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Tax havens and cross-border licensing with transfer pricing regulation

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Abstract
Multinational enterprises (MNEs) have incentive to reduce tax payment through transfer pricing. The incentive is stronger when MNEs own intangibles, because it is easy to transfer them across countries. To mitigate such strategic tax planning, the OECD proposes the arm's length principle (ALP). This paper deals with technology patents as an example of intangibles and investigates how the ALP affects MNEs' licensing strategies and welfare in a model with a tax haven. The ALP may distort MNEs' licensing decisions, because providing a license to unrelated firms restricts MNEs' profit-shifting opportunities due to the emergence of comparable transaction. Interestingly, the termination of licensing in the presence of the ALP may worsen domestic welfare if the (potential) licensee and the MNE's subsidiary do not compete in the domestic market but may improve welfare if they compete. The results under ad valorem royalty are in distinct contrast with those under per-unit royalty.

Keywords Multinational enterprises · Intangibles · Licensing · Transfer pricing · Arm's length principle

JEL Classification D45 · F23 · H26 · L12

1 Introduction

It is well known that multinational enterprises (MNEs) take advantage of differences in corporate tax rates and preferential tax measures provided by various countries. In particular, it has been reported that MNEs often artificially shift their profits across countries to avoid taxation (Huizinga & Laeven, 2008; Egger et al., 2010; Zucman, 2014; Davies et al., 2018; Tørsløv et al., 2020). For example, according to

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the estimation of Tørsløv et al. (2020), more than $600 billion, which was close to 40% of multinational profits, was shifted to tax havens in 2015.[1] Such huge profit-shifting is basically conducted via "transfer pricing" of intra-firm transactions across countries which account for more than 60% of world trade. With respect to the prices of goods and services within a firm (i.e., transfer prices), there is no market mechanism. Thus, MNEs can manipulate transfer prices for tax planning.

The member countries of Organisation for Economic Co-operation and Development (OECD) have cooperated in efforts to tackle this problem by setting guidelines for transfer pricing and carrying out the Base Erosion and Profit Shifting (BEPS) project.[2] OECD (2017) stipulates

> When independent enterprises transact with each other, the conditions of their commercial and financial relations (e.g., the price of goods transferred or services provided and the conditions of the transfer or provision) ordinarily are determined by market forces. (Chapter I, p. 33)

These market-driven conditions are codified into the "arm's length principle (ALP)," which is found in Article 9 of the OECD Model Tax Convention. The ALP is the framework for bilateral treaties between not only OECD member countries but also many non-OECD countries. The application of ALP has received substantial attention in the context of international taxation.[3] In fact, three out of fifteen actions of the BEPS projects deal with issues on transfer pricing and action 8 particularly targets transfer pricing on intangible transactions based on ALP.[4]

As a method of exercising the ALP, the comparable uncontrolled price (CUP) method is considered ideal. It suggests that tax authorities audit tax avoidance behaviors by comparing the prices used in intra-firm transactions with those of similarly uncontrolled transactions between independent parties, i.e., arm's length prices (OECD, 2017).

Reality, unfortunately, is not as simple. In particular, it is very difficult to audit intra-firm transfers of intangibles because of the following ambiguous nature of intangibles.[5] First, it is easy to shift intangibles across countries without having a

[1] Tax havens include Ireland, the Netherlands, Luxembourg, Switzerland, Singapore, the Bahamas, Barbados, Bermuda, and the Cayman Islands, among others.

[2] The BEPS project was proposed by OECD in 2012 to limit the risk of tax avoidance by MNEs. In particular, 15 action plans were stipulated as international taxation rules. Currently over 135 countries and jurisdictions are collaborating on the implementation of the BEPS actions. For more detailed information, see the following web page: https://www.oecd.org/tax/beps/

[3] Many countries have taken the OECD's transfer pricing guidelines very seriously. In fact, some countries have renewed their law based on actions of the BEPS project. For example, Australia incorporated the OECD's transfer pricing guidelines in its transfer pricing law. Section 1 Foreign Tax Code in Germany defines the main aspects of the German interpretation of the ALP. The UK also has enacted the OECD guidelines in its law. For more details, see the following web site: https://www2.deloitte.com/global/en/pages/tax/articles/beps-action-implementation-matrices.html

[4] See https://www.oecd.org/tax/beps/beps-actions/action8-10/

[5] One of the most famous examples of profit-shifting through intangible assets is the "Double Irish with a Dutch Sandwich" conducted by Apple, Google, and Facebook, among others. It was reported that Google saved at least $3.7 billion in taxes in 2016 using this method (https://www.irishtimes.com/business/economy/double-irish-and-dutch-sandwich-saved-google-3-7bn-in-tax-in-2016-1.3343205).

substantial physical presence in transfer destinations. Thus, MNEs tend to locate their intangibles in tax havens to minimize their tax payments.[6] For instance, profits shifted to Ireland via royalties accounted for approximately 23% of Ireland's annual GDP between 2010 and 2015.[7] Second and more importantly, finding appropriate fees or royalties for intangibles is difficult. As pointed out by the OECD (2017), "Tax administrations should not automatically assume that associated enterprises have sought to manipulate their profits. There may be a genuine difficulty in accurately determining a market price in the absence of market forces or when adopting a particular commercial strategy."

In the case of transactions of intangibles, therefore, it is difficult to apply the CUP method.[8] In practice, practitioners heavily rely on a different method called the transactional net margin (TNM) method because of its ease of use.[9] According to the US Internal Revenue Service, the most frequently used transfer pricing method for both the sales of tangibles and intangibles in advance pricing agreements (APAs) is the comparable profits method or the TNM method, which accounted for 89% in 2016.[10] The Agency, Japan also reports that the share of the TNM method in mutual agreement procedures closed during the 2019 operation year was 59%.[11] Despite the fact that different methods of the ALP are used, the extant literature ignores how MNEs determine their transfer pricing via intangible assets under different methods of the ALP.

Against this background, we theoretically explore the relationship between the ALP and MNEs' technology transfers through patent licensing. Specifically, we investigate how the ALP affects MNE's licensing strategy and welfare in the presence of a tax haven. On one hand, if the MNE decides to license its technology to unrelated firms, then a comparable transaction appears, and the CUP method becomes applicable. Thus, the MNE needs to set the same royalty for both related and unrelated parties. On the other hand, if the MNE transfers its technology only internally, then there is no comparable transaction and the tax authority relies on the TNM method. When making a licensing decision, the MNE faces a trade-off between the license revenues from the unrelated parties and the greater opportunity for profit-shifting to a tax haven via transfer pricing. Although the MNE always

[6] For empirical evidence of location choices for intangible assets, see Dischinger and Riedel (2011), Karkinsky and Riedel (2012), and Griffith et al. (2014), among others.

[7] See the Financial Times (https://www.ft.com/content/d6a75b56-215b-11e8-a895-1ba1f72c2c11).

[8] In the case of intangibles, the CUP method is often called the comparable uncontrolled transaction method.

[9] The TNM method is explained in Sect. 2.3. The OECD proposes three different additional methods of exercising the ALP: the cost plus method, the resale price method, and the transactional profit split method.

[10] An APA is a prior agreement between a tax payer and tax authorities on the method of calculating arm's length prices for transactions between the taxpayer and its related parties. For details, see https://www.irs.gov/irb/2017-15_IRB. The comparable profits method is mainly used in the U.S. to calculate appropriate transfer prices. Basically, these two methods are the same, with the only difference being that the TNM method deals with investigations based on transaction units, whereas the comparable profits method investigates firm-level transactions.

[11] See https://www.nta.go.jp/english/MAP-Report/2020.pdf.

licenses its technology to the local firm without the ALP, the MNE may terminate technology patent with the ALP when tax avoidance opportunity under TNM method is huge or licensing revenues from the local firm are small. Thus, the very presence of the ALP may affect the MNE's licensing decisions and welfare.

