}\sqrt{\beta} - \mu L(\sigma - s_2) < 0,$$

which holds under $\beta < \overline{\beta}$. Noting that $t_2^* = \widehat{t}_2$, we have

$$\begin{aligned} G_1(t_1 = t_1^*, t_2 = t_2^*) &> G_1(t_1 = t_2^*, t_2 = t_2^*) = \mu L_1 t_2^*/\sigma - \beta t_2^*/(1-t_2^*) \\ &> \mu L_2 t_2^*/\sigma - \beta t_2^*/(1-t_2^*) \\ &= G_2(t_2 = t_2^*) > 0. \end{aligned}$$

Figure 2.5: Sustains points under tax competition



tax rate: $t_1^* < \widehat{t}_1$ (see Eq. (2.6)).

Whether t_1^* is higher or lower than t_2^* depends on country 1's market-size share s_1. We can confirm that t_1^* is likely to be higher than t_2^* as s_1 is higher (or s_2 is lower). The intuition is as follows. Profit shifting from country 1 to 2 is less effective when country 2's market size is smaller and there are less exports to 2. Country 1 does not have to fear the erosion of taxable profits so that it can set t_1^* higher than t_2^*, while maintaining production agglomeration.

As in the no-transfer-pricing case, the equilibrium taxes are consistent with the core-periphery situation.[30] We can further show that ϕ^S is smaller than $\widehat{\phi}^S$ (see Eq. (2.7)), implying that full production agglomeration is more likely to occur due to transfer pricing, as illustrated in Figure 2.5.[31]

Thus, our main result in the exogenous-tax case, i.e., profit shifting making more likely production agglomeration in the high-tax country, carries over when countries

[30] Due to transfer pricing, ϕ^S takes a more complicated form than $\widehat{\phi}^S$ defined in Eq. (2.7). See Appendix B.7 for details.

[31] This result is independent of whether t_1^* is higher or lower than t_2^*. For the MNE's viewpoint, if $t_1^* > t_2^*$, country 1 is attractive not just because of its large market size but also because of the direction of profit shifting that makes their affiliates competitive. If $t_1^* < t_2^*$, on the other, the direction of profit shifting works against production agglomeration in country 1. But this effect is weaker than the effect of country 1's large market size enhanced by its lower tax rate.

are quite different in their market size.

These findings are summarized as follows (see Appendix B.7 for a proof).

Proposition 2.4 *(Tax competition with transfer pricing).*
Assume that $\beta < \overline{\beta} \equiv \mu L_2/\sigma$. Consider tax competition in the core-periphery situation with transfer pricing. The following holds:

(i) (Country 1's tax rate vs. country 2's) Country 1's tax rate is higher than country 2's if country 1 is large enough: $t_1^* > t_2^*$ if $s_1 > s_1^*$, where $s_1^* \in (1/2, 1)$ is the solution of $(\sigma s_1 - s_2)^2/s_2^3 - \mu L(\sigma-1)^2/(\beta\sigma) = 0$. Otherwise, country 1's equilibrium tax rate is equal to or lower than country 2's: $t_1^* \leq t_2^*$ if $s_1 \leq s_1^*$.

(ii) (Tax rates with and without transfer pricing) Compared to the no-transfer-pricing case, country 1's tax rate becomes low, whereas country 2's tax rate remains unchanged: $t_1^* < \widehat{t}_1$; $t_2^* = \widehat{t}_2$.

(iii) (Sustain points with and without transfer pricing) Compared to the no-transfer-pricing case, country 1 is likely to maintain the full agglomeration of production: $\phi^S < \widehat{\phi}^S$.

The conclusion that profit shifting pushes taxes downward (Proposition 2.4 (ii)) can be found in Haufler and Schjelderup (2000), who employ a framework of perfect competition with equal-sized countries.[32][33] Our result partly extends theirs to a setting with imperfect competition and unequal-sized countries.

By contrast, Stöwhase (2005, 2013) obtain the opposite result: the presence of profit shifting softens tax competition by increasing the equilibrium tax rates of both large and small countries.[34] Introducing profit shifting reduces MNEs' tax payments and makes them less sensitive to international tax differences; thus, tax competition becomes less severe. On the other, governments chase the shifted profits and intensify tax competition. In Stöwhase (2005, 2013), the former effect dominates the latter,

[32] Compared to the no-transfer-pricing case, the equilibrium tax difference always becomes small as long as country 1's tax rate is higher than country 2's, i.e., $0 < t_1^* - t_2^* < \widehat{t}_1 - \widehat{t}_2$ if $s_1 > s_1^*$.

[33] Agrawal and Wildasin (2019) also show that globalization, defined by a decline in relocation costs, leads to tougher tax competition in a linear spatial model where agglomeration is exogenously given.

[34] Becker and Riedel (2013) also obtain the similar result, although MNEs in their model cannot shift profits for tax-saving purposes.

whereas the opposite is true in our model. These differing results are mainly because our imperfectly competitive framework gives rise to the strategic purpose of transfer pricing. The strategic effect strengthens profit-shifting incentives and increases the tax-base sensitivity, leading to tougher tax competition.

2.5 Conclusion

Countries with lower corporate tax rates are expected to host more multinational production. Such a naive view may be challenged, however, because economic integration marked by falling trade costs allows for profit shifting and may thus change the location incentive of multinationals. To investigate this, we have introduced transfer pricing into a simple two-country model of trade and geography.

In the early stage of economic integration, the low-tax country attracts more production plants than the high-tax country. Further integration completely reverses this pattern and leads to the agglomeration of production in the high-tax country. With low trade costs expanding intra-firm trade, transfer pricing can be used for strategic motives as well as profit shifting. Shifting profits from the high-tax to the low-tax country through low transfer prices makes distribution affiliates competitive, whereas shifting profits the other way around does the opposite. MNEs thus prefer to locate production in the high-tax country in the late stage of economic integration.

The similar result can be obtained in a tax-competition framework in which two countries differ in size. In addition, introducing profit shifting may make tax competition fiercer by reducing the large country's equilibrium tax rate. These findings may help understand how economic integration shapes the distribution of multinational production and affects corporate tax policies.

Although our model is admittedly stylized, we believe that it is versatile enough to accommodate several extensions. One interesting extension is to introduce tax haven countries. While we assume that MNEs shift profits between affiliates in two countries, MNEs may do so using non-production affiliates in a third country with almost zero taxes. The question is which non-tax haven country, the high-tax or the low-tax one, benefits from the presence of tax haven countries. Another extension is to examine the impact of different international tax systems, such as separate accounting and formula apportionment. The system that prevents profit shifting effectively may differ depending on the degree of economic integration. We leave these avenues for future research.

Chapter 3

Tariff Elimination versus Tax Avoidance: Free Trade Agreements and Transfer Pricing

3.1 Introduction

For the past two decades, tax avoidance by multinational enterprises (MNEs) has been a controversial topic as the world has become more globalized. According to estimates by the OECD, at least 4% of tax revenue in 2015 disappeared because of profit shifting.[1] One way to shift profits across countries is to manipulate the price of intra-firm trade (transfer price), which is known as abusive transfer pricing. Specifically, because MNEs determine the prices of transactions between related companies, they manipulate these prices to decrease profits in high-tax countries and increase profits in low-tax countries. Some empirical research has provided evidence of transfer pricing being used to save tax payments.[2] As the taxes paid by firms are one of the main sources of government revenues, tax avoidance by MNEs has become a serious issue, as trade liberalization and the creation of global value chains increase intra-firm trade and provide MNEs with greater opportunities to redistribute their tax base to low-tax

This chapter is based on joint work with Hiroshi Mukunoki (Mukunoki and Okoshi, 2019b).

[1] See `www.oecd.org/tax/corporate-tax-remains-a-key-revenue-source-despite-falling-rates-worldwide.htm`, accessed on November 14, 2019.

[2] For instance, Swenson (2001), Clausing (2003), Cristea and Nguyen (2016), and Davies et al. (2018) provided empirical evidence of transfer price manipulation. Blouin et al. (2018) found conflicting motives when MNEs use transfer pricing to lower corporate tax as well as tariff payments.

countries.

Our primary focus is on how such losses of tax revenues are linked to trade liberalization driven by trade agreements. Trade agreements among countries facilitate firms' exports and imports; however, they also influence firms' behaviors in other respects including transfer pricing and generate more complicated welfare effects. In particular, the specific rules needed to implement trade agreements complicate the effects of trade liberalization. Here, we focus on the rules of origin (ROO) of a free trade agreement (FTA), which require exporters in member countries making tariff-free exports to other member countries to prove that the exported products originated within the FTA.[3] To meet ROO, firms may change their strategies such as their input procurement. For instance, Conconi et al. (2018) concluded that the ROO of the North-American Free Trade Agreement (NAFTA) reduce imports of inputs from non-member countries, suggesting that such rules cause input procurement to become inefficient. From the viewpoint of tax avoidance, this also implies that ROO can be an obstacle for MNEs to shift profits within the firm because they may need to consider whether their intra-firm transactions satisfy the requirements of ROO.

One way to prove the origin is to satisfy a value-added (VA) criterion, which is closely related to transfer price manipulation.[4] The VA criterion requires firms to add a sufficient value inside FTA member countries. Specifically, let p denote the export price of the product and r denote the value of input materials, which are used per unit of final good production and do not originate in the FTA. Then, a VA criterion typically requires that the VA ratio, $(p-r)/p$, is above the specified level. This method of calculating the VA content is called the "transaction value method." The value of input materials depends on the transfer price if MNEs procure inputs from related companies outside FTA countries. Therefore, a VA criterion can be a constraint for MNEs to engage in tax avoidance via abusive transfer pricing.

Although this possibility has been overlooked in the economic literature on transfer

[3]Regional trade agreements in goods are classified into FTAs and customs unions. Unlike customs unions, member countries of an FTA can set their own tariff schedule against non-member countries, which provides an opportunity for firms producing outside the FTA to save tariff payments by choosing as a transit country the member country whose tariff against non-member countries is low and re-exporting from that country to other FTA member countries whose tariffs against non-member countries are higher. See, for example, Stoyanov (2012) for evidence of firms' incentive to transship a good through FTA members. To forestall firms from tariff avoidance, the WTO stipulates ROO.

[4]Other ways to prove the origins of products include changing the tariff classification criterion and specific process criterion. Although the effects of these criteria are also important, this study focuses only on the VA criterion.

pricing and that of FTA, it has been pointed out by some policy papers. For instance, Eden (1998) examined the ROO of NAFTA and suggested that "... underinvoicing parts coming outside North America and overinvoicing locally made parts would increase the North American content." Falvey and Reed (1998) indicated that the VA criterion "... allows room for [the] manipulation of prices as well as quantities, and may generate additional incentives for transfer pricing by multinationals." Reuter (2012) also pointed out that "most rules of origin are on a percent-of-value basis. ... By overinvoicing the value added, the MNE can more easily meet a rule-of-origin test and qualify for duty-free entry for its products into another country in the free trade area."[5] Furthermore, the World Customs Organization suggests that one of the disadvantages of the VA criterion of ROO is possible exposure to transfer pricing.[6] As Estevadeordal and Suominen (2003) reported that 68 of the 87 FTAs they analyzed employ a VA criterion at least in a particular product category, these statements tell us that investigating the role of ROO to restrict the abusive use of transfer pricing is important to understand the impact of FTAs on tax avoidance and welfare.

As countries have dealt with the tax avoidance problem, analyzing the anti-tax avoidance aspect of ROO is important for policymakers. In reality, different groups of policymakers, namely, customs and tax authorities, are responsible for designing trade policies and regulations on transfer pricing. Therefore, the interaction between these two authorities has been rare. According to WCO (2018), "... the WCO [World Customs Organization] is working with the OECD and World Bank Group to encourage Customs and tax administrations to establish bilateral lines of communication in order to exchange knowledge, skills and data, where possible, which will help ensure that each authority has the broadest picture of a MNE's business, its compliance record and can make informed decisions on the collect revenue liability." Thus, as the number of FTAs and volume of intra-firm trade have increased, exploring the relationship between transfer prices and ROO is an urgent issue.

Against this background, this study builds an international monopoly model to investigate an MNE's response to an FTA formation with two new elements: transfer pricing and ROO.

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[5]Some practitioners see the link as one factor to be considered and state that "if transfer pricing changes the value of local content, then the ROO as applied may remove any FTA benefit that was previously available" (see `https://www.expertguides.com/articles/oecd-beps-project-and-trade-new-perspectives/AREXIEUO`, accessed on May 3, 2018).

[6]See `http://www.wcoomd.org/-/media/wco/public/global/pdf/topics/origin/overview/origin-handbook/rules-of-origin-handbook.pdf`, accessed on May 3, 2018

3.1.1 Preview of the model and results

The MNE produces final goods within an FTA member country and exports the goods to the other FTA member country. The MNE procures inputs from either an FTA member country or a low-tax country outside the FTA. We assume input production is efficient in the outside country. Therefore, if the MNE procures inputs from a related company in a country outside the FTA, it can exploit efficient inputs as well as shift profits across countries by manipulating the transfer price.

In the absence of ROO, the MNE always prefers to produce inputs outside the FTA by itself and engage in tax avoidance by setting a high transfer price. However, the presence of ROO restricts the manipulation of the transfer price because a high transfer price reduces the VA ratio of the final product inside the FTA. If the MNE procures inputs inside the FTA, it always complies with the ROO and exports its product without paying a tariff, although it cannot save tax payments by transfer pricing. If the MNE locates its upstream affiliate in a country outside the FTA, it either saves corporate tax payments by setting a high transfer price or complies with the ROO to avoid a tariff burden by setting a low transfer price. Thus, the MNE chooses one of three options: (i) procuring inputs inside an FTA to comply with the ROO and eliminate tariffs, (ii) fully manipulating its transfer price to avoid tax payments at the expense of the preferential tariff of the FTA, or (iii) adjusting its transfer price to comply with the ROO to both eliminate tariffs and pursue partial tax avoidance.[7] This model exhibits the MNE's choice of "tariff elimination versus tax avoidance" via its location choice of producing inputs and/or transfer price manipulation.

The third option, adjusting the transfer price to comply with the ROO, is the optimal choice for the MNE when the stringency of the VA criterion is low and adjusting the transfer price is less costly for the MNE. However, stricter ROO induce the MNE to deviate more from the optimal abusive transfer price, which retains a part of the MNE's tax base in the high-tax country. Because of this inefficient tax avoidance, a higher VA criterion changes the MNE's optimal choice. When the tax differential is huge and the MNE purchases inputs made in an FTA country, the MNE gives up the FTA tariff but manipulates the transfer price to pursue tax avoidance. This is because the tax avoidance motive is greater than the tariff avoidance motive.

[7] Although the MNE uses its transfer price for ROO compliance, it can still shift profits from one country to another to save tax payments when the VA requirement is less stringent and the tax gap is large. Nevertheless, the overall tax payments become larger because the transfer price is suboptimal from the viewpoint of tax savings.

As ROO restrict the abusive use of transfer pricing by either a change in input procurement or an adjustment of the transfer price, tax revenues in a high-tax country increase. Thus, the VA criterion works as an anti-tax avoidance policy. An interesting result is that the direction of shifted profits can be from a low-tax country to a high-tax country when the MNE adjusts the transfer price to meet the VA criterion. This is because the gain from efficient input production outside FTA countries becomes greater as the tariff falls, and this outweighs the loss from more tax payments in a high-tax country. This case is possible when the tax gap is small.

We also show that ROO transform an infeasible FTA into a feasible one. In the absence of ROO, an FTA formation is harmful for member countries when the initial tariff is small and the loss from the disappearance of tariff revenues exceeds consumers' gains. In the presence of ROO, FTA countries can collect tax revenues from the MNE. Although consumers' gains from the FTA are smaller than those without ROO, tax revenues from the MNE can cover the smaller consumers' gains and the loss of tariff revenues. Our results present a new role of ROO in preventing abusive transfer pricing and making the FTA an welfare-improving one for member countries.

However, the country makes little tax revenue from the MNE when the absolute level of the corporate tax in the high-tax country is low. In this case, ROO can deteriorate total welfare inside FTA countries and make an initially feasible FTA infeasible.

3.1.2 Relationship to the literature

The welfare effects of FTAs with ROO have previously been analyzed, but such studies focus on intermediate goods markets.[8] Krishna and Krueger (1995) showed that ROO may work as a hidden protection against input suppliers outside the FTA. Ju and Krishna (2005) showed that ROO increase the price of FTA-made inputs and reduce total output if they are not so stringent such that all firms comply with the ROO, whereas they have the opposite effects if ROO are sufficiently stringent such that some firms choose not to comply with them. In Ju and Krishna (2005), however, the output price is fixed and they did not consider how ROO affect consumers. Demidova and Krishna (2008) extended Ju and Krishna (2005) to include the productivity heterogeneity of final good producers and showed that productivity sorting ensures the

[8] More broadly, many studies have investigated the welfare effects of regional trade agreements both theoretically and empirically. See Freund and Ornelas (2010) for a review of the literature on regional trade agreements.

negative relationship between the stringency of ROO and demand for FTA-made inputs (i.e., wages). Ishikawa et al. (2007) focused on final good markets and showed that ROO have a role to segment markets within the FTA and that both inside and outside firms producing final goods may benefit from ROO at the cost of consumers. Mukunoki (2017) showed that an FTA with ROO may harm consumers if it changes outside firms' location decisions. None of these papers, however, have considered transfer price manipulation to meet ROO. Mukunoki and Okoshi (2019a) investigated a firm's export price manipulation to comply with ROO, particularly how an MNE's transfer price manipulation affects inputs imported from outside FTA. Furthermore, Felbermayr et al. (2019) suggested that there is little rationale for ROO because tariff circumvention is not profitable for 86% of bilateral trade because of the small differences in external tariffs and non-negligible transport costs. This study thus provides a new rationale for ROO from the viewpoint of tax avoidance by an MNE.

Specifically, this study examines the connection between transfer pricing and trade policy. Some studies have investigated the relationship between transfer pricing and trade barriers including tariffs. Horst (1971) showed that the optimal transfer price is influenced by not only tax differentials but also tariffs. Schjelderup and Sørgard (1997) showed that if the importing country imposes an ad valorem tariff on inputs, an MNE can save tariff payments by reducing its export price.[9] Then, the optimal transfer price is influenced by both corporate tax avoidance and tariff avoidance. Kant (1988b) regarded the transfer price as a tool to repatriate profits when a foreign subsidiary is not fully owned by the parent firm. With the partial ownership of the foreign affiliate, the profit shifted from the home to the foreign country is partly distributed to other owners. The study found that even when the tax rate in the home country is higher than the tax rate in the host country, an MNE has an incentive to remit all the profit earned in the low-tax host country if both the tariff and the proportion of the MNE's ownership shares in the foreign affiliate are low. This research, however, did not explicitly consider trade liberalization by forming an FTA, let alone the effects of ROO on transfer prices.

The presented model also contributes to the literature on transfer pricing policies since MNEs have been accused of tax avoidance activities and how to regulate transfer prices has been a central issue in policy debates. Several studies have examined the impacts of policies on transfer price manipulation. Elitzur and Mintz (1996) investigated

[9] Given the multiple roles of transfer prices, recent work has examined MNEs' optimal strategies (Hyde and Choe, 2005; Nielsen et al., 2008; Dürr and Göx, 2011). None of them, however, link transfer pricing and ROO.

the determinants of transfer prices when tax authorities use the cost-plus method to infer the appropriate transfer price. Nielsen et al. (2003) compared the use of transfer prices under two international tax systems, namely, separating account and formula apportionment.[10] Choi et al. (2018b) examined the impact of the arm's length principle, under which MNEs should set the same price for intra-firm transactions as for the same transaction conducted between independent firms.[11] As their focus was on direct regulation on transfer pricing, transfer pricing for meeting ROO has been overlooked in the literature.

The rest of the paper is organized as follows. In Section 3.2, we set up the model and derive an equilibrium without ROO. Sections 3.3 and 3.4 investigate the effect of an FTA with ROO. Section 3.5 discusses the robustness of the main results by relaxing some key assumptions. The last section concludes.

3.2 Model

There are three countries, H, F, and O; countries H and F are potential FTA members. Fig. 3.1 illustrates the model. A single firm, an MNE, produces a final good using inputs and sells it in country F.[12] For simplicity, the benchmark model ignores the output market in country H and focuses only on the consumers in country F.[13] The representative consumer's utility in country F is given by $U = ax - x^2/2$, where x is the consumption of the final good. By utility maximization, the inverse demand function becomes $p = a - x$.

One of the two member countries, country H, has a location advantage for final good production because of low factor prices, a large pool of skilled labor, and so on. There-

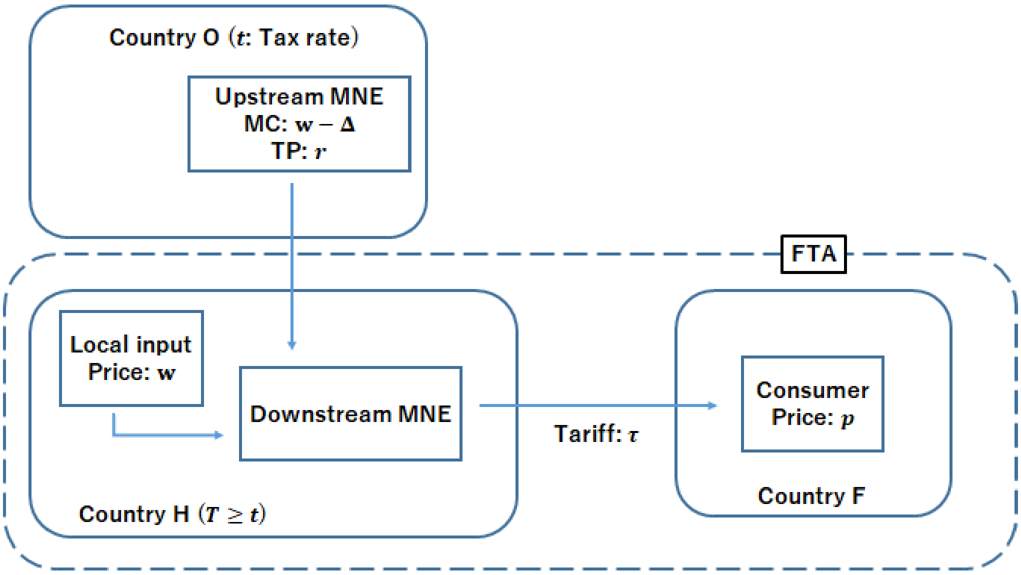
[10]The traditional international corporate tax system is the separating account system that computes MNEs' national tax base by regarding intra-firm transactions as inter-firm transactions. On the contrary, under the formula apportionment system, MNEs' tax payments to one country depend on their consolidated tax base and the proportion of activity operated in the country. See more details in Chapter XVI, Article 86 of European Commission (2011).

[11]Bauer and Langenmayr (2013), Choe and Matsushima (2013), and Kato and Okoshi (2019b) also investigated the effect of the arm's length principle on the input procurement decision, tacit collusion, and input production location, respectively.

[12]If we consider local firms in the FTA members and oligopoly in the final good market, the fundamental properties of our results remain unchanged, although the analysis becomes more complicated. See Mukunoki and Okoshi (2019b) for an oligopoly version of the model.

[13]This assumption does not qualitatively change our main results as long as the two markets are segmented in the sense that the MNE can make a separate decision in each market.

FIGURE 3.1: Model



fore, country H always hosts a downstream affiliate of the MNE (firm M_H). The MNE's headquarters (firm M_O) is located in country O.[14] M_O may also produce an input for final good production, as explained below.

Firm M_O has already operated in country O and makes positive profits, $\overline{\pi}$, that are exogenously given. To produce the final product, firm M_H needs to procure one unit of inputs for the production of one unit of final products.[15] Firm M_H can procure the input from a perfectly competitive input market inside FTA countries, which supply the input at the price of w. Alternatively, firm M_O located in country O can produce the input at the cost of $w - \Delta$. We assume $\Delta > 0$ and $\Delta \in [0, w]$. Therefore, input production in country O is more efficient than that in country H. This implies that the self-production of the input in country O gives the MNE not only a lower input cost but also a tax-saving opportunity via the manipulation of the transfer price, which is

[14]This type of foreign direct investment (FDI) is known as export platform FDI, where the FDI firm exports from the host country to other countries. For example, see Tekin-Koru and Waldkirch (2010) for Mexican evidence of its increasing role as a host of export platform FDI. Tintelnot (2017) showed the share of output exported to countries outside the host country by U.S. MNEs. For instance, the share of exports located in Belgium was 63% in 2004.

[15]We can consider a more general situation in which the MNE uses a continuum of inputs and decides the extent to which it uses the intra-firm inputs for final good production. As explained in Section 3.5.2, this modification does not change the qualitative results of the benchmark model.

denoted by r. We assume away transfer pricing that realizes negative reported profits because tax authorities can audit tax avoidance.

Without the FTA, country F imposes a specific tariff, τ, on imports of the final good. We consider the case in which $\tau < a - w + \Delta$ holds to rule out negative output in the equilibrium. In addition, the governments in countries O and H respectively levy t and T as a corporate tax on reported profits.[16][17] To focus on the impact of FTA formation on the final good market, tariffs on inputs are assumed away. Hereafter, we focus on the case in which $T \geq t$ holds.[18]

3.2.1 The equilibrium without ROO

Let us first derive the market equilibrium without ROO in each scheme of the MNE choice. In the inshoring scheme, denoted as scheme I, the MNE purchases the input from local producers. Firm M_H earns profits under the cost of inputs w and a tax rate T. In the offshoring scheme, denoted as scheme O, the MNE's headquarters in country O, firm M_O, produces the input at the production cost of $w - \Delta$. Firm M_O sells the input to firm M_H at the input price denoted by r. Thus, r is the transfer price of the MNE.

The post-tax profits under the inshoring scheme are given by

$$\Pi^I = (1-T)\underbrace{\left(\frac{a-w-\lambda\tau}{2}\right)^2}_{\pi_H^I} + (1-t)\underbrace{\overline{\pi}}_{\pi_O^I}, \tag{3.1}$$

where λ is a state variable that takes zero if the MNE qualifies for an FTA tariff rate and unity otherwise. π_i^s represents the reported profits of firm M_i under scheme $s \in [I, O]$.

[16] We use the terms "tax rate" and "tax revenue" to represent the corporate tax rate and corporate tax revenue, respectively. Here, tax rate and tax revenue are distinguished from tariff rate and tariff revenue.

[17] In this model, we postulate that the governments in countries O and H adopt a territorial tax system instead of a worldwide one. After the United States moved from a worldwide tax system to a territorial tax system in xxxx, most OECD countries have since adopted a territorial tax system.

[18] This situation is consistent with the real-world observation. For instance, Mexico and Belgium have higher corporate taxes than other countries and these countries are major host countries of export platform FDI. See also footnote 14.

In the offshoring scheme, the MNE maximizes

$$\Pi^O = (1-T)\underbrace{(p-r-\lambda\tau)x}_{\pi_H^O} + (1-t)\underbrace{[\{r-(w-\Delta)\}x+\overline{\pi}]}_{\pi_O^O}$$

with respect to r and x, subject to $\pi_H^O \geq 0$ and $\pi_O^O \geq 0$. Since $\frac{\partial \Pi_O}{\partial r} = (T-t)x > 0$ always holds, the MNE is willing to set the optimal transfer price as high as possible. Therefore, the optimal abusive transfer price is set at the level that transfers all the profits earned in a high-tax country to a low-tax country, $r = p - \lambda\tau$.[19] Thus, the post-tax profits under the offshoring scheme are given by

$$\Pi^O = (1-t)\left(\frac{a-w+\Delta-\lambda\tau}{2}\right)^2 + (1-t)\overline{\pi}. \tag{3.2}$$

Irrespective of the formation of an FTA, the MNE always prefers the offshoring scheme to the inshoring scheme as

$$\Pi^O - \Pi^I = (1-t)\left(\frac{a-w+\Delta-\lambda\tau}{2}\right)^2 - (1-T)\left(\frac{a-w-\lambda\tau}{2}\right)^2 \geq 0 \tag{3.3}$$

holds. Intuitively, procurement from its upstream affiliate provides the MNE with both efficient input production and the opportunity to shift profits.

For notational convenience, we use the superscript "$*$" for the variables in the pre-FTA case and "$\widehat{\ }$" for the variables for post-FTA without ROO hereafter.

3.2.2 The welfare effects of FTA formation without ROO

To explore the welfare effects of FTAs, we focus on the total welfare of FTA countries. If the redistribution of gains from the FTA is possible between member countries, the FTA is feasible if total welfare increases. The total welfare of FTA countries is the sum of the consumer surplus in country F (CS^s), tax revenues of country H paid by the MNE (TR_H^s), and tariff revenues in country F (TR_F^s):

$$W^s = CS^s + TR_H^s + TR_F^s = \frac{(x^s)^2}{2} + T\pi_H^s + \lambda\tau x^s. \tag{3.4}$$

[19] We assume there is no cost of shifting profits across countries. This is a conventional way of determining the optimal transfer price in the literature, when cost-for-profit shifting is absent. We relax this assumption by introducing a standard convex concealment cost in Section 3.5.3.

Total welfare does not include the post-tax profits of the MNE because it is owned by residents outside the FTA.

