Quality upgrading for tax avoidance*

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Abstract

Governments sometimes incentive firms to upgrade their quality of goods but such a policy makes it difficulty to collect tax revenue from multinational enterprises (MNEs) because the application of the arm's length principle is hard. Thus, with tax avoidance opportunities, effects of the optimal policy for R&D and regulation on tax avoidance are in question. This paper links the innovation for quality upgrading with profit shifting. As the opportunities of tax avoidance increases gains from an MNE's investment in quality, it contributes to quality upgrading, which spillovers to a local firm. Moreover, the model shows that tightening the profit shifting regulation can improve total welfare under a large R&D subsidy and loose enforcement of profit shifting regulation because the tax revenue losses are serious. However, stricter enforcement of the regulation hurts the non-haven country otherwise, because it leads to less R&D and decreases consumer surplus and profits of firms.

Keywords: Tax avoidance; Vertical differentiation; The arm's length principle

JEL classification number: F23; H26; L13

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1 Introduction

As globalization proceeds, recent evidence has shown an increase in research and development (R&D) expenditure and remarkable technological progress. For example, National Science Foundation shows that worldwide R&D expenditure rose from $336 trillion in 2009 to $451 trillion in 2016.[1] Moreover, Bagwell (2007) also reports examples of large spendings on advertisement by U.S. firms which serve to increase product differentiation. In 2003, $3.43 billion was spent by General Mortors 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 drug. From the viewpoint of international trade, some empirical research have found links between quality upgrading and trade liberalization. Amiti and Khandelwal (2013) shows that lower tariff encourages firms to upgrade their quality if the product varieties are close to the world frontier, and Fernandes and Paunov (2013) also conclude that transportation costs have a negative and significant impact on product quality. These empirical outcomes suggest that firms' investments are one of the most important strategies to survive in the globalized market.

In addition, the increase in R&D activities may be outcome of governments' policy designs. According to Appelt et al. (2019), the number of OECD countries with R&D tax incentives grew from 19 in 2000 to 30 out of 36 countries in 2018. Bloom et al. (2019) also argue some policies to spur technological innovation. As these technological progress are expected to result in economic growth, these kinds of policy-driven incentivization can be positively viewed.

From the viewpoint of international taxation, however, technological progress also causes a problem to make it difficult to collect corporate tax from multinational enterprises (MNEs). By the nature of intangible assets, one of the frequently used tax avoidance strategies of MNEs is to relocate their intangible assets such as patent rights and trademarks and collect profits in tax haven countries.[2] Belz et al. (2017) pointed out that a lot of R&D intensive firms have their subsidiaries in tax havens for tax avoidance via royalty payments. As relocation of intellectual property rights are easy, technological innovation increases MNEs' opportunities of profit shifting by creating new intangible assets.

Moreover, technological upgrading exacerbates MNEs' profit shifting because auditing their tax avoidance behaviour becomes harder. To prevent MNEs from avoiding taxes, manipulation of prices

[1]Note that these numbers does not distinguish "process" and "product" innovations. However, according to Scherer and Ross (1990), 3/4 of R&D expenditures by U.S. firms' are used for product R&D, which indicates that the expenditure on product differentiation is non-negligible.

[2]See Juranek et al. (2018) and Choi et al. (2019) for royalty payments. Other channels of profit shifting include internal debt or interest payment, and intra-firm trade. See, for example, Hong and Smart (2010) on the former and Kato and Okoshi (2019).

on intra-firm transaction, or transfer price, is regulated with OECD guideline. In the guideline, transfer price should be the one used in inter-firm transaction, or arm's length (AL) price, which is called the AL principle.[3] Following the principle, tax authorities try to audit MNEs' tax avoidance behaviour by comparing the transfer price with the AL price from comparable uncontrolled transactions. However, finding proper AL price is difficult because product differentiation including technological difference makes intra-firm transaction less comparable with other AL transactions. Therefore, in practice, both consultant companies and tax authorities frequently rely on a range of transfer prices, or AL range, which provides MNEs with room to manipulate their transfer prices for the purpose of profit shifting.

This link between product differentiation and profit shifting is empirically supported. Bernard et al. (2006), Cristea and Nguyen (2016), Davies et al. (2018) and Liu et al. (2019) used export price data in the U.S., Denmark, France, and U.K. and showed the significant difference between transfer prices and AL prices. Moreover, they categorized industry into homogeneous and differentiated sectors and conclude that transfer prices are more sensitive to tax change for differentiated goods category as compared to homogeneous goods (e.g. Davies et al. (2018), Table 2). Given the above facts, it seems realistic to assume that MNEs expect such tax avoidance gains from R&D investments when they determine their investment.

The impacts of MNEs' tax avoidance is sizable, which is widely recognized. For example, OECD estimated that the annual revenue losses from MNEs' tax avoidance are from \$100 billion to \$240 billion.[4] Zucman (2014) shows an increasing share of U.S. corporate profits made in tax havens from 2% in 1983 to 17% in 2013. Furthermore, Tørsløv et al. (2018) also estimate that MNEs shifted more than \$600 billion to tax havens.[5] Although these empirical facts imply the importance of understanding MNEs' motive of R&D activities by linking tax avoidance, few theoretical research has been conducted. As recent development of R&D activities can be supported by some policies mentioned above, it is essential to reconsider effects of policies related to R&D.

To this end, this paper constructs an international duopoly model with one MNE and one local firm producing vertically differentiated goods, or different quality goods. Our model introduces a link between quality gap and ease of profit shifting. When profit shifting is possible, an MNE

[3] 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.

[4] See `https://www.oecd.org/tax/beps/`.

[5] Because of these huge losses, OECD countries try to deal with this issue by launching "base erosion and profit shifting (BEPS) project." In the project, 3 out of 15 actions are devoted for issues related to transfer pricing (see action 8-10).

benefits more from R&D investments because wider quality gap makes shifting profits easier. Due to this additional incentive, we find that the MNE's optimal investment in quality upgrading with profit shifting is higher than without profit shifting.

