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

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Abstract

Product differentiation both enhances consumer utility and firm profits but at the same time makes it difficult for tax authorities to audit MNE tax avoidance strategies, as the arm's length principle is difficult to apply. This paper incorporates these positive and negative aspects of product differentiation and studies the interrelation between profit shifting and product differentiation. The model shows that MNEs engage in more investment in product differentiation in the presence of profit shifting opportunities, and that globalization accelerates the investment. The model also shows that globalization can improve welfare in a non-tax haven.

Keywords: Tax Avoidance, Product differentiation, Arm's length principle, Globalization
JEL classification: F23, H26, L13

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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 quarters of R&D expenditures by U.S. firms were used for product R&D. Bagwell (2007) also reported examples of large spending 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 Procter and Gamble, and Pfizer devoted $2.84 billion to advertise its drugs. Such an investment in product differentiation is an important strategy of firms because it makes the market competition less fierce and allows them 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 is considered. This is supported by "love of variety" pioneered by Dixit and Stiglitz (1977) and Krugman (1980).[1] Furthermore, the work of Hotelling (1929) is a classical study that introduced a heterogeneous preference on goods and concluded a positive socially optimal level of duopolists' product differentiation. 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 the product differentiation.

From the viewpoint of global taxation, however, product differentiation exacerbates the difficulties of collecting corporate tax revenue, because of the tax avoidance behavior 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 or patents. As Organization for Economic Co-operation and Development (OECD) guidelines stipulate, such a price used in intra-firm transactions should be used in inter-firm transaction, or arm's length (AL) price, which is known as the AL principle.[2] 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, the OECD guideline states that, "[T]here are some significant cases in which the arm's length principle is

[1] For example, Ardelean (2006) estimated the parameter of love of variety (see Table 1 of her paper).
[2] AL principle is set in Article 9 of the OECD Model Tax Convention.

difficult and complicated to apply, for example, in MNE groups dealing in the integrated production of highly specialized goods, in unique intangibles and/or in the provision of specialized services."[3] Hence, product differentiation makes it difficult to find comparable transactions because of the necessity for the characteristics of the comparable products in inter-firm transaction to be similar to the products traded in the intra-firm transaction. Due to the difficulty, both consultant companies and tax authorities frequently rely on other methodologies and a range of transfer prices, or AL range, in practice, which provides MNEs with room to manipulate their transfer prices for profit shifting.[4]

Due to the complexities, recent evidence shows a non-negligible impact of MNEs' tax avoidance in the world economy. OECD stated that annual revenue losses from MNEs' tax avoidance are estimated $100 billion to $240 billion.[5] In addition, tax revenue losses are magnified by the use of tax havens. Zucman (2014) showed that the share of U.S. corporate profits made in tax havens has risen from 2% in 1983 to 17% in 2013. Moreover, Tørsløv et al. (2018) also estimated that more than $600 billion were shifted to tax havens. Tax avoidance by MNEs has attracted global attention, and more than 135 countries currently collaborate based on Base Erosion Profit Shifting (BEPS) project because of the sizeable impact on tax revenue losses. Among 15 actions of BEPS project, three actions target transfer pricing, and OECD released a new transfer pricing guidance on financial transaction in February 2020 to reinforce actions 4 and 8-10. The update aims to strictly enforce tax administration by giving the application of the hard-to-value approach, which is highly related to R&D investments of MNEs.[6]

Although global collaboration for international tax issues has been strengthened, each government sometimes designs policies such as R&D incentive tax and/or subsidy to induce firms to engage in R&D activity without considering the AL principle. Therefore, understanding the MNEs' incentive to conduct tax avoidance and its welfare effects is essential to make appropriate policies from both R&D and tax viewpoints.

Indeed, the 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)

[3]See https://www.oecd-ilibrary.org/docserver/tpg-2017-en.pdf?expires=1580823209&id=id&accname=ocid49014612&checksum=0465D173CEED90A136FA054047E36AB3 on page 36.

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

[5]See http://www.oecd.org/ctp/oecd-presents-outputs-of-oecd-g20-beps-project-for-discussion-at-g20-finance-ministers-meeting.htm.

[6]With the nature of intangible assets, the relocation of their property rights is easy, whereas their proper valuation is difficult, indicating huge impacts of transfer price on intangibles on profit shifting. See https://www.oecd.org/tax/beps/beps-actions/actions8-10/.

used export price data in the U.S., Denmark, and France and showed evidence on transfer prices manipulation. Moreover, they categorized industry into homogeneous and differentiated sectors and conclude that transfer prices are more sensitive to tax changes when the goods category is differentiated (e.g. Davies et al. 2018, Table 2).[7] Liu et al. (2019) employed U.K. data and showed 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 its welfare effects.

To this end, this paper incorporates tax avoidance behavior 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 equilibrium 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 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 reduction in the equilibrium tax rate, which is known as "race to the bottom."[8]

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 occurs 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, indicating an already-small tax revenue without profit shifting, 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.