Since member countries cannot collect tax revenues when the MNE chooses offshoring, total welfare under offshoring becomes

$$\begin{aligned}\widetilde{W} - W^{O*} &= \widehat{CS} - CS^{O*} - TR_F^{O*} \\ &= \frac{-2(a-w+\Delta)+3\tau}{8} \gtreqless 0 \iff \tau \gtreqless \frac{2(a-w+\Delta)}{3} \equiv \tau^W. \qquad (3.5)\end{aligned}$$

As equation (3.5) shows, an FTA without ROO generates a trade-off between an increase in the consumer surplus and disappearance of tariff revenues. When the initial tariff rate is high, the consumers' gains exceed tariff revenues and the FTA formation increases the total welfare of member countries. This section concludes with the following proposition.

Proposition 3.1 *In the absence of ROO, the MNE always procures inputs from its upstream affiliate outside FTA countries. Forming an FTA benefits member countries when the initial tariff rate is high ($\tau > \tau^W$) and hurts them when it is low ($\tau < \tau^W$).*

3.3 Equilibrium with ROO

In this section, we consider FTA formation with ROO. As stated in the Introduction, our focus is on the VA criterion of ROO. Specifically, a VA criterion is applied to exports of the final good in the FTA. For notational convenience, we use "$\sim$" as a circumflex for the variables in the presence of ROO.

3.3.1 The MNE's decisions in each scheme

After an FTA is formed, firm M_H needs to meet the VA criterion to be eligible for the elimination of τ. Specifically, ROO require firm M_H to add a proportion of at least $\underline{\alpha}(\in [0,1])$ of the values of exported goods within the FTA. There are three cases, which we explain sequentially below.

If firm M_H chooses the offshoring of input production and sets an abusive transfer price, $\widehat{r} = p$, the VA ratio is always zero, which fails to meet the requirement of the ROO.

Hence, the final good exports of the MNE incur the tariff, τ, even after the formation of the FTA. We call this case scheme N (non-compliance).[20] The equilibrium outcomes of this scheme are obtained by setting $\lambda = 1$ in equations (3.2) and (3.4), as well as in the other corresponding welfare components.

For firm M_H to utilize the FTA tariff, it has to comply with the ROO by either (i) inshoring the input procurement (scheme I) or (ii) setting r such that

$$\alpha \equiv \frac{p^O - r}{p^O} \geq \underline{\alpha} \tag{3.6}$$

is satisfied. We call this case scheme B (binding ROO). It is apparent that $(p^O - r)/p^O$ is decreasing in r and thereby the VA ratio, α, is more likely to exceed $\underline{\alpha}$ as the MNE sets a lower r. Remember that $\frac{\partial \Pi_O}{\partial r} > 0$ holds. Then, the optimal transfer price is set such that it binds equation (3.6), which is calculated as

$$\widetilde{r}^B = (1 - \underline{\alpha})p. \tag{3.7}$$

As the ROO become stricter, the MNE needs to add more VA inside the FTA and thus the optimal transfer price must decrease by $\underline{\alpha}p$, which is regarded as the adjustment factor for meeting the ROO. We can easily see that $\widetilde{r}^B$ is decreasing in $\underline{\alpha}$ and is equivalent to $\widehat{r}$ with $\underline{\alpha} = 0$.

Given the optimal transfer price, the post-tax profits of the MNE are given by

$$\begin{aligned}\Pi^B &= (1-T)\underbrace{(p - \widetilde{r}^B)x^B}_{\pi_H^B} + (1-t)\underbrace{[\{\widetilde{r}^B - (w - \Delta)\}x^B + \overline{\pi}]}_{\pi_O^B} \\ &= \{1 - t - \underline{\alpha}(T - t)\}(p - c_M)x^B + (1-t)\overline{\pi},\end{aligned} \tag{3.8}$$

where $c_M = \frac{(1-t)(w-\Delta)}{\{1-t-\underline{\alpha}(T-t)\}} (\geq w - \Delta)$ represents the "perceived marginal cost" of producing the final good.[21] The perceived marginal cost is higher than the physical marginal cost, $w - \Delta$, as long as $\underline{\alpha}$ is positive and $T > t$. Given the level of t, both an increase in the stringency of the ROO ($\underline{\alpha}$) and that in the tax differential ($T - t$) increase the

[20] Some empirical evidence shows that not all firms use FTA tariffs because of the existence of ROO, which means the impacts of FTA formation are heterogeneous across firms. See, for example, Takahashi and Urata (2010) and Hayakawa et al. (2013).

[21] The terminology "perceived marginal cost" is often used in the analysis of vertically related industries in the context of industrial organization. See Choi et al. (2018b) for an application of this terminology in the tax avoidance literature.

perceived marginal cost.

We can interpret the perceived marginal cost as follows. Without any ROO, the MNE shifts all the profits to a low-tax country by setting $\widetilde{r} = p$. From $\widetilde{r} = p$, the introduction of the ROO decreases the transfer price by as much as $\underline{\alpha}p$ and increases the per-unit tax payments of the MNE by as much as $\underline{\alpha}(T-t)p > 0$. This means that the ROO decrease the MNE's post-tax profits of selling the final good and makes it less aggressive in the product market under scheme B. The lower incentive to sell the final good is reflected in the perceived marginal cost.

The output decision of the MNE is made with c_M instead of $w - \Delta$, generating the following equilibrium profit:

$$\widetilde{\Pi}^B = \frac{\{(1-t)(a-w+\Delta) - \underline{\alpha}(T-t)a\}^2}{4\{1-t-\underline{\alpha}(T-t)\}} + (1-t)\overline{\pi}. \tag{3.9}$$

The post-tax profits under scheme B are a decreasing function of $\underline{\alpha}$ because an increase in $\underline{\alpha}$ induces the MNE to set a transfer price that deviates more from the level at which it avoids tax payments in the high-tax country.

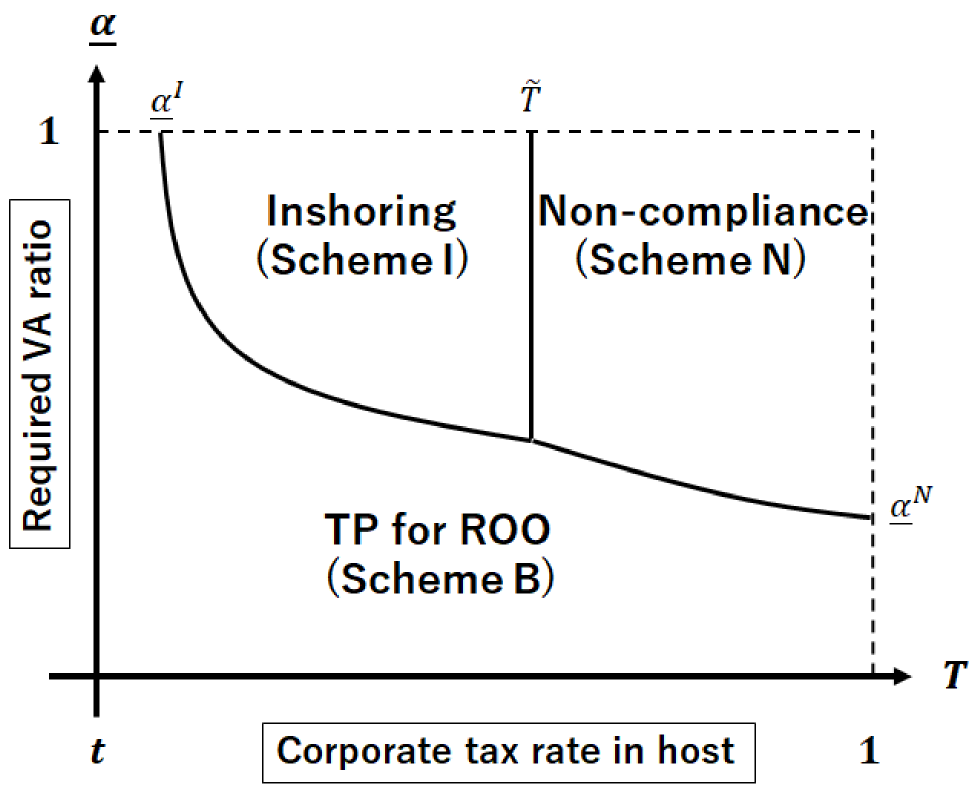
3.3.2 The MNE's choice of scheme

Among the three possible schemes (I, N, and B), the MNE chooses the one that maximizes its profits. Let us first compare $\widetilde{\Pi}^I$ with $\widetilde{\Pi}^N$. Since both profits are independent of the VA threshold, $\underline{\alpha}$, the tariff level and tax differential determine which profit is larger. The MNE faces a trade-off between tax avoidance and tariff avoidance. If the tax differential is large, the MNE prefers scheme N to scheme I because of the stronger incentive to avoid tax payments in country H. If the tax differential is small, scheme I is more preferable for the MNE. Thus, there exists a unique threshold of T, $\widetilde{T}$, such that $\widetilde{\Pi}^I = \widetilde{\Pi}^N$ holds. As a larger tariff discourages the MNE from choosing scheme N, $\frac{\partial \widetilde{T}}{\partial \tau} > 0$ holds.[22]

Let us next compare the profits in scheme B with those in schemes N and I. Since $\widetilde{\Pi}^B = \widehat{\Pi}$ holds at $\underline{\alpha} = 0$, which is larger than $\widetilde{\Pi}^N$ and $\widetilde{\Pi}^I$, and $\widetilde{\Pi}^B$ is decreasing in $\underline{\alpha}$, we can derive a unique threshold, $\underline{\alpha}^N$ (resp. $\underline{\alpha}^I$), above which the MNE prefers scheme N (resp. scheme I) to scheme B. Intuitively, under less strict ROO, the MNE prefers

[22]Formally, the threshold is calculated as $\widetilde{T} = 1 - (1-t)\left(\frac{a-w+\Delta-\tau}{a-w}\right)^2 < 1$. We can confirm that $\widetilde{T}$ is greater than t if and only if $\Delta < \tau$ holds. To secure the existence of the equilibrium with scheme I, we additionally assume $\Delta < \tau$ hereafter.

Figure 3.2: The equilibrium MNE's choice



scheme B to schemes N and I because adjusting the transfer price to comply with those ROO becomes less costly as the VA criterion becomes less stringent.[23] In other words, the MNE's gains from tariff elimination by adjusting the transfer price become smaller as the FTA is attached to more stringent ROO.

Putting the above comparisons together, we characterize the equilibrium outcomes as follows, which is illustrated in Figure 3.2.

Proposition 3.2 *After an FTA with ROO is formed, the MNE chooses (i) inshoring if $T \leq \widetilde{T}$ and $\alpha > \underline{\alpha}^I$ hold, (ii) offshoring and its exports incur a tariff if $\widetilde{T} < T$ and $\alpha > \underline{\alpha}^N$ hold, and (iii) offshoring and it adjusts its transfer price to meet The ROO if $\underline{\alpha} \leq \min\{\underline{\alpha}^I, \underline{\alpha}^N\}$ holds.*

Proof. See Appendix C.1.

[23]Here, the MNE meets the ROO by changing its transaction input price. An offshoring firm may also adjust its export price p to meet the VA criterion. This possibility is analyzed by Mukunoki and Okoshi (2019a).

Remember that the MNE always chooses the self-production of inputs before an FTA is formed. After an FTA is formed, this proposition suggests that the MNE may change its input procurement from self-production to the purchase of local inputs, even though the production cost is higher. As Conconi et al. (2018) showed, ROO lower the likelihood of input procurement from non-FTA countries. This "input trade diversion" corresponds to the area of scheme I in Figure 3.2.

Further, as Takahashi and Urata (2010) and Hayakawa et al. (2013) pointed out, some firms may not utilize FTA tariffs because of the burden of the ROO. This possibility corresponds to the areas $\widetilde{T} \leq T$ and $\underline{\alpha}^N \leq \underline{\alpha}$ in Figure 3.2. A standard explanation of the non-use of an FTA is that export firms must incur additional costs to meet the ROO. Our model suggests another burden of meeting the ROO: it increases tax payments by restricting the MNE's freedom to adjust its transfer price.

3.4 Welfare effects with ROO

In this section, we explore the welfare effect of the FTA with ROO. As the FTA has no effect if the post-FTA equilibrium scheme is scheme N, we investigate the welfare effects in schemes I and B. Hereafter, we discuss the effect on each component of welfare and the total welfare of member countries. We also discuss the optimal level of the ROO that maximizes members' joint welfare.

3.4.1 Consumer surplus

Let us begin with the effect on consumers. Under scheme I, FTA formation increases the marginal cost of production from $w - \Delta$ to w because the MNE changes the location of its input procurement. However, the FTA formation also eliminates the tariff, τ, faced by the MNE. We can easily confirm that the MNE chooses scheme I only if $\Delta < \tau$ holds (see footnote 22). Therefore, the FTA always decreases the MNE's marginal cost of exports whenever scheme I becomes the equilibrium outcome and it always increases the exports of the MNE.[24]

Under scheme B, the MNE also faces a higher marginal cost because the perceived marginal cost is higher than $w - \Delta$. As in scheme I, however, the MNE chooses

[24]Specifically, the change in exports becomes $\Delta x^{I*} = \widetilde{x}^I - x^{O*} = (\tau - \Delta)/2$, which is positive if $\Delta < \tau$ holds.

scheme B only if the cost reduction from tariff elimination dominates the increase in the marginal cost of production (see the Appendix for details). Therefore, the FTA always increases the exports of the MNE whenever scheme B becomes the equilibrium outcome. Putting the two cases together, we have the following proposition.

Proposition 3.3 *An FTA formation with ROO always benefits consumers if the MNE utilizes an FTA tariff and has no effect on consumers otherwise. The presence of ROO decreases consumers' gains.*

Proof. See Appendix C.2.

Although FTA formation is beneficial for consumers, ROO decrease consumers' gains because of the increase in the production cost due to the inefficient procurement of inputs (scheme I) or increase in the perceived marginal cost (scheme B). Hence, ROO have no effect on consumers' gains in scheme B because the tariff is eliminated and the MNE continues to produce the efficient input by itself. However, they actually diminish the increase in exports and consumers' gains because giving up full tax avoidance increases the MNE's perceived marginal cost. We should recognize this export-decreasing effect of ROO driven by the change in the MNE's transfer pricing.

3.4.2 Tax revenue

When the MNE engages in transfer pricing, an FTA with ROO enables member countries to recover some of the MNE's tax base. When the MNE procures the input from the local input market (scheme I), there are no opportunities to shift profits and all the tax base is retained in country H. When the MNE adjusts its transfer price to meet the VA criterion of ROO, a part of the tax base is retained in country H because of the limited use of abusive transfer pricing.

Notably, we can confirm that ROO reverse the direction of profit shifting across countries. To see this point more clearly, it is useful to decompose the optimal transfer prices into the "tax avoidance motive" and "tariff elimination motive." In the pre-FTA equilibrium, the optimal transfer price is always above the marginal cost of input production:

$$r = w - \Delta + \underbrace{\frac{a - w + \Delta - \lambda\tau}{2}}_{\text{Tax avoidance motive}}. \tag{3.10}$$

The second term of equation (3.10) represents the tax avoidance motive, which makes the transfer price as high as making the profit of the downstream affiliate of the MNE zero.

In scheme B of the post-FTA equilibrium, the tariff elimination motive counters the tax avoidance motive and the optimal transfer price is expressed as

$$\widetilde{r}^B = w - \Delta + \underbrace{\frac{a - w + \Delta}{2}}_{\text{Tax avoidance motive}} - \underbrace{\frac{\underline{\alpha}\{(1-t)a + (1-T)(w-\Delta) - \underline{\alpha}(T-t)a\}}{2\{1 - t - (T-t)\underline{\alpha}\}}}_{\text{Tariff eliminative motive}}. \tag{3.11}$$

The third term of equation (3.11) captures the tariff elimination motive, which is zero at $\underline{\alpha} = 0$ and increasing in $\underline{\alpha}$. If the Tariff elimination motive is sufficiently large such that $\widetilde{r}^B$ is lower than $w - \Delta$, the profits of the MNE are shifted from the low-tax country to the high-tax country, which is in sharp contrast to the conventional effect of transfer pricing.

Therefore, the direction of profit shifting relies on the size of the two motives. Indeed, we can derive a unique threshold of $\underline{\alpha}$, $\underline{\alpha}^r$, such that $\widetilde{r}^B < w - \Delta$ holds and profits shift from a high-tax country to a low-tax country if $\underline{\alpha} > \underline{\alpha}^r$ holds. Figure 3.3 illustrates the reversal of profit shifting.[25] The dotted line represents $\underline{\alpha}^r$ and the dotted area in the figure is the case in which profits flow from a low-tax country to a high-tax country. The following proposition summarizes the effect on tax revenue.

Proposition 3.4 *An FTA formation with ROO reduces the profits of the MNE shifted from a high-tax country to a low-tax country if the MNE utilizes an FTA tariff. The MNE rather shifts its profits from a low-tax country to a high-tax country if tariff elimination motive of transfer pricing is sufficiently large.*

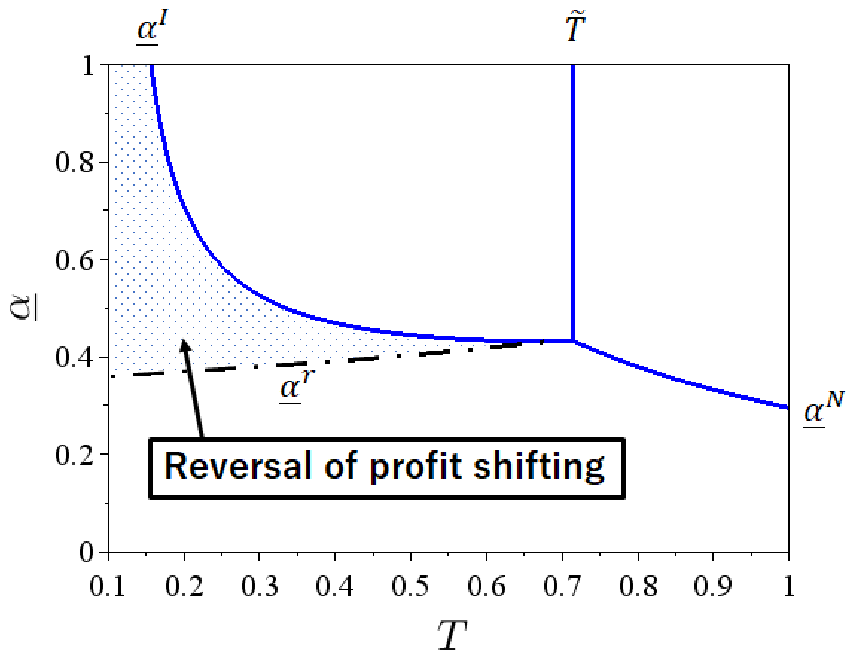
Proof. See Appendix C.3.

This proposition sheds new light on the role of ROO that has been overlooked in policy debates. As Proposition 3.2 shows, an FTA formation with ROO can induce the MNE to give up the self-production of inputs as well as the opportunity to avoid tax.[26] This result suggests that a VA criterion provides another channel to keep MNEs away from

[25] We use the following parameters for the figure: $a = 1$, $w = 1/2$, $\Delta = 1/32$, $\tau = 1/4$, and $t = 1/10$.

[26] This effect would be observed in the other two criteria of ROO, that is, the tariff classification criterion and specific process criterion.

Figure 3.3: The direction of the MNE's shifted profits



tax avoidance by restricting the extent of abusive transfer pricing. Thus, although the main purpose of imposing ROO is to prevent trade circumvention, ROO also play a role in preventing tax avoidance.

Furthermore, Proposition 3.4 provides a new empirical implication for estimating transfer pricing. As our model shows, the optimal transfer price depends on the stringency of the VA criterion, suggesting that the observed transfer prices can reflect not only the tax avoidance motive but also the tariff elimination motive.[27]

3.4.3 Total welfare of member countries

Let us discuss how the presence of ROO changes the effect of FTA formation on the total welfare of member countries. Remember that Proposition 3.1 suggests that an FTA without ROO is feasible in the sense that it increases the total welfare of member countries if and only if the initial tariff is sufficiently large ($\tau > \tau^W$).

As seen in this section, ROO reduce consumers' gains from an FTA formation in country F. However, ROO also help generate tax revenues in country H if the MNE

[27] Although there are other ways of shifting profits such as using internal debt and making royalty payments, the tariff elimination motive behind the transfer pricing of tangible assets remains.

changes its input procurement or adjusts its transfer price to comply with the ROO. This indicates that ROO can make an infeasible FTA without ROO feasible and they can also make an initially feasible FTA without ROO infeasible.

Let us first discuss the welfare effect of an FTA formation in schemes I and B. In the case of scheme I, total welfare is sum of the consumer surplus and tax revenue from the MNE:

$$\widetilde{W}^I = \frac{(a-w)^2}{8} + T\frac{(a-w)^2}{4}. \tag{3.12}$$

By comparing $\widetilde{W}^I$ with W^{O*}, we obtain the threshold of T, $\widetilde{T}^W$, such that $\widetilde{W}^I = W^{O*}$ holds at $T = \widetilde{T}^W$, which is given by

$$\widetilde{T}^W = \frac{2(a-w)(\Delta+\tau) - (\tau-\Delta)(\Delta+3\tau)}{2(a-w)^2}. \tag{3.13}$$

We have $\widetilde{W}^I > W^{O*}$ for $T > \widetilde{T}^W$ and $\widetilde{W}^I > W^{O*}$ holds for $T < \widetilde{T}^W$. An FTA with ROO improves total welfare when the corporate tax in country H is sufficiently large and the tariff revenue gains from the ROO dominate the loss of the consumer surplus.

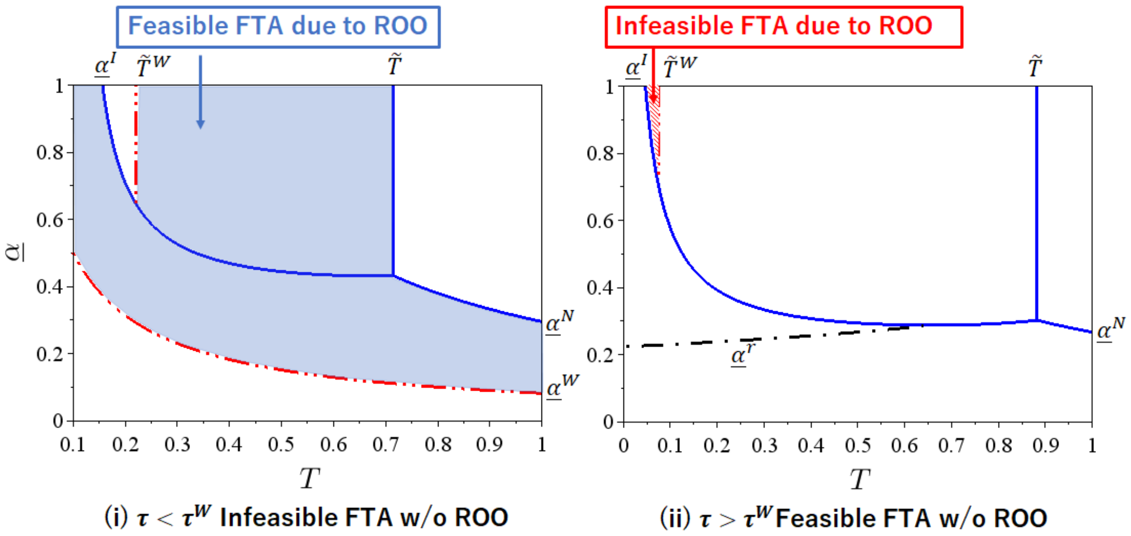
Total welfare under scheme B also includes tax revenue from the MNE, given by

$$\begin{aligned}\widetilde{W}^B =& \frac{\{(1-t)(a-w+\Delta) - \underline{\alpha}a(T-t)\}^2}{8\{1-t-\underline{\alpha}(T-t)\}^2} \\ &+ T\underline{\alpha}\left(\frac{\{(1-t)(a+w-\Delta) - \underline{\alpha}a(T-t)\}\{(1-t)(a-w+\Delta) - \underline{\alpha}a(T-t)\}}{4\{1-t-\underline{\alpha}(T-t)\}^2}\right).\end{aligned} \tag{3.14}$$

At $\underline{\alpha} = 0$, regime B is identical to the post-FTA equilibrium without ROO ($\widetilde{W}^B = \widehat{W}$). Starting from $\underline{\alpha} = 0$, an increase in the stringency of ROO has two opposite effects on $\widetilde{W}^B$. On the one hand, a stricter VA requirement reduces the transfer price and thereby increases the tax revenue that country H collects. On the other hand, it diminishes consumers' gains from an FTA formation by increasing the MNE's perceived marginal cost and reducing the amount of exports. There is thus an inverted U-shaped relationship between $\widetilde{W}^B$ and $\underline{\alpha}$. Specifically, the former effect dominates the latter and $\frac{\partial \widetilde{W}^B}{\partial \underline{\alpha}} > 0$ holds when $\underline{\alpha}$ is small, whereas the latter effect dominates the former and $\frac{\partial \widetilde{W}^B}{\partial \underline{\alpha}} < 0$ holds when $\underline{\alpha}$ is large.[28]

[28] Let $\underline{\alpha}^x$ be the threshold of $\underline{\alpha}$ such that the amount of exports is constant before and after the FTA is formed, $\widetilde{x}^B = x^{O*}$. Since we have $\frac{\partial \widetilde{W}^B}{\partial \underline{\alpha}}|_{\underline{\alpha}=0} > 0$, $\frac{\partial^2 \widetilde{W}^B}{\partial \underline{\alpha}^2} < 0$, and $\frac{\widetilde{W}^B}{\partial \underline{\alpha}}|_{\underline{\alpha}=\underline{\alpha}^x} < 0$, there exists a unique threshold, $\underline{\alpha}_0^W \in [0, \underline{\alpha}^x)$, such that $\frac{\widetilde{W}^B}{\partial \underline{\alpha}}|_{\underline{\alpha}=\underline{\alpha}_0^W} = 0$ holds.

FIGURE 3.4: ROO and the feasibility of an FTA formation



Because of the increased tax revenue, ROO can make an initially infeasible FTA feasible. Suppose $\tau < \tau_W$, with which an FTA without ROO reduces total welfare (see Proposition 3.1). Since stricter ROO improve post-FTA welfare in scheme B, post-FTA welfare can be larger than pre-FTA welfare even with $\tau < \tau_W$. Specifically, we can specify a threshold of $\underline{\alpha}$, $\underline{\alpha}^W$, at which $\widetilde{W}^B = W^{O*}$ holds.[29] When $\underline{\alpha}^W < \min[\underline{\alpha}^I, \underline{\alpha}^N]$ holds, an FTA formation improves the total welfare of member countries in scheme B for $\underline{\alpha} > \underline{\alpha}^W$.[30] The left figure of Figure 3.4 provides a numerical example that $\underline{\alpha}^W < \min[\underline{\alpha}^I, \underline{\alpha}^N]$ holds.[31] In the shaded area in scheme B, an FTA formation improves total welfare. Further, an FTA formation can improve total welfare in scheme I. As shown above, an FTA formation improves total welfare in scheme I if $T > \widetilde{T}^W$ holds. Therefore, ROO can transform an infeasible FTA into a feasible one because the increased tax revenue from the MNE compensates for the tariff revenue loss.

Proposition 3.5 *When $\tau < \tau^W$ holds and an FTA formation is infeasible without*

[29]At $\underline{\alpha} = \underline{\alpha}^x$, an FTA formation does not change the MNE's exports of the final good or the consumer surplus. We can simplify the change in total welfare to the sum of tax revenue and the loss of tariff revenue, $\widetilde{W}^B - W_{O*}|_{\underline{\alpha}=\underline{\alpha}^x} = T\underline{\alpha}^x\widetilde{\pi}^B_H - \tau x^{O*} = \tau x^{O*}\left\{\left(\frac{T(1-t)}{T-t}\right)\left(\frac{a+w-\Delta+\tau}{2(w-\Delta+\tau)}\right) - 1\right\} > 0$. This means that a threshold $\underline{\alpha}^W \in [0, \underline{\alpha}^x)$ exists that satisfies $\widetilde{W}^B = W^{O*}$.

[30]Although $\widetilde{W}^B$ is an inverted U-shaped curve in $\underline{\alpha}$, we always have $\widetilde{W}^B > W^{O*}$ at $\underline{\alpha} = \min[\underline{\alpha}^I, \underline{\alpha}^N]$ because $\min[\underline{\alpha}^I, \underline{\alpha}^N] < \underline{\alpha}^x$ holds. This means that an FTA formation always improves total welfare for $\underline{\alpha}^W < \underline{\alpha} \le \min[\underline{\alpha}^I, \underline{\alpha}^N]$.

[31]The parameters are set as follows: $a = 1$, $\Delta = 1/32$, and $\tau = 1/4$. The left figure is drawn with $w = 1/2$ and $t = 1/10$, whereas the right figure uses $w = 2/3$ and $t = 0$.