The MNE's quality upgrading induces the local firm to invest more in its quality as well under Bertrand competition but discourage the local to invest under Cournot competition. Under Bertrand competition, this is because the MNE's quality upgrading attracts more consumers and induce the MNE to set higher price, which means that the price competition is mitigated. Thus the local firm's gains from investment in quality also increases. Under Cournot competition, the MNE's quality upgrading attracts more consumers and induces the MNE to supply more, which means fiercer market competition. Hence, the local firm's R&D gains shrink and the local firm invest less in quality.

We also analyse the impact of two policies on welfare: R&D subsidy and transfer pricing regulation. Our numerical examples show that the optimal R&D policy is to give subsidies because non-cooperative competition between the firms results in underinvestment in R&D activities because they ignore the gains for consumers, which is in line with the extant literature.

On transfer pricing regulation, our numerical analysis shows that with a fixed R&D subsidies, stricter regulation can improve total welfare in the non-haven country. This happens when the government offer generous R&D subsidy and enforce loosely transfer pricing regulation. Under the environment, losses of tax revenue due to the MNE's tax avoidance is a serious problem, and thus tightening the regulation prevents the MNE from shifting its tax base. However, when either the government offer less generous R&D subsidy or the enforcement level of the regulation is strict enough, tightening the regulation is indeed harmful. This is simply because such environment provide less gains from R&D activities and firms' R&D investments are socially suboptimal. Overall, the result indicates that when one evaluates/designs regulation on tax avoidance, taking R&D aspects into account is important.

1.1 Related literature

This paper contributes to several fields of research. First, our model contributes to the research on tax avoidance by MNEs. After Copithorne (1971) and Horst (1971), a variety of authors have studied transfer pricing and profit shifting. Elitzur and Mintz (1996) shows the role of transfer price as managerial incentives. Schjelderup and Sørgard (1997) points out another strategic purpose of manipulating transfer prices by assuming a decentralized MNE. Recent development of research focuses on the AL principle by considering interrelation between transfer pricing and other MNEs' strategies. Bauer and Langenmayr (2013), Choe and Matsushima (2013), Choi et al. (2019), and Kato and Okoshi (2019) explores the impact of the AL principle on firms' decision of FDI, firms' incentive for tacit collusion, MNEs' choice of licensing, and an MNE's location choice of input production, respectively.[6] However, these papers do not explicitly relate product differentiation to ease of profit shifting.

One exception and the closest paper to the current paper is Okoshi (2021) which considers horizontal product differentiation rather than vertical differentiation. The former focuses on differentiation based on personal preferences such as tastes and designs whereas the latter targets differentiation with clear rankings such as quality.[7] Therefore, the current paper provides additional insights from the viewpoint of vertical investment. Moreover, the current paper introduces a local firm whereas Okoshi (2021) investigates interaction between two MNEs, which enables us to see the subsequent impact on a local firm.

Second strand of related literature is ones to explore the optimal policy with endogenous choices of vertical product differentiation. Zhou et al. (2002) construct a third-country-market model with two firms from different two countries and analyse the optimal policies from the perspective of "strategic trade policy" discussion. Toshimitsu (2003) also analyzes the optimal policy in closed economy with different competition, namely, Bertrand versus Cournot competition, and concludes that a subsidy for R&D is socially optimal under Bertand competition whereas a tax is the optimal policy under Cournot. However, these papers ignore tax avoidance of MNEs, and thus it is impossible to draw conclusions with tax avoidance properties.

The rest of the paper is organized as follow. The next section explains the model and derives the equilibrium without profit shifting. Section 3 introduces a tax haven while section 4 explores welfare analysis. Our benchmark analysis assume Bertrand competition and section 5 extends the model into Cournot compeition. The last section concludes.

2 Model

We begin with our analysis without profit shifting which is introduced in the next section. Consider a domestic country (country D) with three sectors: heterogeneous sector (sector X), homogeneous

[6]There are other policies or international cooperation to prevent MNEs from shifting profits across countries. For example, Nielsen et al. (2010) analyse "separate accounting" and "formula apportionment", Haufler et al. (2018) explore controlled foreign company rules, and Gresik et al. (2017) considers "safe habor rules" and "earning stripping rules".

[7]For example, Lin and Saggi (2002) investigate endogenous decision on horizontal R&D.

sector (sector Y), and public sector (sector G). The heterogeneous sector is characterised by duopoly market structure with one local and one multinational firm, labelled firm L and M while the homogeneous sector is assumed to be perfectly competitive market. The public sector is provided by the government.

Government The government provides public good by using tax revenues in the country. Note that sector Y is perfect competitive and there are no tax base in the sector whereas sector X is characterised by duopoly and tax base arises. To collect tax revenue TR, the government levies an exogenously given positive tax rate t_D on the tax base. Let G be the amount of public good provision. Then, the amount of public good is equal to tax revenue, that is, $G = TR$.

Consumers Consumers are vertically differentiated in their preference on product quality in sector X. As in the extant literature, we assume that each consumer purchases either one or zero unit of vertically differentiated, or different quality products. Specifically, their type is characterized by $\theta \in [0, 1]$, and associated with the following utility function;

$$u(\theta, q_i) = \theta q_i \tag{1}$$

where $q_i \in [0, \infty)$ is the level of quality that firm i produces.

The utility function yields the following net utility from consumption of product i,

$$V(\theta, q_i, p_i) = \theta q_i - p_i, \tag{2}$$

where p_i is the price of product i. As consumers have their one-dimension quality preference θ, we can derive a unique threshold that all consumers with larger θ buy high quality product. As explained later, let us assume that firm M produces higher quality good than firm L, that is, $q_M > q_L$ holds. Then, the marginal consumer to for the high quality good is,

$$V(\theta, q_M, p_M) \geq V(\theta, q_L, p_L), \iff \theta \geq \frac{p_M - p_L}{q_M - q_L} \equiv \theta_M. \tag{3}$$

Analogously, we obtain the threshold for low quality good against the non-purchase option as follows,

$$V(\theta, q_L, p_L) \geq 0 \iff \theta \geq \frac{p_L}{q_L} \equiv \theta_L. \tag{4}$$

These two information immediately provides us with the following demand function,

$$x_M = 1 - \theta_M = 1 - \frac{p_M - p_L}{q_M - q_L}, \quad \text{and} \quad x_L = \theta_M - \theta_L = \frac{p_M - p_L}{q_M - q_L} - \frac{p_L}{q_L}. \tag{5}$$

Consumers own the firms and the their income I consists of post-tax profits of the firms in sector X. For simplicity, we assume that all consumers have enough income to purchase one differentiated good if they want it. All the remaining incomes after purchase of differentiated good is used for consumption of the homogeneous goods. We use sector Y as a numeraire sector and the price of the homogeneous good is unity. Therefore, the total consumption of the homogeneous goods is $\widehat{y} = I - p_M x_M - p_L x_L$, where I represents total individual income equal to firms' net profits.