We contribute to transfer pricing literature by capturing this aspect of profit-shifting using intangibles. We explicitly model the determination of transfer prices according to the ALP and show that the ALP increases tax revenues while potentially harming consumers. As a result, the ALP can worsen economic welfare.[12] Specifically, we demonstrate that the mechanisms of the negative impacts depend on the market structure. If the MNE and the local firm do not compete in the final-good market, the ALP can deteriorate domestic welfare when the MNE does not license its technology because the local firm's production improvement is not realized. If the MNE and the local firm compete in the market, however, the ALP can decrease domestic welfare when the MNE licenses its patent to the local firm.[13] This is because the MNE produces less to increase the local firm's revenues and consequently larger MNE's revenues in a tax haven via licensing revenues from the local firm. These results indicate market competition plays a critical role in determining welfare impacts.

Many studies about patent licensing have assumed licensing either by means of a per-unit royalty or a fixed fee alone. However, as documented by San Martin and Saracho (2010), most license contracts have adopted the ad valorem scheme for royalty payments instead of a per-unit royalty or a fixed fee. In our analysis, therefore, we focus on ad valorem royalties as licensing payments. Moreover, despite the fact that licensing improves production costs, the interaction between patent licensing and the market has been largely overlooked, because extant literature has often considered only perfectly competitive markets. Our model of imperfect competition can capture this interaction.

Furthermore, we examine the case of per-unit royalty to emphasize transfer pricing under different modes of royalty. We show that the results in the case of an ad valorem royalty contrast strikingly with those in the case of a per-unit royalty. Without market competition between the MNE and the local firm, the ALP resulting in no licensing can worsen domestic welfare because of smaller consumer surplus in the case of an ad valorem royalty. However, such ALP benefits the domestic country in the case of a per-unit royalty because the effective marginal cost for the local firm remains the same and there is no impact on consumer surplus. Moreover, with market interaction between firms, the ALP leading to no licensing benefits consumers in the case of an ad valorem royalty whereas it harms consumers in the case of

[12] Behrens et al. (2014) and Choi et al. (2020) also show that transfer pricing regulations may harm consumers and worsen welfare in different contexts.

[13] We observe a number of cross-border licensing within an industry. For example, Fujifilm Corporation licensed its technology to produce antiviral drug called Avigan to an Indian and a UAE's pharmaceutical company, Dr. Reddy's Laboratories Ltd. and Global Response Aid in 2020. In addition, in 2021, Novavax Inc and Takeda Pharmaceutical Company Ltd. concluded their contract on the use of intellectual property rights for the production of vaccination of COVID-19. Ishikawa & Okubo (2013) also list many other examples of cross-border licensing to rival firms. For example, Samsung Electronics Co. Ltd. used to enter a lot of licensing contracts with Japanese and European firms.

a per-unit royalty. The reason of consumer-hurting ALP under a per-unit royalty is that the ALP ending up with TNM method removes the MNE's strategic use of royalty setting which induces the MNE to produce more. These results also imply that welfare effect of the ALP depends on the type of royalty choice as well.

Currently, the ALP is the international transfer pricing regulation to which both OECD and non-OECD member countries have agreed. However, theoretical studies which basically focus on transfer pricing regulation itself are rather limited (Samuelson, 1982; Raimondos-Møller & Scharf, 2002; Bauer & Langenmayr, 2013; Choe & Matsushima, 2013; Keuschnigg & Devereux, 2013; Behrens et al., 2014; Choi et al., 2018, 2020) and the most of them are concerned with only the CUP method.[14] Additionally, the theoretical analysis of profit-shifting via intangibles has to date been limited only a few studies, including those of Juranek et al. (2018), Juranek et al. (2018), and Hopland et al. (2019). They incorporated royalty payments in their analysis but they did not consider licensing to external firms. Hence, the choice between the CUP and the TNM method, which is the focus of our analysis, was not investigated. To our knowledge, the TNM method has never been dealt with in the theoretical literature on transfer pricing.

The rest of the paper is organized as follows. Section 2 presents a basic setup with licensing by means of ad valorem royalties and analyzes how the ALP (i.e., the CUP and TNM methods) affects MNEs' incentives to licensing in the presence of a tax haven. In the basic model, the good produced by the licensee is not substitutable with the good produced by the MNE. Section 3 explores the effects of the ALP on domestic welfare with a tax haven. Section 4 extends the basic model to examine substitutability of the goods. Section 5 considers the case of per-unit royalty and makes a comparison. Section 6 concludes the paper.

2 Basic model

Consider the world composed of a domestic country, a foreign country, and another foreign country, labeled D, F, and H, respectively. Country H is a tax haven. Its corporate tax rate is lower than that of country D and is normalized to zero. We assume for simplicity that there is no source tax on royalty payments.[15] There is a single MNE, the headquarters of which is located in country F . There is a single local firm (called firm Y) in country D. Firm X, a subsidiary of the MNE located in country D, and firm Y, respectively, produce goods X and Y. The two goods are independent and not substitutable.[16] Each firm is a monopolist in country D. Because we are primarily interested in the MNE's profit-shifting from the domestic country to the tax haven and the domestic welfare consequences of introducing the ALP, we assume

[14] Transfer pricing of tangibles has also been explored from different aspects. See Schjelderup and Sørgard (1997), Auerbach and Devereux (2018), Mukunoki and Okoshi (2021), and Kato and Okoshi (2022), for example. Studies that explore actions of the BEPS project other than transfer pricing include Gresik et al. (2017), Haufler et al. (2018), and Agrawal (2021), among others.

[15] For example, royalty payments within the EU are exempted from the source tax.

[16] In Sect. 4, we consider the case in which the goods are substitutes.

that both goods are consumed only in country D. MNE's decision making on both the transfer price and production is centralized.[17]

On production costs, there is no fixed cost (FC) and the original marginal cost (MC) of producing good i $(i = X, Y)$ is c_i. The MNE owns a technology patent which can reduce MCs. Although the two goods are not substitutes, the patented technology is assumed to be applied to the production of both goods. With the patent, each firm can reduce its MC from c_i to zero. Thus, firm X's MC is always zero, whereas firm Y's MC is zero only when the patent is granted to the local firm. We assume that the licensing contract is by means of ad valorem royalties on revenue basis. The MNE offers ad valorem royalties r_x for internal licensing (i.e., licensing to firm X) and r_y for external licensing (i.e., licensing to firm Y), respectively.

Let π_{ic} denote the monopoly profits when MC of good i $(i = X, Y)$ with its MC c_i. Since the internal licensing always occurs, firm X 's profits are always π_{x0}. Firm Y's profits depend on whether licensing takes place or not. The profits are π_{yc} without licensing and π_{y0} with licensing, respectively.

We solve the following three-stage game. In the first stage, the MNE determines its internal and external royalty rates. The MNE specifically makes a take-it-or-leave-it offer to firm Y.[18] After observing the royalty rates, firm Y decides whether to accept the license contract. Finally, firms X and Y produce and supply their products in country D.

2.1 The benchmark case: without a tax haven

To clarify the effects of a tax haven and the ALP, this subsection analyzes the case without the tax haven. We assume that the domestic corporate tax rate, t, and the foreign corporate tax rate are the same.[19]

The MNE has a patent which reduces MC from c_i to 0. Therefore, the subsidiary's MC is always 0, whereas the local firm's MC is either c_y or 0. If the MNE grants a license to the local firm, the local firm pays a license fee to the MNE. The royalty rate of the license is $r_y \in [0, 1]$. Formally, the post-tax profits can be written as

$$\Pi_M = (1 - t)(\pi_{x0} + \lambda r_y \pi_{y0}), \tag{1}$$

$$\Pi_y = (1 - t)\{\lambda(1 - r_y)\pi_{y0} + (1 - \lambda)\pi_{yc}\}, \tag{2}$$

[17] According to practitioners, decision making on transfer pricing is centralized in almost all the MNEs in Western countries. See (Mori (2014), p.410).

[18] Our qualitative results do not depend on the MNE's full bargaining power assumption. If the licensee has some bargaining power, the royalty rate would be lower and the MNE will have less incentives to license its technology. Nonetheless, the overall qualitative effects would be intact. In addition, if the licensing contract is a two-part tariff, the bargaining power by the licensee will only affect the lump-sum component and the royalty rate would be the same independent of the relative bargaining power of the MNE and the local firm.

[19] Even if the foreign tax rate is higher than the domestic one, the analysis in this subsection would not change with the assumption that the MNE establishes a shell company in the domestic country and transfers its patent to the shell company.

where λ is a binary variable which takes one if the external licensing arises and zero otherwise.[20] It should be noted that a change in t does not affect output levels.