ROO, an FTA formation with ROO improves the total welfare of member countries if the MNE adjusts its transfer price to comply with the ROO and $\underline{\alpha}^W < \underline{\alpha} < \min[\underline{\alpha}^I, \underline{\alpha}^N]$ *hold or if the MNE purchases local inputs and* $T < \widetilde{T}^W$ *holds. In these cases, ROO make an initially infeasible FTA feasible.*

However, ROO may negatively affect total welfare and make an initially feasible FTA formation infeasible. The right figure of Figure 4 corresponds to the case with $\tau > \tau^W$, where the formation of an FTA without ROO is beneficial for member countries. The dotted curve in scheme B represents $\underline{\alpha}^r$, above which we see the reversal of profit shifting discussed in the previous section. The figure shows that an FTA stays feasible even if we take ROO into account, so that ROO increase the gains of forming an FTA under scheme B in the equilibrium because $\frac{\partial \widetilde{W}^B}{\partial \underline{\alpha}} > 0|_{\underline{\alpha}=0}$ holds. If both $\underline{\alpha}$ and T are high so that scheme N is the equilibrium outcome, there is no welfare change from an FTA formation. Moreover, if the equilibrium outcome is scheme I and $T \leq \widetilde{T}^W$ holds, the gains from increased tax revenue are smaller than the loss from the lower consumer surplus. In this case, ROO transform a welfare-improving FTA formation into a welfare-reducing one.

The next proposition summarizes these results.

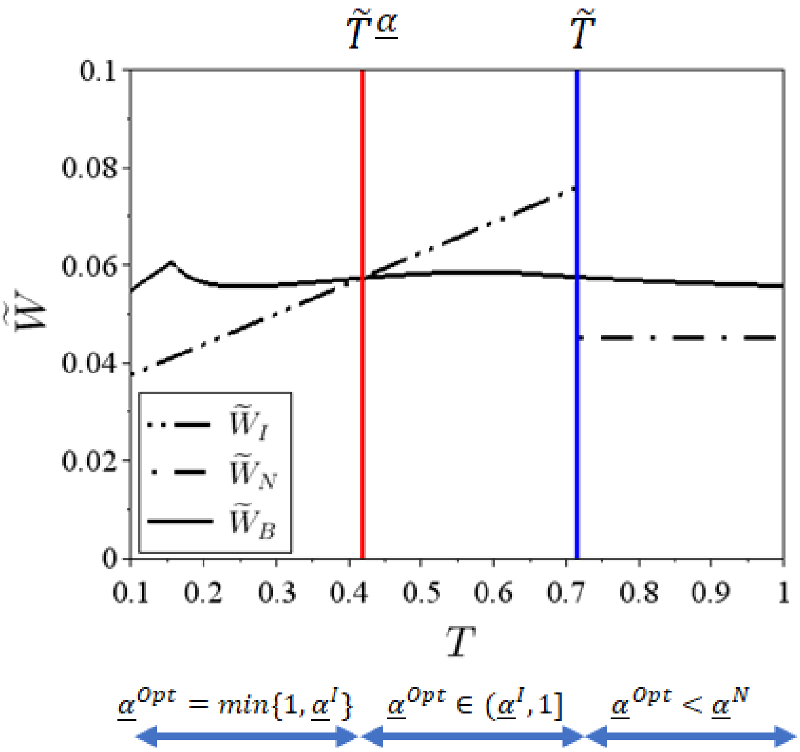
Proposition 3.6 *When* $\tau \geq \tau^W$ *holds and an FTA formation is feasible without ROO, an FTA formation with ROO deteriorates total welfare if it induces the MNE to purchase local inputs to meet the ROO and* $T \leq \widetilde{T}^W$ *holds. In this case, ROO can make an initially feasible FTA infeasible.*

From Propositions 3.3 and 3.4, we know that an FTA with ROO benefits consumers and makes profit shifting difficult. Proposition 3.5 suggests that ROO with a certain level of $\underline{\alpha}$ can be necessary for FTA formation. A formation of an FTA with ROO works as an effective policy not only to promote trade liberalization but also to prevent the MNE from engaging in tax avoidance, and the latter effect is important to secure welfare-improving FTA formation. Proposition 3.6 suggests, however, that ROO can also deter the formation of an FTA if it is feasible without ROO.

3.5 Discussion

Our benchmark analysis provided a set of new results not thus far explored in the extant literature. In this section, we discuss an extension of the model and the robustness of

Figure 3.5: The welfare of member countries with the optimal level of $\underline{\alpha}$



the main results by relaxing some of the assumptions made in the benchmark model.

3.5.1 The optimal VA requirement

We showed that the MNE's choice and welfare effect of an FTA critically depend on the level of $\underline{\alpha}$. Here, we discuss how member countries choose $\underline{\alpha}$ if it is endogenously determined.

As $\frac{\partial \widetilde{W}^B}{\partial \underline{\alpha}}|_{\underline{\alpha}=0} > 0$ holds, the optimal level of the VA ratio, which is denoted by $\underline{\alpha}^{Opt}$, is always positive. Under scheme B, total welfare is an inverted U-shaped curve in $\underline{\alpha}$, and it is maximized at $\underline{\alpha} = \underline{\alpha}_0^W$ at which $\frac{\partial \widetilde{W}^B}{\partial \underline{\alpha}} = 0$ is satisfied. If $\underline{\alpha}_0^W < \min[\underline{\alpha}^I, \underline{\alpha}^N]$ holds, and the welfare-maximizing level within scheme B becomes $\underline{\alpha}_0^W$. If $\underline{\alpha}_0^W \geq \min[\underline{\alpha}^I, \underline{\alpha}^N]$ holds, however, it becomes the upper bound of $\underline{\alpha}$ in scheme B, $\min[\underline{\alpha}^I, \underline{\alpha}^N]$.

A further increase in $\underline{\alpha}$ changes the equilibrium scheme from scheme B to either scheme N or scheme I. The full tax avoidance in scheme N means that total welfare is independent of the corporate tax in country H. Total welfare in scheme I, however, is increasing in T because it generates more tax revenues.

Figure 3.5 illustrates a numerical example that shows maximized total welfare in each scheme with optimal VA criterion, when $\tau < \tau^W$ holds.[32] The solid curve is total welfare in scheme B given that $\underline{\alpha}$ is optimally set to maximize total welfare. The two dotted lines illustrate total welfare in schemes I and N. In this example, we can see a threshold of T, denoted as $\widetilde{T}^{\underline{\alpha}}$, which satisfies $\widetilde{W}^B = \widetilde{W}^I$.

If $T < \widetilde{T}^{\underline{\alpha}}$ holds, Scheme B realizes the highest total welfare. In this case, the optimal VA criterion is the highest one that realizes scheme B, $\underline{\alpha}^{Opt} = \min[1, \underline{\alpha}^I]$. If $\widetilde{T}^{\underline{\alpha}} < T < \widetilde{T}$ holds, Scheme I brings the highest total welfare. In this range of T, the optimal $\underline{\alpha}$ is any $\underline{\alpha}$ that induces the MNE to purchase local inputs within FTA countries, or $\underline{\alpha}^{Opt} \in (\underline{\alpha}^I, 1]$. If $T > \widetilde{T}$ holds, scheme B again realizes the highest total welfare. However, the optimal level is less than the highest one that realizes Scheme B, and it is given by $\underline{\alpha}^{Opt} = \underline{\alpha}_0^W < \underline{\alpha}^N$. This is easily understood by considering the perceived marginal costs. Remember the perceived marginal cost rises as the tax gap widens or the VA criterion becomes stricter. A higher perceived marginal cost decreases the amount of exports, $\widetilde{x}^B$, as the tax gap widens or the VA criterion becomes stricter. Since the degree of the decrease in exports and its welfare cost are small when the tax gap is small, the increase in tax revenues dominates when $T < \widetilde{T}^{\underline{\alpha}}$ holds. If the tax gap is large, however, the optimal level of the VA requirement in scheme B balances out the gains from the increased tax revenues and losses from the increased perceived marginal cost.

This numerical analysis suggests that to determine the stringency of ROO, policy-makers should take into account its effects on tax revenues. In reality, VA thresholds are usually set between 30% and 60%.[33] Our model predicts that the VA criterion of ROO may play a positive role in preventing tax avoidance by MNEs and secure welfare gains for member countries when the host countries of export platform MNEs impose high tax rates. This is actually the case with NAFTA (now USMCA), where Mexico attracts FDI and levies a high corporate tax. Moreover, as different VA thresholds are imposed on different products, the design of a VA criterion or choice of ROO criteria should differ across the products MNEs actively produce.

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[32] This figure is drawn with the following parameters: $a = 1$, $w = 1/2$, $\Delta = 1/32$, $\tau = 1/4$, and $t = 1/10$.

[33] See `http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=TAD/TC/WP(2015)28/FINAL&docLanguage=En`.

3.5.2 Partial procurement of inputs

We have assumed that the MNE makes a binary choice about input procurement, that is, a "make all or buy all" choice. It would be more realistic to suppose that the MNE purchases some proportion of parts from local suppliers and procures the rest via intra-firm transactions, which we refer to as scheme P.

Suppose that the MNE uses a continuum of inputs indexed in the $[0,1]$ space. Let $\beta \in [0,1]$ denote the proportion of inputs that firm M_H procures from firm M_O in country O. This means that the $1-\beta$ proportion of the input is procured within FTA countries. The amount of intra-firm trade becomes βx and the modified VA ratio is given by $\frac{p-\beta r}{p}$. The MNE maximizes

$$\Pi = (1-t)[\beta\{r-(w-\Delta)\}x+\overline{\pi}] + (1-T)[\{p-\beta r-(1-\beta)w\}x] \tag{3.15}$$

with respect to x, r, β, which is subject to $\pi_H \geq 0$, $\pi_O \geq 0$, and $\frac{p-\beta r}{p} \geq \underline{\alpha}$.

Since $\frac{\partial \Pi}{\partial r} > 0$ holds, the optimal transfer price, r^P, is again set at the level such that $p - \beta r^P - (1-\beta)w = 0$ is satisfied. Furthermore, we can also confirm that $\frac{\partial \Pi}{\partial \beta} > 0$ always holds, which implies that the MNE sets β as high as possible. Formally, the optimal β satisfies $\beta = \max\{0, 1-\frac{\underline{\alpha}p}{w} \equiv \beta^P\}$. Let x^P denote the corresponding optimal level of x. Then, the equilibrium post-tax profits in scheme P become

$$\Pi^P = (1-t)\left[\left(1-\frac{\underline{\alpha}\Delta}{w}\right)(p-c_M^P)x^P + \overline{\pi}\right], \tag{3.16}$$

where the modified perceived marginal cost is $c_M^P = \frac{w(w-\Delta)}{w-\underline{\alpha}\Delta}$, which falls between $w-\Delta$ and w.

The reason why the optimal β can be zero is explained as follows. Given that the MNE sets the abusive transfer price as r^P, the VA ratio with $r = r^P$ becomes $\frac{(1-\beta)w}{p}$. If $\frac{w}{p} \leq \underline{\alpha}$ holds, the MNE can never comply with the ROO when $\beta > 0$. Since $\frac{w}{p} < 1$, there exists a unique cutoff of $\underline{\alpha}$, $\underline{\alpha}^P_{\beta=0}$, above which the MNE sets $\beta^P = 0$. In this case, the MNE manipulates its transfer price to comply with the ROO (i.e., scheme B), or it may choose scheme I or N. Thus, we can conclude that schemes N, I, and B are still the equilibrium outcomes when $\underline{\alpha} \geq \underline{\alpha}^P_{\beta=0}$ holds, whereas the area of scheme B is replaced with that of scheme P below $\underline{\alpha} < \underline{\alpha}^P_{\beta=0}$.

One notable difference from the benchmark model is that ROO can transform a feasible FTA into an infeasible one in scheme P. This happens in the benchmark model when the equilibrium outcome is scheme I. However, in this modified setup, the MNE's tax base is zero and ROO reduce the gains from an FTA formation, which generates a possibility that ROO worsen total welfare if the required VA ratio is high. Specifically, let $\underline{\alpha}_W^P$ be the threshold such that $\widetilde{W}^P = W^{O*}$ holds. Then, an FTA formation is infeasible when $\underline{\alpha} > \underline{\alpha}_W^P$ holds.

3.5.3 Concealment costs for transfer price manipulation

In the benchmark model, the MNE can freely manipulate the transfer price. Here, we show that the assumption of costless transfer pricing is not critical to obtain the main results.

In practice, MNEs need to explain the plausibility of transfer pricing to shift profits across countries. As MNEs shift more profits between countries, explaining the reasons for the greater deviation from the appropriate price, or the arm's length price, becomes more difficult. Following the literature on transfer pricing, we introduce the following "concealment cost" in the case of offshoring, which is increasing in the gap between the transfer price and production cost of inputs:

$$C(r, x^O) = \frac{\delta\{r - (w - \Delta)\}^2 x^O}{2}. \tag{3.17}$$

In this concealment cost, the parameter δ captures the difficulty of concealing tax avoidance, which reflects a well-enforced tax authority, for example. The post-tax profits under offshoring are modified as

$$\begin{aligned} \Pi^O &= (1-t)[\{r - (w - \Delta)\}x^O\overline{\pi}] + (1-T)[(p - r - \lambda_M\tau)x^O] - C(r, x^O), \\ &= (1-t)\overline{\pi} + (1-T)(p - c_M^C)x^O, \end{aligned} \tag{3.18}$$

where $c_M^C = \frac{(1-t)(w-\Delta)+(1-T)\lambda\tau-(T-t)r}{1-T} + \frac{\delta\{r-(w-\delta)\}^2}{2(1-T)}$ is the effective marginal cost.

In this setup, the concealment cost can prevent the MNE from transferring all the profits from country H to country O. In other words, the MNE can choose the transfer price and final good price such that $p > r + \lambda_M\tau$ holds, even in the absence of ROO. Given that some of the MNE's tax base remains in country H, our welfare analysis has several modifications.

First, an FTA formation in the absence of ROO now depends on the tax differential between T and t. Substituting the optimal level of r that maximizes Π^O into c_M^C, the perceived marginal cost in the equilibrium is calculated as $c_M^C = w - \Delta + \lambda\tau - \frac{(T-t)^2}{2\delta}$. Thus, as the tax difference between countries widens, the perceived marginal cost lowers. Since the MNE becomes less willing to increase r because of the concealment cost, it has an incentive to increase x^O and lower p, which saves the MNE's tax payments in country H by narrowing the gap between p and $r + \lambda_M\tau$. This incentive is reflected in the perceived marginal cost. Because the elimination of tariffs increases the gap between p and $r + \lambda_M\tau$, it gives the MNE an extra incentive to increase x^O to avoid tax payments. The increase in x^O is advantageous for member countries because it benefits consumers. Therefore, in the presence of concealment costs, an FTA formation without ROO is more likely to benefit member countries as the tax gap widens.

Second, $p > r + \lambda_M\tau$ implies that the VA ratio is positive even in the absence of ROO. In the benchmark model, the MNE always chooses a zero VA ratio in FTA countries in the absence of ROO. This implies that the VA requirement of ROO affects neither the MNE's transfer pricing nor its location choice when $\underline{\alpha}$ is sufficiently small because the MNE has already satisfied the required VA ratio.

Even if we consider these new elements, the nature of our results does not change. Specifically, an FTA formation without ROO may harm member countries, and ROO can transform an infeasible FTA into a feasible one. The opposite case is also possible, where ROO transform a feasible FTA into an infeasible one.

3.5.4 The role of profit shifting

So far, we have analyzed the impact of ROO given the MNE always has an option to manipulate transfer price to shift profits. In the literature on tax avoidance, whether profit shifting itself is harmful for high-tax countries is one of the main interests. Although profit shifting hurts high-tax countries by reducing tax revenues, the effect is more complicated than it seems. For instance, Hong and Smart (2010) theoretically showed that the use of tax havens is beneficial for a high-tax country because it stimulates the economic activities of MNEs and enables a high-tax country to set an even higher tax rate. Here, we provide another reason why MNEs' profit shifting is beneficial for high-tax countries. To this end, we consider the situation in which the MNE cannot manipulate transfer price.

In this alternative setup, the intra-firm transaction takes place at the price of $w - \Delta$ and all the tax base of the MNE remains in country H irrespective of whether an FTA is formed. This means that scheme O is always the optimal choice for the MNE in the pre-FTA equilibrium. Once an FTA with ROO is formed, the VA ratio is calculated as $\alpha = \frac{a-w+\Delta}{a+w-\Delta} \equiv \underline{\alpha}^{UB}$. Therefore, the MNE keeps producing its own inputs in country O as long as $\underline{\alpha} \leq \underline{\alpha}^{UB}$ holds. If $\underline{\alpha} > \underline{\alpha}^{UB}$ holds, however, the MNE cannot comply with the ROO on the self-production of inputs. In this case, the MNE always starts procuring inputs inside the FTA (scheme I) because the gains from the elimination of tariff is greater than the loss from the higher input cost (i.e., $\tau > \Delta$). From the viewpoint of welfare, FTA countries prefer the MNE to produce its own inputs (scheme O) and thus they set the optimal VA ratio below $\underline{\alpha}^{UB}$.

Given this equilibrium property under no profit shifting, we compare the post-FTA welfare of high-tax member countries with and without profit shifting. The required VA ratio with profit shifting is also set at the level that maximizes the joint welfare of member countries. We find that if the corporate tax rate in the high-tax country, T, is relatively small, profit shifting can improve the welfare of high-tax member countries.[34]

The intuition behind this outcome is explained as follows. Without profit shifting, country H can collect tax revenues from the MNE, but these are relatively small because T is not large. Thus, the welfare of high-tax member countries becomes relatively small in these tax environments. With profit shifting, Proposition 3.4 suggests that the MNE rather shifts its profits from a low-tax country to a high-tax country if τ is relatively high and the tariff elimination motive of transfer pricing is large. This implies that allowing transfer pricing actually leads to larger tax revenues in high-tax countries because the MNE manipulates its transfer price to eliminate tariffs rather than avoid tax. Thus, our analysis provides the possibility that transfer pricing benefits a high-tax country.

3.6 Conclusion

The recent proliferation of FTAs is playing a key role in advancing trade liberalization between countries and the cross-border economic activities of MNEs prevail globally. This study investigated a vertically integrated MNE's input production and pricing strategies to analyze the welfare effects of FTA formation when the MNE can manipulate its transfer price of intra-firm trade. As in previous studies, the MNE uses its transfer price to avoid a high corporate tax. After the formation of an FTA, however, there emerges another reason for transfer price manipulation in the presence of ROO.

[34] The detailed calculation of the numerical example in this case will be provided upon request.

Specifically, if the ROO of the FTA employ a VA criterion, the FTA induces the MNE to manipulate the transfer price to comply with the ROO and be eligible for tariff elimination.

When the VA criterion of the ROO is low, the MNE prefers transfer price manipulation since adjusting the transfer price is straightforward. However, once the required VA level is high, transfer price adjustment decreases the efficiency of tax avoidance so that the manipulation of the transfer price for the ROO is suboptimal. If the tax gap between a country outside the FTA and a member country is large, the MNE produces a necessary input in the outside country at the expense of the FTA tariff rate because the gain from tax avoidance is large. If it is small, the MNE procures the input in the inside country to qualify for the FTA tariff. This result is in line with empirical and anecdotal evidence that (i) FTAs sometimes induce input relocation to inside FTA countries, (ii) not all firms export using the preferential tariffs of FTAs, and (iii) transfer price manipulation is a factor in the difference in corporate tax rates and the required VA criterion of ROO.

Our model also showed the possibility that ROO can prevent profit shifting by an MNE via either a change in procurement strategy or another use of transfer prices. Owing to the emergence of the MNE's tax base, ROO can transform an infeasible FTA into a feasible one. Therefore, the formation of FTAs with ROO is expected to work as an effective policy to not only induce trade liberalization but also keep MNEs away from tax avoidance. A remarkable result is that the direction of the MNE's shifted profits is the opposite of that under common knowledge when the MNE manipulates the transfer price for ROO.

The above argument does not indicate that the highest VA criterion is always optimal because it deteriorates the efficiency of tax avoidance, increases the MNE's perceived marginal cost, and reduces the amount of exports to another FTA member country. Our analysis showed that the optimal VA level depends on corporate tax rates. This implies that policymakers should pay close attention to the link between tariffs and corporate taxes even though cooperation between customs departments and tax authorities is rarely observed in reality.

There remains room for further research. We assumed that tax rates and tariff rates are exogenously given. It would be intriguing to investigate how the formation of an FTA affects the outcomes of tax competition among countries as well as the optimal tariffs set by FTA members. Another direction in which to extend the model is to examine the effects of regulations on transfer pricing, such as the arm's length principle, in the presence of ROO. Finally, further empirical investigation on the relationship between ROO and transfer pricing is essential.

Chapter 4

Innovation for Tax Avoidance: Product Differentiation and the Arm's Length Principle

4.1 Introduction

Investment in research and development (R&D) has been growing over years. According to the National Science Foundation, worldwide R&D expenditure rose from $336,571 million in 2009 to $451,831 million in 2016. Although these numbers do not distinguish between R&D types, empirical evidence suggests that product differentiation is a core reason for R&D. According to Scherer and Ross (1990), three quarter of R&D expenditures by U.S. firms' were used for product R&D. Bagwell (2007) also reports examples of large spendings on advertisement by U.S. firms which serve to increase product differentiation. To give some examples, in 2003, $3.43 billion was spent by General Motors for cars and trucks, $3.32 billion was used for detergents and cosmetics manufactured by Protecter and Gamble, and Pfizer devoted $2.84 billion to advertise its drugs. Such an investment in product differentiation is one of the most important strategies of firms because it makes competition between firms gets less fierce and firms are able to enjoy more market power by differentiating their products from those of rival firms.

The increase in market power due to product differentiation is not always harmful for consumers, once individuals' preference over varieties are considered. This is supported by "love of variety" pioneered by Dixit and Stiglitz (1977) and Krugman (1980).

For example, Ardelean (2006) estimates the parameter of love of variety (see Table 1. of her paper). Furthermore, Hotelling (1929) is a classical paper which introduces heterogeneous preference on goods and concludes that the socially optimal level of duopolists' product differentiation is positive. These indicate higher degrees of product differentiation can benefit not only firms but also consumers and gives a rationale for governments to design policies to promote product differentiation.

From the viewpoint of global taxation, however, product differentiation exacerbates the difficulties of collecting corporate tax revenue, because of the tax avoidance behaviour of multinational enterprises (MNEs). MNEs exploit tax rate differentials between countries by shifting their profits to low-tax environments by means such as transfer pricing. The transfer price is the price used in intra-firm transactions, on intermediate products and/or intangible assets such as trademarks. As OECD guidelines stipulate, such a price used in intra-firm transactions should be the one used in inter-firm transaction, or arm's length (AL) price, which is known as the AL principle. Based on the principle, tax authorities compare the transfer price used by an MNE to the AL price from comparable uncontrolled transactions, so-called comparable uncontrolled price (CUP) method. However, product differentiation makes it difficult to find comparable transactions, since characteristics of the comparable products in inter-firm transaction should be similar to the ones of the good traded in the intra-firm transaction.[1] Due to the difficulty, in practice, both consultant companies and tax authorities frequently rely on other methodologies and a range of transfer prices, or AL range, which provides MNEs with room to manipulate their transfer prices for the purpose of profit shifting.[2]

This link between product differentiation and profit shifting is empirically supported by academic literature as well. Bernard et al. (2006), Cristea and Nguyen (2016), and Davies et al. (2018) used export price data in the U.S., Denmark, and France and showed the significant difference between transfer prices and AL prices. Moreover, they categorized industry into homogeneous and differentiated sectors and conclude

[1] AL principle is set in Article 9 of the OECD Model Tax Convention. the OECD guideline states thet "[T]here are some significant cases in which the arm's length principle is difficult and complicated to apply, for example, in MNE groups dealing in the integrated prodution of highly specialised goods, in unique intangibles and/or in the provision of specialised services." See `https://www.oecd-ilibrary.org/docserver/tpg-2017-en.pdf?expires=1580823209&id=id&accname=ocid49014612&checksum=0465D173CEED90A136FA054047E36AB3` on page 36.

[2] According to the Internal Revenue Service, the most frequently used method for transfer pricing investigation was the comparable profits method or the transactional net margin method in 2016. See `https://www.irs.gov/irb/2017-15_IRB`..

that transfer prices are more sensitive to tax changes when the goods category is differentiated (e.g. Davies et al. (2018), Table 2).[3] Liu et al. (2019) also investigates the interrelation between them by employing U.K. data and shows that transfer mispricing is concentrated in R&D intensive firms (see Table 3 of their paper). Even though the empirical evidence points to a link between product differentiation and MNEs' profit shifting, a theoretical approach that combines these two aspects has not been developed so far. To the best of my knowledge, this is the first paper that studies this link and analyzes its welfare effects.

Tax avoidance by MNEs has attracted global attention because of its sizable impact on tax revenue losses.[4] Especially, tax revenue losses are magnified by the use of tax havens. Zucman (2014) shows that the share of U.S. corporate profits made in tax havens has risen from 2% in 1983 to 17% in 2013. Tørsløv et al. (2018) also estimate that more than $600 billion were shifted to tax havens. As governments sometimes design policies such as R&D incentive tax and/or subsidy to induce firms to engage in R&D activity, understanding the MNEs' incentive to conduct tax avoidance and its welfare effects is essential to make appropriate policies.

To this end, this paper incorporates tax avoidance behaviour into a model with endogenous product differentiation. To reflect the above argument, this paper introduces a link between product differentiation and the ease of profit shifting. When profit shifting is possible, MNEs benefit more from product differentiation because higher product differentiation makes shifting profits easier. Due to this additional incentive, we find that the optimal investment in product differentiation in the presence of profit shifting is higher than in the absence of profit shifting. We also analyze the impact of globalization which is characterized as an increase in the mobility of tax bases. We find that globalization results in greater post-tax profits of MNEs, higher consumer surplus from the differentiated products, and lower tax revenues in a high tax country.

These results are robust even if we extend our model by endogenizing the corporate tax rate. We confirm an emergence of a tax haven reduces the equilibrium tax rate. Furthermore, our numerical example shows that globalization results in a further

[3]See also Belz et al. (2017) that pointed out that tax avoidance is frequently observed in R&D intensive industries. Traditional explanation is that R&D intensive MNEs shifts profits through transfer pricing on intangible assets such as patents by locating in low tax countries.

[4]OECD stated that annual revenue losses from MNEs' tax avoidance are estimated $100 billion to $240 billion. See `http://www.oecd.org/ctp/oecd-presents-outputs-of-oecd-g20-beps-project-for-discussion-at-g20-finance-ministers-meeting.htm`.

reduction in the equilibrium tax rate, which is known as "race to the bottom".[5]

One intriguing result is that tax haven with a fixed tax rate can increase welfare in a non-tax haven country because the gains of product differentiation are more than the losses from tax revenue losses. Hence, welfare-improving globalization takes place when the relative importance from the tax revenue losses is small. Specifically, this occurs when either (a) marginal utility from the tax revenues is small or (b) a corporate tax rate in a domestic country is low, which means tax revenue without profit shifting is already small, and investment cost for product differentiation is small, which increases consumers' gains via more differentiation. However, our numerical examples with an endogenous tax rate do not support the welfare-improving globalization in total.

We argue the optimal policy for product differentiation as well. In the absence of profit shifting, the equilibrium investment in product differentiation is always the level below the optimal. With a tax haven, tax revenue loss by profit shifting makes the optimal investment level lower. Therefore, the excess product differentiation is possible if a government weights more on tax revenues.

As an extension, we also consider the case of differentiation on their production technologies, known as "process innovation". Similar to product differentiation, developing their own technologies makes it difficult to find appropriate AL price since the same logic of a link between differentiation and the AL principle is applicable while it does not affect consumers' preference but decreases marginal cost of production. In this case, the emergence of a tax haven is harmful for MNEs even though they engage in tax avoidance. Note that more differentiation in final products boosts demands on the products and this benefits are magnified by rival's investments. In the case of process innovation, however, the rival's investment makes the market competition fiercer and the gains from process innovation are smaller. Due to these differences, the MNEs benefit from the opportunities of tax avoidance in the case of product differentiation while the impact of arising profit shifting hurts MNEs in the case of process innovation.

4.1.1 Related literature

This paper contributes to several fields of research. The first strand of literature studies endogenous product differentiation. Lin and Saggi (2002) show a stronger

[5] This result is also in line with a stylized fact of a reduction in corporate tax rates over time. According to OECD stat, the average statutory corporate tax rate in OECD countries dropped from 32 % in 2000 to 23.51% in 2019. See `https://stats.oecd.org/index.aspx?DataSetCode=TABLE_II1`.

incentive to engage in more product differentiation in the presence of process R&D, because innovation increases the benefit from product differentiation. A few papers study endogeneous product differentiation in the open economy. Beladi et al. (2012) incorporate an outsourcing firm in their analysis, but the focus is on differences in technology and wages across firms and countries. Ferguson (2015) analyzed the impact of trade liberalization in a monopolistically competitive model with a constant elasticity of substitution in consumption. For the papers closer to ours, Braun (2008) explored the impact of economic integration on product R&D and shows that economic integration increases operating profits from the export market and thus results in more product differentiation. Bastos and Straume (2012) also consider a two-country model and introduce per-unit tariffs on firms' exports and. They conclude that economic integration leads to a stronger incentive to invest in product differentiation in order to mitigate market competition due to a intensified international competition driven by economic integration. Therefore, their analysis does not allow to draw any conclusions for product differentiation due to a tax motive, which is the focus of our paper.