Consumers are also gains from public goods provision. The aggregate utility, or welfare, in country D is,

$$W = \int_{\theta_L}^{\theta_M} u(\theta, q_L) - p_L d\theta + \int_{\theta_M}^{1} u(\theta, q_M) - p_M d\theta + \Pi_M + \Pi_L + \beta G, \tag{6}$$

where Π_i is post-tax net profits of firm i, and β is preference parameter of the public good.

Firms The two firms produce vertically differentiated product to consumers in country D. To focus on tax avoidance channel, both firms produce their goods with zero constant marginal cost $c = 0$ while their level of quality differs. In particular, we assume that the MNE produces higher quality product than the local firm, $q_M > q_L$.[8] This is because as the MNE has an opportunity for tax avoidance and the fraction of operating profits is greater for the MNE than the local firm, the MNE's budged for R&D investment is larger.

The levels of their quality is endogenously detemined by R&D activities. Let q_i be the investment level for quality and the resulting quality level of firm i. The investment cost is $F(q_i)$ with the following set of standard assumptions for the existence and uniqueness of the equilibrium: $F'(q_i) > 0$, $F''(q_i) > 0$, $F'''(q_i) \geq 0$, $F'(0) = 0$ and $F'(\infty) = \infty$. Given the differentiation levels, the firms determine an amount of supplies and make operating profits which are denoted by π_i.

The sequence of the game is as follow. At the first stage, both firms decide the investment level. Given the quality investment level, firms compete in a Bertrand fashion and make operating profits. At each stage, their decisions are made simultaneously. We solve the two stage game by backward

[8]One might concern that it is natural to assume producing high quality goods entails larger cost. However, as MNEs tend to be more productive than national firms, it is possible that both types of firms have the same/similar marginal costs.

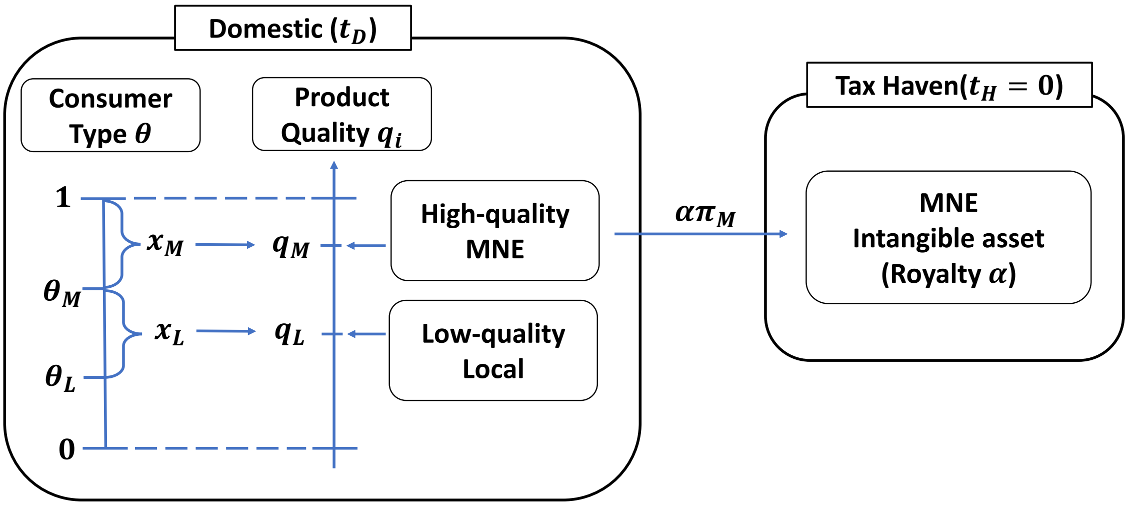

Figure 1: Model

induction. We begin the analysis without tax haven in this section and introduce a tax haven where the MNE owns a shell company and shifts some profits. The model is illustrated with Figure 1.

2.1 Equilibrium in Benchmark case

From eq.(5), firm i maximizes the following operating profits by choosing price p_i

$$\pi_M = p_M\left(1 - \frac{p_M - p_L}{q_M - q_L}\right), \qquad \text{and} \qquad \pi_L = p_L\left(\frac{p_M - p_L}{q_M - q_L} - \frac{p_L}{q_L}\right).$$

By the first order conditions, we obtain the following optimal prices,

$$p_M = \frac{2(q_M - q_L)q_M}{4q_M - q_L}, \qquad \text{and} \qquad p_L = \frac{q_L(q_M - q_L)}{4q_M - q_L}, \tag{7}$$

and the consequent operating profits of the firms are,

$$\pi_M = \frac{4(q_M - q_L)q_M^2}{(4q_M - q_L)^2}, \quad \text{and} \quad \pi_L = \frac{(q_M - q_L)q_M q_L}{(4q_M - q_L)^2}. \tag{8}$$

As known in the literature, $\frac{\partial \pi_M}{\partial q_M} > 0$ always holds, which means that a firm producing high-quality goods has an incentive to invest in quality upgrading to mitigate price competition. In addition, $\frac{\partial \pi_L}{\partial q_L} > 0$ holds if and only if $q_M > \frac{7q_L}{4}$ holds. This is because quality upgrading for a low-quality firm has two conflicting effects. On the one hand, quality upgrade increases consumers' willingness to pay for the good, and thus the low-quality firm can increase its price. On the other hand, narrower quality gap intensifies competition against the high-quality firm. Therefore, the low-quality firm has an incentive to upgrade its product when the quality gap is wide and the first effect dominates the latter. Following the extant literature, we assume $q_M > \frac{7q_L}{4}$ throughout the analysis.