[7]See also Belz et al. (2017) who pointed out that tax avoidance is frequently observed in R&D intensive industries. The 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.

[8]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`.

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, excess product differentiation is possible if a government weighs 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 because the same logic of a link between differentiation and the AL principle is applicable; however, it does not affect consumers' preference but decreases the marginal cost of production. Here, 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 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, whereas the impact of increasing profit shifting hurts MNEs in the case of process innovation.

1.1 Related literature

This study contributes to several fields of research. The first strand of literature studies endogenous product differentiation. Lin and Saggi (2002) showed a stronger incentive to engage in more product differentiation in the presence of process R&D, because innovation increases the benefit from product differentiation. A few works have studied endogenous product differentiation in the open economy. Beladi et al. (2012) incorporated an outsourcing firm in their analysis, but their focus was on the differences in technology and wages across firms and countries. Ferguson (2015) analyzed the impact of trade liberalization in a monopolistically competitive model with constant elasticity of substitution in consumption to explore how market size affects R&D activities of firms. For the studies closer to ours, Braun (2008) explored the impact of economic integration on product R&D and showed that economic integration increases operating profits from the export market and thus results in more product differentiation. Moreover, Bastos and Straume (2012) considered a two-country model and introduced per-unit tariffs on firms' exports and examine the effect on wages for skilled- and unskilled labors. They concluded that economic integration leads to a stronger incentive to invest in product differentiation to mitigate the market competition due to an intensified international competition driven by economic integration. However, their analysis

does not allow drawing any conclusions for product differentiation due to a tax motive, which is the focus of our study.

Second, our model also contributes to the research on tax avoidance by MNEs. After Copithorne (1971) and Horst (1971), many authors have studied transfer pricing and profit shifting. For instance, Kant (1988) first introduced 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 works have studied AL regulation, considering MNEs' strategies. Among them, Bauer and Langenmayr (2013), Choi et al. (2020), and Choi et al. (2019) have studied the impact of AL principle on organization form of firms, tax competition, and licensing strategies, respectively. As AL regulation does not allow MNEs to discriminate input prices or royalty on patent between related affiliate and independent firms, they show AL regulation distort an MNE's strategies (make or buy decision of inputs, monopoly outputs, and licensing to an unrelated firm or not, respectively). However, they did not consider the similarity of transactions, whereas our study considers the link between product differentiation and profit shifting.

A few scholars have seen the link. For instance, Yao (2013) considered a spatial product differentiation model with profit shifting in a Hotelling fashion and showed that the opportunity of manipulating transfer price induces a wider distance of two MNEs' location. Kato and Okoshi (2019) incorporated 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 study explicitly explores the interrelation between product differentiation and the eases of profit shifting by endogenizing investment in product differentiation. Therefore, the contribution of this study 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 structured as follows. Section 2 explains the basic model and derives the equilibrium in an autarky situation where profit shifting is impossible. Section 3 introduces profit shifting by incorporating a tax haven. Section 4 argues the welfare effects, and Section 5 discusses some extensions. Finally, Section 6 concludes.

2 The benchmark model

Our benchmark model abstracts from profit shifting. Consider a domestic country (country D) where both consumption and production occur. In the economy, three sectors exist: 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, labeled 1 and 2, because they have a subsidiary in a tax haven (country H), which is introduced in the next section.

Government The government has only one tax instrument 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 ($t_D \in [0,1]$). Sector Y is perfectly competitive and makes zero profits; therefore, tax revenue (TR) can be generated only from 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 in section 5.2.

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;

$$\begin{aligned} &U(x_i, x_j, y, G) = u(x_i, x_j) + y + \beta G \\ &\quad \text{where} \quad u(x_i, x_j) = a(x_i + x_j) - \frac{(x_i)^2 + (x_j)^2 + 2s x_i x_j}{2} \quad i \in \{1,2\}, \;\; j \neq i, \end{aligned} \tag{1}$$

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 becomes smaller.[9] 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 the MNEs' post-tax profits. Therefore, the utility maximization yields the optimal consumption level of the numeraire homogeneous good as $\widehat{y} = I - \sum_{i=1}^{2} p_i x_i$.

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), they engaged in investment to differentiate their goods from those of 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 follows. 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.

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

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

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

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

function, which is $x_i^R = \frac{a-c-sx_j}{2}$. As s becomes 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 product substitutability becomes 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.

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 rivals. To identify variables, we use a superscript "O" for variables without profit shifting.

MNE i maximize the following post-tax profits,

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

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

$$\left.\frac{\partial \Pi_i^O}{\partial d_i}\right|_{d_i=d_j=d^O} = \frac{2(1-t_D)(a-c)^2}{(3-2d^O)^3} - F'(d^O) = 0. \tag{4}$$

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

3 Tax Haven and Globalization

Next, we consider the case where the MNEs may shift profit into country H by some means such as transfer pricing on tangible/intangible assets. We assume that country H is insignificant and country H has no consumption. This is a standard assumption in the 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.[10] 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.