Second, our model also contributes to the research on tax avoidance by MNEs. After Copithorne (1971) and Horst (1971), a number of authors have studied transfer pricing and profit shifting. Kant (1988a) first introduces legal or other costs of profit shifting to obtain an interior solution. Traditionally, this field has been analyzed in a perfect competition setup but a few recent works also incorporated market imperfection in their analysis. Some papers study AL regulation with taking MNEs' strategies into account. Among them, Choi et al. (2018b) and Choi et al. (2019) study the impact of AL principle on an MNE's sourcing and licensing strategies, respectively. As AL regulation does not allow MNEs to discriminate input prices/royalty on patent between related affiliate and independent firms, they show AL regulation distort an MNE's strategies (dual sourcing vs single sourcing and licensing to an unrelated firm or not, respectively). However, they do not consider the similarity of transactions whereas our paper considers the link between product differentiation and profit shifting.

A few papers saw the link. Yao (2013) considers a spatial product differentiation model with profit shifting in a Hotelling fashion and shows that the opportunity of manipulating transfer price induces a wider distance of two MNEs' location. Kato and Okoshi (2019b) incorporate the link between product differentiation and the ease of profit shifting in their robustness analysis. In their analysis, an MNE sells differentiated inputs to a related affiliate and an independent firm so that transfer price manipulation is still possible with a limited degree but the degree of differentiation is fixed. Our paper explicitly explores the interrelation between product differentiation and the eases of profit shifting by endogenizing investment in product differentiation. Therefore, the contribution of this paper is to incorporate characteristics of products into the cost function of profit shifting, which plays a significant role in practice and provides policy implications.

The rest of the paper is organized as follow. The next section explains the basic model and derives the equilibrium in autarky situation where profit shifting is impossible. Section 4.3 introduces profit shifting by incorporating a tax haven. Section 4.4 argues the welfare effects while section 4.5 discusses some extensions. The last section concludes.

4.2 The benchmark model

Our benchmark model abstracts from profit shifting. Consider a domestic country (country D) where both consumption and production take place. In the economy, there exist three sectors: an imperfect competition sector (sector X), a homogeneous goods sector (sector Y) and a public sector. In the Y sector, we assume perfect competition so that no positive profits accrue to any firm in the sector. The X sector is characterized by an oligopolistic market structure and has only two operating firms because of high entry cost. We refer to these firms as MNEs, labelled 1 and 2, since they have a subsidiary in a tax haven (country H), which is introduced in the next section.

Consumers Individuals in country D are identical and share the same preferences over consumption of the three types of goods provided by the MNEs, perfectly competitive firms and the government in country D. The preferences of a representative individual are given by the following quasi-linear utility function;

$$U(x_i, x_j, y, G) = u(x_i, x_j) + y + \beta G$$
$$\text{where} \quad u(x_i, x_j) = a(x_i + x_j) - \frac{(x_i)^2 + (x_j)^2 + 2sx_ix_j}{2} \quad i \in \{1, 2\}, \ \ j \neq i, \quad (4.1)$$

and x_i is the consumption level of the product manufactured by the MNE i, y is the consumption of the homogeneous good, and G is the quantity of the public good. a and β are parameters and exogenously given. β represents the marginal utility from the public good.

The parameter $s \in [0, 1]$ represents the degree of substitutability between the two products manufactured by the MNEs. The degree of substitutability is endogenously determined by MNEs' investments described below and the products are more differentiated as s approaches zero. At the other extreme case, the MNEs' goods are homogeneous if s is 1.

The utility function yields the following inverse demand function,

$$p_i = a - x_i - sx_j.$$

Note that our utility function has a property of "love of variety" and the inverse demand function shifts outward as the degree of substitutability gets smaller.[6] This is because the more differentiated products increase the individuals' willingness to pay for each product.

Individuals own the MNEs and thus their income I consists of post-tax profits of the MNEs. Therefore, utility maximization yields the optimal consumption level of the numeraire homogeneous good as $\widehat{y} = I - \sum_{i=1}^{2} p_i x_i$.

Government The government has only one tax instrument in order to finance the provision of the public good: a proportional corporate tax rate on the reported profits of the MNEs in country D. The government imposes a positive tax rate on firms' profits ($t_D \in [0, 1]$). Since the sector Y is perfectly competitive and makes zero profits, tax revenue (TR) can be generated only from the sector X. The government can transform one unit of the numeraire good into one unit of the public good, which means $G = TR$ holds.

In our benchmark model, we assume that the tax rate is exogenously given. Later, we also argue the optimal tax rate and the effect of globalization on the tax rate.

Firms Our focus is on the differentiated sector. The MNEs produce their goods with constant marginal cost c and compete over quantity. Before the MNEs produce the goods, they also have a chance to invest in product differentiation. Following Lin and Saggi (2002), at the first stage, they engage in investment to differentiate their

[6] If the two goods are perfect substitute $s = 1$, the inverse demand function is linear, which is the case that the elasticity of substitute is approaching to infinity, and love of variety effect vanishes. As the degree of product differentiation or the elasticity of substitute get smaller, indifference curves become more convex with respect to origin.

goods from the one made by the rival MNE. Let $d_i \in \left[0, \frac{1}{2}\right]$ be the investment level by MNE i and a measure of differentiation level. Then, the degree of substitutability is given by $s = 1-(d_1+d_2)$. The investment cost is assumed to be $F(d_i)$ with $F'(d_i) > 0$ and $F''(d_i) > 0$. To secure interior levels of d_i, we assume that $F'(0) = 0$ and $F'\left(\frac{1}{2}\right)$ is sufficiently large. Throughout the analysis, we assume that second order condition is satisfied.

The sequence of the game is as follow. At the first stage, both MNEs decide the investment level. Given the investment level, and hence the degree of product differentiation, the MNEs compete in a Cournot fashion and make operating profits. We solve the two stage game by backward induction.

4.2.1 2nd stage: Market outcome

We denote the operating profits of MNE i by $\pi_i = (p_i - c)x_i$ and the post-tax profits by Π_i. As in standard Cournot competition, the equilibrium output and price level by MNE i are

$$\widehat{x}_i = \left(\frac{a-c}{2+s}\right) = \left(\frac{a-c}{3-d_i-d_j}\right), \quad \text{and,} \quad \widehat{p}_i = \frac{a+(2-d_i-d_j)c}{3-d_i-d_j}. \tag{4.2}$$

Even though more product differentiation softens market competition between them and increases market power, it leads to more outputs by the MNEs because the (residual) demand expands. We can see this from the best response function of MNE i. Let x_i^R be the best response function, which is $x_i^R = \frac{a-c-sx_j}{2}$. As s gets lower, meaning their goods are more differentiated, MNE i increases its own output levels for any given output of its rival. Although MNE i also negatively responds with such an increase in MNE j's output, the degree of its response declines because the substitutability of the products gets less. In total, sx_j decreases and thus, the best response x_i^R increases.

Due to this feature of market expansion, more outputs by MNEs do not mean a reduction in prices in this setup. Remember that the inverse demand function shifts outward because of more product differentiation, which increases consumers' willingness to pay and creates more demand. Formally, we can easily confirm the effect of product differentiation on the price,

$$\frac{\partial \widehat{p}_i}{\partial d_i} = \frac{a-c}{(3-d_i-d_j)^2} > 0,$$

so that more product differentiation always results in a higher price. As more product differentiation increases both supplies and prices, it obviously increases the operating profits of MNEs.

4.2.2 1st stage: Investment decision

As more product differentiation results in greater operating profits, each MNE has an incentive to differentiate their product from the rival's. For the purpose of identifying variables, we use a superscript "O" for variables without profit shifting.

The MNEs maximize the following post-tax profits,

$$\Pi_i^O = (1 - t_D)\left(\frac{a - c}{3 - d_i - d_j}\right)^2 - F(d_i). \tag{4.3}$$

Thus, the optimal investment level d^O is characterized in symmetric equilibrium,

$$\left.\frac{\partial \Pi_i^O}{\partial d_i}\right|_{d_i = d_j = d^O} = \frac{2(1 - t_D)(a - c)^2}{(3 - 2d^O)^3} - F'(d^O) = 0. \tag{4.4}$$

The first term is the (tax adjusted) marginal benefit from differentiation via market expansion while the second term is marginal cost of the investment. Therefore, the optimal investment level is the one which equates the marginal benefit and marginal cost of investment.

4.3 Tax Haven and Globalization

Next, we consider the case where the MNEs have a possibility to shift profit into country H by some means such as transfer pricing on tangible/intangible assets. We assume that country H is very small and there is no consumption in country H. This is a standard assumption in literature of tax havens because tax havens such as Caribbean islands frequently have a relatively small county size but provide opportunities of tax planning via non-production transaction such as patent royalty or internal debt.[7] We modify the game by introducing profit shifting stage after the first stage. In other words, the MNEs decide the amount of their supplies and shifted profits simultaneously.

[7] Even if we introduce consumption in country H, the results are qualitatively robust.

4.3.1 Cost of profit shifting

In general, engaging in tax avoidance is costly. For example, MNEs need to hire specialists on accounting such as accountants or lawyers to justify shifted profits between related companies. This cost is known as *concealment* cost in the literature. Therefore, irrespective of means of profit shifting such as transfer pricing or a licensing fee, the MNEs have to incur the cost.

In the literature of tax avoidance, the cost is assumed to increase as more profits are shifted because experts in accounting branch or consulting firms have to exert much effort to save tax and MNEs may need to pay more rewards to them so as to shift more profits. We assume that the cost is formulated as

$$C(\eta, \pi_i^S) = \frac{\eta(\pi_i^S)^2}{2\pi_i} \tag{4.5}$$

where π_i^S represents the amount of shifted profits to country H and η is a measure of difficulty of profit shifting.[8] This specification implies that a given amount of profit shifting is easier to hide when total profits are large. Therefore, the marginal cost of profit shifting is less as MNEs makes larger operating profits.

This traditional formulation of the cost function has one caveat that it does not reflect comparability of an intra-firm transaction with another. In this model, it is straight forward to assume that the cost of profit shifting gets lower as the products are more differentiated. To capture this aspect, we decompose η into two elements. First part of η is factors that MNEs cannot change, which is denoted by θ. One example of the factors is the prevalence of knowledge or information of using tax havens, which makes it easy to shift profits into tax havens. As such knowledge and information prevail as globalization proceeds, we interpret a reduction in θ as a measure of globalization.[9] Second, the difficulty of profit shifting also depends on the degree of product differentiation between the MNEs. In any forms of intra-firm transactions, tax authorities need to find appropriate comparable price or CUP. If the intra-firm traded assets either tangible or intangible are differentiated, finding CUP is difficult for tax authorities.

[8] This specification is also used in some empirical papers. See, for example, Hines Jr and Rice (1994), Huizinga and Laeven (2008), Amerighi and Peralta (2010), and Gumpert et al. (2016). We argue this specification of concealment costs more in detail in section 4.5.1.

[9] The existing literature also interprets this term as the degree of government's attention to auditing profit shifting. In this case, higher θ can be interpreted as stricter policy or regulation such as worldwide cooperation, e.g. BEPS project or AL principle. For example, see Hindriks et al. (2018) that incorporate governments' effort on tax enforcement in their concealment cost.

Thus, shifting profits gets easier as products are more differentiated. To incorporate these two properties, we assume $\eta = \theta s$.

We use a superscript "P" for the case with profit shifting.

4.3.2 Profit shifting

When profit shifting is possible, MNE i maximizes the following post-tax global profits,

$$\Pi_i^P = (1 - t_D)(\pi_i - \pi_i^S) + \pi_i^S - F(d_i) - \frac{\theta s (\pi_i^S)^2}{2\pi_i},$$

where the first term is post tax profits in country D and the second term is those in country H. The first order condition provides the following optimal shifted profits,

$$\widehat{\pi}_i^S = \frac{t_D}{\theta s} \pi_i. \tag{4.6}$$

To secure positive reported profits in country D, we assume $\frac{t_D}{\theta s} \in [0, 1]$.

The optimal amount of shifted profits is determined by balancing the marginal benefit with the marginal cost from profit shifting. Eq.(4.6) shows four determinants of profit shifting. The MNEs shift more profits when tax gap gets wider, which increases the benefit of saving tax payment, and when the world is well globalized, captured by lower θ, which reduces the cost of profit shifting. Intuitively, the shifted profits are 0, which corresponds with the case of no profit shifting, when there is no tax gap, $t_D = 0$, or the world is not globalized, $\theta \to \infty$.

On top of these two determinants which are argued in the existing literature, two more new channels caused by product differentiation appear in this model. First, as higher product differentiation, captured by higher d_i or lower s, makes it difficult to find CUP, it decreases the marginal cost of profit shifting. Second, as more operating profits reduces the cost of shifting profits, the shifted profits are increasing in the operating profits.[10] As we saw above, product differentiation increases operating profits so that both of these new determinants positively affect the MNEs' tax saving strategy.

[10] In the transfer pricing literature, the amount of shifted profits is product of transfer price and the amount of exports. Therefore, they also has a similar channel to ours that more exports (or more operating profits) leads to more shifted profits. Unlike our model, however, their channel is related to benefit side since MNEs are able to shift more profits when they conduct intra-firm trade more even if the same transfer price are set while our model indicates the channel through cost side. For example, see Choi et al. (2018b).

Plugging in the optimal shifted profits, the maximized profits become,

$$\Pi_i^P = \left(1 - t_D + \underbrace{\frac{t_D^2}{2\theta s}}_{\text{Tax saving gains}}\right)\pi_i - F(d_i). \tag{4.7}$$

The last term of the bracket appears in the presence of profit shifting, which captures the net gains from tax savings. From the equation, we can see the decision on profit shifting is independent from the quantity setting. Thus, the outcome of the quantity decision is the same as in the benchmark.

4.3.3 Investment decision with profit shifting

In the presence of profit shifting, eq.(4.2) rewrites the post-tax profits of MNE i as,

$$\Pi_i^P = \left(1 - t_D + \frac{t_D^2}{2\theta(1 - d_i - d_j)}\right)\left(\frac{a - c}{3 - d_i - d_j}\right)^2 - F(d_i). \tag{4.8}$$

Similarly, the first order condition shows the condition that the optimal investment level d^P satisfies as,

$$\begin{aligned}\left.\frac{\partial \Pi_i^P}{\partial d_i}\right|_{d_i=d_j=d^P} &= \frac{2(1-t_D)(a-c)^2}{(3-2d^P)^3} + \underbrace{\frac{t_D^2(a-c)^2}{\theta(1-2d^P)(3-2d^P)^3}}_{\text{Tax avoidance effect}} \\ &\quad + \underbrace{\frac{t_D^2}{2\theta(1-2d^P)^2}\frac{(a-c)^2}{(3-2d^P)^2}}_{\text{Concealment cost effect}} - F'(d^P) = 0. \end{aligned} \tag{4.9}$$

The second and third terms appear as the additional incentives to capture marginal benefits from tax savings since the term of tax saving gains exists in eq.(4.7). The second term in eq.(4.9), we refer to this as "*tax avoidance effect*", captures the marginal benefit from the existence of profit shifting. As the more product differentiation results in the higher operating profits and shifted profits, the opportunity to shift profits is more profitable as investment in product differentiation increases even with the fixed tax saving term in eq.(4.7). Furthermore, the third term in eq.(4.9) captures the link between product differentiation and the cost of profit shifting, we refer to this as "*concealment cost effect*". More product differentiation benefits the MNEs via less cost of profit shifting so that it increases tax saving gains even with fixed operating profits. As the new terms are always positive, the chance to save tax payments provides a stronger incentive to invest in product differentiation with the MNEs.

Note that the concealment cost effect is a specific term in this model as the effect reflects the determinant that more product differentiation leads to lower cost of profit shifting. With a traditional concealment cost, product differentiation has no impacts on the cost structure so that the term disappears once we ignore the relation between product differentiation and the cost of profit shifting. To clarify this point, let d^T be the equilibrium investment level under the case of traditional concealment cost where the concealment cost is unrelated to product differentiation. Then, $d^T < d^P$ holds because of disappearance of the positive concealment cost effect. These arguments lead to the following proposition.

Proposition 4.1 *The opportunity of profit shifting induces the MNEs to invest more in product R&D,* $d^O < d^P$*. This effect is reinforced when product differentiation reduces the costs of profit shifting,* $d^T < d^P$*.*

4.3.4 Globalization

In the last subsection, we see the impact of globalization on product differentiation but this is one extreme example of globalization, that is, autarky to open economy. Although the above analysis provides several arguments, considering marginal changes in globalization is helpful to explain the reality since the recent world is featured not by drastic globalization. Thus, this section focuses on the effect of a reduction in θ.

By differentiating eq.(4.9) with respect to θ, we obtain

$$\frac{\partial}{\partial \theta}\left(\frac{\partial \Pi_i^P}{\partial d_i}\right)\bigg|_{d_i=d_j=d^P} \propto -\left(\underbrace{\frac{1}{3-2d^P}}_{\text{Via tax avoidance effect}} + \underbrace{\frac{1}{2(1-2d^P)}}_{\text{Via concealment cost effect}}\right) < 0. \quad (4.10)$$

Globalization reduces the cost of profit shifting, increases tax saving gains, and thus increases the marginal benefit of the investment via both tax avoidance effect and concealment cost effect. As the optimal level of the investment is determined so as to balance the marginal benefit and the marginal cost of the investment, globalization clearly induces the MNE to invest more in product differentiation. Thus, we have the following proposition.

Proposition 4.2 *Globalization induces the MNEs to invest more in product differentiation,* $\frac{\partial d^P}{\partial \theta} < 0$.

Propositions 4.1 and 4.2 give a new rationale for current development of product differentiation from the tax avoidance angle. A common explanation on the development is that relocating intangible assets is easy and provides MNEs with opportunities of profit shifting across countries. Therefore, the intangible assets developed as outcomes of R&D investments enables MNEs to engage in tax avoidance. However, our model shows another complementary channel which facilitates MNEs to invest more in product differentiation in the presence of interrelation between product differentiation and the ease of profit shifting. In short, the model shows the potential incentives of obtaining more intangible assets for tax avoidance which is ignored by the conventional explanation.

4.4 Welfare effect

4.4.1 Welfare effects of lower profit shifting costs

Globalization has three effects on the post-tax global profits of the MNEs. Directly, globalization magnifies the tax saving gains. On top of that, the more product differentiation via globalization increases not only operating profits but also tax saving gains. Note that these indirect effects are reinforced by more investments of a rival's MNE. Clearly, the three effects augment the post-tax global profits. Formally, we can obtain the following inequality,

$$\frac{\partial \Pi_i^P}{\partial \theta} \propto \underbrace{-\frac{t_D^2}{2\theta^2(1-2d^P)}}_{\text{Direct: Tax saving}} + \left\{ \underbrace{\frac{t_D^2}{2\theta(1-2d^P)^2}}_{\text{Indirect: Tax saving}} + \underbrace{\left(\frac{2}{3-2d^P}\right)\left(1-t_D+\frac{t_D^2}{2\theta(1-2d^P)}\right)}_{\text{Indirect: Demand size}} \right\} \frac{\partial d_j^P}{\partial \theta} < 0, \tag{4.11}$$

where the first term represents the direct effect of a marginal change in θ and the second term captures indirect effects via a change in investment level of a rival firm. Thus, globalization benefits the MNEs.

Next, we analyze the impact on a consumer surplus from the differentiated products. Let CS_X be denoted as the consumer surplus,

$$\begin{aligned} CS_X &= a(x_i^P + x_j^P) - \frac{\left(x_i^P\right)^2 + \left(x_i^P\right)^2 + 2sx_i^P x_j^P}{2} - \sum_{i\in\{1,2\}} p_i^P x_i^P \\ &= 2(2 - d_i^P - d_j^P)\left(\frac{a-c}{3 - d_i^P - d_j^P}\right)^2 \end{aligned} \tag{4.12}$$

As consumers love variety, there are two effects of more product differentiation on consumer surplus. First, the volume of consumption is one of determinants which is captured by the second term of eq. (4.12). More product differentiation results in more consumption and thus obviously has a positive effect on the consumer surplus via the volume effect. In contrast to the positive effect, product differentiation has a negative effect on the consumer surplus via price increases. Recall that product differentiation increases the market demands for each product and thus increases the prices. This aspect is captured by the first term of eq.(4.12). Irrespective of the counteracting effects, the first derivative of the consumer surplus with respect to θ is,

$$\frac{\partial CS_X}{\partial \theta} = \frac{\partial CS_X}{\partial d_i^P}\frac{\partial d_i^P}{\partial \theta} + \frac{\partial CS_X}{\partial d_j^P}\frac{\partial d_j^P}{\partial \theta} = \frac{4(1-2d^P)(a-c)^2}{(3-2d^P)^3}\frac{\partial d^P}{\partial \theta} < 0. \tag{4.13}$$

Therefore, the positive effect of product differentiation due to globalization always exceeds the negative one.

In contrast to the positive effects on consumers and the MNEs, globalization can have a negative impact on tax revenues in country D which is formulated as,

$$TR_D^P = t_D\left(\sum_{i\in\{1,2\}} \pi_i^P - \pi_i^S\right) = 2t_D\left(1 - \frac{t_D}{\theta(1 - d_i^P - d_j^P)}\right)\left(\frac{a-c}{3 - d_i^P - d_j^P}\right)^2, \tag{4.14}$$

which yields,

$$\frac{\partial TR_D^P}{\partial \theta} = \frac{2t_D(a-c)^2}{(3-2d^P)^2}\left\{\frac{t_D}{\theta^2(1-2d^P)} + \left(\frac{2}{3-2d^P} - \frac{t_D(5-6d^P)}{\theta(1-2d^P)^2(3-2d^P)}\right)\frac{\partial d_i}{\partial \theta}\right\}. \tag{4.15}$$

The direct effect is to induce outflows of tax base to country H, which is the first term of the second parenthesis. The indirect effects via product differentiation, however, work in the opposite directions. On the one hand, more product differentiation also results in more outflows of tax bases as it increases tax saving gains. One the other hand, more product differentiation also increases the operating profits of the MNEs. Therefore, the overall impact of globalization on tax revenues in country D is not obvious.

With eq.(4.9), the implicit function theorem rearranges eq.(4.15) into,

$$\frac{\partial TR}{\partial \theta} = \frac{t_D \Gamma}{\theta^2 (1-2d^P)\Gamma_{SOC}},$$
$$\text{where} \quad \Gamma \equiv \Gamma_{SOC} + \left(\frac{2}{5-6d^P} - \frac{t_D}{\theta(1-2d^P)} \right) \frac{(a-c)^2 t_D^2 (5-6d^P)^2}{2(1-2d^P)(3-2d^P)^4}, \tag{4.16}$$
$$\text{and} \quad \Gamma_{SOC} \equiv \frac{6(a-c)^2}{(3-2d^P)^4} \left\{ 2(1-t_D) + \frac{t_D^2(5-6d^P)}{2\theta(1-2d^P)^2} \right\} - \frac{(a-c)^2 t_D^2 (13-18d^P)}{\theta(1-2d^P)^3(3-2d^P)^3} - F''(d_i). \tag{4.17}$$

As we assume the second order condition holds, Γ_{SOC} is negative and thus, sign $\left(\frac{\partial TR}{\partial \theta}\right)$ = sign $(-\Gamma)$ holds. From eqs.(4.16) and (4.17), we have,

$$\frac{\partial TR}{\partial \theta} > 0 \iff \Gamma < 0 \iff F''(d_i) > \underline{F} \equiv \left(\frac{(a-c)^2}{(3-2d^P)^4} \right) \Gamma_F \tag{4.18}$$
$$\text{where} \quad \Gamma_F \equiv \frac{2}{(3-2d^P)} \left(6(1-t_D) + \frac{t_D^2(5-6d^P)}{1-2d^P} \right) + \frac{t_D^2}{\theta(1-2d^P)^2} \left(\frac{(5-6d^P)\{6-t_D(5-6d^P)\}}{2(3-2d^P)} - \frac{13-18d^P}{1-2d^P} \right)$$

This sufficient condition means that globalization always leads to a reduction in tax revenue in country D when the investment is sufficiently costly, or large $F''(d_i)$. This is because the net gains from the investment are small due to larger investment costs and thus the investment level does not increase much, which implies the increase in operating profits is also small.

The above discussions are summarized as the following proposition.

Proposition 4.3 *Globalization, captured by a reduction in θ, always benefits consumers and MNEs. However, globalization decreases tax revenue from MNEs when investment cost is sufficientyly large, or $F''(d_i) > \underline{F}$ holds.*

Given the effects on consumers, the MNEs and tax revenues, the overall effect on welfare in country D is also ambiguous. We assume that the government's objective function is the welfare of consumers. Note that consumers own the MNEs so that MNEs' post-tax profits accrue to consumers. Thus, we can compute the objective function of the government as,

$$U(x^P, y^P, G^P) = CS_X^P + \sum_{i\in\{1,2\}} \Pi_i^P + \beta TR_D^P. \tag{4.19}$$

Obviously, globalization benefits country D when the weight on public goods is close to zero.[11]

Even if β is large, however, welfare-improving globalization is possible when the tax rate is low and thus tax revenue without profit shifting is small. This situation implies a reduction in tax revenue due to profit shifting is less significant. As the tax revenue losses are relatively small, globalization can improve welfare when it increases consumers' and the MNEs' gains a lot. This is most likely when profit shifting and investment in R&D are less costly, that is, θ and $F''(d_i)$ are small enough. Formally, we can obtain at $\theta = \frac{t_D}{s}$,

$$\left.\frac{\partial U}{\partial \theta}\right|_{\theta=\frac{t_D}{s}} \propto 2\beta - 1 + \frac{(a-c)^2(5-6d^P)}{(1-2d^P)(3-2d^P)^4\Gamma_{SOC}}\left(\frac{t_D\beta(1+2d^P)}{3-2d^P} - \frac{t_D}{2} + 2(1-d^P)\right). \tag{4.20}$$

Note that Γ_{SOC} is negative and decreasing in $F''(d_i)$. Therefore, the second term gets smaller as $F''(d_i)$ becomes bigger, which makes eq.(4.20) likely to be positive. On the contrary, the second term gets larger if $F''(d_i)$ is small enough. At an extreme point $F''(d_i) = \underline{F}$,

$$\left.\frac{\partial U}{\partial \theta}\right|_{\theta=\frac{t_D}{s}, F''(d_i)=\underline{F}} = 2\beta - 1 + \frac{1}{t_D^2}\underbrace{\left(\frac{2}{1-6d^P}\right)}_{<0\ \because\ \text{SOC}}\left(\frac{t_D\{2\beta - 3 + 2t_D(2\beta+1)\}}{2(3-2d^P)} + 2(1-d^P)\right), \tag{4.21}$$

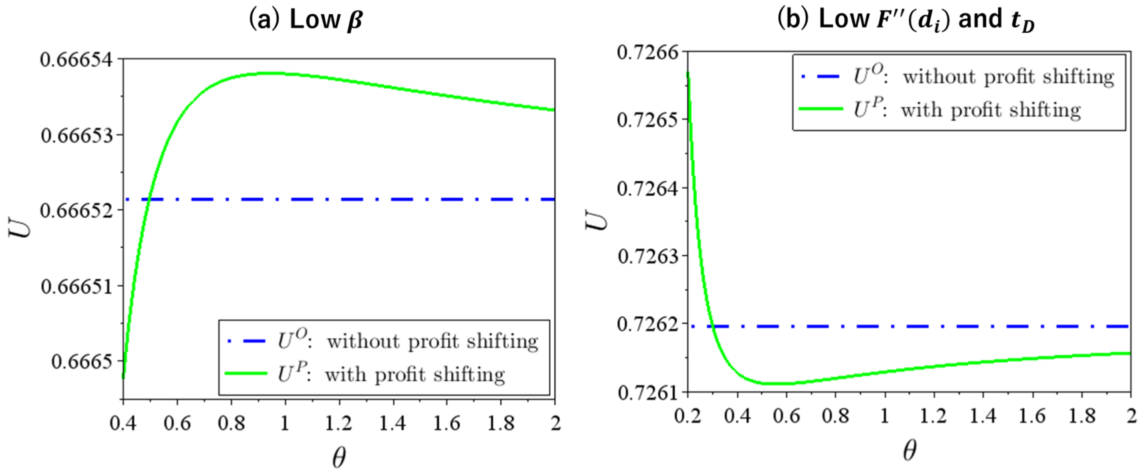
which implies that $\frac{\partial U}{\partial \theta} < 0$ likely holds when t_D is closer to zero.

The above discussion is summarized as the next proposition.

Proposition 4.4 *Globalization improves total welfare if either β is close to 0 or*

[11] Another situation corresponding with this situation is the one that government sector is sufficiently inefficient to provide the public goods. In the literature of mixed oligopoly, it is well known that state-owned firms are relatively inefficient because of less incentive to improve their operation skills. In this model, we can capture this scenario by introducing c_G as a marginal cost of public goods provision and assuming c_G is sufficiently large because $G = \frac{TR}{c_G}$ holds. In the benchmark model, we assume $c_G = 1$.