After the price decision, both firms determine their investment level by incurring investment cost $F(q_i)$. Note that they also have to pay corporate tax, and the maximands are,

$$\Pi_M = (1 - t_D)\pi_M - F(q_M), \tag{9}$$

$$\Pi_L = (1 - t_D)\pi_L - F(q_L). \tag{10}$$

Let (q_M^*, q_L^*) be the equilibrium pair of qualities, and then they satisfy the following first order conditions,

$$\frac{\partial \Pi_M}{\partial q_M} = (1 - t_D)\frac{\partial \pi_M}{\partial q_M} - F'(q_M) = 0, \tag{11}$$

$$\frac{\partial \Pi_L}{\partial q_L} = (1 - t_D)\frac{\partial \pi_L}{\partial q_L} - F'(q_L) = 0. \tag{12}$$

This first order condition shows that the optimal investment qualities are based on tax-adjusted marginal gain from investment and marginal cost of investment. As $\pi_M > \pi$ holds, we can easily confirm $q_M^* > q_L^*$.

3 Tax havens

This section introduces tax haven (country H) which imposes low corporate tax which are assumed to be zero $t_H = 0$ following the extant literature. As firm M makes greater net profits than firm L, the firm is able to establish its shell company in country H and engage in tax avoidance.

Profit shifting is conducted via royalty payments of patent technology. The MNE owns the firm-specific technology as a result of R&D activities. The property right of the technology is relocated in the shell company and collect royalty revenue by licensing the technology with the royalty rate.[9] Specifically, let $\alpha \in [0, 1]$ be transfer price on intangible assets, namely royalty rate, and hence firm M can shift profits to $\alpha\pi_M$.[10]

Profit shifting arises costs to justify their decision on transfer pricing, and the cost is known as

[9]This pattern of relocating property rights into a low tax country is empirically supported. See, for example, Dischinger and Riedel (2011), Karkinsky and Riedel (2012), and Griffith et al. (2014).

[10]This type of royalty is known as ad-valorem royalty, and this is one of the most frequently used ways. For empirical evidence, see San Martín and Saracho (2010). In the context of profit shifting, Choi et al. (2019) also use this method in their theoretical analysis.

concealment costs in the literature. For example, concealment costs include wage and rewards to hire experts such as lawyers and consultant staffs to make documents for transfer pricing regulations. As justifying transfer pricing gets more difficult as the firm tries to shift more profits, rewards to the experts must increase to give them incentives to exert efforts.[11] To reflect the nature, this paper introduces the following form of concealment costs,

$$C(\eta, \alpha) = \frac{\eta \alpha^2 \pi_M}{2} \tag{13}$$

where η is a measure of difficulty of profit shifting.

We modify the concealment cost by introducing quality difference based on the property of the AL principle. As argued in Introduction, it is difficult for tax authorities to find proper AL prices, and thus the cost of profit shifting gets larger.[12] To reflect this property, we decompose η into two elements: the enforcement level of transfer pricing ϕ and the difference of qualities of the goods $(q_M - q_L)$. For simplicity, η is assumed to be $\eta = \frac{\phi}{q_M - q_L}$. This specification means that larger ϕ represents stricter enforcement of international cooperation such as BEPS project, whereas wider quality gap makes applications of the AL principle more difficult and profit shifting becomes easier.[13]

3.1 Equilibrium with tax haven

Given the concealment cost, the stage game is modified by adding profit shifting phase in the last stage. In the stage, firm M determines α to maximize the following post-tax profits,

$$\Pi_M^T = (1 - t_D)(\pi_M - \alpha \pi_M) + (1 - t_H)\alpha \pi_M - F(q_M) - \frac{\eta \alpha^2 \pi_M}{2},$$

which yields the following optimal transfer price,

$$\widehat{\alpha} = \frac{t_D}{\eta} = \frac{(q_M - q_L)t_D}{\phi}. \tag{14}$$

[11] Alternatively, concealment costs can be interpreted as the expected penalties because of being audited by tax authorities.

[12] In reality, tax authorities frequently rely on Transactional Net Margin Method to audit tax avoidance. Under the method, tax authorities compare an MNE's profit level indicator such as a ratio of net profit to an appropriate case with reference firms one. Thus, we can also interpret wider quality gap as less plausibility that the low-quality firm is chosen as reliable reference firm.

[13] In the paper, we do not endogenize the enforcement level of regulation by a government. See Hindriks and Nishimura (2021) for the endogenous choice of regulation.

The optimal transfer price increases if tax rate in country D is higher because the benefits from tax avoidance is greater. In contrast, the optimal transfer price decreases if transfer mispricing is hard either stronger tax enforcement (larger ϕ) or narrower quality gap (smaller $q_M - q_L$).

By substituting the optimal transfer price, the equilibrium post-tax profits of firm M is,

$$\Pi_M^T = \left(1 - t_D + \underbrace{\frac{(q_M - q_L)t_D^2}{2\phi}}_{\text{Tax saving gains}}\right) \pi_M - F(q_M), \tag{15}$$

whereas the maximand of firm L is the same as eq.(10). The new post-tax profits of firm M has an additional term in the parenthesis which captures tax saving gains. Due to the new term, the first order condition for the MNE's quality decision is also modified as follows,

$$\frac{\partial \Pi_M^T}{\partial q_M} = (1 - t_D)\frac{\partial \pi_M}{\partial q_M} + \underbrace{\frac{(q_M - q_L)t_D^2}{2\phi}\frac{\partial \pi_M}{\partial q_M}}_{\text{Profit shifting gains}} + \underbrace{\frac{t_D^2}{2\phi}\pi_M}_{\text{Differentiation gains}} - F'(q_M) = 0. \tag{16}$$

The second term in the above equation capture an additional incentive for quality upgrading because more operating profits remain in the firm. We refer this gains to "profit shifting gains". The third term captures the gains from wider quality gap to make profit shifting less costly, which is referred as "differentiation gains". These two additional gains clearly increase the investment of the MNE. Let q_i^T be the equilibrium quality level of firm i. Then, $q_M^T > q_M^*$ holds.