Given Eq. (2), the local firm accepts the licensing offer if and only if

$$\Pi_y\Big|_{\lambda=1} \geq \Pi_y\Big|_{\lambda=0} \iff r_y \leq 1 - \frac{\pi_{yc}}{\pi_{y0}} = \frac{\Omega}{\pi_{y0}}, \tag{3}$$

where $\Omega \equiv \pi_{y0} - \pi_{yc} > 0$. Since the two firms do not interact in the markets, the MNE is always willing to license its technology to the local firm. From Eq. (1), it is always optimal for the MNE to obtain license revenues by setting the highest royalty subject to Eq. (3), $r_y = \Omega/\pi_{y0} \equiv r_y^*(< 1)$. In other words, the MNE will set the royalty rate such that license revenues equal Ω.

In equilibrium, the post-tax profits become

$$\Pi_M^* = (1-t)\left(\pi_{x0} + \Omega\right) \text{ and } \quad \Pi_y^* = (1-t)(1-r_y^*)\pi_{y0} = (1-t)\pi_{yc}. \tag{4}$$

As seen in the above equation, the optimal license contract makes the local firm indifferent between with and without licensing.

2.2 A tax haven without the ALP

We now introduce a tax haven into the analysis. We assume that the MNE establishes a shell company, firm S, in country H without any cost. Obviously, transferring the patent to the shell company is the optimal strategy for the MNE, because it can make more profits in the tax haven not only by profit-shifting from firm X but also by license revenues from firm Y. We assume for simplicity that the headquarters transfers the patent to the shell company free of charge.[21] The profits of the MNE and firm Y are, respectively, given by

$$\Pi_M^{TH} = (1-t)(1-r_x^{TH})\pi_{x0} + r_x^{TH}\pi_{x0} + r_y^{TH}\pi_{y0},$$
$$\Pi_y^{TH} = (1-t)(1-r_y^{TH})\pi_{y0},$$

where the first term of Π_M^{TH} is the post-tax profits of firm X and the second and third terms are the license revenues from firms X and Y recorded in country H.

We first consider the case without the ALP. In this case, the MNE can set ad valorem royalties without any constraint. The optimal royalty rate is one with which all profits of firm X are shifted to firm S. Thus, $r_x^{*TH} = 1$, whereas the arm's length royalty rate is the same as the benchmark case (i.e., $r_y^{*TH} = r_y^*$).

[20] In the presence of the external licensing, π_{y0} equals firm Y 's revenues because there is no FC for production.

[21] In reality, it is often observed that intellectual property rights (IPRs) are transferred within a firm free of charge or at low prices. For example, when Google used a tax avoidance scheme, the Double Irish with a Dutch Sandwich, the headquarters transferred its IPRs to its Irish subsidiary at an extremely low price (see Saez and Zucman, 2019).

As a result, we obtain the same licensing strategy as the benchmark case in equilibrium. This is because the country where the MNE reports the tax base simply changes from country D to country H. Because the corporate tax is proportionally imposed on the profits, the tax rates never affect the licensing strategy. Therefore, the post-tax profits are computed as

$$\Pi_M^{*TH} = \pi_{x0} + \Omega, \quad \text{and} \quad \Pi_y^{*TH} = (1-t)\pi_{yc}\left(= \Pi_y^*\right). \tag{5}$$

2.3 A tax haven with the ALP

Finally, we investigate the effect of the ALP in the presence of a tax haven. The ALP restricts the MNE's profit-shifting strategy through one of two methods, the CUP method and the TNM method. The TNM method examines the profit-level indicator (PLI), defined as net profits relative to an appropriate base (e.g., sales) that a taxpayer realizes from a controlled transaction. With the TNM method, the PLI of the taxpayer from the controlled transaction should be equal to the PLI obtained in a comparable transaction by an independent enterprise (i.e., a reference firm).

First, if the MNE licenses the technology to the local firm, the CUP method applies. The MNE is unable to price-discriminate because of the emergence of a comparable transaction and arm's length royalty. Put differently, the MNE must set a uniform royalty rate, r^{CUP}. The MNE's problem can be stated as follows:

$$\begin{aligned} \underset{r^{CUP}}{Max}\ \Pi_M^{CUP} &= (1-t)(1-r^{CUP})\pi_{x0} + r^{CUP}(\pi_{x0}+\pi_{y0}) \\ &= (1-t)\left(1+\frac{t}{1-t}r^{CUP}\right)\pi_{x0} + r^{CUP}\pi_{y0} \end{aligned}$$

subject to

$$\Pi_y^{CUP}\Big|_{\lambda=1} \geq \Pi_y^{CUP}\Big|_{\lambda=0} \iff r \leq 1 - \frac{\pi_{yc}}{\pi_{y0}} = r_y^*(<1).$$

Because Π_M^{CUP} is strictly increasing in r^{CUP}, the optimal royalty rate is given by $r^{*CUP} = r_y^*$. This strategy generates the following post-tax profits:

$$\Pi_M^{*CUP} = (1-t)\left[1+\frac{t}{1-t}\left(1-\frac{\pi_{yc}}{\pi_{y0}}\right)\right]\pi_{x0} + \Omega \tag{6}$$

$$\begin{aligned} &= (1-t)\left[1+\frac{t}{1-t}\left(\frac{\Omega}{\pi_{y0}}\right)\right]\pi_{x0} + \Omega, \\ \Pi_y^{*CUP} &= (1-t)\pi_{yc}\left(= \Pi_y^* = \Pi_y^{*TH}\right). \end{aligned} \tag{7}$$

Note that the imposition of the ALP does not lead to the elimination of profit-shifting.[22] As seen in Eq. (6), the MNE shifts only a part of its profits to the tax haven. As discussed in Sect. 2.1, r^{*CUP} is determined only by the market condition of good Y. This means that the MNE's global post-tax profits under the CUP method increase as Ω increases.

Alternatively, if the MNE does not license its technology, no comparable transaction appears. Hence, the royalty rate is regulated by the TNM method. Under TNM method, the tax authority compares MNEs' PLI with a reference firm's PLI.[23] The selection criteria of the reference firm are based upon an evaluation of the functional risks of the taxpayer and the reference firm (e.g., R&D risk and credit risk). This implies that they may not operate in the same industry. Moreover, a particular taxpayer can propose a reference firm for the TNM method in an APA.[24] However, the tax authorities still reserve the right to reject the APA application and can choose the reference firm to some extent.

Given the above features, with the TNM method, the royalty rate r_x^{TNM} is set such that the PLI of firm X equals the PLI of the reference firm which is exogenously given by $1-\eta$ in this subsection.[25] That is, $(p_x x - r_x^{TNM} p_x x)/p_x x = 1-\eta$ where p_x and x are the price and the output level of good X. Then, $r_x^{*TNM} = \eta$ holds. Thus, we have the following post-tax profits under the TNM method:

$$\begin{aligned}\Pi_M^{*TNM} &= (1-t)(1-\eta)\pi_{x0} + \eta\pi_{x0} \\ &= (1-t)\pi_{x0} + t\eta\pi_{x0},\end{aligned} \tag{8}$$

$$\Pi_y^{*TNM} = (1-t)\pi_{yc}\left(= \Pi_y^{*} = \Pi_y^{*TH} = \Pi_y^{*CUP}\right). \tag{9}$$

[22] Some existing literature such as Peralta et al. (2006) and Yao (2013) considers cases in which the ALP completely eliminates the opportunity of profit-shifting. In our model, however, the MNE still enjoys some profit-shifting because the ALP makes the royalties equal between related and unrelated firms and a part of profits are shifted to the shell company. This is based on the assumption that the MNE can relocate the patent without any costs. Although such reallocation of technologies into tax havens is restricted and costly by current anti-tax avoidance measures such as the European exit tax and the modified nexus approach, the MNE can avoid such measures by relocating the intellectual property rights ex ante. The incentive of relocation ex ante is theoretically analyzed and supported by Sharma et al. (2021). See also footnote 21.

[23] According to the Internal Revenue Service, the most frequently used PLI is operating margin (i.e., the ratio of operating profits to sales) which accounts for 67%. There are several other measures of the PLI, such as belly ratio and return on assets or capital employed, which accounted for 33%. On service transactions, the comparable profits method or the TNM method was used in 76% of the cases. The most commonly used PLI was the operating margin (43%).