Figure 4.1: Welfare



the triplet $(t_D, \theta, F''(d_i))$ *is sufficiently small.*

Figure 4.1 illustrates welfare in country D without and with profit shifting cases. The dashed line represents welfare without profit shifting while the solid curve depicts that with profit shifting.[12] The left figure is the case where β is low and corresponds to (a) of proposition 4.4. The solid curve in the figure is an inverse U-shape and globalization improves welfare when θ is large. As β gets larger, the negative impact from tax revenue loss becomes more important and the losses from tax revenue is likely to exceed the gains when tax avoidance is easy to conduct, or θ is low. As β increases, the curve shifts toward downwardly and welfare improving globalization is less likely to happen.

Alternatively, the right figure shows the case where t_D and $F''(d_i)$ are small and illustrates (b) of proposition 4.4. Unlike the case with low β, the shape of welfare curve is U-shaped and globalization improves welfare when θ is low as proposition 4.4 predicts.

These figures provide us with two important policy implications. First, as another interpretation of θ is the degree of tax enforcement, we can see the effect of a stricter enforcement, captured by a higher θ, which differs across the two cases. If a country imposes a high corporate tax but sees public goods provision less importantly, a stricter enforcement tends to be beneficial when globalization proceeds well, or θ is

[12] This figure is derived using the following parameter values and function: $a = 2$, $c = 1$, and $F(d_i) = \frac{\gamma d_i^2}{2}$ for both figures. For the left figure, $\beta = 0.671$, $t_D = 0.3$ and $\gamma = 1$ are used while we use $\beta = 1$, $t_D = 0.1$ and $\gamma = 0.615$ for the right one.

low. However, engaging in more stringent enforcement likely to be welfare improving when the world is less globalized if a country levies a low corporate tax.

Second and more importantly, the figures shed light on a new possibility of beneficial tax havens. Although a traditional view of tax havens is negative because of less provisions of the public good (e.g. Slemrod and Wilson (2009)), Hong and Smart (2010) argued desirable aspect of tax havens because profit shifting makes MNEs' investments in economic activity less sensitive to tax differentials and thus enables a non-haven country to impose a high tax without keeping MNEs' capital away. In our model, however, the source of desirability stems from consumers' and MNEs' benefits driven by product differentiation. This is the case with a large θ in the left figure and a low θ in the right figure.

4.4.2 Endogenous tax rate

So far, we fixed the corporate tax rate in country D. Hereafter, we endogenize the tax rate. To assure that the government has an incentive to provide the public good, β is assumed to be greater than unity, $\beta > 1$.

In the absence of profit shifting, the first order condition for the tax rate is derived as,

$$\begin{aligned}\frac{\partial U^O}{\partial t_D} &= \left(\frac{2(a-c)^2}{(3-2d^O)^2}\right)\left[\beta - 1 + \left(\frac{2\{2(1-d^O)+t_D(2\beta-1)\}}{3-2d^O}\right)\frac{\partial d^O}{\partial t_D}\right] \\ &\propto \beta - 1 - \frac{4\{2(1-d^O)+(2\beta-1)t_D\}(a-c)^2}{F''(d^O)(3-2d^O)^4 - 12(1-t_D)(a-c)^2}. \end{aligned} \tag{4.22}$$

The first two terms in the square bracket are the direct effect that an marginal utility from the public good and marginal (dis)utility from the homogeneous good. As we assume $\beta > 1$, the government has an incentive to collect greater tax revenue on the one hand. On the other hand, the rest term of the bracket is the net indirect effects via a change in product differentiation. As an increase in tax rate discourages the MNEs to invest in product differentiation because a higher corporate tax rate reduces the post tax operating profits and thus gains from product differentiation. This negatively affects consumer surplus, operating profits of the MNEs and tax revenue. Thus, the sign of eq.(4.22) is ambiguous. To see the impact of tax haven on the equilibrium tax rate, we assume $\beta > 1 + \frac{4(a-c)^2\{2(1-2d^O)+t_D\}}{(3-2d^O)^4F''(d^O)-4(a-c)^2\{3(1-t_D)+2t_D\}}$ and the equilibrium tax rate without a tax haven is positive.

With profit shifting, the first order condition for the government is,

$$\frac{\partial U^P}{\partial t_D} = 2\left(\frac{a-c}{3-2d^P}\right)^2 \left[\beta - 1 \quad \underbrace{-\frac{(2\beta-1)t_D}{\theta(1-2d^P)}}_{\text{Net direct effect of tax avoidance}} + \left\{\left(\frac{2\{2(1-d^P)+t_D(2\beta-1)\}}{3-2d^P}\right) - \underbrace{\left(\frac{t_D^2(5-6d^P)(2\beta-1)}{2\theta(1-2d^P)^2(3-2d^P)}\right)}_{\text{Indirect effect via tax avoidance}}\right\}\frac{\partial d^P}{\partial t_D}\right], \tag{4.23}$$

which shows two new effects via tax avoidance. First, as an additional direct effect, an increase in tax rate gives the opportunity of profit shifting for tax savings. Even though such a tax avoidance contributes to an increase in consumption of homogeneous goods, it reduces tax revenues and thus public good provision which is more valuable for the consumer. Moreover, since such a tax avoidance behaviour entails concealment costs, the net direct effect of the tax avoidance is negative. Second, a change in corporate tax rate also affects the investment level, which influences the effectiveness of tax avoidance as well.

Likewise the case without profit shifting, these effects make the sign of eq.(4.23) unclear. However, we confirm $\frac{\partial d^O}{\partial t_D} < \frac{\partial d^P}{\partial t_D}$, which implies the MNEs' response to a change in the tax rate is less sensitive with profit shifting because they can shift some profits to a haven country and the tax burden is mitigated.[13] Hence, the optimal tax rate is more influenced by the direct effects, which indicates that the government's incentive to impose a higher corporate tax rate for the public good provision is weakened.

Here, we rely on numerical calculation as it is impossible to derive analytical results of globalization. In Table 4.1, the numerical results are provided with $\beta = 1.21$ for the upper two tables and $\beta = 1.01$ for the bottom one.[14] The top table shows outcomes with endogenous tax rate while the middle one represents results with a fixed tax rate of the optimal one without profit shifting $\theta = \infty$.

[13]Note that $\frac{\partial d^O}{\partial t_D} < 0$ holds.

[14]Other parameter values used in the table are: $a = 2$, $c = 1$, and $\gamma = 0.8$. "—" in the lower table represents the case where $\frac{t_D}{\theta s} > 1$, which is outside our focus.

TABLE 4.1: Optimal tax rate

I. Endogenous tax

θ	1	5	10	25	50	100	150	200	∞
$\widehat{t}_D$	0.00657	0.03280	0.06524	0.15746	0.28643	0.46110	0.56760	0.63796	0.86033
$\widehat{d}^P$	0.11750	0.11343	0.10851	0.09515	0.07780	0.05629	0.04608	0.03637	0.01328
$\widehat{TR}^P$	0.00170	0.00846	0.01671	0.03958	0.07033	0.11004	0.13333	0.14839	0.19461
$\widehat{U}^P$	0.71263	0.71266	0.71269	0.71277	0.71289	0.71306	0.71316	0.71323	0.71335
$\widehat{t}^{eff}$	0.00651	0.03252	0.06470	0.15623	0.28449	0.45871	0.56525	0.63577	0.86033
$\widehat{t}^{eff}/\widehat{t}_D$	0.99086	0.99146	0.99172	0.99218	0.99322	0.99481	0.99585	0.99656	1.0

II. Fixed tax at $t_D = 0.86033 (= \widehat{t}_D|_{\theta=\infty})$

θ	1	5	10	25	50	100	150	200	∞
d^P	—	—	0.02314	0.01711	0.01518	0.01423	0.01391	0.01375	0.01328
TR^P	—	—	0.17943	0.18865	0.19165	0.19314	0.19363	0.19388	0.19461
U^P	—	—	0.70547	0.71026	0.71181	0.71258	0.71284	0.71297	0.71335
t^{eff}	—	—	0.78272	0.82967	0.84506	0.85271	0.85525	0.85652	0.86033
t^{eff}/t_D	—	—	0.90979	0.96436	0.98225	0.99114	0.99409	0.99557	1.0

III. Fixed tax at $t_D = 0.1$ if $\theta < \infty$

θ	1	5	10	25	50	100	150	∞ with $\widehat{t}_D = 0$
d^P	0.22359	0.21184	0.21054	0.20977	0.20952	0.20938	0.20935	0
U^P	0.75593	0.75363	0.75339	0.75325	0.75320	0.75318	0.75317	0.77509

As argued above, the equilibrium tax rate under profit shifting is lower than the one without profit shifting and globalization lowers the optimal tax rate. This is in line with the stylized fact known as "race to the bottom". Moreover, most of propositions under a fixed tax rate are carried over even if we endogenize the tax rate.

However, proposition 4.4 is the one which is not replicated. The middle table suggests that a reduction in welfare by globalization is not because we endogenize the tax rate but because the optimal tax rate without profit shifting is sufficiently high. As an increase in welfare is realized when the triplet $(t_D, \theta, F''(d))$ is small enough, the optimal tax rate without profit shifting does not satisfy the statement of proposition 4.4 in this example.

To investigate the welfare-improving globalization, another numerical example is shown in the bottom table. As proposition 4.4 suggests, the bottom table represents a case that globalization improves welfare in country D under a fixed tax rate $t_D = 0.1$ if profit shifting is possible, or $\theta < \infty$. In the parameter values, globalization leads to an increase in welfare. However, the tax rate is not optimal without a tax haven and the optimal tax rate is zero whose values of investment and welfare are shown in the right edge of the table. Immediately, we can see that the emergence of a tax haven is harmful for the domestic country.

The reason why welfare-improving globalization in the last subsection was observed is obviously the tax rate was not the optimal both before and after a tax haven emerges.[15] However, a tax rate is not always optimal industry-wide because of the nature of corporate taxation that a government imposes a unique corporate tax rate across industries. Therefore, welfare-enhancing globalization occurs when the initial tax rate is low enough due to , for example, other industries and adjustment of a tax rate is difficult to conduct.

By comparing the top and the middle tables, we can also see the impact of endogenizing tax rate and the main source of welfare reduction because of globalization. As reduction in tax revenue is dramatical with an endogenous tax rate compared to the one with a fixed tax rate, the primary reason of decline in welfare is drop of tax revenue when tax is endogenized. To brake welfare reduction, the government gives the MNE more incentive to conduct product differentiation that increases consumer surplus and the MNEs' profits by reducing a tax rate. This gives us an important implication that the best tax policy is the one resulting in more product differentiation at the expense of

[15]The equilibrium tax rate without a tax haven is relatively large when the cost of investment is small or it is zero when the government weight a small weight on the public goods provision.

tax revenue. This seems surprising because the provision of the public good is more valuable. As tax revenue is not reliable source to increase welfare under profit shifting, the government shifts main sources to maximize welfare to consumers' gain and the MNEs' profits.

The last investigation of the endogenous tax rate is whether product differentiation accelerates the efficiency of tax avoidance of the MNEs. A standard way of measuring the efficiency of profit shifting is to compute effective tax rate, which is the ratio of tax payments to operating profits. In this model, the effective tax rate is computed as,

$$t^{eff} = \frac{t_D\left(1-\frac{t_D}{\eta}\right)\pi_i}{\pi_i} = t_D\left(1-\frac{t_D}{\theta(1-2d^P)}\right). \tag{4.24}$$

This indicates that the effective tax rate is determined by the tax rate and the effectiveness of profit shifting, captured by the second term of eq.(4.24).

Table 4.1 displays a case that globalization contributes to a decrease in the effective tax rate for both an endogenous and a fixed tax cases but the decline is more prominent under an endogenous tax. Notably, the main reason of the decline in the effective tax rate is caused not by the efficiency of tax avoidance, but by a reduction in the tax rate. We can see this by looking at the two bottom columns of the top and middle tables. The bottom columns show the efficiency of tax avoidance and that profit shifting becomes more efficient as globalization proceeds since the number of the columns decreases. The smaller numbers under a fixed tax rate than those under an endogeneous tax rate indicates that the MNEs' tax avoidance is more effective under an exogenous tax rate in the sense that the proportion of the MNEs' shifted profits is greater although the effective tax rate is lower under a fixed tax rate. This alerts a simple comparison of the effective tax rate over years as a measure of development of tax avoidance because the reduction may come from a direct reduction in tax rate and not from the efficiency of tax avoidance $1-\frac{t_D}{\eta}$.

4.5 Discussions and policy implications

This section discusses some key setups and assumptions.

4.5.1 Concealment cost

For simplicity, the benchmark model introduces a specific form of concealment cost which is a function of lump sum shifted profits. Although this makes the model tractable, it also makes the ways of profit shifting ambiguous. As one of the main channel of profit shifting to tax haven is conducted with royalty payments on intangible assets, this subsection assumes that the two MNEs have their own intangible asset such as patent or trade marks in a tax haven to show robustness of the results.

Usually, royalty payments are based on proportional to sales. By assuming $c = 0$, the concealment cost can be modified as;

$$C(\alpha_i, \pi_i) = \frac{\eta \alpha^2 \pi_i}{2}$$

where $\alpha \in [0, 1]$ represents the royalty rate. As the amount of shifted profits is $\pi_i^s = \alpha \pi_i$ in this case, the optimal royalty rate is;

$$\widehat{\alpha}_i = \frac{t_D}{\eta},$$

which reduces the post-tax profits as;

$$\Pi_i^P = (1 - t_D)(\pi_i - \widehat{\alpha}_i \pi_i) + \widehat{\alpha}_i \pi_i - \frac{\eta \widehat{\alpha}_i^2 \pi_i}{2} = \left(1 - t_D + \frac{t_D^2}{2\eta}\right) \pi_i$$

which is the same as eq.(4.7) so that the following benchmark analysis and results hold in this modified setup.

4.5.2 Product differentiation in inputs

Another possibility on the source of differentiation is technological differentiation for inputs rather than product differentiation of final products. In such a case, differentiation does not necessarily result in an increase in utility from the products in the sense of varieties. However, if an MNE develops its own technology to produce inputs in more efficient way, which is known as “process innovation”, the MNE produces more products. In order to see the impact of types of R&D activities, this subsection considers the case with process innovation.

As a source of differentiation comes from input, we assume homogeneous final products, or $s = 1$, and the marginal cost of input is $c_i = c - d_i$ instead of c where d_i is the investment level for process innovation. Likewise, MNEs incur investment cost $F(d_i) = \frac{\gamma d_i^2}{2}$ to reduce marginal cost c_i. We assume that this investment creates firm specific technologies to reduce the marginal cost and more investment makes it difficult for tax authorities to audit tax avoidance. Therefore, the coefficient of profit shifting η is again a function of the investment levels.[16] For simplicity, we specify the concealment cost as;

$$C(\eta, \pi_i^S) = \frac{\eta(\pi_i^S)^2}{2\pi_i}, \quad \text{where} \quad \eta = \frac{\theta}{d_i + d_j}. \tag{4.25}$$

Then, the post tax profits for the MNEs become $\Pi_i^P = \left(1 - t_D + \frac{(d_i+d_j)t_D^2}{2\theta}\right)\pi_i - F(d_i)$. The tax avoidance gain captured by the third term exists and makes the investment more than the case without profit shifting as proposition 4.1 suggests.

Notably, even though such additional investments reduce the marginal cost, the MNEs' equilibrium post-tax profits can decrease because of fierce market competition. In the form of product innovation, an increase in firm j's investment expands the demand of MNE i so that an increase in investment costs of MNE i is covered by magnified market expansion by MNE j. However, an increase in MNE j's investment in process innovation shrinks the market share of MNE j, which means that an increase in investment costs of MNE i dominates an increase in operating profits. Formally, we can see the effect:

$$\begin{aligned} \frac{\partial \Pi_i^P}{\partial \theta} &= -\frac{t_D^2 d^P}{\theta^2}\left(\frac{a-c+d^P}{3}\right)^2 + \frac{\partial \Pi_i^P}{\partial d_i^P}\frac{\partial d_i^P}{\partial \theta}, \\ &\propto \left[\underbrace{-\frac{t_D^2 d^P(a-c+d^P)}{\theta^2}}_{\text{Direct: Tax saving}} + \left\{\underbrace{\frac{t_D^2(a-c+d^P)}{2\theta}}_{\text{Indirect: Tax saving}} \underbrace{-2\left(1 - t_D + \frac{d^P t_D^2}{\theta}\right)}_{\text{Indirect: Competition}}\right\}\frac{\partial d_i^P}{\partial \theta}\right], \end{aligned} \tag{4.26}$$

where the third effect is not indirect demand size effect as seen in eq.(4.11) but indirect competition effect. In the appendix, we show that total effects can be negative and globalization hurts MNEs. Therefore, unlike product differentiation on final product,

[16] Even though the subsequent marginal cost is the same across firm, it is plausible assumption that η is a function of investment levels. Suppose there are several tasks to produce the goods and the total marginal cost without R&D investment is c. Each MNE decreases marginal costs of different tasks by investing in process innovation and the total reduction in marginal costs is d_i. Note that the value of patents is not comparable as patents are task specific. Therefore, there are still room for the MNEs to justify their transfer prices to some extent.

process innovation driven by tax avoidance hurts MNEs if eq.(4.26) is positive. This new result is summarized as the following proposition.

Proposition 4.5 *Suppose that investments in R&D are the form of process innovation. Then, globalization results in a reduction in the post-tax profits of the MNEs if eq.(4.26) is positive.*
Proof. See Appendix.

As a common anticipation of tax havens is to benefit MNEs by providing them with tax avoidance opportunities, proposition 4.5 is an intriguing result. Even though the post-tax profits without tax havens are greater than those with tax havens, conducting more investments is a dominant strategy for each MNE, which results in the "prisoner's dilemma" outcome in a non-cooperative game.

4.5.3 Under or excess investment

We explore whether the equilibrium product differentiation are excess- or under-investments in the benchmark model. Without a tax haven, it is easily obtained that the equilibrium degree of product differentiation is less than the optimal level of product differentiation that maximizes welfare in country D. This is because more product differentiation increases consumer surplus and tax revenue but such gains are out of MNEs' consideration. Formally,

$$\left.\frac{\partial U^O}{\partial d_i}\right|_{d_i=d^O} = \frac{4(a-c)^2(1-d^O+2\beta t_D)}{(3-2d^O)^3} > 0, \tag{4.27}$$

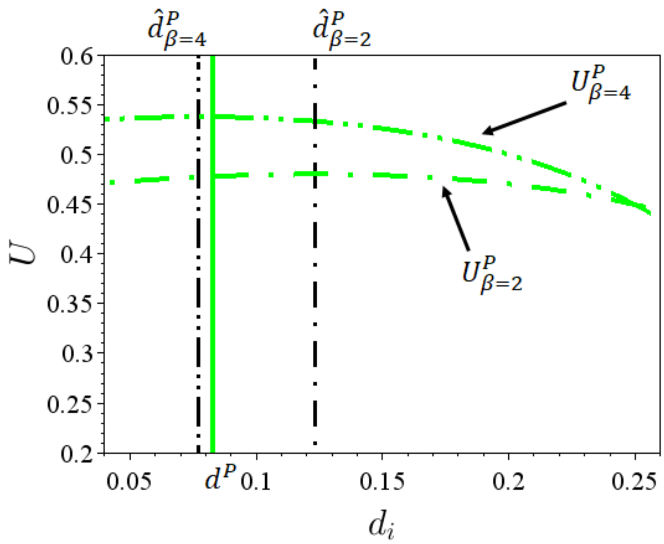
is obtained.

With a tax haven, it is unclear whether the equilibrium level of product differentiation is below the socially optimal level. At d^P, the first derivative of welfare with respect to d is;

$$\left.\frac{\partial U(x_i^P, x_j^P, y^P)}{\partial d_i}\right|_{d=d^P} = \frac{(a-c)^2}{(3-2d^P)^3}\left(2(1-2d^P) + 2\beta t_D - \frac{t_D^2(5-6d^P)(2\beta-1)}{2\theta(1-2d^P)^2}\right). \tag{4.28}$$

The first and second terms in the parenthesis are the change in consumer surplus from the differentiated products and the change in tax revenue from operating profits, respectively, and the third term shows the net loss from tax avoidance. The loss term

Figure 4.2: Socially optimal d



becomes greater as profit shifting is less costly, or low θ, and the marginal utility from the public goods β is large. Specifically, we can calculate,

$$\left.\frac{\partial U(x_i^P, x_j^P, y^P)}{\partial d_i}\right|_{d=d^P} < 0$$

$$\iff \beta > \frac{4(2-2d^P-t_D)\theta(1-2d^P)^2 + t_D^2(5-6d^P)}{2\{t_D^2(5-6d^P) - 2t_D\theta(1-2d^P)^2\}} \equiv \beta^P_{opt}, \qquad (4.29)$$

as a condition where excess investment is realized.

Figure 4.2 shows the above discussions.[17] In the figure, welfare in country D under the case of profit shifting with two different β are depicted. The vertical solid line represents the equilibrium investment level d^P. A single-dot curve illustrates welfare with $\beta = 2$ and the single-dot vertical line shows the socially optimal level of investment, denoted by $d^P_{\beta=2}$. As we can see the order $d^P < \widehat{d}^P_{\beta=2}$, the equilibrium investment is under-investment. However, the double-dot curve and vertical line depict those with $\beta = 4$, and the opposite order is observed $\widehat{d}^P_{\beta=4} < d^P$, which means the equilibrium is characterized as excess-investment. As mentioned above, if the country sees a larger weight on the public good provision, an emergence of a tax haven can result in excess-investment in product differentiation.

[17]The parameter values used for the figure is: $a = 2$, $c = 1$, $t_D = 0.3$, $\theta = 0.6$, and $F(d_i) = \frac{d_i^2}{2}$.

The above argument is summarized as the following proposition.

Proposition 4.6 *In the absence of profit shifting, the level of investment on product differentiation is less than the optimal level. However, opportunities of profit shifting makes the degree of investments in product differentiation greater than the optimal degree when the government weights tax revenue less, namely,* $\left.\frac{\partial U(x_i^P, x_j^P, y^P)}{\partial d^P}\right|_{d_i=d_j=d^P} < 0$ *holds if and only if* $\beta > \beta_{opt}^P$ *holds.*

This proposition implies that policies to facilitate R&D investment in product differentiation does not necessarily lead to welfare improvement in the presence of profit shifting although they are always welfare improving without profit shifting. Given the huge tax revenue losses explained in the introduction, the currently arising competition for attracting R&D activities such as patent box may cause more R&D activities and result in excess-investment.

4.6 Concluding remarks

In this paper, we have analyzed MNEs' incentive to invest more in product differentiation in the presence of profit shifting. Product differentiation reduces the similarity of MNEs' products, which makes it difficult for tax authorities to find comparable or appropriate AL price and to audit MNEs' tax avoidance behaviours. Based on this practical difficulty, our model has shown a new rationale that MNEs engage in higher product differentiation. We also have analyzed the impacts of globalization, captured by a reduction in marginal cost of using a tax haven. Globalization reduces the cost of profit shifting and increase a marginal benefit from product differentiation. As a result, the further globalization leads to the more product differentiation.

The more product differentiation has counteracting effects. On the positive side, consumers and MNEs benefit due to more product differentiation and less market competition. On the negative side, tax revenue in a high tax country becomes smaller and thus the provision of a public good is scarce. Our result showed that globalization can improve welfare in a non-tax haven country when the tax revenue losses are not significant. Surprisingly, our numerical example showed that under such situations, an emergence of a tax haven can increase. This striking result does not appear once we endogenized the tax rate of the non-tax haven country.

We have also considered some extensions and found several policy implications from the model. First, designing policies to promote product differentiation is not always beneficial if profit shifting is taken into account. This is because product differentiation magnifies profit shifting which reduces a public goods provision. As this loss is more important when a country recognizes a higher weights on utility from the public good, a policy reducing product differentiation is likely optimal. Second, our analysis predicts that a type of differentiation is crucial for MNEs. Product differentiation always benefits the MNEs thanks to the market expansion while product innovation can hurt them due to a fiercer competition effect. This implies policy makers should pay attention to types of R&D when they design policies for R&D.

Even though this study found a set of new results, our analysis can be extended in several ways. First of all, although this study implicitly assumes that the world adopts separate accounting system, MNEs' incentive to invest in product differentiation can differ under formula apportionment which allocates MNEs' tax base across countries based on real economic activities and is independent of product characteristics. As introduction of formula apportionment is frequently argued, the effects of a change in international tax scheme is important to understand. Furthermore, we postulated that product differentiation takes place in the final product market but product differentiation is also seen in intermediate industries. Thus, investigation of a vertically related industries can be interesting. Finally, governments' behaviours should be analyzed more in detail in order to obtain richer policy implications. Especially, as globally cooperative actions such as BEPS project begins, interaction between countries in non-cooperative and cooperative game can be one of the interesting extensions.

Conclusion

This dissertation has considered MNEs' tax avoidance strategies. All the chapters are based on imperfect competition setups and have addressed specific questions which are based on empirically observed relationship, such as transfer pricing for ROO (Chapter 3), MNEs' location in a high tax country (Chapter 1 and Chapter 2) and tax avoidance by R&D intensive MNEs (Chapter 4). In this conclusion, I will draw some inferences that are common to all chapters although the main focuses are different.

The first three chapters have investigated how MNEs' location choice is influenced by tax regulation, economic integration and trade policy in the presence of profit shifting. One of the common striking results is that locating an affiliate of MNEs in a high tax country can be the optimal international organization structure, if profit shifting is allowed. This can be the opportunity of transferring profits being made from a high tax country (Chapter 1). Another rationale in Chapter 2 is that locating in a high tax country lowers transfer prices, which makes its distribution branch more aggressive in foreign markets. In addition, locating in a high tax country can be profitable by pursuing a preferential tariff, as we have seen in Chapter 3. As policy makers expect that lowering their corporate tax rate attracts FDI, this result is surprising. However, it is in line with several empirical findings (e.g. Overesch (2009) and Horner and Aoyama (2009)). Moreover, Chapter 1 and 3 have shown that this pattern of geographically separated location is an outcome in the absence of regulations such as the ALP and ROO. Although the primary reason of these rules is to prevent transfer pricing manipulation and trade deflection, they may also contribute to prevent MNEs' tax avoidance via location choices.

A major interest of both academics and policy makers is the effect of MNEs' tax avoidance decision on corporate tax revenue. Chapters 1 and Chapter 2 reveal that in the presence of tax avoidance, attracting FDI does not necessarily lead to an increase in tax revenue. In Chapter 1, the tax base in a low tax country increases thanks to the ALP but tax revenues in the low tax country declines. When the ALP does not exist, a large proportion of profits are shifted from a high tax country to a low tax country. With the ALP, however, such inflows of profits no longer flows to a low tax country. Additionally, in Chapter 2, a high tax country can attract MNEs' production units if trade costs are low. However, tax revenues fall nevertheless, because tax avoidance is highly efficient under these conditions.

The last two chapters also indicate a positive side of profit shifting in a high tax country. The traditional view of tax avoidance is negative because falling revenues lead to less public good provisions (e.g. Slemrod and Wilson (2009)). In contrast to this negative evaluation, Chapter 3 has argued that transfer pricing with ROO can induce inflows of an MNE's tax base into an FTA region and Chapter 4 has pointed out that more product differentiation undertaken to avoid taxes can benefit consumers. This highlights the importance of research across fields as MNEs' business operations are complex and there may exist hidden positive effects of profit shifting, even though tax avoidance tends to hurt a high tax country.

In this dissertation, I have pointed out several effects of regulations (i.e. the ALP and ROO) by combining profit shifting with other strategies of MNEs (namely location choice and R&D activities), and some of the derived results contrast with common knowledge. This clearly means that a further analysis is indispensable to get a fuller understanding of the implications of tax avoidance. Furthermore, given the huge importance of tackling the issues of MNEs' tax avoidance, worldwide political cooperation such as BEPS project is essential in the coming generation. Therefore, further research in this direction remains an important topic for both academics and policy makers.

Appendices

A Appendix to Chapter 1

A.1 List of Key Variables

Table A.1: List of Key Variables of Chapter 1

Benchmark	Co-location	Separate location
Internal price of the input	g	g^S (transfer price)
Arm's length price of the input	g_*	g_*^S
Price of the affiliate's final good	p	p^S
Price of the local firm's final good	p_*	p_*^S
Quantity of the affiliate's final good	q	q^S
Quantity of the local firm's final good	q_*	q_*^S
Pre-tax profit of the upstream affiliate	π_u	π_u^S
Pre-tax profit of the downstream affiliate	π	π^S
Pre-tax profit of the local firm	π_*	π_*^S
Total post-tax profit of the MNE	Π	Π^S

Arm's Length Principle (ALP)	Co-location	Separate location
Arm's length price of the input	$\tilde{g}$	$\tilde{g}^S$
Price of the affiliate's final good	$\tilde{p}$	$\tilde{p}^S$
Price of the local firm's final good	$\tilde{p}_*$	$\tilde{p}_*^S$
Quantity of the affiliate's final good	$\tilde{q}$	$\tilde{q}^S$
Quantity of the local firm's final good	$\tilde{q}_*$	$\tilde{q}_*^S$
Pre-tax profi of the upstream affiliate	$\tilde{\pi}_u$	$\tilde{\pi}_u^S$
Pre-tax profit of the downstream affiliate	$\tilde{\pi}$	$\tilde{\pi}^S$
Pre-tax profit of the local firm	$\tilde{\pi}_*$	$\tilde{\pi}_*^S$
Total post-tax profit of the MNE	$\widetilde{\Pi}$	$\widetilde{\Pi}^S$

We note that (i) in the ALP case, the internal price is equal to the arm's length price, (ii) the downstream firms produce one unit of final goods using one unit of intermediate inputs, and (iii) the pre-tax profits from the parent country $\bar{\pi}$ are always constant.