3.1 Cost of profit shifting

In general, engaging in tax avoidance is costly. For example, MNEs must 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 must 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 must exert much effort to save tax. Moreover, MNEs may pay more rewards to them to shift more profits. We assume that the cost is formulated as

$$C(\eta, \pi_i^S) = \frac{\eta(\pi_i^S)^2}{2\pi_i} \tag{5}$$

where π_i^S represents the amount of shifted profits to country H and η is a measure of difficulty of profit shifting.[11] 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 make larger operating profits.

This traditional formulation of the cost function has one caveat that it does not reflect the comparability of an intra-firm transaction with another. In this model, it is straight forward to assume that the cost of profit shifting becomes 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

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

[11] This specification is also used in some empirical studies. See, for example, Hines Jr and Rice (1994), Huizinga and Laeven (2008), Amerighi and Peralta (2010), and Gumpert et al. (2016).

measure of globalization.[12] 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 should find an appropriate comparable price or CUP. If the intra-firm traded transactions of either tangible or intangible assets are differentiated, finding CUP is difficult for tax authorities.[13] Thus, shifting profits becomes easier as products are more differentiated. To incorporate these two properties, we assume $\eta = \theta s$.

In the following analysis, we use a superscript "P" for the case with profit shifting.

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,

$$\widehat{\pi}_i^S = \frac{t_D}{\theta s}\pi_i. \tag{6}$$

The following analysis assumes $\frac{t_D}{\theta s} \in [0, 1]$, because reporting more profits than operating profits makes the reported profits in country D negative and tax authorities are easy to audit tax avoidance.

The optimal amount of shifted profits is determined by balancing the marginal benefit with the marginal cost from profit shifting. Eq.(6) shows four determinants of profit shifting. The MNEs shift more profits when the tax gap becomes 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, corresponding to the case of no profit shifting, when tax gap does not exist, $t_D = 0$, or the world is not globalized, $\theta \to \infty$.

On top of these two determinants that are argued in the existing literature, two more new channels caused by product differentiation appear in this model. First, higher product differentiation, captured by higher d_i or lower s, makes it difficult to find CUP; hence, it decreases

[12] The existing literature also interprets this term as the degree of government's attention to auditing profit shifting. Here, higher θ can be interpreted as a stricter policy or regulation such as worldwide cooperation, e.g. BEPS project or AL principle. For example, see Hindriks and Nishimura (2021) who incorporated governments' effort on tax enforcement in their concealment cost.

[13] In the current model, we do not have an intra-firm transaction of the heterogeneous good for simplicity. However, we can have qualitatively the same results even if we introduce intra-firm transaction of the goods by considering two-country model.

the marginal cost of profit shifting. Second, as more operating profits reduce the cost of shifting profits, the shifted profits are increasing in the operating profits.[14] As we saw above, product differentiation increases operating profits so that both of these new determinants positively affect the MNEs' tax-saving strategy.

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

$$\Pi_i^P = \left(1 - t_D + \underbrace{\frac{t_D^2}{2\theta s}}_{\text{Tax-saving gains}}\right)\pi_i - F(d_i). \tag{7}$$

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.

3.3 Investment decision with profit shifting

In the presence of profit shifting, eq.(2) rewrites the post-tax profits of MNE i as,

$$\Pi_i^P = \left(1 - t_D + \frac{t_D^2}{2\theta(1 - d_i - d_j)}\right)\left(\frac{a-c}{3 - d_i - d_j}\right)^2 - F(d_i). \tag{8}$$

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

$$\left.\frac{\partial \Pi_i^P}{\partial d_i}\right|_{d_i = d_j = d^P} = \frac{2(1-t_D)(a-c)^2}{(3-2d^P)^3} + \underbrace{\frac{t_D^2(a-c)^2}{\theta(1-2d^P)(3-2d^P)^3}}_{\text{Tax avoidance effect}} + \underbrace{\frac{t_D^2}{2\theta(1-2d^P)^2}\frac{(a-c)^2}{(3-2d^P)^2}}_{\text{Concealment cost effect}} - F'(d^P) = 0. \tag{9}$$

The second and third terms are the additional incentives to capture marginal benefits from tax savings as the term of tax-saving gains exists in eq.(7). The second term in eq.(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.(7). Furthermore, the third term in eq.(9) captures the link between product differentiation and the cost of profit shifting, we refer to this as "*concealment cost effect*."

[14] In the transfer pricing literature, the amount of shifted profits is the product of transfer price and the number of exports. Therefore, they also have a channel similar to ours; that is, more exports (or more operating profits) lead to more shifted profits. Unlike our model, however, their channel is related to the benefit side because MNEs can shift more profits when they conduct intra-firm trade more even if the same transfer price is set, whereas our model indicates the channel through cost side.

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. Hence, the above argument is summarized as the following proposition.