[24] Once an APA is made, the tax authorities neither adjust nor audit the pricing of specified transactions under the agreed to transfer pricing method for 3 to 5 years. In Japan, 133 APA applications were submitted in 2019. See https://www.nta.go.jp/english/Report_pdf/2021e.pdf

[25] As explained in above, this reference firm is not necessarily in the same industry or the potential licensee. For example, in March 1999, the Japanese national tax tribunal made a decision on arm's length royalty based on 23 transactions as comparable transactions which included different countries and products. See Fujieda and Tsunoda (2020).

A comparison of the two post-tax profits reveals the condition used to determine whether to license the technology. Formally, the MNE grants the license to the local firm if and only if

$$\Delta\Pi_M \equiv \Pi_M^{*CUP} - \Pi_M^{*TNM} \tag{10}$$

$$= \left\{ (1-t)\left[1 + \frac{t}{1-t}\left(\frac{\Omega}{\pi_{y0}} \right) \right] \pi_{x0} + \Omega \right\} - \left\{ (1-t)\pi_{x0} + t\eta\pi_{x0} \right\} \tag{11}$$

$$= \Omega - t\left[\eta - \underbrace{\frac{\Omega}{\pi_{y0}}}_{=r^{*CUP}=r_y^*} \right] \pi_{x0} > 0. \tag{12}$$

We can easily confirm that

$$\frac{\partial \Delta\Pi_M}{\partial \eta} < 0, \frac{\partial \Delta\Pi_M}{\partial \Omega} > 0.$$

Thus, given the other parameters, we can define a threshold of η, η^L, such that the MNE is indifferent to licensing and non-licensing. Licensing arises if and only if $\eta \leq \eta^L (\equiv \Omega(\pi_{y0} + t\pi_{x0})/(t\pi_{x0}\pi_{y0}))$. It is obvious that $\eta^L > \Omega/\pi_{y0} = r_y^*$.

Thus, the following proposition is established.

Proposition 1 *The introduction of the ALP in the presence of the tax haven results in non-licensing if η is sufficiently large or if Ω is sufficiently small.*

The proposition is intuitive. The MNE faces a trade-off between license revenues from the local firm and the profit-shifting from its subsidiary to the tax haven. The latter is likely to dominate the former as η becomes larger and Ω (or c_y) becomes smaller.

3 Welfare analysis

In this section, we consider the effects of the ALP on domestic welfare. Following the previous literature (e.g., Kind et al., 2005), we assume that the MNE is owned by residents in the foreign country. Thus, domestic welfare comprises consumer surplus, firm Y's profits, and domestic tax revenues.[26] Note that the sum of firm Y's post-tax profits and tax revenues from firm Y is always constant and equal to π_{yc}.

[26] The domestic country may benefit from knowledge spillovers caused by licensing, which are beyond the scope of this paper.

Consumer surplus in the market of good X also remains constant. Thus, a change in domestic welfare is simply the sum of a change in consumer surplus in the market of good Y, CS_y, and a change in tax revenues from the MNE, TR_x. Obviously, CS_y is larger with licensing than without it.

In the absence of the ALP, domestic welfare with the tax haven is always less than that of the benchmark case, because the presence of the tax haven does not affect the licensing strategy. Instead, it leads to leakage of tax revenues from the domestic country to the tax haven. Thus, the presence of the tax haven is always harmful for the domestic country.

We now investigate the welfare effects of the ALP in the presence of the tax haven. To this end, we compare domestic welfare between the two regimes with and without the ALP. If the introduction of the ALP does not affect the licensing strategy of the MNE, that is, if the MNE is still engaged in licensing with the ALP (which is the CUP method in this case), the impact of the ALP is straightforward. Obviously, CS_y is not affected. Under the CUP method, MNE's profit-shifting is restricted, which means that TR_x increases. Thus, the ALP increases domestic welfare by $t(1-r^{*CUP})\pi_{x0}$, implying $W^{*CUP} > W^{*TH}$ holds. However, if the ALP changes the licensing strategies, that is, if the MNE is not engaged in licensing under the ALP, a trade-off arises. On one hand, the ALP decreases MNE's profit-shifting to the tax haven and hence TR_x increases. On the other hand, non-licensing lowers productivity of the local firm and hence CS_y decreases. Thus, $W^{*TNM} > W^{*TH}$ may or may not hold. We then obtain the following lemma.

Lemma 1 *While $W^{*CUP} > W^{*TH}$ holds, the comparison between W^{*TNM} and W^{*TH} is ambiguous.*

W^{*TNM} is decreasing in η while both W^{*CUP} and W^{*TH} are independent of η. Thus, $W^{*TNM} > W^{*CUP}$ and $W^{*TNM} > W^{*TH}$ are likely if η is close to 0 and vice versa if η is close to 1. Recall that whether licensing occurs or not depends on $\Delta\Pi_M (\equiv \Pi_M^{*CUP} - \Pi_M^{*TNM})$ and hence licensing occurs if and only if $\eta \leq \eta^L$.

The following computation reflecting linear demands clarifies lemma 1. Assume that the inverse demands are given by

$$p_x = A - ax \quad \text{and} \quad p_y = B - by. \tag{13}$$

Then, we obtain

$$x^{*TH} = \frac{A}{2a}, y^{*TH} = \frac{B}{2b},$$
$$x^{*TNM} = \frac{A}{2a}, y^{*TNM} = \frac{B - c_y}{2b}.$$

First, domestic welfare without the ALP, W^{*TH}, is compared to that with the TNM method, W^{*TNM}:

$$W^{*TNM} - W^{*TH} = CS_y^{*TNM} - CS_y^{*TH} + t(1-\eta)\frac{A^2}{4a} \tag{14}$$

$$= -\frac{c_y(2B-c_y)}{8b} + t(1-\eta)\frac{A^2}{4a} \geq 0 \iff \eta \leq 1 - \frac{ac_y(2B-c_y)}{2tbA^2} \equiv \eta^W. \tag{15}$$

$W^{*TNM} < W^{*TH}$ holds if and only if $\eta > \eta^W$, because greater η results in more opportunity of profit-shifting for the MNE. The increase in tax revenues caused by the ALP (which is the TNM method in this case) is not large enough to cover the decrease in consumer surplus in the market of good Y.

Thus, we have two cases. With $\eta^L < \eta^W$, the ALP may enhance domestic welfare even if licensing does not occur in the presence of the ALP. More specifically, if $\eta^L < \eta < \eta^W$, domestic welfare increases even without licensing. With $\eta^L > \eta^W$, however, the ALP improves domestic welfare if and only if licensing arises (recall Lemma 1).

We can thus derive the condition under which $\eta^L < \eta^W$ holds:

$$\eta^L < \eta^W \iff t > \frac{aB^2(2B^2 + 2Bc_y - c_y^2)}{2bA^2(B-c_y)^2} \equiv \underline{t}.$$

This is illustrated in Fig. 1. Therefore, if licensing does not occur in the presence of the ALP, the ALP is necessarily harmful to the domestic country with $t < \underline{t}$ but may be beneficial with $t > \underline{t}$. When t is high, the tax revenues may be large enough to offset the consumer loss.

The results are illustrated in Figs. 2 and 3.[27] The figures show how η affects the MNE's licensing strategy and domestic welfare. Figure 2 is drawn with $t = 0.3 < \underline{t}$, meaning $\eta^L > \eta^W$. If $\eta < \eta^L$, the MNE has an incentive for licensing and domestic welfare is larger with the ALP (i.e., the CUP method) than without. If $\eta > \eta^L$, on the other hand, licensing does not occur and domestic welfare is smaller with the ALP (i.e., the TNM method) than without. Thus, if the MNE terminates licensing because of the ALP, the domestic country loses. Figure 3 is drawn with $t = 0.5 > \underline{t}$, meaning $\eta^L < \eta^W$. In this case, even if the ALP leads the MNE to stop licensing, the domestic country gains with $\eta < \eta^W$.

These results are summarized in the following proposition.

Proposition 2 *Suppose that the ALP is introduced in the presence of a tax haven. The ALP improves domestic welfare if licensing occurs. More specifically, domestic welfare improves if and only if* $\eta < \max\{\eta^L, \eta^W\}$.