A.2 Proof of Proposition 1.3

Tax Revenues in the Host Country. Assuming $T > \overline{T} = 1/4$, we show that when $t \in (\underline{t}, t^*)$, tax revenues in the benchmark case, TR_H, are greater than those in the

ALP case, $\widetilde{TR}_H$. It suffices to check the difference of taxable profits:

$$\widetilde{TR}_H - TR_H = t[\tilde{\pi}_u + \tilde{\pi} + \tilde{\pi}_* - (\pi^S + \pi^S_*)] < 0,$$
$$\rightarrow \tilde{\pi}_u + \tilde{\pi} + \tilde{\pi}_* - (\pi^S + \pi^S_*) \equiv \Gamma < 0.$$

If it is shown that (i) $\Gamma < 0$ holds at $t = t^*$ and (ii) Γ is increasing in t, we can conclude that Γ is negative for $t \in (\underline{t}, t^*)$. First we check (i):

$$\Gamma|_{t=t^*} = -\frac{13(1-c)^2}{72} < 0.$$

(ii) requires the following condition:

$$\frac{d\Gamma}{dt} = -\frac{\partial(\pi^S + \pi^S_*)}{\partial g^S}\frac{dg^S}{dt} > 0,$$
$$\text{where } \frac{dg^S}{dt} = \frac{2(1-c)(1-T)}{t-2T+1} > 0,$$

noting that profits earned in the host under the ALP, $\tilde{\pi}_u + \tilde{\pi} + \tilde{\pi}_*$, are independent of transfer price and thus of tax rates. We only need to check that profits in the host in the benchmark case, $\pi^S + \pi^S_*$, are decreasing in transfer price, g^S:

$$\frac{\partial(\pi^S + \pi^S_*)}{\partial g^S} = \frac{5g^S - 4}{8}$$
$$< \frac{g^S_* - 1}{2} < 0,$$

where we make use of $g^S < g^S_*$ and $g^S_* < 1$. Both (i) and (ii) are proved to be true and thus we complete the proof.

Tax Revenues in the World. We first show $g^S < c$ for $t \in (\underline{t}, t^*)$ while assuming $T > \overline{T} = 1/4$. $g^S < c$ requires the following condition:

$$g^S - c = \frac{(1-c)(t-T)}{t-2T+1} < 0,$$

which obviously holds under our assumption.

We then show the following:

$$\begin{aligned}\widetilde{TR}_W - TR_W &= -T\pi_u^S + t[\tilde{\pi}_u + \tilde{\pi} + \tilde{\pi}_* - (\pi^S + \pi_*^S)] \\ &= -T\pi_u^S + t\Gamma \equiv \Delta > 0,\end{aligned}$$

where TR_W and $\widetilde{TR}_W$ are world tax revenues in the benchmark and the ALP cases, respectively.

Analogous to the previous case, if it is shown that (i) Δ is positive at $t = t^*$ and (ii) Δ is decreasing in t, we can conclude that $\Delta > 0$ holds for $t \in (\underline{t}, t^*)$. First we see (i):

$$\Delta|_{t=t^*} = \frac{(13 - 2T)(1-c)^2}{216} > 0.$$

To prove (ii), it suffices to show

$$\begin{aligned}\frac{d\Delta}{dt} &= -T\frac{d\pi_u^S}{dt} + \Gamma + t\frac{d\Gamma}{dt} \\ &< t\left(\frac{d\Gamma}{dt} - \frac{d\pi_u^S}{dt}\right) + \Gamma \\ &= t\frac{\partial(\pi^S + \pi_*^S - \pi_u^S)}{\partial g^S}\frac{dg^S}{dt} + \Gamma < 0,\end{aligned}$$

where from the first to the second line we make use of $t < t^* < T$. As we have seen $dg^S/dt > 0$ and $\Gamma < 0$, we only need to check

$$\begin{aligned}\frac{\partial(\pi^S + \pi_*^S - \pi_u^S)}{\partial g^S} &= -\frac{c + 2 - 3g^S}{2} \\ &< -\frac{c + 2 - 3c}{2} \\ &= -(1 - c) < 0,\end{aligned}$$

noting that $g^S < c$ from the first to the second line. We complete the proof.

A.3 A Local Firm in the Upstream Industry

In the text, the upstream affiliate is the only supplier of inputs. One may wonder this setting is crucial for the results, but it is not the case. We see that the upstream affiliate may be located in the high-tax parent country ("separate location") in the benchmark case (Proposition 1.1) and the imposition of the ALP may change this location pattern (Proposition 1.2). We introduce a local upstream firm in the host country. The local upstream firm has the same marginal cost c as the MNE's upstream affiliate and competes with the affiliate in a Bertrand fashion. The timing proceeds in the same manner as in the text. First, the MNE chooses a location for upstream production. Then the MNE and the local upstream firm set input prices. Finally the downstream affiliate and the local firm source the inputs and produce final goods.

As inputs produced by the two upstream firms are homogeneous, the downstream firms buy inputs from the lowest price supplier. Hence, the dominant strategy for the local upstream is to set its input price equal to the marginal cost c. Considering this strategy of the local upstream, the MNE sets input prices equal or lower than c. We need to modify the MNE's maximization problem so as to include inequality constraints on input prices.

Benchmark Case. Let us first look at the separate-location scheme. The maximization problem for the MNE is modified as[1]

$$\max_{g^S, g_*^S} \Pi^S = (1-T)[\bar{\pi} + (g^S - c)q^S + (g_*^S - c)q_*^S] + (1-t)(p^S - g^S)q^S,$$
$$\text{s.t. } g^S \leq c, \ g_*^S \leq c,$$

where the final good's price p^S and quantities (q^S, q_*^S) are defined in Section 1.3 and we assume that the MNE upstream affiliate takes all the input demand if its prices are equal to the ones of the local upstream.

Letting λ and μ be the Lagrange multipliers for the constraints of $g^S \leq c$ and $g_*^S \leq c$ respectively, we solve the above problem to get

$$g^S = c + \frac{(1-c)(t-T)}{t-2T+1} < c,$$
$$\lambda = 0,$$
$$g_*^S = c,$$
$$\mu = (1-c)(1-T)/2 > 0,$$

[1] We do not distinguish the notation of variables between the unconstrained problem in the text and the constrained problem here.

where we maintain the assumptions (A1): $t > \underline{t}$ and $t < T$. As the multipliers are all non-negative, the equilibrium prices satisfy the Kuhn-Tucker conditions for optimization. g^S allows a similar interpretation to the one for the unconstrained optimal transfer price defined in Eq. (1.6). The first term is the base price equal to the arm's length price. The second term represents the tax-manipulation effect.

The associated post-tax profits are then given by

$$\Pi^S = (1-T)\left[\bar{\pi} + \frac{(1-T)(1-c)^2}{4(t-2T+1)}\right].$$

Under the co-location scheme in the benchmark case as discussed in Section 1.3, the MNE sets input prices higher than c in the unconstrained maximization problem, i.e., $g > c$ and $g_* > c$. Hence, in the constrained problem here, it can be confirmed that the MNE sets input prices equal to c, i.e., $g = c$ and $g_* = c$, and obtains the following post-tax profits:

$$\Pi = (1-T)\bar{\pi} + \frac{(1-t)(1-c)^2}{4}.$$

As easily seen, Π is smaller than Π^S at $t \in (\underline{t}, T)$. In other words, the MNE's optimal choice is that the upstream affiliate is always located in the parent country (separate location). Even when considering the local upstream, our conclusion still holds; the upstream production may be located in the high-tax country for the tax-manipulation purpose.

ALP Case. In the ALP case, the optimal input prices in the unconstrained problem discussed in Section 1.4 are never below the marginal cost c under the two schemes, i.e., $\tilde{g} > c$ and $\tilde{g}^S > c$. By the same reasoning as before, it can be confirmed that the constrained problem gives the input prices equal to the marginal cost, i.e., $\tilde{g} = c$ and $\tilde{g}^S = c$. Hence, the associated profits are identical with the one under the co-location scheme in the benchmark case, i.e., $\widetilde{\Pi} = \widetilde{\Pi}^S = \Pi$ at $t \in (\underline{t}, T)$. Unlike the benchmark case, the tax-manipulation effect disappears and the two countries are indifferent as to the location choice. In this generalized setting, we still see that the imposition of the ALP may change the location pattern as argued in the text.

A.4 Many Local Firms in the Downstream Industry

As in A.3, we see here that our main conclusions are maintained in a more generalized setting than in the text. Consider N local firms in the downstream industry. The local firms are assumed to be symmetric and have the same marginal cost c. If N is set to be unity, all the following results reduce to the corresponding results in the text.

The demand functions for the downstream affiliate and the local firm j are respectively given by

$$p = 1 - q,$$
$$p_{*j} = 1 - q_{*j}.$$

The following procedure is the same as in the text and we solve the problem backward. Considering the above demand schedules, the downstream firms choose quantities to maximize their own profits:

$$q = \frac{1-g}{2},$$
$$q_{*j} = \frac{1-g_{*j}}{2}.$$

Benchmark Case. Given the optimal quantities the downstream firms choose, the MNE sets input prices to maximize its post-tax profits. In the co-location scheme, the equilibrium input prices are given by

$$g = c,$$
$$g_* = \frac{1+c}{2},$$

where $g_{*j} = g_*$ holds for all j and the SOCs trivially hold.

The total post-tax profits in equilibrium are calculated as

$$\Pi = (1-T)\bar{\pi} + \frac{(1-t)(1-c)^2(2+N)}{8}.$$

The equilibrium input prices in the separate-location scheme are given by

$$g^S = c + \frac{(1-c)(t-T)}{t-2T+1},$$
$$g^S_* = \frac{1+c}{2},$$

where $t - 2T + 1 > 0$ and the SOCs hold under (A1): $t > \underline{t}$. Under $t < T$, the second term of g^S is negative so that the tax-manipulation effect works in the same way as in Eq. (1.6).

The total post-tax profits in equilibrium are calculated as

$$\Pi^S = (1-T)\left[\bar{\pi} + \frac{(1-c)^2\{Nt - 2(1+N)T + 2 + N\}}{8(t-2T+1)}\right].$$

Taking difference between the post-tax profits in the two schemes gives

$$\Pi - \Pi^S = \frac{\Theta'(1-c)^2(T-t)}{16(t-2T+1)},$$
$$\text{where } \Theta' \equiv 2(2+N)t + 4(1+N)T + 2N.$$

The profit difference becomes zero at $t = T$ and $t = t'$ where t' is the solution of $\Theta' = 0$. It can be confirmed that t' is in between $(\underline{t}, 1]$ if N is not sufficiently large.[2] In this case, we have $\Pi - \Pi^S < 0$ for $t \in (\underline{t}, t')$ and $\Pi - \Pi^S \geq 0$ for $t \in [t', T)$. We can conclude that the MNE chooses the separate location if the tax difference is large as in Proposition 1.1.

ALP Case. Analogous to the benchmark case, the equilibrium input price under the co-location scheme becomes

$$\tilde{g} = \frac{c + N + cN}{1 + 2N},$$

where the SOC trivially holds. It can be confirmed that $g < \tilde{g} < g_*$ holds as in the

[2]It always holds that $t' < T$. t' is decreasing in N if N is not sufficiently large, implying $t' > \underline{t}$ for not sufficiently large N.

text. The total post-tax profits are given by

$$\widetilde{\Pi} = (1-T)\bar{\pi} + \frac{(1-t)(1-c)^2(1+N)^2}{4(1+2N)}.$$

Turning to the separate-location scheme, the equilibrium input price becomes

$$\tilde{g}^S = \underbrace{\frac{c+N+cN}{1+2N}}_{=\tilde{g}} + \frac{(1-c)(1+N)(t-T)}{(1+2N)[t-2(1+N)T+1+2N]}.$$

We can check that as long as N is not sufficiently large, $g^S < \tilde{g} < g_*$ holds as in the text.

The total post-tax profits under the separate-location scheme are given by

$$\widetilde{\Pi}^S = (1-T)\left[\bar{\pi} + \frac{(1-T)(1-c)^2(1+N)^2}{4\{t-2(1+N)T+1+2N\}}\right],$$

where the SOC requires

$$t-2(1+N)T+1+2N > 0.$$

The profit difference then becomes

$$\widetilde{\Pi} - \widetilde{\Pi}^S = \frac{(T-t)(1-c)^2(1+N)^2[t-(1+2N)T+2N]}{4(1+2N)[t-2(1+N)T+1+2N]},$$

which is positive as long as the SOC holds. This implies that in the ALP case the MNE always chooses the co-location scheme as in Proposition 1.2.

A.5 Trade Costs

We introduce here trade costs for inputs. If the upstream affiliate is located in the parent country, the downstream firms pay an extra unit trade cost $\tau > 0$ when importing inputs (Kind et al., 2005). If it is located in the host country, trade costs play no role and the analysis is the same as in the text. Thus, we present only the results in the separate-location scheme in the following.

Benchmark Case. The maximization problems of the downstream firms are modified as

$$\max_{q} \ \pi^S = (p^S - g^S - \tau)q^S,$$
$$\max_{q_*} \ \pi_*^S = (p_*^S - g_*^S - \tau)q_*^S.$$

Solving these gives

$$q^S = \frac{1 - g^S - \tau}{2},$$
$$q_*^S = \frac{1 - g_*^S - \tau}{2}.$$

The total post-tax profit of the MNE is also modified accordingly:

$$\Pi^S = (1-T)[\overline{\pi} + (g^S - c)q^S + (g_*^S - c)q_*^S] + (1-t)(p^S - g^S - \tau)q^S.$$

The equilibrium input prices to maximize it are given by

$$g^S = c + \frac{(1-c-\tau)(t-T)}{t-2T+1},$$
$$g_*^S = \frac{1+c-\tau}{2}.$$

We impose an assumption of $\tau < 1 - c$ to ensure positive outputs. The equilibrium total post-tax profit is calculated as

$$\Pi^S = (1-T)\left[\overline{\pi} + \frac{(1-c-\tau)^2(t-4T+3)}{8(t-2T+1)}\right].$$

Taking difference between the post-tax profits in the two schemes gives

$$\Pi - \Pi^S = \frac{F(t)}{16(t-2T+1)},$$
$$\text{where } \ F(t) \equiv -3(1-c)^2t^2 + [\tau\{2(1-c)-\tau\} + (1-c)^2(7T-1)]t$$
$$+ \tau[2(1-c)-\tau](1-T)(3-4T) + T(4T-1)(1-c)^2.$$

We check (i) whether $F(t) = 0$ has two real roots and (ii) whether at least either of them falls into $(\underline{t}, T)$.

$F(t) = 0$ has two real roots if its determinant D is positive:

$$D(\tau) \equiv (1-T)^2[\tau^4 - 4(1-c)\tau^3 - 30(1-c)^2\tau^2 - 68(1-c)^3\tau + (1-c)^4] > 0,$$
$$\text{for } \tau \in [0, 1-c).$$

We can verify this inequality by noting the following relations:

$$D(\tau = 0) = (1-T)^2(1-c)^4 > 0,$$
$$D(\tau = 1-c) = 36(1-T)^2(1-c)^4 > 0,$$
$$D'(\tau) = -4(1-T)^2(1-c-\tau)[\tau^2 - 2(1-c)\tau - 17(1-c)^2] > 0.$$

Let t_1 and t_2 be respectively the smaller and the larger root of $F(t) = 0$. From the facts that $F(t)$ has a negative coefficient of the quadratic term and that $\partial F(t;\tau)/\partial\tau = 2(1-T)(1-c-\tau)(t-4T+3) > 0$ holds, we see t_1 is decreasing in τ while t_2 is increasing in τ. At $\tau = 0$, t_1 is reduced to $t^* = (4T-1)/3$ and t_2 to T.

If $T > 3/4$ holds, t_1 lies in $(0, T)$ regardless of τ so that the separate-location scheme is chosen for $t \in (0, t_1)$. If $T \leq 3/4$ holds, t_1 may become negative at sufficiently high trade costs. The maximum level of trade costs that allows for the separate-location scheme is given by

$$\overline{\tau} = (1-c)\sqrt{1 - \frac{8T^2 - 8T + 3}{(1-T)(3-4T)}}.$$

Even if $T \leq 3/4$, we observe the separate-location scheme for $t \in (0, t_1]$ as long as $\tau < \overline{\tau}$.

In sum, as in Proposition 1.1, assuming the parent's tax rate is high enough ($T > 3/4$), the MNE locates the upstream affiliate in the high-tax parent country if the host's tax rate is low enough ($t \in (\underline{t}, t_1]$) and otherwise locates it in the low-tax host country. Higher trade costs reduce the range of tax rates where the separate-location scheme is chosen, i.e., $dt_1/d\tau < 0$.

ALP Case. Analogously, the equilibrium input price to maximize the total post-tax profit is given by

$$\tilde{g}^S = \frac{1+2c-\tau}{3} + \frac{2(1-c-\tau)(t-T)}{3(t-4T+3)}.$$

The associated total post-tax profit becomes

$$\widetilde{\Pi}^S = (1-T)\left[\overline{\pi} + \frac{(1-c-\tau)^2(1-T)}{t-4T+3}\right].$$

The profit difference is given by

$$\widetilde{\Pi} - \widetilde{\Pi}^S = \frac{(1-c)^2(t-3T+2)(T-t) + 3\tau[2(1-c)-\tau](1-T)^2}{3(t-4T+3)} > 0,$$

where we note that $\tau < 1-c < 2(1-c)$. This implies that with the ALP the MNE always chooses the co-location scheme as in Proposition 1.2.

A.6 Costs of Transfer Pricing

Some studies in the literature assume that MNEs are subject to an extra concealment cost of transfer pricing (e.g., Nielsen et al., 2003, 2008; Kind et al., 2005). We formulate here the concealment cost as a quadratic function of the difference between the transfer price and the arm's length price, i.e., $C(g, g_*) = \delta(g - g_*)^2/2$ with $\delta \geq 0$. Following the above-mentioned studies, we assume that the upstream affiliate bears this cost. Thus, the concealment cost does not affect the optimal choices by the downstream firms, which are the same as those given in the text.

Benchmark Case. In the co-location scheme, the total post-tax profit is modified as

$$\Pi = (1-T)\overline{\pi} + (1-t)[(g-c)q + (g_*-c)q_* - C(g,g_*) + (p-g)q],$$
$$\text{where } C(g,g_*) = \delta(g-g_*)^2/2, \quad \delta \geq 0,$$

noting that the optimal outputs (q, q_*) chosen by the downstream firms are the same as those in the text: $q = (1-g)/2$; $q_* = (1-g_*)/2$. The equilibrium input prices to maximize it are given by

$$g = \frac{\delta + c(1+2\delta)}{1+3\delta},$$
$$g_* = \frac{1+2\delta + c(1+4\delta)}{2(1+3\delta)}.$$

The equilibrium total post-tax profit then becomes

$$\Pi = (1-T)\overline{\pi} + \frac{(1-t)(1-c)^2(3+8\delta)}{8(1+3\delta)}.$$

In the separate-location scheme, we can analogously define the total post-tax profit and compute the equilibrium input prices as follows:

$$g^S = c + \frac{(1-c)[t-T+\delta(t-2T+1)]}{t-2T+1+\delta(t-4T+3)},$$
$$g_*^S = \frac{(t-2T+1)(1+c+2\delta)+4c\delta(1-T)}{2[t-2T+1+\delta(t-4T+3)]}.$$

The equilibrium total post-tax profit is calculated as

$$\Pi^S = (1-T)\left[\overline{\pi} + \frac{(1-c)^2\{t-4T+3+8\delta(1-T)\}}{8\{t-2T+1+\delta(t-4T+3)\}}\right].$$

Taking difference between the post-tax profits in the two schemes gives

$$\Pi - \Pi^S = \frac{G(t)(1-c)^2(T-t)}{8(1+3\delta)[t-2T+1+\delta(t-4T+3)]},$$
$$\text{where } G(t) \equiv (1+\delta)(3+8\delta)t - 8(3T-2)\delta^2 - (20T-9)\delta + 1 - 4T,$$

noting that its sign only depends on $G(t)$. $G(t)=0$ holds at t^{**}, which is defined by

$$t^{**} = \frac{4T-1}{3} - \frac{8\delta(2+5\delta)(1-T)}{3(1+\delta)(3+8\delta)}.$$

Without the concealment cost, t^{**} is reduced to t^* defined in Eq. (1.8). When $T > \overline{T} = 1/4$ holds as in the text and δ is not too high, t^{**} becomes positive.[3] In this case, as in Proposition 1.1, we observe the separate-location scheme for $t \in (\underline{t}, t^{**}]$ and the

[3] δ is bounded above by $\overline{\delta} \equiv \min\{\hat{\delta}, \hat{\hat{\delta}}\}$, where $\hat{\delta} \equiv \sup\{\delta : t^{**} > 0\}$ and $\hat{\hat{\delta}} \equiv \min\{\sup\{\delta : \Pi > 0\}, \sup\{\delta : \Pi^S > 0\}\}$.

co-location scheme for $t \in (t^{**}, T)$. The more difficult concealment is, the less likely we are to observe the separate-location scheme, i.e., $dt^{**}/d\delta < 0$.

ALP Case. As the transfer price must be equal to the arm's length price, the concealment cost plays no role. The results in both schemes are the same as those in the text.

A.7 Differentiated Inputs

In the text, the downstream affiliate and the local firm purchase the same input from the upstream affiliate. We consider here the situation where the two downstream firms need a different type of inputs. The upstream affiliate produces the two different inputs using different technology. That is, the marginal cost of input for the downstream affiliate is $c \in [0, 1)$, while that for the local firm is $c_* \in [0, 1)$.

As the input for the downstream firm is not perfectly comparable to that for the local firm, tax authorities cannot require that the prices of the two inputs must be the same. Instead, they allow for a certain range of arm's length price. This arm's length range gives the MNE room for price differentiation even under the ALP. The partial comparability of the two inputs implies that they are produced using more or less the same technology. We thus assume the difference of marginal cost is not too large: $|c_* - c| < 1 - c$.

Benchmark Case.

In the co-location scheme, the total post-tax profit is

$$\Pi = (1 - T)\overline{\pi} + (1 - t)[(g - c)q + (g_* - c_*)q_* + (p - g)q],$$

where the optimal outputs (q, q_*) chosen by the downstream firms are the same as those in the text: $q = (1 - g)/2$; $q_* = (1 - g_*)/2$. The equilibrium input prices to maximize it are

$$g = c,$$
$$g_* = \frac{1 + c_*}{2},$$

where we note $g < g_*$. The equilibrium total post-tax profit then becomes

$$\Pi = (1-T)\overline{\pi} + (1-t)\left[\frac{(1-c)^2}{4} + \frac{(1-c_*)^2}{8}\right].$$

In the separate-location scheme, the total post-tax profit is modified as follows:

$$\Pi^S = (1-T)[(g^S - c)q^S + (g_*^S - c_*)q_*^S] + (1-t)(p^S - g^S)q^S.$$

The equilibrium input prices are

$$g^S = c + \frac{(1-c)(t-T)}{t-2T+1},$$
$$g_*^S = \frac{1+c_*}{2},$$

where we note $g^S < g_*^S$. The equilibrium total post-tax profit is calculated as

$$\Pi^S = (1-T)\left[\overline{\pi} + \frac{(1-c_*)^2}{8} + \frac{(1-T)(1-c)^2}{4(t-2T+1)}\right].$$

The MNE prefers the co-location scheme if

$$\Pi - \Pi^S = \left(\frac{1}{8(t-2T+3)}\right)\Big[(T-t)[t\{3-2c(2-c)-c_*(2-c_*)\}$$
$$-2T\{(1-c)^2+(1-c_*)^2\} + (1-c_*)^2\Big] > 0,$$
$$\to t > t^* \equiv \frac{2T[(1-c)^2+(1-c_*)^2]-(1-c_*)^2}{3-2c(2-c)-c_*(2-c_*)}.$$

where we can confirm $t^* \in (0, T)$ if T is sufficiently large:

$$T > \overline{T} \equiv \max\left\{\frac{1}{4}, \frac{(1-c_*)^2}{2[(1-c)^2+(1-c_*)^2]}\right\}.$$

The co-location scheme is chosen if the host's tax rate is close to the parent's ($t \in (t^*, T)$) and the separate-location scheme is chosen otherwise ($t \in (0, t^*]$) as in Proposition 1.1.

ALP Case. In the co-location scheme, the transfer price $\tilde{g}$ must be within the range of $[\tilde{g}_* - e, \tilde{g}_* + e]$ with $e > 0$. We assume e is not too large, otherwise the situation is reduced to the benchmark case. The MNE sets the price $\tilde{g}_*$ to the local firm and $\tilde{g} = \tilde{g}_* + \tilde{e}$ to the downstream affiliate, where $\tilde{e} \in [-e, e]$. It chooses $\tilde{g}_*$ and $\tilde{e}$ to maximize the total post-tax profit:

$$\max_{\tilde{g}_*, \tilde{e}} \widetilde{\Pi} = (1-T)\overline{\pi} + (1-t)[(\tilde{g}_* + \tilde{e} - c)\tilde{q} + (\tilde{g}_* - c_*)\tilde{q}_* + (\tilde{p} - \tilde{g}_* - \tilde{e})\tilde{q}],$$

noting that the optimal outputs $(\tilde{q}, \tilde{q}_*)$ chosen by the downstream firms are the same as those in the text.

As the fact that $g < g_*$ holds in the benchmark case suggests, the MNE tries to set $\tilde{g}$ lower than $\tilde{g}_*$ and thus chooses $\tilde{e} = -e$. The equilibrium input prices are

$$\tilde{g}_* = \frac{1 + c + c_* + e}{3},$$
$$\tilde{g} = \tilde{g}_* - e = \frac{1 + c + c_* - 2e}{3}.$$

The total post-tax profit can then be rewritten as

$$\widetilde{\Pi} = (1-T)\overline{\pi} + (1-t)\left[\frac{(2 - c - c_*)^2}{12} - \frac{e(1 - 2c + c_* + e)}{6}\right].$$

In the separate-location scheme, we can analogously define the total post-tax profit and compute the equilibrium input prices as follows:

$$\tilde{g}_*^S = \frac{1 + c + c_* + e}{3} + \frac{(2 - c - c_* + 2e)(t - T)}{3(t - 4T + 3)},$$
$$\tilde{g}^S = \tilde{g}_*^S - e = \frac{1 + c + c_* - 2e}{3} + \frac{(2 - c - c_* + 2e)(t - T)}{3(t - 4T + 3)},$$

where the MNE sets $\tilde{e} = -e$ as implied by $g^S < g_*^S$. The equilibrium total post-tax profit is calculated as

$$\widetilde{\Pi}^S = (1-T)\left[\overline{\pi} + \frac{(1-T)(2 - c - c_*)^2 - 2e\{e(t - 2T + 1) + \kappa\}}{4(t - 4T + 3)}\right],$$

where $\kappa \equiv (1 - c)(1 - t) - (c - c_*)(t - 2T + 1)$.

Taking difference between the post-tax profits in the two schemes gives

$$\widetilde{\Pi} - \widetilde{\Pi}^S = \frac{H(e)(T-t)}{12(t-4T+3)},$$

$$\text{where } H(e) \equiv -2(t-6T+5)e^2 + 2[1-t+2c(t-3T+2) - c_*(t-6T+5)]e + (2-c-c_*)^2(t-3T+2).$$

Since $T - t > 0$ and $t - 4T + 3 > 0$ hold, the inequality is positive if $H(e) > 0$ holds. Noting that $t - 6T + 5 > 0$ and $t - 3T + 2 > 0$ hold because of (A1): $t > \underline{t}$, we see that $H(e)$ has a negative coefficient of the quadratic term and that $H(0) > 0$. These observations imply that $H(e) > 0$ holds if $e \in (0, e_2)$, where e_2 is the larger root of $H(e) = 0$. In other words, if the degree of input differentiation is so low that the arm's length range is narrow enough, the MNE always chooses the co-location scheme as in Proposition 1.2.

A.8 Endogenous Profits in the Parent Market

In the text, we assume that the MNE earns exogenous profits $\overline{\pi}$ from different business in the parent country. Here we endogenize it by introducing a local downstream firm in the parent. The local firm is the monopolist facing the demand curve of $P_* = 1 - Q_*$. It sources the same type of inputs as do the downstream firms in the host, from the upstream affiliate at the price of G_*. As the parent's and the host's markets are segmented, the presence of the local firm does not affect the equilibrium outputs and input prices for the downstream firms in the host. It only affects the location choice of the MNE, as we shall see below.