Given the higher new quality of the MNE, we can also see quality upgrading for firm L. This is because an increase in quality of the MNE mitigates market competition, and thus results in greater operating profits of firm L, or $\frac{\partial \pi_L}{\partial q_M} > 0$. Hence, we obtain $q_L^T > q_L^*$.

The following proposition summarizes the above argument.

Proposition 1. The opportunities of profit shifting upgrades the quality of both high and low quality goods. That is, $q_M^* < q_M^T$ and $q_L^* < q_L^T$ hold.

This proposition is in line with and provide a new rationale for the observed fact argued in Introduction. In the literature of international trade, reduction in trade costs such as lower tariff or transportation costs leads to quality upgrading. Our model indicates observed quality upgrading is promoted by growing opportunities of tax avoidance. Note that our price competition model suggests that quality upgrading spillovers to local firm as well.[14]

[14]Under Cournot competition, as we will see in section 5, this spillover effect does not hold because quality is strategic substitute in the case. However, an industry-wide increase in R&D investments is possible because the magnitude of tax

The core mechanism of the proposition is similar to findings of Toshimitsu (2003) that considers firm specific policy. In his paper, firm-specific policy is considered, and subsidising a high-quality firm results in quality upgrading in both firms under Bertrand competition. In our model, the chance of tax avoidance works as if it is the high-quality firm-specific R&D subsidy.

It is also noteworthy that the differentiation gains arise because of the AL principle. If the AL principle is not introduced, the MNE does not link profit shifting and product differentiation. However, with the AL principle, firm-specific technology or property of goods are important factor for tax authority to audit tax avoidance behaviour, and thus the MNE is more eager to engage in R&D investments. In sum, the MNE's R&D investment are associated with how OECD design the transfer pricing guideline.[15]

4 Policies and welfare

Tax authority usually concerns about tax revenue and exert effort to audit tax avoidance by MNEs but R&D policies designed by a government often target welfare maximization. This section aims at exploring how transfer pricing regulation and R&D policy interact by considering effects of policies on tax revenues and weighted total welfare.

Following Toshimitsu (2003), the government offers the R&D policy such that the government pays $s(\in [-1, 1])$ portion of R&D costs to firm i as subsidy. If s is negative, the policy represents R&D tax. The subsidy is financed by tax revenues in the industry.

Consumer surplus We can formulate consumer surplus as follows,

$$CS = \int_{\theta_L}^{\theta_M} \theta q_L - p_L d\theta + \int_{\theta_M}^{1} \theta q_M - p_L d\theta = \frac{q_M^2(4q_M + 5q_L)}{2(4q_M - q_L)^2}. \tag{17}$$

With the assumption $q_M > \frac{7q_L}{4}$, $\frac{\partial CS}{\partial q_i} > 0$ holds. Therefore, policies stimulating quality upgrading benefits consumers. As this benefit is ignored by firms, this is one reason why a government needs to subsidize firms.

avoidance directly influences the MNE and hence an increase in the MNE's investment dominates that of the local firm. See section 5 and appendix A more in detail.

[15]For example, the gains disappear if countries adopt formula apportionment. Formula apportionment splits the total operating profits of MNEs based on the share of economic activities of an MNE based on sales, capital and/or payrolls.

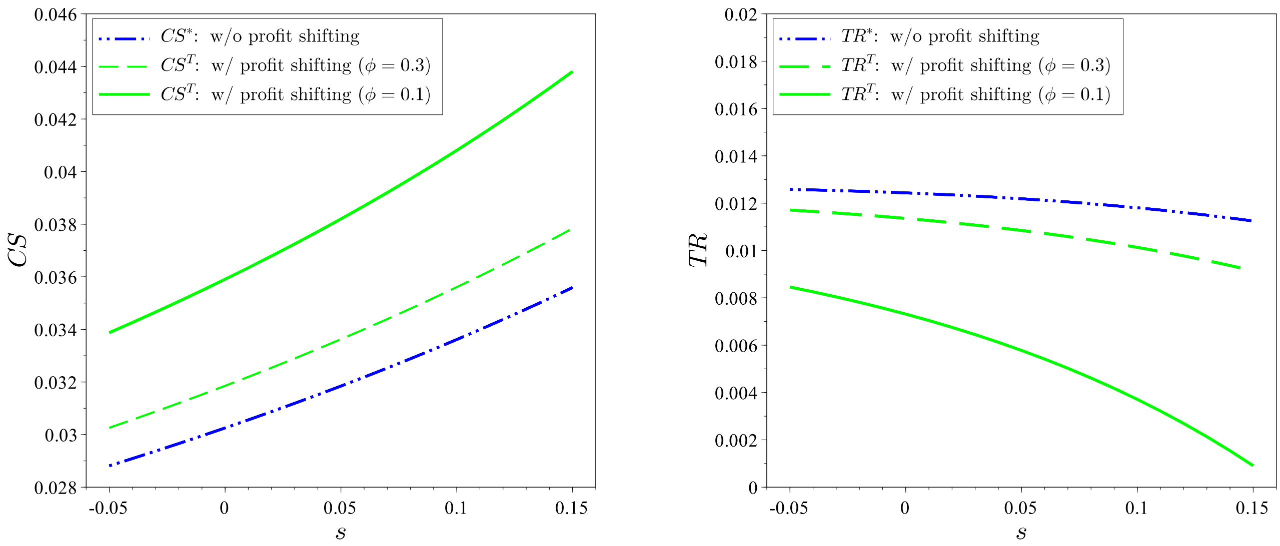

Figure 2: Consumer surplus and tax revenue

Tax revenue The tax revenues are computed as,

$$TR = t_D \left\{ \left(1 - \frac{t_D(q_M - q_L)}{\phi} \right) \pi_M + \pi_L \right\} - sF(q_M) - sF(q_L). \tag{18}$$

Quality upgrading driven by the opportunities of tax avoidance has three effects on tax revenue. First, operating profits of both firms increase due to less market competition. Second, however, such increases in R&D costs results in an increase in R&D subsidy which reduces tax revenue. Moreover, as the main tax avoidance influences the MNE whereas the local are impacted indirectly, the quality gap increases and the MNE's tax base are outflows more.