We next take the choice of η into account. As described in Sect. 2, APAs are often made. In its scheme, a tax payer can pre-consult the tax authority about the reference firm. Although the government cannot freely choose the reference firm or η, it still

[27] We set $A = B = a = b = 1$ and $c_y = \frac{1}{10}$ in Figs. 2 and 3.

has freedom of choice to some extent. Given the fact, we specifically assume that the government can choose $\eta \in [\underline{\eta}, \overline{\eta}]$ where $0 < \underline{\eta} < \overline{\eta} < 1$.

We consider an extended game where in Stage 0, prior to the MNE's decision on royalty rates, the domestic government chooses η from a certain range to maximize domestic welfare. If $\underline{\eta} < \eta^L$, the government sets η to induce licensing. As long as licensing is induced, the size of η does not matter. This is because domestic welfare with licensing is independent of η. If $\underline{\eta} \geq \eta^L$ on the other hand, the government chooses $\eta = \underline{\eta}$. Note that the ALP harms the domestic country if $\underline{\eta} > \max\{\eta^W, \eta^L\}$.

Thus, we have the following proposition.

Proposition 3 *Suppose that the government chooses η from the domain $[\underline{\eta}, \overline{\eta}]$ where $0 < \underline{\eta} < \overline{\eta} < 1$. The optimal royalty rate η^* is given by $\eta^* = \underline{\eta}$ if $\eta^L \leq \underline{\eta}$ and $\underline{\eta} \leq \eta^* \leq \min\{\eta^L, \overline{\eta}\}$ if $\underline{\eta} < \eta^L$.*

This proposition says that the domestic government should choose a reference firm which leads to licensing. However, if licensing cannot be induced with a possible choice set of reference firms, the domestic government should choose a reference firm with the lowest η. Note that licensing is more likely to occur with a lower η. Thus, whether or not licensing is induced, the domestic government should choose a reference firm with the lowest η, i.e., the most stringent regulation.

4 Substitutable goods

In the basic model, to clarify our point, we have assumed that both goods X and Y are not at all substitutable. In this section, we consider the case in which the two goods are substitutable. We show that the results with substitutable goods contrast clearly with those in the basic model.

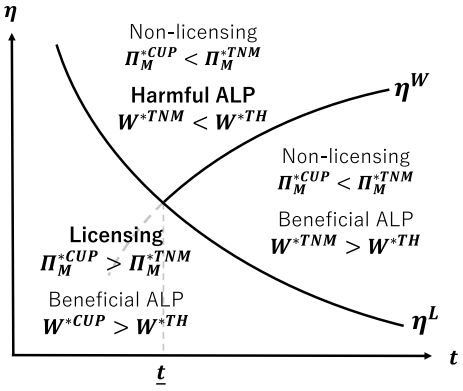
We assume that the MNE and the local firm produce a homogeneous good and are engaged in Cournot competition. We also assume the following linear demand:

$$\widetilde{p} = A - a(\widetilde{x} + \widetilde{y}). \tag{16}$$

One may think that the MNE's subsidiary exits the market after providing the license, enabling the local firm to earn the monopoly profits and extracting possibly a higher rent through a license fee. As Mukherjee (2007) points out, however, the commitment by the MNE for not entering the market may not be credible. In our analysis, therefore, we focus on the Cournot duopoly.

4.1 A tax haven with the ALP

In the case of non-licensing with the ALP, the MNE has to set the internal royalty rate equal to the comparable value η. The profits are



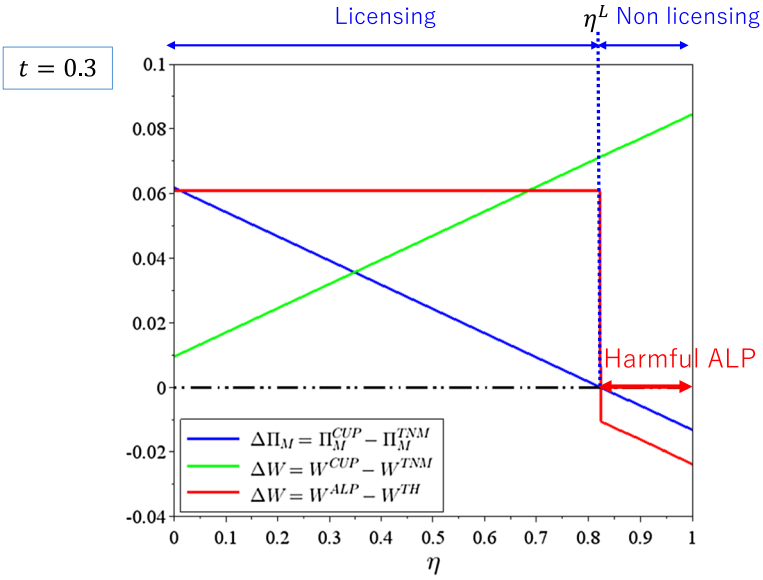


Fig. 1 Licensing decision and welfare in equilibrium

Fig. 2 Welfare effects of the ALP with $t = 0.3$

$$\begin{aligned}\widetilde{\Pi}_M^{TNM} &= (1-t)(1-\eta)\widetilde{p}\widetilde{x} + \eta\widetilde{p}\widetilde{x} \\ &= (1-t+\eta t)\widetilde{p}\widetilde{x}, \\ \widetilde{\Pi}_y^{TNM} &= (1-t)\left(\widetilde{p} - c_y\right)\widetilde{y}.\end{aligned} \tag{17}$$

Noting that the outputs are independent of the internal royalty rate, we obtain

$$\widetilde{x}^{*TNM} = \frac{A + c_y}{3a}, \quad \widetilde{y}^{*TNM} = \frac{A - 2c_y}{3a}. \tag{18}$$

Thus, the MNE's profits with the TNM method become

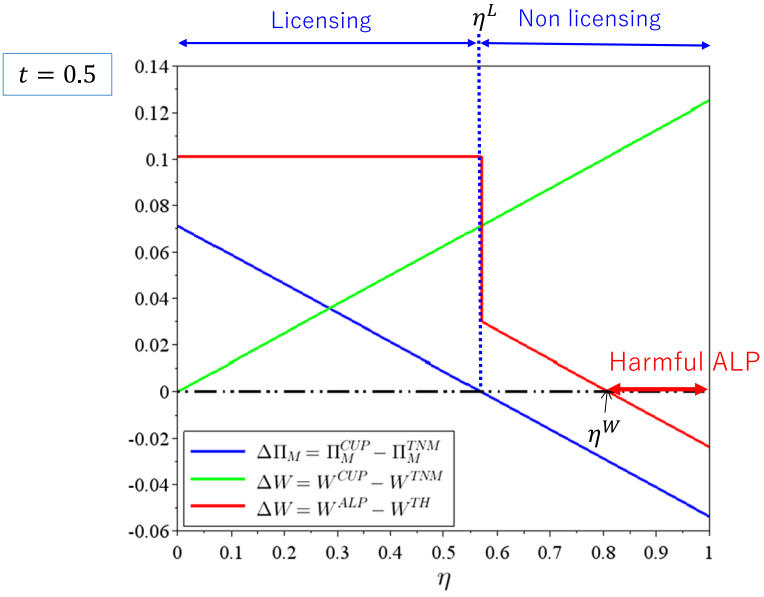


Fig. 3 Welfare effects of the ALP with $t = 0.5$

$$\widetilde{\Pi}_M^{*TNM} = (1 - t + t\eta)\frac{(A + c_y)^2}{9a},$$
$$\widetilde{\Pi}_y^{*TNM} = (1 - t)\frac{(A - 2c_y)^2}{9a} \equiv \widetilde{\Pi}_y^{*}.$$

In the case of licensing with the ALP, the MNE cannot price-discriminate between its subsidiary and the local firm.

$$\begin{aligned}\widetilde{\Pi}_M^{CUP} &= (1 - t)(1 - \widetilde{r}^{CUP})\widetilde{px} + \widetilde{r}^{CUP}\widetilde{px} + \widetilde{r}^{CUP}\widetilde{py} \\ &= (1 - t + t\widetilde{r}^{CUP})\widetilde{px} + \widetilde{r}^{CUP}\widetilde{py}, \\ \widetilde{\Pi}_y^{CUP} &= (1 - t)(1 - \widetilde{r}^{CUP})\widetilde{py}.\end{aligned} \tag{19}$$