Benchmark Case. In the co-location scheme, the total post-tax profit is modified as

$$\Pi = (1-t)[(g-c)q + (g_* - c)q_* + (G_* - c)Q_* + (p-g)q],$$

where the optimal outputs (q, q_*) chosen by the downstream firms are the same as those in the text: $q = (1-g)/2$; $q_* = (1-g_*)/2$. We also note $Q_* = (1-G_*)/2$. The equilibrium input prices to maximize it are given by

$$g = c,$$
$$g_* = G_* = \frac{1+c}{2}.$$

The equilibrium total post-tax profit then becomes

$$\Pi = \frac{(1-t)(1-c)^2}{2}.$$

In the separate-location scheme, the total post-tax profit is modified as follows:

$$\Pi^S = (1-T)[(g^S - c)q^S + (g_*^S - c)q_*^S + (G_*^S - c)Q_*^S] + (1-t)(p^S - g^S)q^S.$$

The equilibrium input prices are

$$g^S = c + \frac{(1-c)(t-T)}{t-2T+1},$$
$$g_*^S = G_*^S = \frac{1+c}{2}.$$

The equilibrium total post-tax profit is calculated as

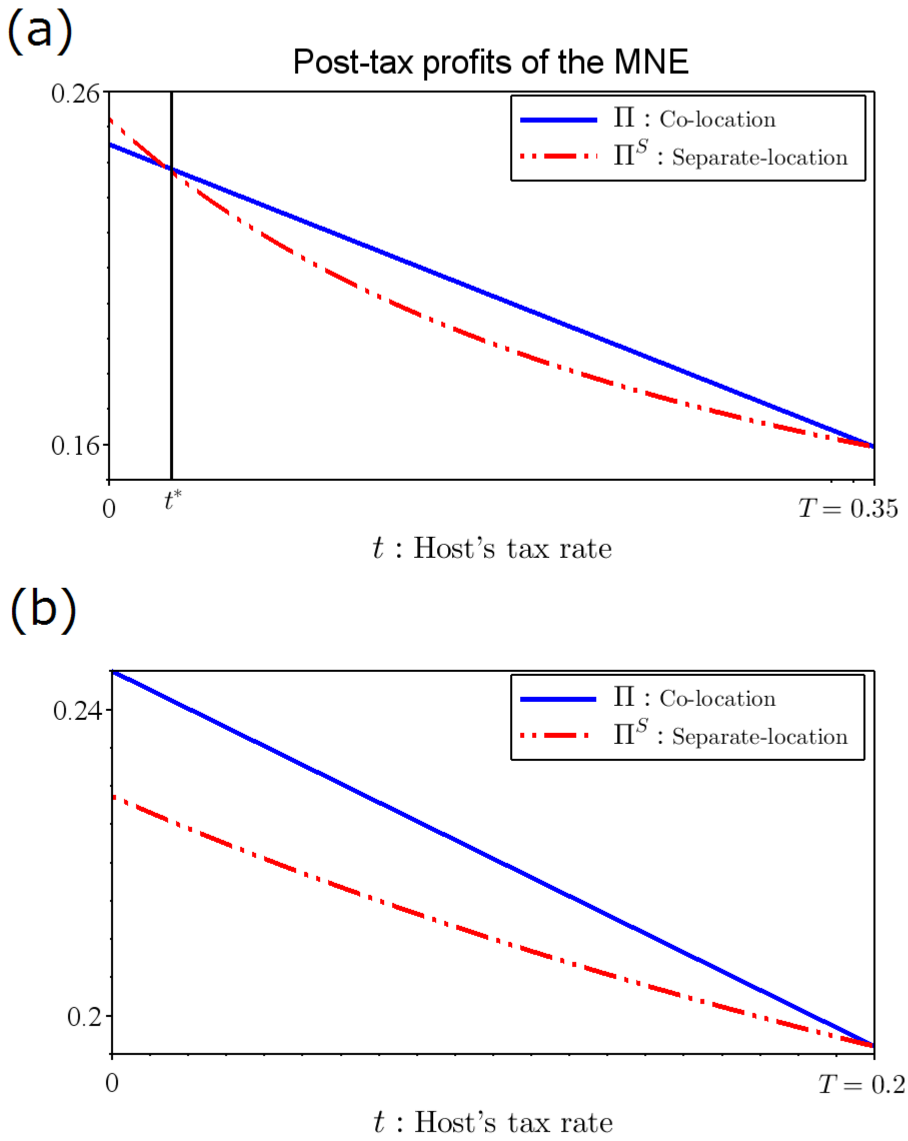
$$\Pi^S = \frac{(1-T)(1-c)^2(t-3T+2)}{4(t-2T+1)}.$$

The profit difference takes a complex form and is hard to characterize analytically. We thus rely on numerical simulations. Figure A.1 draws the total post-tax profits in the two schemes for different levels of the host's tax rate.[4] In Figure A.1 (a), where the parent's tax rate is high ($T = 0.35$), the separate-location scheme is chosen for $t \in (0, t^*)$ and the co-location scheme for $t \in [t^*, T)$. In Figure A.1 (b), where the parent's tax rate is low ($T = 0.2$), the co-location scheme is chosen for the entire range $t \in (0, T)$. We have experimented various parameter values and confirmed the qualitatively same results as in Proposition 1.1. That is, the higher the parent's tax rate is, the more likely we are to observe the separate-location scheme as Figure A.1 (a) shows.

ALP Case. Analogous to the benchmark case, the equilibrium input price in the

[4]The parameter values are the same as those in Figure. 1.1: $c = 0.3$; (a)$T = 0.35$; (b)$T = 0.2$. In this numerical example, $\underline{t} = 0$ holds.

Figure A.1: Production location choice in the benchmark case: (a) high T and (b) low T



co-location scheme is derived as follows:

$$\tilde{g} = \tilde{g}_* = \tilde{G}_* = \frac{1+2c}{3}.$$

The associated total post-tax profit becomes

$$\widetilde{\Pi} = \frac{(1-t)(1-c)(5-8c)}{9}.$$

To make $\widetilde{\Pi}$ positive, we assume $c < 5/8$.

In the separate-location scheme, the equilibrium input prices and the resulting total post-tax profit are

$$\tilde{g}^S = \tilde{g}^S_* = \tilde{G}^S_* = \frac{1+2c}{3} + \frac{2(1-c)(t-T)}{3(t-4T+3)}.$$

The associated total post-tax profit becomes

$$\widetilde{\Pi}^S = \frac{2(1-T)^2(1-c)^2(t-3T+2)}{(t-4T+3)^2}.$$

Because the profit difference is difficult to characterize analytically, we again use numerical simulations. Figure A.2 illustrates the total post-tax profits in the two schemes for different levels of the host's tax rate.[5] Unlike the benchmark case, the co-location scheme is chosen for the entire range even when the parent's tax rate is high. We have conducted many simulations and confirmed that the ALP prevents the MNE from choosing the separate-location scheme as in Proposition 1.2.

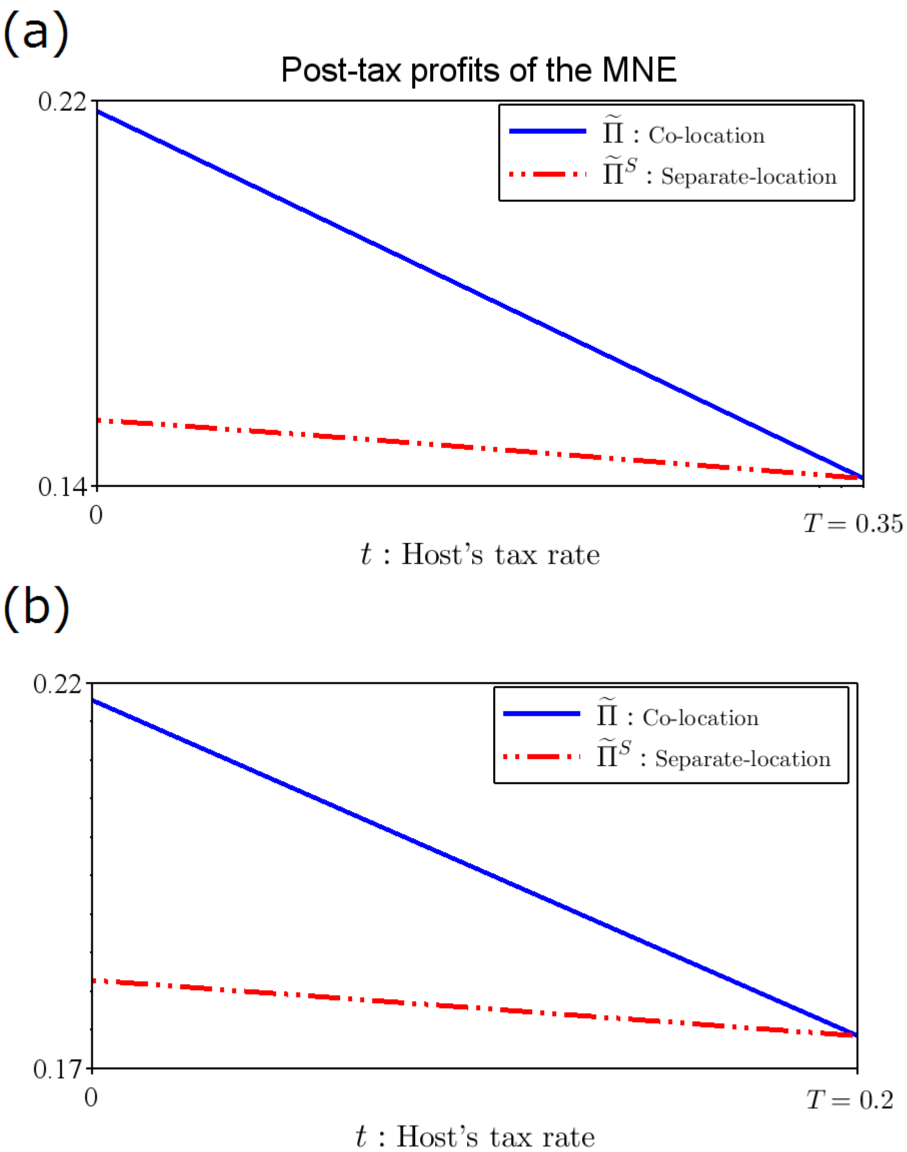
A.9 Welfare Analysis

We confirm here that the results on tax revenues stated in Proposition 1.3 carry over to social welfare. That is, the location change induced by the ALP decreases the host country welfare, while increases global welfare.

Host Country Welfare. Assuming $T > 1/4$, we show that when $t \in (\underline{t}, t^*)$, the social welfare of the host country in the benchmark case, W_H, are greater than that in the

[5] The parameter values are the same as those in Figure 1.2: $c = 0.3$; (a)$T = 0.35$; (b)$T = 0.2$.

Figure A.2: Production location choice in the ALP case: (a) high T and (b) low T



ALP case, $\widetilde{W}_H$. W_H and $\widetilde{W}_H$ are defined as follows:

$$W_H = \underbrace{\frac{(q^S)^2}{2} + \frac{(q^S_*)^2}{2}}_{\text{Consumer surplus}} + \underbrace{(1-t)(\pi^S + \pi^S_*)}_{\text{Producer surplus}} + \underbrace{t(\pi^S + \pi^S_*)}_{\text{Tax revenues}},$$

$$\widetilde{W}_H = \underbrace{2 \times \frac{\tilde{q}^2}{2}}_{\text{Consumer surplus}} + \underbrace{(1-t)(\tilde{\pi}_u + 2\tilde{\pi})}_{\text{Producer surplus}} + \underbrace{t(\tilde{\pi}_u + 2\tilde{\pi})}_{\text{Tax revenues}},$$

where we note $\tilde{q} = \tilde{q}_*$ and $\tilde{\pi} = \tilde{\pi}_*$.

Taking the difference of these two gives

$$\widetilde{W}_H - W_H = \left[\tilde{q}^2 - \frac{(q^S)^2 + (q^S_*)^2}{2}\right] + \underbrace{[\tilde{\pi}_u + 2\tilde{\pi} - (\pi^S + \pi^S_*)]}_{(-)}.$$

As we know from Proposition 1.3 that the second square bracket term is negative, it suffices to check the first square bracket term is negative:

$$\tilde{q}^2 - \frac{(q^S)^2 + (q^S_*)^2}{2} = \frac{(1-c)^2 f(t)}{288(t-2T+1)^2},$$

$$\text{where } f(t) \equiv 23t^2 + 46(1-2T)t + 56T^2 - 20T - 13.$$

This is negative if $f(t) < 0$. We can confirm $f(t) < 0$ by noting that (i) $f(t)$ is monotonically increasing in t for $t \in (\underline{t}, t^*)$ and (ii) $f(t)$ takes a negative value at the two endpoints of $\underline{t}$ and t^*. The host country attains a higher consumer surplus under no regulation than under the ALP. Without the ALP, the lower transfer price helps the downstream affiliate reduce its price, benefiting the host's consumers more.

We can thus conclude that the location change triggered by the ALP reduces the host country welfare.

Global Welfare. We show that global welfare under no regulation is higher than that under the ALP for $t \in (\underline{t}, \hat{t})$, where $\hat{t}$ is smaller than t^*. Let W_P (or $\widetilde{W}_P$) be the social welfare of the parent country under the regulation (or under the ALP), which are given by

$$W_P = \underbrace{T(\overline{\pi} + \pi_u^S)}_{\text{Producer surplus}} + \underbrace{(1-T)(\overline{\pi} + \pi_u^S)}_{\text{Tax revenues}},$$

$$\widetilde{W}_P = \underbrace{T\overline{\pi}}_{\text{Producer surplus}} + \underbrace{(1-T)\overline{\pi}}_{\text{Tax revenues}}.$$

Global welfare is defined as the sum of the host's and parent's social welfare. Comparing the global welfare under the ALP with that under no regulation yields

$$\begin{aligned}\widetilde{W}_P + \widetilde{W}_H - (W_P + W_H) &= \overline{\pi} + \tilde{q}^2 + \tilde{\pi}_u + 2\tilde{\pi} - \left[\overline{\pi} + \frac{(q^S)^2 + (q_*^S)^2}{2} + \pi_u^S + \pi^S + \pi_*^S\right] \\ &= \frac{(1-c)^2 h(t)}{288(t-2T+1)^2},\end{aligned}$$

where $h(t) \equiv 97t^2 + 2(25 - 122T)t + 136T^2 - 28T - 11$.

This is positive if $h(t) > 0$. We can confirm $h(t) = 0$ at $t = \hat{t} \in (\underline{t}, t^*)$ by noting that (i) $h(t)$ is monotonically decreasing in t for $t \in (\underline{t}, t^*)$, (ii) $h(\underline{t}) > 0$, and (iii) $h(t^*) < 0$.

We can thus conclude that if the international tax difference is sufficiently large ($t \in (\underline{t}, \hat{t})$), the location change induced by the ALP increases global welfare, i.e., $\widetilde{W}_P + \widetilde{W}_H - (W_P + W_H) > 0$.

B Appendix to Chapter 2

B.1 Equilibrium Allocation of Production Plants

We first prove Proposition 2.1 by showing whether the equilibrium share of plants n_1 exceeds one-half depending on trade costs. Then, we further investigate how a marginal change in trade costs affects n_1.

Proof of Proposition 2.1. Using Eqs. (2.5-1) and (2.5-2), we can write the profit differential as

$$\begin{aligned}\Delta\Pi \equiv \Pi_1 - \Pi_2 = \frac{\mu}{2\sigma} \cdot \frac{(1-t_1)(1-\phi\gamma_2) - \phi\gamma_2(t_1-t_2)(\sigma-1)/\sigma}{n_1 + \phi\gamma_2 n_2} \\ - \frac{\mu}{2\sigma} \cdot \frac{(1-t_2)(1-\phi\gamma_1) - \phi\gamma_1(t_2-t_1)(\sigma-1)/\sigma}{\phi\gamma_1 n_1 + n_2}. \qquad \text{(B1)} \\ \text{where } \gamma_i \equiv \left(\frac{\sigma - \Delta t_i}{\sigma}\right)^{\sigma-1}, \ \Delta t_i \equiv \frac{t_j - t_i}{1-t_i}, \quad \text{for } i \neq j \in \{1,2\}.\end{aligned}$$

We evaluate this at $n_1 = 1/2$:

$$\begin{aligned}\Delta\Pi|_{n_1=1/2} &= \frac{\mu(t_1-t_2)\cdot F(\phi)}{\sigma^2(1+\phi\gamma_1)(1+\phi\gamma_2)}, \\ \text{where } F(\phi) &\equiv \gamma_1\gamma_2(2-\sigma)(t_1-t_2)\phi^2 \\ &+ [2\sigma\{\gamma_1(1-t_1) - \gamma_2(1-t_2)\} + (\gamma_1+\gamma_2)(t_1-t_2)]\phi - \sigma(t_1-t_2),\end{aligned}$$

The sign of the profit differential is determined by $F(\phi)$. At the level of ϕ that satisfies $F(\phi) = 0$, the equilibrium distribution of plants becomes one-half.

We denote this value of ϕ by ϕ^*, and it is given by the larger (smaller) root of $F(\phi) = 0$ under $\sigma < 2$ ($\sigma > 2$). We can confirm that ϕ^* falls within $(0, 1)$ from the facts that (i) $F(\phi)$ is a quadratic function of ϕ, (ii) $f(0) < 0$, and (iii) $f(1) > 0$.

If $\phi < \phi^*$ or $F(\phi) < 0$, then the profit differential is negative, implying that MNEs with production in country 1 have an incentive to relocate. Thus, the long-run equilibrium must be $n_1 < 1/2$. Similarly, if $\phi > \phi^*$ or $F(\phi) > 0$, then the positive profit differential at $n_1 = 1/2$ requires that the long-run equilibrium be $n_1 > 1/2$. These findings establish Proposition 2.1.

Equilibrium plant allocation and trade costs. Here, we show that as trade costs decline, the equilibrium share of production plants in country 1 first decreases, then increases. By solving the profit differential for n_1, we obtain

$$n_1 = \frac{(1-t_1)(1+\phi^2\Gamma_1\gamma_2) - \phi(1-t_2)(\Gamma_2+\gamma_2)}{(1-t_1)[1-\phi(\Gamma_1+\gamma_1)+\phi^2\Gamma_1\gamma_2] + (1-t_2)[1-\phi(\Gamma_2+\gamma_2)+\phi^2\Gamma_2\gamma_1]}, \quad \text{(B2)}$$

where $\Gamma_i \equiv \left(\frac{\sigma - \Delta t_i}{\sigma}\right)^{\sigma}$.

We differentiate this with respect to ϕ:

$$\frac{dn_1}{d\phi} = \frac{G(\phi)}{H(\phi)},$$

where

$$\begin{aligned} G(\phi) \equiv\ & [\{t_1(2-t_1)-1\}\Gamma_1\gamma_2(\Gamma_1+\gamma_1) - \{t_2(2-t_2)-1\}\Gamma_2\gamma_1(\Gamma_2+\gamma_2)]\phi^2 \\ & + 2(1-t_1)(1-t_2)(\Gamma_1\gamma_2 - \Gamma_2\gamma_1)\phi \\ & + \{t_2(2-t_2)-1\}(\Gamma_2+\gamma_2) - \{t_1(2-t_1)-1\}(\Gamma_1+\gamma_1), \\ H(\phi) \equiv\ & \big[\{\Gamma_1\gamma_2(1-t_1) + \Gamma_2\gamma_1(1-t_2)\}\phi^2 \\ & \quad - \{(\Gamma_1+\gamma_1)(1-t_1) + (\Gamma_2+\gamma_2)(1-t_2)\}\phi + 2 - t_1 - t_2\big]^2 > 0. \end{aligned}$$

We note that (i) the numerator is a quadratic function of ϕ and that (ii) $H(\phi) > 0$ for any $\phi \in [0,1]$. Furthermore, we can verify that (iii) the slope is negative at $\phi = 0$:

$$\left.\frac{dn_1}{d\phi}\right|_{\phi=0} \simeq \frac{t_2 - t_1}{\sigma(2-t_1-t_2)} < 0,$$

where we use a Taylor approximation such that $\Gamma_i \simeq 1 - \Delta t_i + [(\sigma-1)/\sigma](\Delta t_i)^2$ and $\gamma_i \simeq 1 - [(\sigma-1)/\sigma]\Delta t_i + [(\sigma-1)(\sigma-2)/\sigma^2](\Delta t_i)^2$.

We then find $\phi^{\#}$ that satisfies $dn_1/d\phi = 0$, or equivalently $G(\phi) = 0$:

$$\phi^{\#} \simeq \frac{\sigma}{\sigma - (\sigma-1)\Delta t_1 \Delta t_2}, \quad \text{(B3)}$$

where the approximation was used as before. We can confirm that $\phi^{\#}$ is within $(0,1)$. From (i) and (iii), we observe that $dn_1/d\phi$ changes its sign at $\phi^{\#}$ from negative to positive. In sum,

$$\frac{dn_1}{d\phi}\begin{cases} < 0 & \text{if } \phi \in [0, \phi^{\#}) \\ = 0 & \text{if } \phi = \phi^{\#} \\ > 0 & \text{if } \phi \in (\phi^{\#}, \phi^S) \\ = 0 & \text{if } \phi \in [\phi^S, 1] \end{cases}, \tag{B4}$$

where ϕ^S is the sustain point, which will be discussed in detail in Appendix B.2.

B.2 Proof of Proposition 2.2

We first confirm that the high-tax country 1 hosts all production plants when the trade costs are zero. Then, we show that there exists the level of trade freeness above which the full agglomeration is realized; that is, the sustain point ϕ^S. Finally, we show that ϕ^S decreases with t_1, but increases with t_2

Full agglomeration at zero trade costs. Evaluating the profit differential (B1) at $\phi = 1$ yields

$$\Delta\Pi|_{\phi=1} = \underbrace{\frac{\mu(t_2 - t_1)(\sigma - 1)}{2\sigma^2}}_{<0}\left(\frac{\omega_1}{\gamma_1 n_1 + n_2} + \frac{\omega_2}{n_1 + \gamma_2 n_2}\right),$$

$$\text{where } \omega_i \equiv \gamma_i + \frac{\sigma(1-\gamma_i)}{(\sigma-1)\Delta t_j}, \quad \text{for } i \neq j \in \{1, 2\},$$

noting that $\Delta t_1 < 0 < \Delta t_2$ and $\gamma_1 > 1 > \gamma_2$. The profit differential is positive (negative) if the big bracket term is negative (positive). We will check that the big bracket term is indeed negative, the condition for which is

$$\begin{aligned} &\frac{\omega_1}{\gamma_1 n_1 + n_2} + \frac{\omega_2}{n_1 + \gamma_2 n_2} < 0, \\ &\to \omega_1(n_1 + \gamma_2 n_2) + \omega_2(\gamma_1 n_1 + n_2) < 0, \\ &\to n_1 \underbrace{[\omega_1(1-\gamma_2) + \omega_2(\gamma_1 - 1)]}_{>0} + \omega_1\gamma_2 + \omega_2 < 0, \end{aligned}$$

noting that $n_2 = 1 - n_1$. The inequality holds for any $n_1 \in [0, 1]$ if the following holds

$$\begin{aligned} &n_1[\omega_1(1-\gamma_2) + \omega_2(\gamma_1 - 1)] + \omega_1\gamma_2 + \omega_2 \\ &\qquad < 1 \cdot [\omega_1(1-\gamma_2) + \omega_2(\gamma_1 - 1)] + \omega_1\gamma_2 + \omega_2 < 0, \\ &\to \omega_1 + \omega_2\gamma_1 < 0. \end{aligned}$$

Using a Taylor approximation such that $\gamma_i \equiv (1 - \Delta t_i/\sigma)^{\sigma-1} \simeq 1 - [(\sigma-1)/\sigma]\Delta t_i$, we can confirm that the inequality holds:

$$\omega_1 + \omega_2\gamma_1 \simeq -\frac{(t_1 - t_2)^2}{\sigma^2(1-t_1)(1-t_2)} < 0.$$

Hence, the profit differential at $\phi = 1$ is positive for any $n_1 \in [0, 1]$. All MNEs are willing to establish production plants in the high-tax country 1, that is, $n_1|_{\phi=1} = 1$.

Sustain point. Evaluating the profit differential (B1) at $n_1 = 1$ gives

$$\Delta\Pi|_{n_1=1} = \frac{\mu \cdot I(\phi)}{2\sigma^2\phi\gamma_1},$$

where $I(\phi) \equiv -\gamma_1\gamma_2(1-t_2)(\sigma - \Delta t_2)\phi^2 + \gamma_1(1-t_1)(2\sigma - \Delta t_1)\phi - \sigma(1-t_2)$.

Since the denominator is positive, the sign of the profit differential is determined by $I(\phi)$. Solving $I(\phi) = 0$ for $\phi \in [0, 1]$ gives the sustain point ϕ^S (if any).

We observe that $I(\phi)$ is a quadratic function of ϕ with a negative coefficient of ϕ^2. A further inspection reveals that

$$\begin{aligned} I(0) &= -\sigma(1-t_2) < 0, \\ I(1) &= \sigma[2\gamma_1(1-t_1) - (1+\gamma_1\gamma_2)(1-t_2)] + \gamma_1(1+\gamma_2)(t_1 - t_2) > 0, \end{aligned}$$

noting that $2\gamma_1(1-t_1) - (1+\gamma_1\gamma_2)(1-t_2) > 2\gamma_1(1-t_1) - (1+\gamma_1)(1-t_2) = (\gamma_1 - 1)(1-t_1) > 0$ holds because $\gamma_1 > 1 > \gamma_2$.

These observations imply that (i) the sustain point $\phi^S \in (0, 1)$ always exists and is given by the smaller root of $I(\phi)$ and that (ii) $I(\phi)$ or the profit differential is negative for $\phi \in [0, \phi^S)$ but positive for $\phi \in (\phi^S, 1]$.

Sustain point and taxes. As Figure 2.2 and Eq. (B4) clearly show, a higher $\phi^\#$, defined in Eq. (B2), makes ϕ^S higher. A close inspection of $\phi^{\#}$ reveals that

$$\frac{d\phi^{\#}}{dt_1} = \frac{\sigma(\sigma-1)(1-t_2)(2-t_1-t_2)(t_2-t_1)}{[(\sigma-1)(t_1-t_2)^2+\sigma(1-t_1)(1-t_2)]^2} < 0,$$
$$\frac{d\phi^{\#}}{dt_2} = \frac{\sigma(\sigma-1)(1-t_2)(2-t_1-t_2)(t_1-t_2)}{[(\sigma-1)(t_1-t_2)^2+\sigma(1-t_1)(1-t_2)]^2} > 0,$$

implying that ϕ^S also decreases (increases) with t_1 (t_2). As the tax difference is larger, multinational production is more likely to be agglomerated in the high-tax country 1.

B.3 Conditions for Positive Profits

The taxable profits are π_{11}, π_{12}, π_{21}, and π_{22}, but only π_{11} can be negative:

$$\pi_{11} = \frac{\mu}{2\sigma}\left[\frac{1}{n_1+\phi\gamma_2 n_2} + \underbrace{\frac{(\sigma-1)\Delta t_1}{\sigma}}_{<0}\frac{\phi\gamma_1}{\phi\gamma_1 n_1+n_2}\right],$$

because of $\Delta t_1 < 0$. Note also that $\pi_{11} > 0$ at $\phi = 0$. We check whether π_{11} remains positive if the following assumption holds:

$$1+\Delta t_1 > 0. \tag{B5}$$

Differentiating π_{11} with respect to ϕ yields

$$\frac{d\pi_{11}}{d\phi} \simeq \frac{(1-\phi)(2-t_1-t_2)[\phi(-\Delta t_1)(\sigma-1)(\sigma-\Delta t_2)-\sigma^2]}{2(1-t_1)[\phi^2(\sigma-\Delta t_1)(\sigma-\Delta t_2)-\sigma^2]},$$

where we use Eq. (B2) and a Taylor approximation such that $\gamma_i \simeq 1-[(\sigma-1)/\sigma]\Delta t_i$. The numerator is always negative:

$$\begin{aligned}\phi(-\Delta t_1)(\sigma-1)(\sigma-\Delta t_2)-\sigma^2 &\leq 1\cdot(-\Delta t_1)(\sigma-1)(\sigma-\Delta t_2)-\sigma^2\\ &= -(1+\Delta t_1)\sigma^2+\Delta t_1(1+\Delta t_2)\sigma-\Delta t_1\Delta t_2 < 0,\end{aligned}$$

because of $-(1+\Delta t_1) < 0$ and $\sigma > 1$.

The sign of the derivative is determined by the square bracket term in the denominator.

We can see that

$$\frac{d\pi_{11}}{d\phi}\begin{cases} > 0 & \text{if } \phi \in [0, \widetilde{\phi}) \\ = 0 & \text{if } \phi = \widetilde{\phi} \\ < 0 & \text{if } \phi \in (\widetilde{\phi}, 1] \end{cases},$$

$$\text{where } \widetilde{\phi} \equiv \frac{\sigma}{\sqrt{(\sigma - \Delta t_1)(\sigma - \Delta t_2)}} \in (0, 1). \tag{B6}$$

This result and $\pi_{11}|_{\phi=0} > 0$ imply that π_{11} takes the minimum value at $\phi = 1$:

$$\pi_{11}|_{\phi=1} = \frac{\mu}{2\sigma}\left[1 + \frac{(\sigma-1)\Delta t_1}{\sigma}\right],$$

noting that $n_1 = 1$ at $\phi = 1$. The inequality holds under Ineq. (B5).