Proposition 1. The opportunity of profit shifting induces the MNEs to invest more in product R&D, $d^O < d^P$.

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, such as eq.(5). Then, $d^T < d^P$ holds because of the disappearance of the positive concealment cost effect.

This result indicates one feature of the AL principles. Some countries or regions argue the introduction of a new international tax system so-called "formula apportionment" instead of the current "separate accounting" system. Under the new system, MNEs' tax base is allocated based on each affiliate's share of the MNE's worldwide activities measured with sales, payrolls, and capital, and thus the concealment cost effect does not arise if the world uses formula apportionment instead of the AL principle under separating accounting. Therefore, the current system tends to induce MNEs to invest more in product differentiation, which is a new rationale for the current increase in R&D activities.

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 because the recent world is featured not by drastic globalization. Thus, this section focuses on the effect of a reduction in θ.

By differentiating eq.(9) with respect to θ, we obtain

$$\frac{\partial}{\partial\theta}\left(\frac{\partial\Pi_i^P}{\partial d_i}\right)\Bigg|_{d_i=d_j=d^P} = -\left(\frac{t_D^2(a-c)^2}{\theta^2(1-2d^P)(3-2d^P)^2}\right)\left(\underbrace{\frac{1}{3-2d^P}}_{\text{Via tax avoidance effect}} + \underbrace{\frac{1}{2(1-2d^P)}}_{\text{Via concealment cost effect}}\right) < 0. \tag{10}$$

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

Propositions 1 and 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 enable MNEs to engage in tax avoidance. However, our model shows another complementary channel that 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 ignored by the conventional explanation.

4 Welfare effect

The previous section explores the effect of tax avoidance opportunities on the MNEs' decision on R&D, and this section explores how globalization affects welfare in country D.

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,

$$\frac{\partial\Pi_i^P}{\partial\theta} \propto \underbrace{-\frac{t_D^2}{2\theta^2(1-2d^P)}}_{\text{Direct: Tax saving}} + \left\{\underbrace{\frac{t_D^2}{2\theta(1-2d^P)^2}}_{\text{Indirect: Tax saving}} + \underbrace{\left(\frac{2}{3-2d^P}\right)\left(1-t_D+\frac{t_D^2}{2\theta(1-2d^P)}\right)}_{\text{Indirect: Demand size}}\right\}\frac{\partial d_j^P}{\partial\theta} < 0, \tag{11}$$

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,

$$CS_X = a(x_i^P + x_j^P) - \frac{\left(x_i^P\right)^2 + \left(x_i^P\right)^2 + 2s x_i^P x_j^P}{2} - \sum_{i\in\{1,2\}} p_i^P x_i^P = 2(2 - d_i^P - d_j^P)\left(\frac{a-c}{3-d_i^P-d_j^P}\right)^2 \quad (12)$$

As consumers love variety, more product differentiation has two effects on consumer surplus. First, the volume of consumption is an element for utility captured by the second bracket of eq. (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 harms 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 bracket of eq.(12). Irrespective of the counteracting effects, the first derivative of the consumer surplus with respect to θ is,

$$\left.\frac{\partial CS_X}{\partial \theta}\right|_{d_i=d_j=d^P} = \frac{4(1-2d^P)(a-c)^2}{(3-2d^P)^3}\frac{\partial d^P}{\partial \theta} < 0. \quad (13)$$

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 harm tax revenues in country D, which is formulated as

$$TR_D^P = t_D\left(\sum_{i\in\{1,2\}} \pi_i^P - \pi_i^S\right) = 2t_D\left(1 - \frac{t_D}{\theta(1-d_i^P-d_j^P)}\right)\left(\frac{a-c}{3-d_i^P-d_j^P}\right)^2, \quad (14)$$

which yields

$$\frac{\partial TR_D^P}{\partial \theta} = 2t_D\left(\frac{a-c}{3-2d^P}\right)^2\left\{\frac{t_D}{\theta^2(1-2d^P)} + \left(\frac{2}{3-2d^P} - \frac{t_D(5-6d^P)}{\theta(1-2d^P)^2(3-2d^P)}\right)\frac{\partial d_i}{\partial \theta}\right\}. \quad (15)$$

The direct effect is to induce outflows of tax base to country H, which is the first term of the second parenthesis of eq.(15). 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.(9), the implicit function theorem rearranges eq.(15) into,

$$\frac{\partial TR}{\partial \theta} = \frac{t_D \Gamma}{\theta^2(1-2d^P)\Gamma_{SOC}},$$

$$\text{where} \quad \Gamma \equiv \Gamma_{SOC} + \left(\frac{2}{5-6d^P} - \frac{t_D}{\theta(1-2d^P)}\right)\frac{(a-c)^2 t_D^2 (5-6d^P)^2}{2(1-2d^P)(3-2d^P)^4}, \tag{16}$$

$$\text{and} \quad \Gamma_{SOC} \equiv \frac{6(a-c)^2}{(3-2d^P)^4}\left\{2(1-t_D) + \frac{t_D^2(5-6d^P)}{2\theta(1-2d^P)^2}\right\} - \frac{(a-c)^2 t_D^2 (13-18d^P)}{\theta(1-2d^P)^3(3-2d^P)^3} - F''(d_i). \tag{17}$$