Then, the outputs and profits are given by

$$\widetilde{x}^{CUP} = \frac{\{(1 - t + t\widetilde{r}^{CUP}) - \widetilde{r}^{CUP}\}A}{\{3(1 - t + t\widetilde{r}^{CUP}) - \widetilde{r}^{CUP}\}a}, \quad \widetilde{y}^{CUP} = \frac{(1 - t + t\widetilde{r}^{CUP})A}{\{3(1 - t + t\widetilde{r}^{CUP}) - \widetilde{r}^{CUP}\}a},$$
$$\widetilde{\Pi}_M^{CUP} = \frac{(1 - t + t\widetilde{r}^{CUP})^3A^2}{\{3(1 - t + t\widetilde{r}^{CUP}) - \widetilde{r}^{CUP}\}^2a}, \quad \widetilde{\Pi}_y^{CUP} = (1 - t)\frac{(1 - \widetilde{r}^{CUP})(1 - t + t\widetilde{r}^{CUP})^2A^2}{\{3(1 - t + t\widetilde{r}^{CUP}) - \widetilde{r}^{CUP}\}^2a}.$$

We can verify $\widetilde{\Pi}_M^{CUP}$ is increasing in $\widetilde{r}^{CUP}$ but $\widetilde{\Pi}_y^{CUP}$ is decreasing in $\widetilde{r}^{CUP}$. Thus, the optimal royalty rate, $\widetilde{r}^{*CUP}$, satisfies the following condition:

$$\widetilde{\Pi}_y^{*CUP} = (1-t)\frac{(1-\widetilde{r}^{*CUP})(1-t+t\widetilde{r}^{*CUP})^2A^2}{\{3(1-t+t\widetilde{r}^{*CUP})-\widetilde{r}^{*CUP}\}^2a} = (1-t)\frac{(A-2c_y)^2}{9a} = \widetilde{\Pi}_y^*.$$

Substituting $\widetilde{r}^{*CUP}$, the MNE's profits with the CUP method become

$$\widetilde{\Pi}_M^{*CUP} = \frac{(1-t+t\widetilde{r}^{*CUP})^3A^2}{\{3(1-t+t\widetilde{r}^{*CUP})-\widetilde{r}^{*CUP}\}^2a}.$$

The relative magnitude of $\widetilde{\Pi}_M^{*CUP}$ and $\widetilde{\Pi}_M^{*TNM}$ is ambiguous. We can confirm that $\Delta\widetilde{\Pi}_M(\equiv \widetilde{\Pi}_M^{*CUP} - \widetilde{\Pi}_M^{*TNM}) < 0$ is possible only if c_y is small. Small c_y implies that licensing is not very attractive to the MNE, because the smaller the c_y , the smaller the license revenues.

4.2 Welfare comparison

We examine how domestic welfare changes when the ALP is introduced in the presence of a tax haven. Since the presence of the ALP does not affect the profits of the local firm, a change in domestic welfare is measured by the sum of changes in tax revenues from the MNE, TR_x, and in consumer surplus, CS. The ALP necessarily makes the tax revenues from the MNE positive. Thus, we check how CS changes as a result of the ALP.

We can prove the following lemma.[28]

Lemma 2 (i) $\widetilde{x}^{*CUP} + \widetilde{y}^{*CUP} < \widetilde{x}^{*TNM} + \widetilde{y}^{*TNM}$, (*ii*) $\widetilde{x}^{*CUP} + \widetilde{y}^{*CUP} < \widetilde{x}^{*TH} + \widetilde{y}^{*TH}$ *if* $t \leq \frac{1}{3}$, *and* (*iii*) $\widetilde{x}^{*TH} + \widetilde{y}^{*TH} < \widetilde{x}^{*TNM} + \widetilde{y}^{*TNM}$.

In the presence of the ALP, the total supply of the good is greater without licensing than with licensing (see Lemma 2 (i)). This seems surprising because the total output is less with licensing despite the fact that licensing leads both firms to produce the good with zero MC. The intuition is as follows. When the goods are substitutes, the MNE decreases the output of its subsidiary to increase the output of the local firm and the price and hence the license revenues from the local firm. The negative effect on the total output caused by the MNE's centralized decision with licensing by means of ad valorem royalties dominates the positive effect of the cost reduction of the local firm.

Lemma 2 (ii) and (iii) say that CS without the ALP may be larger than CS with the CUP method but is smaller than CS with the TNM method. Thus, as a result of the introduction of the ALP, consumers may lose if licensing occurs but gain if it does not.

The above strategic channel of ad valorem royalty on production is analyzed by San Martin and Saracho (2010), but our model newly shows the impact of the ALP on licensing behavior. Without the ALP, external royalty has a collusive effect.

[28] See Appendix A for the proof.

However, with the ALP, such collusive effect may no longer exist when the MNE decides not to license to the local firm.

Given the importance of tax avoidance via intangible asset, the welfare effect of licensing under the ALP is interesting to investigate. Noting that the ALP increases tax revenues, we can establish the following proposition.

Proposition 4 *Suppose that the MNE's subsidiary and the local firm compete in the market. The ALP may harm consumers and worsen domestic welfare if the MNE continues licensing to the local firm, but benefits consumers and improves domestic welfare if the MNE terminates licensing to the local firm.*

Figures 4, 5, and 6 illustrate whether the introduction of the ALP improves domestic welfare.[29] Each figure is drawn with a different tax rate. $\widetilde{\Pi}_M^{*TNM}$ is more likely to exceed $\widetilde{\Pi}_M^{*CUP}$ if η is relatively large and t is relatively small. In the presence of the ALP, licensing occurs if and only if $\eta < \eta^L$. The ALP always improves domestic welfare in Figs. 4 and 5. If licensing is present under the ALP, the increase in the tax revenues dominates the loss of consumers. However, in Fig. 6, the ALP worsens domestic welfare in the presence of licensing because the loss of consumers actually exceeds the increase in the tax revenues.

Proposition 4 provides us with a new implication on the optimal enforcement of the ALP. As the main purpose of the ALP is to prevent MNEs' tax avoidance, extant literature regards stricter enforcement of the ALP as a desirable policy, which is captured by a lower $\overline{\eta}$ in our model. While this is also true in our basic model, it is not necessarily true with goods substitutability because consumers may lose. Thus, even though choosing a reference firm with a lower $\overline{\eta}$ becomes possible thanks to stricter enforcement of the ALP, such a choice does not necessarily imply a welfare improvement in non-tax haven countries.

5 Per-unit royalty

We have investigated transfer pricing with patent licensing by means of ad valorem royalties. In this section, to further emphasize transfer pricing with ad valorem royalties, we consider transfer pricing with patent licensing by means of a per-unit royalty and make a comparison.

The profits with a tax haven are given by

$$\begin{aligned}\Pi_M =&(1-t)(p_x - v_x)x + v_x x + \lambda v_y y\\ =&(1-t)\left(p_x + \frac{tv_x}{1-t}\right)x + \lambda v_y y,\\ \Pi_y =&(1-t)\{\lambda(p_y - v_y)y + (1-\lambda)(p_y - c_y)y\},\end{aligned}$$

[29] Figures 4, 5, 6 are drawn with $c_y = \frac{1}{1000}$ and $A = a = 1$.

where v_x and v_y are the per-unit royalty charged by the MNE. With the CUP method, we have $v_x = v_y$.

5.1 No substitutability

We begin with the case without substitutability between the MNE's final good and the local firm's final good.[30] As we will see immediately, the introduction of the ALP always improves domestic welfare.

First, suppose that the ALP is absent. Then, the MNE has an incentive to grant the patent to the local firm, because the MNE can price-discriminate between its subsidiary and the local firm. On the one hand, the per-unit royalty for the local firm is equal to its MC, c_y to extract all the increased revenues.[31] On the other hand, as shown in Choi et al. (2020), the per-unit royalty for the subsidiary is equal to the monopoly price of good X which would be charged if the effective MC equals zero. That is, the subsidiary produces the monopoly output level with the effective MC equal to zero and all the profits of the subsidiary are shifted to the tax haven.