B.4 Proof of Proposition 2.3

Tax revenues in the two countries can be re-expressed as

$$TR_1 = \frac{\mu L t_1}{2\sigma}\left[1 + \frac{(\sigma-1)\Delta t_1}{\sigma}\frac{\phi\gamma_1 n_1}{\phi\gamma_1 n_1 + n_2}\right],$$
$$TR_2 = \frac{\mu L t_2}{2\sigma}\left[1 + \frac{(\sigma-1)\Delta t_2}{\sigma}\frac{\phi\gamma_2 n_2}{n_1 + \phi\gamma_2 n_2}\right].$$

Taking the difference yields

$$\Delta TR \equiv TR_1 - TR_2 = \frac{\mu L}{2\sigma}\left[t_1 - t_2 + \phi\left(\frac{\sigma-1}{\sigma}\right)\left(\frac{t_1\gamma_1 n_1 \Delta t_1}{\phi\gamma_1 n_1 + n_2} - \frac{t_2\gamma_2 n_2 \Delta t_2}{n_1 + \phi\gamma_2 n_2}\right)\right].$$

At $\phi = 0$, we see $\Delta TR|_{\phi=0} = \mu L(t_1 - t_2)/(2\sigma) > 0$.

If ϕ is below the sustain point ϕ^S, the tax-revenue differential becomes

$$\Delta TR|_{n_1=1} = \frac{\mu L}{2\sigma}\left[t_1 - t_2 + \left(\frac{\sigma-1}{\sigma}\right)t_1\Delta t_1\right].$$

Because of $t_1 > 1/2$, this is negative if $\sigma(1 - 2t_1) + t_1 < 0$, i.e., $\sigma > t_1/(2t_1 - 1)$.

These results establish Proposition 2.3.

B.5 Proof of Lemma 2.1

In the transfer-pricing case, the profit differential at $n_1 = 1$ is

$$\Delta\widehat{\Pi}|_{n_1=1} = \frac{\mu \cdot \widehat{\Theta}(\phi)}{\sigma\phi},$$
$$\text{where } \widehat{\Theta}(\phi) \equiv -s_1(1-\widehat{t}_1)\phi^2 + [s_1(1-\widehat{t}_1) + (1-s_1)(1-\widehat{t}_2)]\phi - (1-s_1)(1-\widehat{t}_2),$$

Clearly, the sign of the profit differential is determined by $\widehat{\Theta}(\phi)$, which is a quadratic function of ϕ. We note that

$$\begin{aligned}
&\text{the sign of the coefficient of } \phi^2 : \quad -s_1(1-\widehat{t}_1) < 0,\\
&\widehat{\Theta}(0) = -(1-s_1)(1-\widehat{t}_2) < 0,\\
&\widehat{\Theta}'(0) = s_1(1-\widehat{t}_1) + (1-s_1)(1-\widehat{t}_2) > 0,\\
&\widehat{\Theta}(1) = 0.
\end{aligned}$$

$\widehat{\Theta}(\phi) = 0$ has two solutions, $\phi = 1$ and $\phi = \widehat{\phi}^S$:

$$\widehat{\phi}^S \equiv \frac{1-s_1}{s_1}\frac{1-\widehat{t}_2}{1-\widehat{t}_1} = \sqrt{\frac{1-s_1}{s_1}} \in (0,1).$$

These imply that $\widehat{\Theta}(\phi)$ and thus $\Delta\widehat{\Pi}|_{n_1=1}$ are non-positive if $\phi \in [0, \widehat{\phi}^S]$, while they are positive if $\phi \in (\widehat{\phi}^S, 1]$. That is, if $\phi \in [\widehat{\phi}^S, 1]$, then all multinational production takes place in the large, high-tax country 1.

B.6 Centralized decision making

In the main text, we considered the case of decentralized decision making, in which the foreign affiliate chooses a price to maximize its own profit. Here, we will examine the case of centralized decision making, in which the MNE chooses all prices to maximize its total profit, using the same framework as in the main text. As we will show, the two different organizational forms give qualitatively similar results.

An MNE with production in country 1 solves the following problem:

$$\max_{p_{11},g_1,p_{12}} \Pi_1 = \max_{p_{11},g_1,p_{12}} (1-t_1)\pi_{11} + (1-t_2)\pi_{12},$$
$$\text{where } \pi_{11} = (p_{11}-a)q_{11} + (g_1 - \tau a)q_{12} - C(g_1, q_{12}),$$
$$\pi_{12} = (p_{12} - g_1)q_{12}.$$

In contrast to decentralized decision making, p_{12} is chosen to maximize Π_1 rather than π_{12}. $C(\cdot)$ is the concealment cost specified as $C(g_i, q_{ij}) = \delta(g_i - \tau a)^2 q_{ij}$ with $\delta \geq 0$ (see Nielsen et al., 2003; Kind et al., 2005; Haufler et al., 2018 for similar specifications).

The first order conditions give the following optimal prices:

$$p_{11} = \frac{\sigma a}{\sigma - 1}, \quad g_1 = \tau a + \frac{\Delta t_1}{2\delta}, \quad p_{12} = \frac{\sigma a}{\sigma - 1}\left(\tau + \frac{\Delta t_1 \Delta t_2}{4a\delta}\right),$$
$$\text{where } \Delta t_i \equiv \frac{t_j - t_i}{1 - t_i}, \quad i \neq j \in \{1, 2\}.$$

Mirror expressions hold for MNEs with production in country 2:

$$p_{22} = \frac{\sigma a}{\sigma - 1}, \quad g_2 = \tau a + \frac{\Delta t_2}{2\delta}, \quad p_{21} = \frac{\sigma a}{\sigma - 1}\left(\tau + \frac{\Delta t_1 \Delta t_2}{4a\delta}\right).$$

As in the decentralized case, g_i decreases with t_i, while it increases with t_j. Since $p_{12} = p_{21}$ and $g_1 < g_2$ hold, we see $p_{12} - g_1 > p_{21} - g_2$, implying a higher profitability of the affiliate in country 1 than that of the affiliate in country 2. As trade costs decline and the shifted profits are larger, more MNEs are likely to locate their affiliate in country 2 to exploit the higher price-cost margin. As a result, plants are agglomerated in country 1 for low trade costs. The mechanism here that transfer pricing does not just shift profits but affects profitability is very close to the one in the decentralized-decision case we show in the text.

Using the optimal prices, we can rewrite the post-tax profit as

$$\begin{aligned}
\Pi_1 &= \frac{(1-t_1)\mu L/2}{\sigma(N_1+\gamma N_2)} \\
&\quad + (1-t_2)\left[\tau + \frac{(2\sigma-1)\Delta t_1 \Delta t_2 - 2(\sigma-1)(\Delta t_1+\Delta t_2)}{4a\delta}\right] \frac{\gamma^{\frac{\sigma}{\sigma-1}}\mu L/2}{\sigma(\gamma N_1+N_2)}, \\
\Pi_2 &= \frac{(1-t_2)\mu L/2}{\sigma(\gamma N_1+N_2)} \\
&\quad + (1-t_1)\left[\tau + \frac{(2\sigma-1)\Delta t_1 \Delta t_2 - 2(\sigma-1)(\Delta t_1+\Delta t_2)}{4a\delta}\right] \frac{\gamma^{\frac{\sigma}{\sigma-1}}\mu L/2}{\sigma(N_1+\gamma N_2)}, \\
&\text{where } \gamma \equiv \left(\tau + \frac{\Delta t_1 \Delta t_2}{4a\delta}\right)^{1-\sigma}.
\end{aligned}$$

The equilibrium distribution of plants is interior if $\Pi_1 - \Pi_2 = 0$ has a solution for $n_1 \in (0,1)$. If $\Pi_1 - \Pi_2 > 0$ ($\Pi_1 - \Pi_2 < 0$), then the economy reaches the corner equilibrium of $n_1 = 1$ ($n_1 = 0$). We obtain

$$n_1 = \begin{cases} \dfrac{1}{2} + \dfrac{(\gamma+1)(t_1-t_2)}{2(\gamma-1)(2-t_1-t_2)} & \text{if } \tau \in (\tau^{S1}, \infty) \quad \text{(i)} \\ 0 & \text{if } \tau \in (\tau^{S2}, \tau^{S1}] \quad \text{(ii)} \\ [0,1] & \text{if } \tau = \tau^{S2} \quad \text{(iii)} \\ 1 & \text{if } \tau \in [1, \tau^{S2}) \quad \text{(iv)} \end{cases},$$

$$\text{where } \gamma \equiv \left(\tau + \frac{\Delta t_1 \Delta t_2}{4a\delta}\right)^{1-\sigma}, \quad \Delta t_i \equiv \frac{t_j - t_i}{1-t_i}, \; i \neq j \in \{1,2\},$$

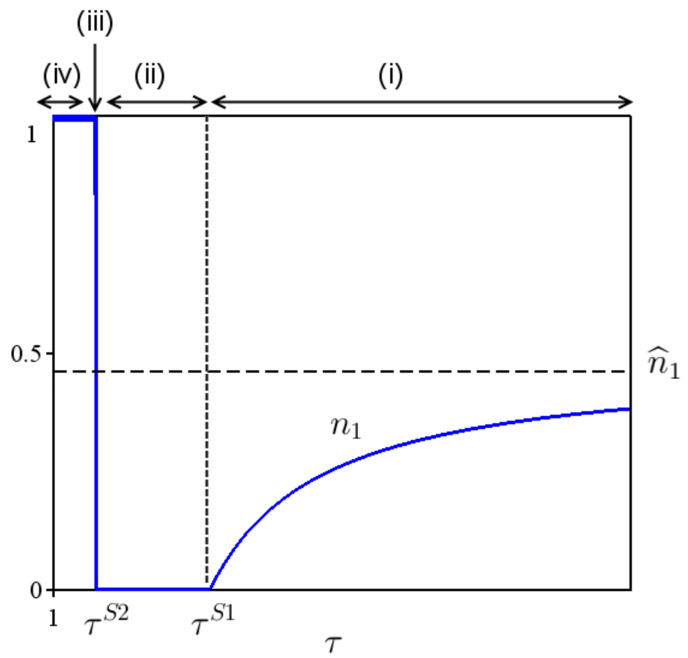
$$\tau^{S1} \equiv \left(\frac{1-t_1}{1-t_2}\right)^{\frac{1}{1-\sigma}} - \frac{\Delta t_1 \Delta t_2}{4a\delta}, \quad \tau^{S2} \equiv 1 - \frac{\Delta t_1 \Delta t_2}{4a\delta},$$

which is illustrated in Figure B.1. The horizontal dotted line represents the share at which the equilibrium share converges as trade costs go to infinity:

$$\widehat{n}_1 \equiv \lim_{\tau\to\infty} n_1 = \frac{1}{2} + \frac{t_2 - t_1}{2(2-t_1-t_2)}.$$

If trade costs are high such that $\tau \in (\tau^{S1}, \infty)$, then the low-tax country hosts more production plants than the high-tax country does. If trade costs are low such that $\tau \in [1, \tau^{S1})$, on the other hand, then the high-tax country attracts all production plants. The result is qualitatively the same as that under decentralized decision making.

Figure B.1: Equilibrium distribution of production plants under centralized decision making



B.7 Proof of Proposition 2.4

(i) Country 1's tax rate vs. country 2's. We derive the condition under which in the transfer-pricing case the equilibrium tax in country 1 is higher than that in country 2, i.e., $t_1^* > t_2^*$:

$$t_1^* = 1 - \sqrt{\frac{\beta\sigma^2 + (\sigma-1)\sqrt{\beta\sigma\mu L_2}}{\mu L(\sigma - s_2)}} > 1 - \sqrt{\frac{\beta\sigma}{\mu L_2}} = t_2^*,$$

$$\to \sqrt{\frac{\beta\sigma}{\mu L_2}} > \sqrt{\frac{\beta\sigma^2 + (\sigma-1)\sqrt{\beta\sigma\mu L_2}}{\mu L(\sigma - s_2)}},$$

$$\to \beta\sigma\mu L(\sigma - s_2) > \mu L_2\left[\beta\sigma^2 + (\sigma-1)\sqrt{\beta\sigma\mu L_2}\right],$$

$$\to \beta\sigma(s_1\sigma - s_2) > s_2(\sigma-1)\sqrt{\beta\sigma\mu L_2},$$

$$\to (\sigma s_1 - s_2)^2/s_2^3 - \mu L(\sigma-1)^2/(\beta\sigma) \equiv \Omega(s_1) > 0.$$

Inspections of $\Omega(s_1)$ reveal

$$\Omega(1/2) = (\sigma - 1)^2[2 - (\mu L)/(\beta\sigma)] < 0,$$
$$\lim_{s_1 \uparrow 1} \Omega(s_1) = \infty,$$
$$\Omega'(s_1) = 2(\sigma + 1)[s_1(\sigma + 1) - 1]/s_2^3 + 3[s_1(\sigma + 1) - 1]^2/s_2^4 > 0,$$

while noting that $\beta < \overline{\beta} \equiv \mu L_2/\sigma < \mu L/(2\sigma)$ and $s_1(\sigma + 1) - 1 > (\sigma - 1)/2 > 0$. As $\Omega(s_1)$ monotonically increases with s_1, $\Omega(s_1) = 0$ has a unique solution in $s_1 \in (1/2, 1)$, which is denoted by s_1^*. If $s_1 > s_1^*$ or $\Omega(s_1) > 0$, we have $t_1^* > t_2^*$. If $s_1 \leq s_1^*$ or $\Omega(s_1) \leq 0$, we have $t_1^* \leq t_2^*$.

(ii) Tax rates with and without transfer pricing. We check that country 1's equilibrium tax rates in the case without transfer pricing is higher than that in the case with transfer pricing: $\widehat{t}_1 > t_1^*$:

$$\widehat{t}_1 = 1 - \sqrt{\frac{\beta\sigma}{\mu L_1}} > 1 - \sqrt{\frac{\beta\sigma^2 + (\sigma - 1)\sqrt{\beta\sigma\mu L_2}}{\mu L(\sigma - s_2)}} = t_1^*,$$
$$\rightarrow \sqrt{\frac{\beta\sigma^2 + (\sigma - 1)\sqrt{\beta\sigma\mu L_2}}{\mu L(\sigma - s_2)}} > \sqrt{\frac{\beta\sigma}{\mu L_1}},$$
$$\rightarrow \mu L_1 \left[\beta\sigma^2 + (\sigma - 1)\sqrt{\beta\sigma\mu L_2}\right] > \beta\sigma\mu L(\sigma - s_2),$$
$$\rightarrow (\sigma - 1)\left[s_1\sqrt{\beta\sigma\mu L_2} - \beta\sigma s_2\right] > 0,$$
$$\rightarrow \beta < \frac{s_1^2}{s_2}\frac{\mu L}{\sigma},$$

which always holds under $\beta < \overline{\beta} \equiv \mu L_2/\sigma$.

(iii) Sustain points with and without transfer pricing. In the transfer-pricing case, the profit differential at $n_1 = 1$ is

$$\Delta\Pi|_{n_1=1} = \frac{\mu \cdot \Theta(\phi)}{\sigma\phi},$$
$$\text{where } \Theta(\phi) \equiv -\gamma_2^* s_1(1 - t_2^*)[(\sigma - \Delta t_2^*)/\sigma]\phi^2$$
$$+ (1 - t_1^*)[\{\sigma - (1 - s_1)\Delta t_1^*\}/\sigma]\phi - (1 - s_1)(1 - t_2^*)/\gamma_1^*,$$

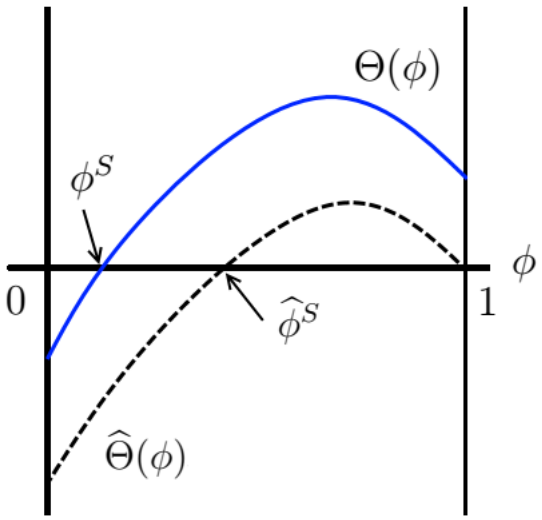
where Δt_i^* and γ_i^* respectively correspond to Δt_i and γ_i evaluated at the equilibrium tax rates: t_i^*. The sign of the differential is determined by $\Theta(\phi)$, which is a quadratic function of ϕ. As in the previous case, we note that

$$\text{the sign of the coefficient of } \phi^2: \quad -\gamma_2^* s_1(1-t_2^*)(\sigma-\Delta t_2^*)/\sigma < 0,$$
$$\Theta(0) = -(1-s_1)(1-t_2^*)/\gamma_1^* < 0,$$
$$\Theta'(0) = (1-t_1^*)[\sigma-(1-s_1)\Delta t_1^*]/\sigma > 0,$$
$$\Theta(1) \simeq \frac{(\sigma-1)(t_1^*-t_2^*)[\sigma(2s_1-1)-s\Delta t_2^*]}{\sigma^2(1-t_2^*)(\sigma-\Delta t_2^*)} > 0,$$
$$\Theta'(1) \simeq \frac{-1}{\sigma^2(1-t_2^*)}\Bigg[(2s_1-1)(1-t_1^*)(1-t_2^*)\sigma^2 - (t_1^*-t_2^*)[s_1(3t_2^*-2t_1^*-1)+1-t_2^*]\sigma - 2s_1(t_1^*-t_2^*)^2\Bigg] < 0,$$
$$\Theta(\widehat{\phi}^S) \simeq \frac{(1-s_1)(1-\widehat{t}_2)(1-t_2^*)(\sigma\Delta\widehat{t}_2-\Delta t_2^*)\Upsilon}{s_1\sigma^2(1-\widehat{t}_1)^2(1-t_2^*)^2(\sigma-\Delta t_2^*)} > 0,$$
$$\text{where } \Upsilon \equiv \sigma^2(1-t_1^*)(1-t_2^*)[s_1(2-\widehat{t}_1-\widehat{t}_2)-(1-\widehat{t}_2)] - s_2(\sigma-1)(1-\widehat{t}_2)(\widehat{t}_1-\widehat{t}_2)^2 > 0,$$

and where the inequalities in the third to fifth lines hold due to the Taylor approximation such that $\gamma_i \simeq 1-[(\sigma-1)/\sigma]\Delta t_i$ and Ineq. (B5). On the fifth line, we notice that $\Delta\widehat{t}_i$ is the corresponding Δt_i evaluated at $\widehat{t}_i$ and $\sigma\Delta\widehat{t}_2 - \Delta t_2^*$ holds because of $\widehat{t}_1 - \widehat{t}_2 > t_1^* - t_2^*$.

From these observations, we can illustrate $\widehat{\Theta}(\phi)$ and $\Theta(\phi)$ as in Figure B.2. The sustain point in the case with transfer pricing ϕ^S is the smaller root of $\Theta(\phi) = 0$. We can thus conclude that the sustain point in the case with transfer pricing, ϕ^S, is lower than that in the case without transfer pricing, $\widehat{\phi}^S$.

Figure B.2: Sustain points under tax competition



C Appendix to Chapter 3

C.1 Proof of Proposition 3.2

The post-tax profits of the MNE under schemes N and I are given by

$$\widetilde{\Pi}^N = \frac{(1-t)(a-w+\Delta-\tau)^2}{4} + (1-t)\overline{\pi}, \tag{C-1}$$

$$\widetilde{\Pi}^I = \frac{(1-T)(a-w)^2}{4} + (1-t)\overline{\pi}. \tag{C-2}$$

The condition under which the MNE prefers scheme I to scheme N is given by

$$\widetilde{\Pi}^I - \widetilde{\Pi}^N > 0 \iff T < 1-(1-t)\left(\frac{a-w+\Delta-\tau}{a-w}\right)^2 \equiv \widetilde{T}. \tag{C-3}$$

From equation (3.9), we can easily confirm that the following inequality holds:

$$\widetilde{\Pi}^B|_{\underline{\alpha}=0} = \frac{(1-t)(a-w+\Delta)^2}{4} + (1-t)\overline{\pi} > \max\{\widetilde{\Pi}^N, \widetilde{\Pi}^I\}. \tag{C-4}$$

Further, the first derivative of $\widetilde{\Pi}^B$ with respect to $\underline{\alpha}$ is

$$\frac{\partial\widetilde{\Pi}^B}{\partial\underline{\alpha}} = \frac{(T-t)\{(1-t)(a-w+\Delta)-(T-t)a\underline{\alpha}\}\xi}{4\{1-t-(T-t)\underline{\alpha}\}} < 0, \tag{C-5}$$

$$\text{where } \xi \equiv [-\{1-t-(T-t)\underline{\alpha}\}-(1-t)(w-\Delta)]$$

Let $\underline{\alpha}^x$ denote the cutoff level of $\underline{\alpha}^x$ such that $\widetilde{x}^B = x^{O*}(=\widetilde{x}^N)$ holds. Specifically, we have

$$\widetilde{x}^B \gtreqless x^{O*} \iff \underline{\alpha} \lesseqgtr \frac{(1-t)\tau}{(T-t)(w-\Delta+\tau)} \equiv \underline{\alpha}^x. \tag{C-6}$$

If evaluated at $\underline{\alpha} = \underline{\alpha}^x$, equation (3.9) becomes

$$\widetilde{\Pi}^B|_{\underline{\alpha}=\alpha_x} = \frac{(1-t)(w-\Delta)(a-w+\Delta-\tau)^2}{4(w-\Delta+\tau)} + (1-t)\overline{\pi}\left(<\widetilde{\Pi}^N\right). \tag{C-7}$$

This implies that there exists the unique cutoff level of $\underline{\alpha}$, $\underline{\alpha}^N \in (0, \underline{\alpha}^x)$, such that $\widetilde{\Pi}^N \geq \widetilde{\Pi}^N$ holds with $\underline{\alpha} \leq \underline{\alpha}^N$ and $T \geq \widetilde{T}$. Moreover, remember that $\frac{\partial\widetilde{\Pi}^I}{\partial T} < 0$ and $\widetilde{\Pi}^I = \widetilde{\Pi}^N$ holds at $T = \widetilde{T}$. Then,

$$\widetilde{\Pi}^I > \widetilde{\Pi}^I|_{T=\widetilde{T}} = \widetilde{\Pi}^N > \widetilde{\Pi}^B|_{\underline{\alpha}=\underline{\alpha}^x} \tag{C-8}$$

holds for any $T \in [t, \widetilde{T}]$. Note that $\widetilde{\Pi}^B > \widetilde{\Pi}^I$ holds if the following condition is satisfied:

$$\widetilde{\Pi}^B|_{\underline{\alpha}=1} > \widetilde{\Pi}^I \iff T < 1 - (1-t)\left(\frac{w-\Delta}{w}\right). \tag{C-9}$$

This implies that there exists the unique cutoff level of $\underline{\alpha}$, $\underline{\alpha}^I \in (0, \underline{\alpha}^x)$, such that $\widetilde{\Pi}^B \geq \widetilde{\Pi}^I$ holds with $\underline{\alpha} \leq \underline{\alpha}^I$ and $1 - (1-t)\left(\frac{w-\Delta}{w}\right) \leq T < \widetilde{T}$. ■

C.2 Proof of Proposition 3.3

Under scheme I, the changes in the amount of supplies from the pre-FTA equilibrium to the post-FTA equilibrium without ROO are

$$\widetilde{x}^I - x^{O*} = \frac{\tau - \Delta}{2} > 0, \tag{C-10}$$

$$\widetilde{x}^I - \widehat{x}^O = \frac{-\Delta}{2} < 0, \tag{C-11}$$

because $\tau > \Delta$ holds. Under scheme B, the FTA formation increases the amount of exports to country F when $\underline{\alpha} < \underline{\alpha}^x$ holds. From Proposition 3.2, we know that $\underline{\alpha} < \underline{\alpha}^x$ holds under scheme B and we always have $\widetilde{x}^B > x^{O*}$. In addition, we can easily confirm that

$$\widetilde{x}^B - \widehat{x}^O = \frac{-(T-t)(w-\Delta)\underline{\alpha}}{2\{1-t-(T-t)\underline{\alpha}\}} < 0 \tag{C-12}$$

holds. ■

C.3 Proof of Proposition 3.4

From equation (3.11), we obtain

$$\frac{\partial \widetilde{r}^B}{\partial \underline{\alpha}} = -\frac{\{1-t-(T-t)\underline{\alpha}\}^2 + (1-T)(1-t)(w-\Delta)}{2\{1-t-(t-t)\underline{\alpha}\}^2} < 0. \tag{C-13}$$

Therefore, $\widetilde{r}^B = w - \Delta + \frac{a-w+\Delta}{2} > w - \Delta$ holds at $\underline{\alpha} = 0$ and $\widetilde{r}^B$ takes the minimum value at $\underline{\alpha} = 1$, which is given by

$$\widetilde{r}^B|_{\underline{\alpha}=1} = 0 < w - \Delta. \tag{C-14}$$

Scheme B is the equilibrium at any $\underline{\alpha}$ if $T < \widetilde{T}$ holds. Therefore, there exists a unique $\underline{\alpha}_r$ such that $\widetilde{r}^B < w - \Delta$ holds when $\underline{\alpha} > \underline{\alpha}_r$ holds. ■

C.4 Key Symbols for Notations

Table B.1: Key symbols for notations

Scheme	λ	Export	Transfer price	MNE's post-tax profits	FTA Welfare
No FTA (w/ "$*$")					
Offshoring ($s = O$)	1	x^{O*}	r^*	Π^{O*}	W^{O*}
FTA w/o ROO (w/ "$\widehat{\ }$")					
Offshoring ($s = O$)	0	$\widehat{x}^O$	$\widehat{r}$	$\widehat{\Pi}^O$	$\widehat{W}^O$
FTA w/ ROO (w/ "$\widetilde{\ }$")					
Inshoring ($s = I$)	0	$\widetilde{x}^I$	$\widetilde{r}^I$	$\widetilde{\Pi}^I$	$\widetilde{W}^I$
Non-compliance ($s = N$)	1	$\widetilde{x}^N$	$\widetilde{r}^N$	$\widetilde{\Pi}^N$	$\widetilde{W}^N$
Binding ROO ($s = B$)	0	$\widetilde{x}^B$	$\widetilde{r}^B$	$\widetilde{\Pi}^B$	$\widetilde{W}^B$

D Appendix to Chapter 4

D.1 Proof of Proposition 4.5

By the implicit function theorem, eq.(4.26) is rewritten as,

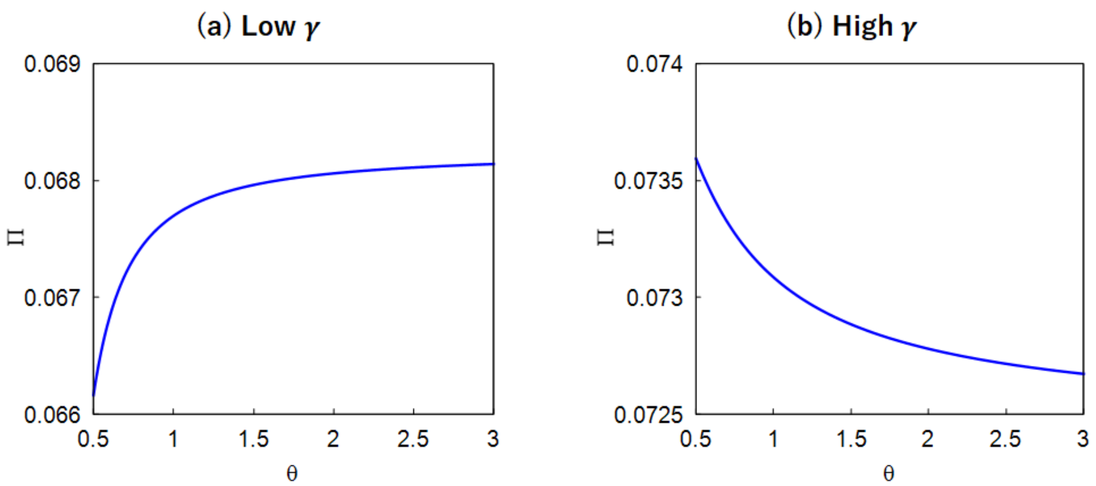
$$\left.\frac{\partial \Pi_i^P}{\partial \theta}\right|_{d=d^P} \propto \left(\frac{t_D^2(a-c+d^P)}{\theta}\right)\left[-\frac{d^P}{\theta}+\left(\frac{t_D^2(a-c+3d^P)}{2\theta}-2(1-t_D)\right)\Xi\right] \gtreqless 0$$

$$\text{where } \Xi \equiv \left(\frac{(a-c+9d^P)}{2\{4\theta(1-t_D)+t_D^2(5(a-c)+9d^P)-9\theta\gamma}\right)$$

$$\Longleftrightarrow \frac{4\theta(1-t_D)(a-c+13d^P)+t_D^2\{-(a-c)^2+14(a-c)d^P+71d^2\}}{36d^P\theta} \equiv \gamma_{P5} \gtreqless \gamma.$$

Thus, globalization reduce the MNEs' post tax profits if $\gamma < \gamma_{P5}$ holds. This concludes proposition 4.5. Figure D.1 shows two patterns of the MNEs' post tax profits with different γ, $\gamma = 1.3$ for the left figure and $\gamma = 1.5$ for the right one by using the following set of parameter values: $a = 2$, $c = 1$, and $t = 0.3$. ■

Figure D.1: MNEs' profits under process innovation



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