As we assume the second-order condition holds, Γ_{SOC} is negative and thus, sign $\left(\frac{\partial TR}{\partial \theta}\right) = \text{sign}\,(-\Gamma)$ holds. From eqs.(16) and (17), we have,

$$\frac{\partial TR}{\partial \theta} > 0 \iff \Gamma < 0 \iff F''(d_i) > \underline{F} \equiv \left(\frac{(a-c)^2}{(3-2d^P)^4}\right)\Gamma_F \tag{18}$$

$$\text{where} \quad \Gamma_F \equiv \frac{2}{(3-2d^P)}\left(6(1-t_D) + \frac{t_D^2(5-6d^P)}{1-2d^P}\right) + \frac{t_D^2}{\theta(1-2d^P)^2}\left(\frac{(5-6d^P)\{6-t_D(5-6d^P)\}}{2(3-2d^P)} - \frac{13-18d^P}{1-2d^P}\right)$$

This sufficient condition means that globalization always decreases 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, implying an also small increase in operating profits.

The above discussions are summarized as the following proposition.

Proposition 3. Globalization, captured by a reduction in θ, always benefits consumers and MNEs. However, globalization decreases tax revenue from MNEs when investment cost is sufficiently 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 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,

$$U = CS_X^P + \sum_{i\in\{1,2\}} \Pi_i^P + \beta TR_D^P. \tag{19}$$

Obviously, globalization benefits country D when the weight on public goods is close to zero.[15]

[15]Another situation corresponding to this situation is the one that government sector is sufficiently inefficient to

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 $\theta = \frac{t_D}{s}$,

$$\left.\frac{\partial U}{\partial \theta}\right|_{\theta=\frac{t_D}{s}} \propto 2\beta - 1 + \frac{(a-c)^2(5-6d^P)}{(1-2d^P)(3-2d^P)^4\Gamma_{SOC}}\left(\frac{t_D\beta(1+2d^P)}{3-2d^P} - \frac{t_D}{2} + 2(1-d^P)\right). \tag{20}$$

Note that Γ_{SOC} is negative and decreasing in $F''(d_i)$. Therefore, the second term becomes smaller as $F''(d_i)$ becomes bigger, making eq.(20) likely to be positive. By contrast, the second term becomes larger if $F''(d_i)$ is small enough. At an extreme point $F''(d_i) = \underline{F}$, we obtain

$$\left.\frac{\partial U}{\partial \theta}\right|_{\theta=\frac{t_D}{s}, F''(d_i)=\underline{F}} = 2\beta - 1 + \frac{1}{t_D^2}\underbrace{\left(\frac{2}{1-6d^P}\right)}_{<0\ \because \text{SOC}}\left(\frac{t_D\{2\beta-3+2t_D(2\beta+1)\}}{2(3-2d^P)} + 2(1-d^P)\right), \tag{21}$$

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. Globalization improves total welfare if either (a) β is close to 0 or (b) the triplet $(t_D, \theta, F''(d_i))$ is sufficiently small.

Figure 1 illustrates welfare in country D without and with profit shifting cases. The dashed line represents welfare without profit shifting, whereas the solid curve depicts that with profit shifting.[16] The left figure is the case where β is low and corresponds to (a) of proposition 4. The solid curve in the figure is an inverse U-shape and globalization improves welfare when θ is large. As β becomes larger, the negative impact from tax revenue loss becomes more important, and the losses from tax revenue are likely to exceed the gains when tax avoidance is easy to conduct, or θ is low. As β increases, the curve shifts 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. Unlike the case with low β, the shape of welfare curve is U-shaped and globalization

provide public goods. In the literature of mixed oligopoly, 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 $c_G = 1$.

[16] 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, whereas $\beta = 1$, $t_D = 0.1$ and $\gamma = 0.615$ are used for the right one.