Now suppose that the ALP is introduced. In the presence of licensing to the local firm, the CUP method applies, implying that the same per-unit royalty must be set between the subsidiary and the local firm. Appendix B shows that the per-unit royalty equals c_y with the CUP method. Thus, the output of the local firm remains the same, which indicates that consumer surplus in the market of good Y, the revenues of firm Y, and the tax revenues from firm Y do not change. However, as shown in Choi et al. (2020), the output of the subsidiary increases because the MNE cannot shift all the profits of subsidiary to the tax haven and tries to shift more profits by increasing the volume of the MNE's production. This means two positive effect of the ALP resulting in CUP method. First, likewise in the previous analyses, domestic tax revenues from the MNE, TR_x, become positive. In addition, consumer surplus in the market of good X, CS_x, increases due to the tax-induced supplies by the MNE. Thus, domestic welfare improves under CUP method.

If the MNE's licensing to the local firm is terminated as a result of the ALP, the TNM method applies. With the TNM method, the per-unit royalty for the subsidiary, v_x, becomes $p_x\eta$ because we have $(p_x x - v_x x)/p_x x = 1 - \eta$. The local firm produces its final good with its original MC to produce good Y, c_y. As a result, Eqs. (8) and (9) hold, and we can readily verify that the outputs of goods X and Y do not change. Additionally, since the ALP makes TR_x positive, domestic welfare improves. Thus, we obtain the following proposition.

Proposition 5 (Per-unit royalty) *Suppose that the MNE's subsidiary and the local firm do not compete in the market and licensing contract is based on per-unit basis.*

[30] This case is somewhat similar to the case explored in Choi et al. (2020). In fact, some of their results are applicable here.

[31] Strictly speaking, the optimal price is less than c_y if c_y is sufficiently high. With Eq. (13), this is the case if $c_y > B/2$. We assume away this case.

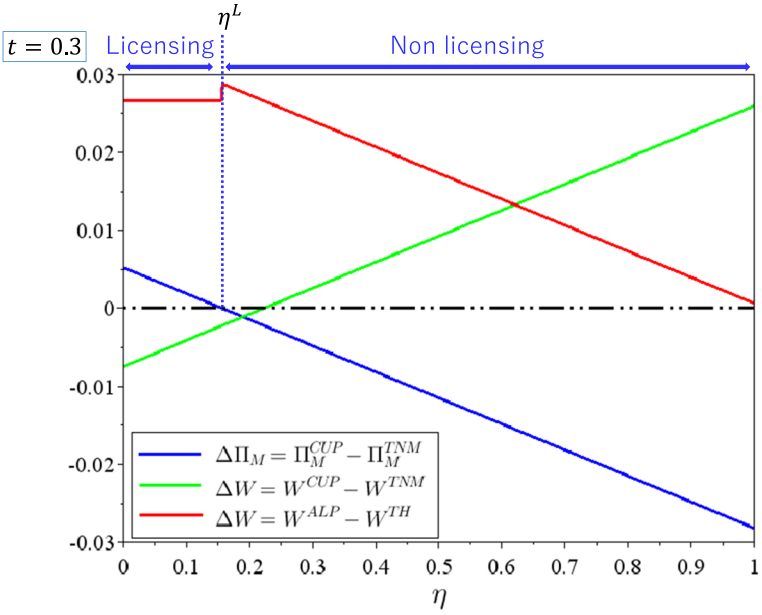


Fig. 4 Perfect substitutability and welfare effects of the ALP with $t = 0.3$

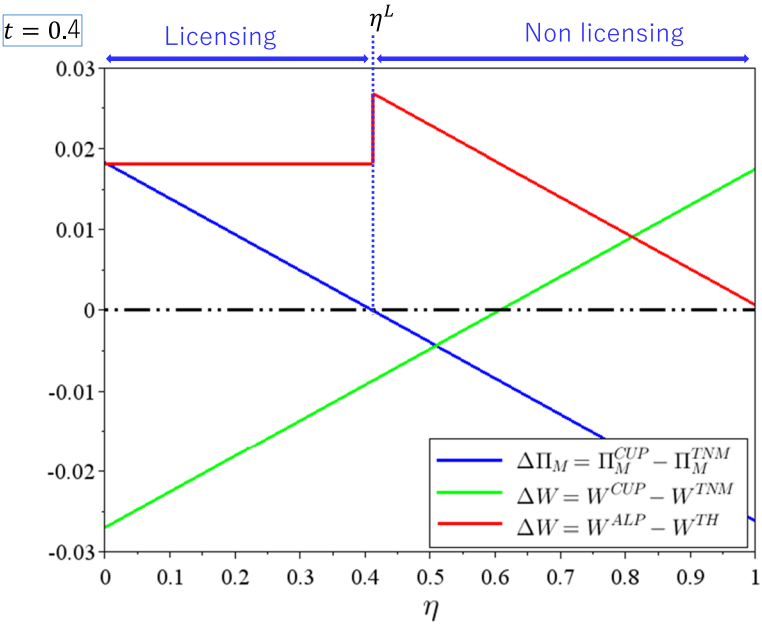


Fig. 5 Perfect substitutability and welfare effects of the ALP with $t = 0.4$

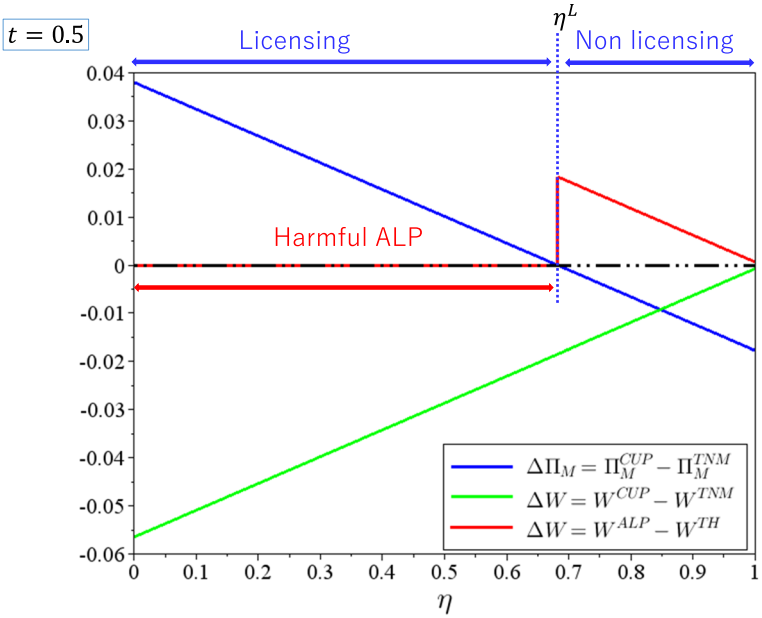


Fig. 6 Perfect substitutability and welfare effects of the ALP with $t = 0.5$

The introduction of the ALP in the presence of the tax haven improves domestic welfare whether or not the MNE license its patent to the local firm.

This proposition is in contrast with Proposition 2 which shows the possibility of negative welfare effect of the ALP under TNM method. The difference stems from the nature of supplies by the local firm. In the case of a per-unit royalty, the supplies by the local firm remain constant as per-unit royalty is equal to its MC, and hence the introduction of the ALP necessarily improves domestic welfare by the appearance of tax revenues from the MNE. However, in the case of ad valorem royalty, the local firm's supplies increase by licensing as ad valorem royalty is proportional to revenues, and the ALP may worsen domestic welfare if the patent is not licensed to the local firm. Overall, patent licensing by means of a per-unit royalty results more likely in welfare improvement.

5.2 Perfect substitutability

Next we consider the case with substitutability to see positive effects of the ALP on consumer and the local firm.

Without the ALP, the MNE always grants patent to the local firm at the per-unit royalty equal to the MC, c_y. Unlike no substitutability case, the equilibrium supplies are functions of the tax rate because the MNE's output decision depends on

tax-adjusted MC including the efficiency of tax-savings.[32] As higher transfer prices induce more profit-shifting and enhance efficiency of tax-savings, the MNE's outputs increase, and the local firm's outputs decrease compared to the standard Cournot duopoly.[33]

With the ALP which drops efficiency of the MNE's tax avoidance, the MNE supplies less and subsequently the local firm supplies more compared to the case without the ALP. With the CUP method, the MNE sets the same per-unit royalty resulting in inefficient tax-savings and an increase in the tax-adjusted MC. With the TNM method, again, we have $v_x = p_x\eta$ and such transfer pricing proportional to good price results in the standard Cournot duopoly outcome shown in Eq. (18). Moreover, by the nature of the take-it-or-leave-it offer, the local firm's supplies do not change between CUP and TNM methods, but increases because of the ALP.