Figure 2 illustrates policy effects on consumers and tax revenue, respectively.[16] The left of Figure 2 shows the effect of subsidy on consumers whereas that on tax revenue is drawn in the right one. In each figure, three curves are depicted; the blue dotted one represents the case without profit shifting, and the green dashed- and solid curves show the case with profit shifting under different regulation levels.

From the left figure, we can also see the upward sloping curves, showing that R&D subsidy benefits consumers. Moreover, at any subsidy level, the solid curve is the highest among the three but the dotted curve locates at the bottom, which means that looser enforcement of transfer pricing regulation is beneficial for the consumers. This is intuitive as more opportunities of profit shifting

[16] We use the following parameter values: $t_D = 0.3$ and $F(q_i) = \frac{q_i^2}{2}$.

boosts R&D by both firms.

On tax revenue, the location of the three curves are completely reversed; the dotted lies at the top and the solid one is at the bottom. Hence, although profit shifting opportunities increases the operating profits of firms, the tax revenue decreases and stricter enforcement of transfer pricing regulation increases tax revenue at any level of R&D subsidy, as expected. In addition, due to the two negative effects, tax revenue decreases as the government provides more R&D subsidy.

4.1 Welfare analysis

As we saw, both policies work in line with expectations of policy makers, but at the same time make another welfare component worse. Hence, exploring welfare effect is important, which is the focus of this subsection.

Here, let us clarify welfare in country D. Based on eq.(6), welfare is rewritten as,

$$\begin{aligned} W = & \frac{q_L x_L(\theta_M + \theta_L)}{2} + \frac{q_M x_M(1+\theta_M)}{2} - \{F(q_M) + F(q_L)\} \\ & + \beta t_D \left[p_M x_M \left(\beta - 1 - \frac{t_D(q_M - q_L)(2\beta - 1)}{2\phi} \right) + p_L x_L(\beta - 1) \right] \end{aligned} \tag{19}$$

where the first line shows consumer surplus minus firm-burdened cost of investments, and the second line shows net-tax revenue.

Figures 3 and 4 provide numerical examples implying that the optimal R&D policy is to subsidize firms.[17] Without tax avoidance, as captured by the double-doted upward sloping curve shows welfare levels increases as R&D subsidy increases. As known in the literature such as Toshimitsu (2003), firms' investments are suboptimal because the gains for consumers are ignored when they determine the investment levels. We can also see this pattern of upward sloping even with profit shifting opportunities, but the slope becomes flatter and flatter as enforcement level becomes looser and looser. With stricter regulation, the optimal policy is still a subsidy whereas the curve under loose regulation is downward sloping, and thus the optimal policy is to tax R&D activities.

Next, given a fixed portion of subsidy s, let us consider the effect of stricter enforcement of transfer pricing regulation which is captured by an increase in ϕ. With a low s, tightening of the regulation worsens total welfare. This is because R&D investment under weak R&D policy is scarce and hence the negative effect of reduction in R&D activities due to stricter regulation dominates an

[17]We use the same parameter values as Figure 2. The only difference between the two figures are the values of β: $\beta = 1.2$ for Figure 3 and $\beta = 1.5$ for Figure 4.

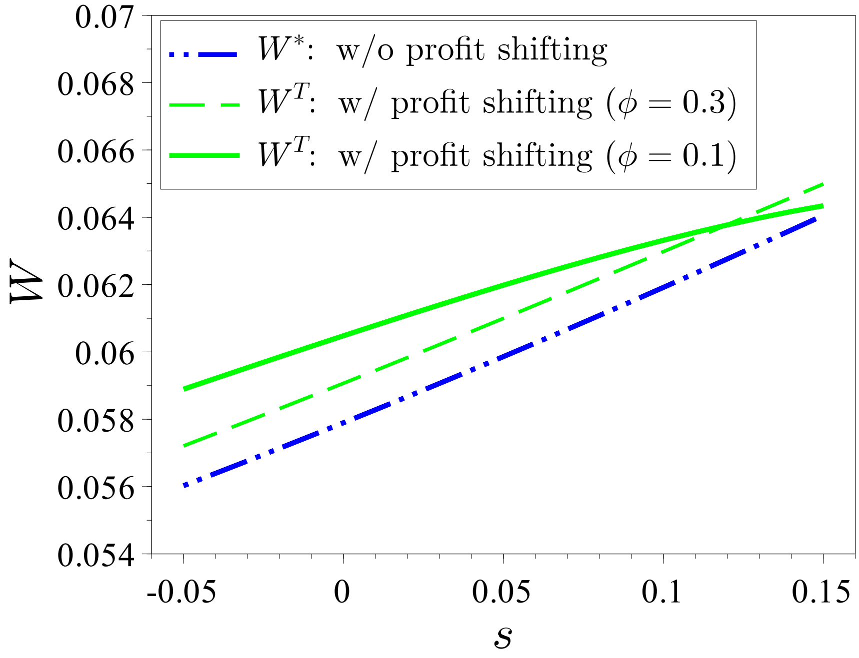

Figure 3: Welfare: $\beta = 1.2$

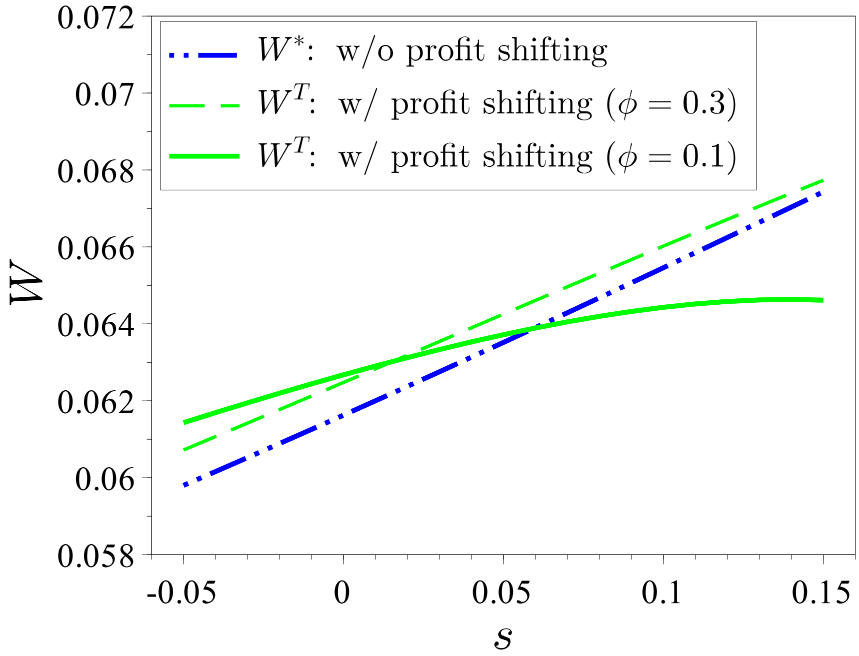

Figure 4: Welfare: $\beta = 1.5$

increase in tax revenue.