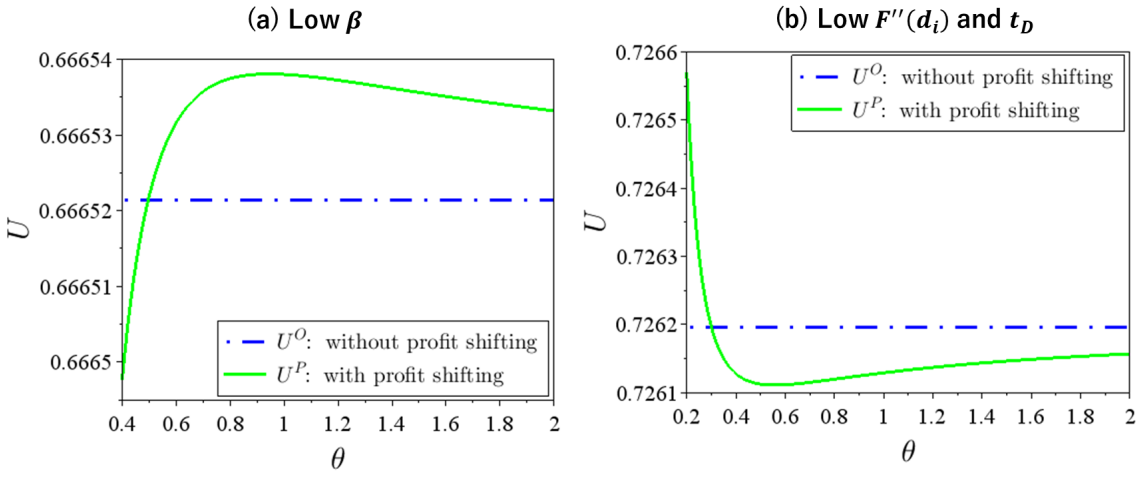

Figure 1: Welfare

improves welfare when θ is low as proposition 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 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 fewer 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.

5 Discussions and policy implications

In this section, we further analyze three additional extensions. In the first extension, we argue the optimal policy for MNEs' investment to give policy implications. Second, we endogenize tax rate and numerically show how the domestic country responds to the globalization. Finally, we consider the other type of innovation, namely, process innovation.

5.1 Under or excess investment

As in Introduction, some countries give R&D incentives such as subsidy or reduced tax rate to inspire firms to engage more in investments. In this subsection, we explore whether the equilibrium product differentiation is over- or under-investments in the benchmark model.

Without a tax haven, the equilibrium degree of product differentiation is easily obtained to be 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,

$$\left.\frac{\partial U^O}{\partial d_i}\right|_{d_i=d^O} = \frac{4(a-c)^2(1-d^O+2\beta t_D)}{(3-2d^O)^3} > 0, \tag{22}$$

is obtained.

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

$$\left.\frac{\partial U(x_i^P, x_j^P, y^P)}{\partial d_i}\right|_{d=d^P} = \frac{(a-c)^2}{(3-2d^P)^3}\left(2(1-2d^P)+2\beta t_D - \frac{t_D^2(5-6d^P)(2\beta-1)}{2\theta(1-2d^P)^2}\right). \tag{23}$$

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 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,

$$\left.\frac{\partial U(x_i^P, x_j^P, y^P)}{\partial d_i}\right|_{d=d^P} < 0 \iff \beta > \frac{4(2-2d^P-t_D)\theta(1-2d^P)^2 + t_D^2(5-6d^P)}{2\{t_D^2(5-6d^P) - 2t_D\theta(1-2d^P)^2\}} \equiv \beta_{opt}^P, \tag{24}$$

as a condition where excess investment is realized.

Figure 2 shows the above discussions.[17] In the figure, the welfare in country D under the case of profit shifting with two different β is 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 $d_{\beta=2}^P$. As we can see the order $d^P < \widehat{d}_{\beta=2}^P$, 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 $\widehat{d}_{\beta=4}^P < d^P$, implying

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

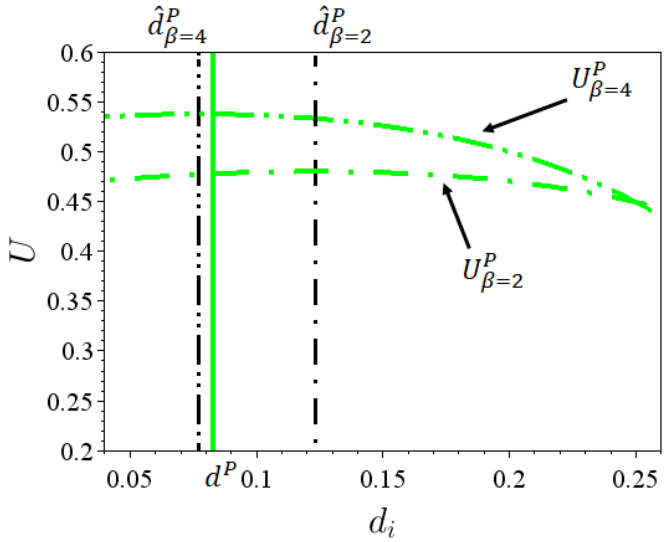

Figure 2: Socially optimal d

the excess-investment characterization of the equilibrium. 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.

The above argument is summarized as the following proposition.

Proposition 5. In the absence of profit shifting, the level of investment on product differentiation is less than the optimal level. However, opportunities for profit shifting make the degree of investments in product differentiation greater than the optimal degree when the government weights tax revenue less. Formally, $\left.\frac{\partial U(x_i^P, x_j^P, y^P)}{\partial d^P}\right|_{d_i=d_j=d^P} < 0$ holds if and only if $\beta > \beta^P_{opt}$ 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.

5.2 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,

$$\begin{aligned}\frac{\partial U^O}{\partial t_D} &= \left(\frac{2(a-c)^2}{(3-2d^O)^2}\right)\left[\beta - 1 + \left(\frac{2\{2(1-d^O)+t_D(2\beta-1)\}}{3-2d^O}\right)\frac{\partial d^O}{\partial t_D}\right] \\ &\propto \beta - 1 - \frac{4\{2(1-d^O)+(2\beta-1)t_D\}(a-c)^2}{F''(d^O)(3-2d^O)^4 - 12(1-t_D)(a-c)^2}. \end{aligned} \tag{25}$$

The first two terms in the square bracket are the direct effect that a marginal utility from the public good and marginal (dis)utility from the homogeneous good. As we assume $\beta > 1$, on the one hand, the government has an incentive to collect greater tax revenue. 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.(25) 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,

$$\begin{aligned}\frac{\partial U^P}{\partial t_D} =& 2\left(\frac{a-c}{3-2d^P}\right)^2\Bigg[\beta - 1 \underbrace{-\frac{(2\beta-1)t_D}{\theta(1-2d^P)}}_{\text{Net direct effect of tax avoidance}} \\ &+\left\{\left(\frac{2\{2(1-d^P)+t_D(2\beta-1)\}}{3-2d^P}\right) - \underbrace{\left(\frac{t_D^2(5-6d^P)(2\beta-1)}{2\theta(1-2d^P)^2(3-2d^P)}\right)}_{\text{Indirect effect via tax avoidance}}\right\}\frac{\partial d^P}{\partial t_D}\Bigg], \end{aligned} \tag{26}$$

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, such a tax avoidance behavior entails concealment costs; hence, 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.(26) unclear. However, we confirm $\frac{\partial d^O}{\partial t_D} < \frac{\partial d^P}{\partial t_D}$, implying that the MNEs' response to a change in the tax rate is less sensitive with profit shifting because of the possibility of profit shifting to a haven country and the mitigation of tax burden. Hence, the optimal tax rate is more influenced by the direct effects,

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

Table 1: Optimal tax rate

indicating a weakened government's incentive to impose a higher corporate tax rate for the public good provision.

Here, we rely on numerical calculation as we cannot derive the analytical results of globalization. In Table 1, the numerical results are provided with $\beta = 1.21$ for the tables.[18] The top table shows outcomes with the endogenous tax rate, whereas the bottom one represents results with a fixed tax rate at the optimal level without profit shifting $\theta = \infty$.

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 reduction in tax rate by globalization 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 is not replicated. The lower 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 in this example.

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.[19] However, a tax

[18]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.

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

rate is not always optimal industry-wide because of the nature of corporate taxation, in which a government imposes a unique corporate tax rate on national and multinational firms across industries. Therefore, welfare-enhancing globalization occurs when the initial tax rate is low enough due to, for example, other industries and difficulty in tax rate adjustment.

By comparing the tables, we can also see the impact of endogenizing tax rate and the main source of welfare reduction because of globalization. As the reduction in tax revenue is dramatic with an endogenous tax rate compared to the one with a fixed tax rate, the primary reason of the decline in welfare is the 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 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

$$t^{eff} = \frac{t_D\left(1-\frac{t_D}{\eta}\right)\pi_i}{\pi_i} = t_D \underbrace{\left(1-\frac{t_D}{\theta(1-2d^P)}\right)}_{\text{Ineffectiveness of profit shifting}}. \tag{27}$$

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.(27).

Table 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 tables. The bottom columns show the efficiency of tax avoidance and that profit shifting becomes more efficient as globalization proceeds because the number of the columns decreases. The smaller numbers under a fixed tax rate than those under an endogenous 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 $1 - \frac{t_D}{\eta}$.

5.3 Product differentiation in inputs

Another possibility for the source of differentiation is a technological differentiation for inputs rather than product differentiation of final products. In such a case, the differentiation does not necessarily increase the 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. 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.[20] For simplicity, we specify the concealment cost as;

$$C(\eta, \pi_i^S) = \frac{\eta(\pi_i^S)^2}{2\pi_i}, \quad \text{where} \quad \eta = \frac{\theta}{d_i + d_j}. \tag{28}$$

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 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, indicating the dominance of an increase in investment costs of MNE i over an increase in

[20] Even though the subsequent marginal cost is the same across firm, η as a function of investment levels is a plausible assumption. Suppose producing the goods requires several tasks 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 is still room for the MNEs to justify their transfer prices to some extent.

operating profits. Formally, we can see the effect:

$$\frac{\partial \Pi_i^P}{\partial \theta} = -\frac{t_D^2 d^P}{\theta^2}\left(\frac{a-c+d^P}{3}\right)^2 + \frac{\partial \Pi_i^P}{\partial d_i^P}\frac{\partial d_i^P}{\partial \theta},$$

$$= \left(\frac{a-c+d^P}{9}\right)\left[\underbrace{-\frac{t_D^2 d^P (a-c+d^P)}{\theta^2}}_{\text{Direct: Tax saving}} + \left\{\underbrace{\frac{t_D^2 (a-c+d^P)}{2\theta}}_{\text{Indirect: Tax saving}}\underbrace{-2\left(1-t_D+\frac{d^P t_D^2}{\theta}\right)}_{\text{Indirect: Competition}}\right\}\frac{\partial d_i^P}{\partial \theta}\right], \quad (29)$$

where the third effect is not indirect demand size effect as seen in eq.(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, process innovation driven by tax avoidance hurts MNEs if eq.(29) is positive. This new result is summarized as the following proposition.