With a large s, however, the solid curve locates below the dashed curve, which implies that tightening the regulation could improve total welfare. Suppose that firms are well subsidized and the enforcement level is loose (low ϕ). This is the case that the ALP application is hard due to wider quality gap, and thus the MNE shifts much profits to a tax haven. Therefore, the main effect of stricter enforcement of transfer pricing regulation is to prevent outflows of the MNE's tax base. Even though tightening of the regulation under loose enforcement can be beneficial, this does not mean that the effect of stricter enforcement always improves total welfare as the dashed- and dotted-curves show.

Figure 4 is the case where the weight on public good or tax revenue is larger ($\beta = 1.5$). The figure shows that welfare level with profit shifting can be lower than that without profit shifting. This situation is an extreme but consistent story that traditional public finance literature claims. However, as the dashed curve again lies above the dotted curve, a slight chance of tax avoidance is beneficial by stimulating R&D activities and the effect of tightening the profit shifting regulation is non-monotone.

The above discussion is summarized as the following proposition.

Proposition 2. With a fixed subsidy for R&D activities, stricter enforcement of profit shifting regulation can improve total welfare under loose enforcement of regulation and large R&D subsidy. Otherwise, it reduces total welfare.

The proposition sheds a new light on transfer pricing regulation. Tax avoidance is widely recognized as undesirable because of less tax revenue and therefore tightening transfer pricing regulation such as BEPS project is regarded as desirable. However, it is well known that R&D investment is suboptimal and any policy to spur R&D investment is beneficial in the literature of industrial organization. Thus, the proposition shows the importance to consider firms' incentive to engage in investment in product differentiation when one evaluates the effect of the regulation.

Finally, it is notable to interpret ϕ related to globalisation. So far, we regard larger ϕ as stricter enforcement of transfer price regulation, and thus recent international corporation such as BEPS project tends to direct policy makers to design for subsidy. However, it is also possible that smaller ϕ as the measure of globalisation.[18] Therefore, given the huge negative effect of tax avoidance explained in the Introduction and the current trend of offering or competing in R&D subsidy policies such as patent box in European countries, the proposition indicates that globalisation under a larger

[18] This interpretation is also done by the extant literature. For example, see Haufler et al. (2008).

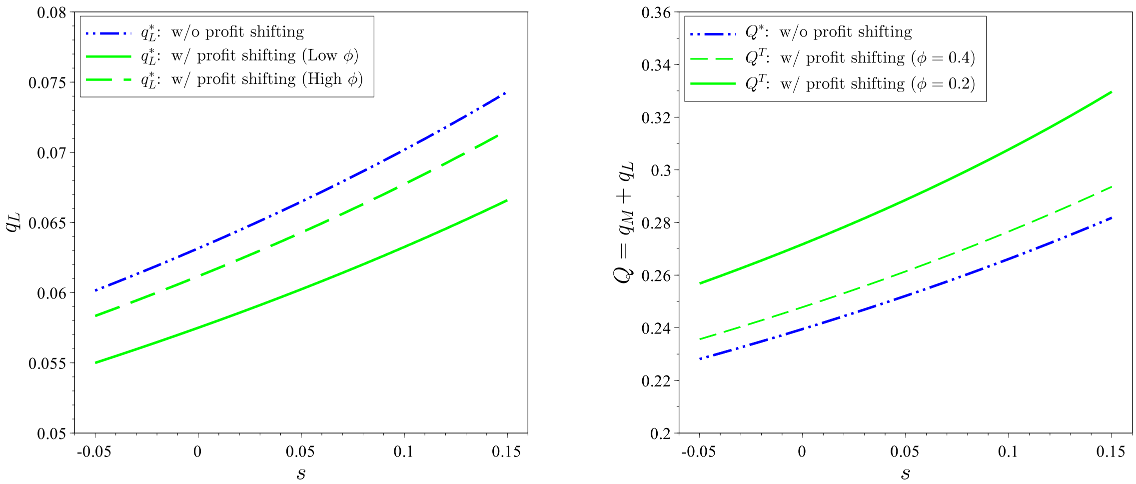

Figure 5: Optimal policy

R&D subsidy is likely to hurt the non-haven country.

5 Extension

In this section, we extend the basic model by assuming Cournot competition instead of Bertrand competition.

As in the benchmark model, the opportunities of tax avoidance magnify the MNE's gains from quality upgrading, and induces the MNE to engage more in R&D investment. This result holds under Cournot competition as well due to the two additional gains from quality upgrading, namely, profit shifting gains and differentiation gains. However, we obtain the opposite outcome on the quality choice of the local firm. This is because the quality choice is strategic substitute under Cournot competition but it is strategic complement under Bertrand competition. Therefore, the effect on the local firm heavily depends on the structure of the market competition.

Even with the opposite effect on the local firm, we can confirm an industry-wide increase in R&D activities thanks to the advent of tax haven. In appendix A, we derive the condition that tax haven leads to an increase in total R&D investment, which is $F''(q_L) > F_Q$. This means when the second derivative of the local firm's investment cost function is sufficiently large, the change in the local's R&D is small and hence an increase in the MNE's R&D likely dominates the reduction of the local firm's R&D investment. This result is in line with the current trend of growing R&D expenditure as introduced in the Introduction. The above discussion is illustrated by Figure 5, and is summarized in the following proposition.

Proposition 3. Under Cournot competition, the opportunities of tax avoidance promote the MNE to upgrade but the local to downgrade its quality. Moreover, an increase in industry-wide R&D investments in quality realizes if the local firm owns inefficient technologies, namely, $dQ \equiv dq_M + dq_L > 0$ holds if and only if $F''(q_L) > F_Q$ holds.
See appendix A.

6 Concluding remarks

Under globalisation, we have observed quality upgrading and tax avoidance in parallel. To prevent MNEs' profit shifting, countries have cooperated internationally such as stricter enforcement of transfer pricing regulation. However, due to the AL principle stipulated in the OECD guideline, ease of MNEs' transfer pricing seems related to product differentiation.

In this paper, we have revisited the effect of policy on R&D activities and enforcement of profit shifting regulation based on vertical product differentiation by introducing an MNE's tax avoidance behaviour. As an additional incentive to invest in quality arises with profit shifting, an MNE's quality upgrading is accelerated. Therefore, tax avoidance opportunities can be seen as an implicit R&D subsidy for MNEs.

Furthermore, the MNE's quality upgrading spillover to a local firm, and the effect varies depending on the market structure. Under the Bertrand competition, it leads to quality upgrading for the local firm as well. Under the Cournot competition, however, the tax avoidance chances discourages the local firm to invest in quality. This difference stems from the fact that quality choice is strategic complement under price competition but is strategic substitute under quantity competition. Although the impact on the local firm is different, an industry-wide increase in R&D investments is confirmed, which is observed in the current statistics.

Moreover, our numerical analysis shows that an increase in quality investment due to tax avoidance or R&D subsidy benefits firms and consumers whereas it decreases tax revenues. This provides us with a natural question: what is welfare effect of such policies. As known in literature of industrial organization, R&D activities are likely suboptimal due to ignorance of consumers gains. Hence, our results also support this view.

On the profit shifting regulation, we obtain two scenarios. On the one hand, stricter enforcement improves total welfare in a non-haven country when R&D subsidy is generous and the current enforcement of the regulation is loose. This is simply because outflows of the MNE's tax base is serious. On the other hand, tightening the regulation worsens total welfare otherwise. In such cases, R&D investment is much scarce and tightening the regulation shrinks the tax avoidance gains from R&D, which results in huge consumers' losses.

The contrasting result includes an important message in the globalised world. As R&D investment seems positively considered because it can result in economic growth, governments sometimes provides firms with subsidies such as patent box introduced in European countries. To improve welfare, our analysis shows that strengthening international corporation of transfer pricing regulation is essential.

Although the paper provides some new insights, there remain several directions of extensions. First, as governments sometimes compete for MNEs' R&D activities, it is important to introduce competition between governments. Second, as globalisation also induce firms to offshore upstream high-tech inputs, considering vertically related industries can be interesting. Moreover and more importantly, empirical investigation on the link between product differentiation and tax avoidance is essential.

Appendices

A Cournot competition

From eq.(5), we can derive the following inverse demand functions,

$$p_M = q_M(1 - x_M) - q_L x_L \quad \text{and} \quad p_L = q_L(1 - x_M - x_L). \tag{20}$$

Given the inverse demand functions, we derive the following equilibrium outcomes,

$$x_M = \frac{2q_M - q_L}{4q_M - q_L} \qquad \text{and} \qquad x_L = \frac{q_M}{4q_M - q_L}. \tag{21}$$

These outputs yield the following operating profits of firms,

$$\pi_M^C = \frac{q_M(2q_M - q_L)^2}{(4q_M - q_L)^2} \qquad \text{and} \qquad \pi_L^C = \frac{q_M^2 q_L}{(4q_M - q_L)^2}. \tag{22}$$

As the market structure does not affect the MNE's choice of tax avoidance, the objective functions are the same as eqs.(15) and eq.(10). This means quality upgrading for the MNE's product because the tax saving gains arises. For the local firm, however, the marginal gains from R&D investment decrease due to the MNE's quality upgrading as

$$\frac{\partial}{\partial q_M}\left(\frac{\partial \pi_L}{\partial q_L}\right) = -\frac{2q_L q_M(8q_M + q_L)}{(4q_M - q_L)^4} < 0 \tag{23}$$

holds. Thus, the profit shifting opportunity for the MNE upgrades the MNE's product but downgrades that of the local firm.

Next, to confirm the condition that an industry-wide increase in R&D investments happens, let define $Q \equiv q_M + q_L$ as the total R&D investments. As the opportunity of the MNE's tax avoidance directly and indirectly affects q_M and q_L, we need to compute,

$$dQ = dq_M + dq_L = dq_M\left(1 + \frac{dq_L}{dq_M}\right) \gtreqless 0. \tag{24}$$

As $dq_M > 0$ holds, we investigate whether the second term is positive.

By totally differentiating eq.(12) with respect to q_M, we have,

$$\begin{aligned}
&(1-t_D)\frac{\partial^2 \pi_L}{\partial q_L^2}dq_L + (1-t_D)\frac{\partial^2 \pi_L}{\partial q_M \partial q_L}dq_M - (1-s)F''(q_L)dq_L = 0\\
\iff\ &\frac{dq_L}{dq_M} = \frac{(1-t_D)\frac{\partial^2 \pi_L}{\partial q_M \partial q_L}}{(1-s)F''(q_L) - (1-t_D)\frac{\partial^2 \pi_L}{\partial q_L^2}}
\end{aligned} \tag{25}$$

and,

$$\begin{aligned}
&\frac{dq_L}{dq_M} = \frac{(1-t_D)\frac{\partial^2 \pi_L}{\partial q_M \partial q_L}}{(1-s)F''(q_L) - (1-t_D)\frac{\partial^2 \pi_L}{\partial q_L^2}} \gtreqless -1\\
\iff\ &F''(q_L) \gtreqless \frac{2(1-t_D)q_M(8q_M + q_L)(q_M + q_L)}{(1-s)(4q_M - q_L)^4} \equiv F_Q,
\end{aligned} \tag{26}$$

which means that $1 + \frac{dq_L}{dq_M} > 0$ holds if and only if $F''(q_L) > F_Q$ holds.

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