Proposition 6. 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.(29) is positive.
Proof. See Appendix.

As a common anticipation of tax havens is to benefit MNEs by providing them with tax avoidance opportunities, proposition 6 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.

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 behaviors. 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.

These findings on developments of more product differentiation are in line with current evidence, but are supported by a new rationale. Traditionally, the reason why MNEs' tax avoidance

is observed more in R&D intensive is that MNEs' have more opportunities of profit shifting because firms in such industries tend to create new intangible assets. In this sense, MNEs' tax avoidance is a secondary product of R&D activities. The current model, however, pointed out that MNEs expect easier profit shifting by product differentiation, and thus MNEs pursue innovation for tax avoidance.

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 welfare. 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 considered. This is because product differentiation magnifies profit shifting that 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, whereas product innovation can hurt them due to a fiercer competition effect. This implies that policymakers should pay attention to the types of R&D when designing 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 all the production process are completed within an MNE. However, production process are sometimes outsourced to unrelated firms recently, considering interrelation with independent firms can be interesting. Finally, governments' behaviors should be analyzed more in detail to obtain richer policy implications. Especially, as globally cooperative actions such as BEPS project begins, interaction between countries in non-cooperative and cooperative games can be an interesting extension.

Appendices

A. Proof of Proposition 6

By the implicit function theorem, eq.(29) is rewritten as,

$$\left.\frac{\partial \Pi_i^P}{\partial \theta}\right|_{d=d^P} \propto \left(\frac{t_D^2(a-c+d^P)}{\theta}\right)\left[-\frac{d^P}{\theta} + \left(\frac{t_D^2(a-c+3d^P)}{2\theta} - 2(1-t_D)\right)\left(\frac{(a-c+9d^P)}{2\{4\theta(1-t_D)+t_D^2(5(a-c)+9d^P)-9\theta\gamma\}}\right)\right] \gtreqless 0$$

$$\iff \frac{4\theta(1-t_D)(a-c+13d^P)+t_D^2\{-(a-c)^2+14(a-c)d^P+71d^2\}}{36d^P\theta} \equiv \gamma_{P5} \gtreqless \gamma. \quad \text{(A-a)}$$

Thus, globalization reduce the MNEs' post tax profits if $\gamma < \gamma_{P5}$ holds. This concludes proposition 6. Figure 3 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 $t = 0.3$. ■

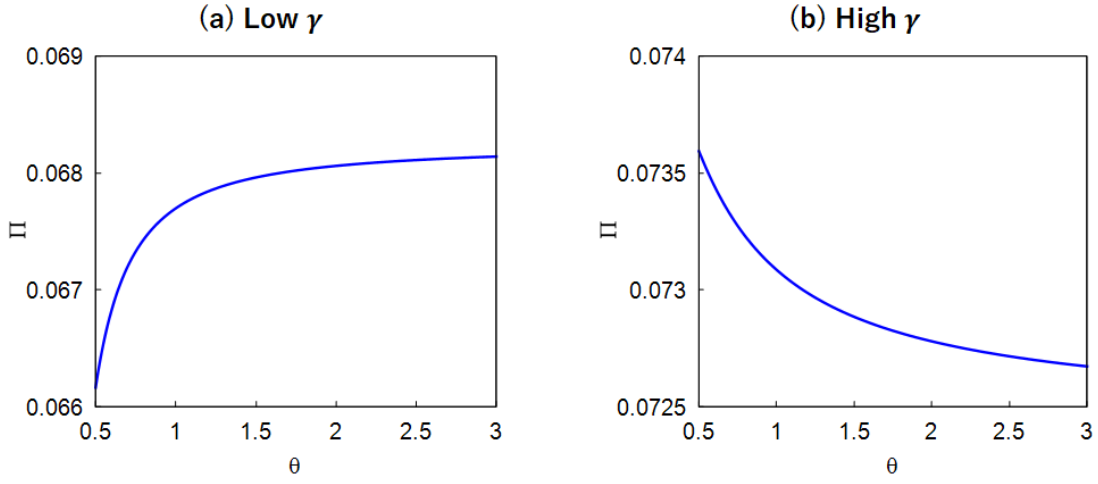

Figure 3: MNEs' profits under process innovation

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