In addition to the above discussion on supplies by each firm, Appendix C shows the following lemma.[34]

Lemma 3 (i) $\tilde{x}^{*TH} > \tilde{x}^{*CUP} > \tilde{x}^{*TNM}$, *(ii)* $\tilde{y}^{*CUP} = \tilde{y}^{*TNM} > \tilde{y}^{*TH}$, *(iii)* $\tilde{x}^{*TNM} + \tilde{y}^{*TNM} < \tilde{x}^{*TH} + \tilde{y}^{*TH}$ *and* *(iv)* $\tilde{x}^{*CUP} + \tilde{y}^{*CUP} > \tilde{x}^{*TH} + \tilde{y}^{*TH}$ *if* $\frac{A(2-t)}{7-5t} < c_y < \frac{A(1-t)}{2-t}$, *while* $\tilde{x}^{*CUP} + \tilde{y}^{*CUP} < \tilde{x}^{*TH} + \tilde{y}^{*TH}$ *if* $\frac{A(1-t)}{2-t} < \frac{A(2-t)}{7-5t}$.

The lemma provides three notable results. First, as the profits of the local firm increase as its output increases, the ALP benefits the local firm (see Lemma 3 (ii)). In the previous analyses, no effects of the ALP on the local firm are confirmed. Hence, this positive effect of the ALP on local firm is observed only in the case with a per-unit royalty and perfect substitutability. Moreover, since the profits of the local firm increase, the ALP increases tax revenues not only from the MNE but also from the local firm.

Second, the effects of the ALP under TNM method on consumer are opposite to those in the case of ad valorem royalty. In the case of ad valorem royalty, Lemma 2 (iii) shows that the ALP necessarily benefits consumers if licensing to the local firm is terminated. However, in the case of per-unit royalty, consumers necessarily lose if licensing does not occur with the ALP (see Lemma 3 (iii)). The difference stems from different channels of strategic use of royalty settings without the ALP. With ad valorem royalty, royalties are set such that the MNE's supplies become less to increase the local firm's revenues and to extract the increased revenues of the local firm. With per-unit royalty, the royalties are determined such that the MNE produces more to increase intra-firm trade and to shift profits into the tax haven. Hence, termination of the licensing due to the ALP impacts on total supplies in opposite directions.

Finally, although the effect of the ALP on consumers is ambiguous with both licensing by means of ad valorem royalties and licensing by means of a per-unit

[32] This tax-adjusted MC for the MNE is $-\frac{tv_x}{1-t} < 0 (= c_x)$ and is known as the perceived marginal costs in the literature. See Choi et al. (2018) for example.

[33] Note that in the absence of the ALP, the Cournot duopoly equilibrium in the domestic market arises if and only if $c_y < \frac{A(1-t)}{2-t}$.

[34] $\frac{A(1-t)}{2-t} > \frac{A(2-t)}{7-5t}$ if and only if $t < \frac{1}{2}$.

royalty (see Lemma 2 (ii) and (iii), and Lemma 3 (iii) and (iv)), the magnitude of consumer surplus in the presence of the ALP is also opposite between the two licensing cases as a result of the above pattern of firms' production. With a per-unit royalty, consumers prefer licensing to non-licensing (see Lemma 3 (i) and (ii)) whereas ad valorem royalties make consumer surplus higher when non-licensing takes place.

Hence, given the positive and negative impacts of the ALP, the ALP may or may not improve domestic welfare. To sum, the following proposition is established.

Proposition 6 (Per-unit royalty) *Suppose that the MNE's subsidiary and the local firm compete in the goods market and licensing contract is based on per-unit basis. The introduction of the ALP in the presence of the tax haven benefits the local firm and increases the tax revenues but may harm consumers. Consumers gain only if the MNE sells the input to the local firm with the ALP.*

6 Concluding remarks

This paper has dealt with the MNE's transfer pricing of intangibles licensed by means of ad valorem royalties. Our focus was on the effects of the ALP on MNE's licensing strategies and economic welfare in the presence of a tax haven. Specifically, we have explored the CUP and TNM methods as the ALP.

Our findings in the basic model, in which a potential licensee is unrelated to the MNE's subsidiary, provide two insights. First, the ALP may distort the MNE's licensing strategy. In the absence of the ALP, the MNE is willing to offer a licensing contract to an unrelated firm regardless of the existence of a tax haven. In the presence of the ALP, however, the MNE may refrain from the offering the contract to eliminate the comparable transaction of licensing, which may enable the MNE to avoid the imposition of the CUP method and enjoy further profit-shifting opportunities from its subsidiary.

Second and more importantly, the disincentivization of licensing may worsen the welfare of high-tax countries. One may expect that anti-tax avoidance policies such as BEPS actions prevent MNEs from profit-shifting and contribute to welfare improvement through an increase in the tax revenue. Our model, however, has shown that such a positive aspect may appear at the expense of consumers, because the MNEs may terminate licensing to remove comparable transactions.

We then investigated the case in which the goods are substitutes as an extension to our basic model. In this case, interestingly enough, consumers may lose even if the licensing still occurs with the ALP. This is because the MNE decreases the output of its subsidiary to take more advantage of the license revenues from the unrelated firm. The point is a strategic effect which is absent in the basic model comes in. As a result, the ALP harms consumers. Thus, the welfare effects of ALP depend on whether or not goods are substitutable.

We have focused on two extreme cases (i.e., non-substitution and perfect substitution) and obtained the distinct results between these cases. In our model, the MNE adjusts a trade-off between the license revenues from the unrelated firm and the greater opportunity for profit-shifting to a tax haven via transfer pricing when offering licensing contracts. The adjustment is most contrasting between the non-substitution case and the perfect substitution case. As shown in Appendix D which examines imperfect substitution, we confirm that the results are robust.

Furthermore, we have examined the case of a per-unit royalty. The results are shown to be in contrast with those in the case of ad valorem royalties. This implies whether the type of licensing contract on royalty payments in question is ad valorem or per-unit royalty could be crucial in evaluating the ALP. Note that we can regard the case of per-unit royalty as the case of tangible inputs. Moreover, we can readily confirm that the results of technology licensing by means of a fixed payment are basically the same as those by means of ad valorem royalties without any substitutability, because there are no strategic interactions via royalty payments in both cases. Thus, licensing scheme also matters in evaluating the ALP.

We use the Cournot model to analyze competition with substitutable products. As demonstrated by Kreps and Scheinkman (1983), we can interpret the Cournot model as a static representation of a two-stage game in which firms first build capacity followed by price competition. For instance, it can be applied to the semi-conductor industry in which firms first build capacity prior to engaging in price competition. However, the Cournot model may be less appropriate for R&D intensive tech firms for which capacity constraint is less relevant. Nonetheless, our main results are robust to Bertrand competition with differentiated products. The reason is that regardless of the mode of competition, the MNE will have incentives to relax competition as its licensing revenues depend on the licensee's revenues, which induces a semi-collusive outcome. This incentive has the effects of impairing consumer welfare in both Cournot and Bertrand models (see Fauli-Oller and Sandonis, 2002). Note also that the MNE may not have incentives to drive the rival firm out with differentiated products because industry revenue maximization requires both products in the market.

Our Cournot framework can also be applied to platform firms with ad-funded business models in two-sided markets. These firms provide services free to consumers but derive revenues from advertising. They choose the amount of advertising (ad load) which determines the advertising price. As the marginal cost of serving consumers is close to zero in digital markets, we can also interpret cost-reducing innovations as quality-enhancing.

Although our model has shed new light on the link between licensing and profit-shifting, further analysis on this topic is essential. A potential extension would be policy analyses focusing more on patents (e.g., the patent box).[35] Although several empirical studies have focused on these kinds of policies rapidly prevailing in Europe, theoretical studies have not been very satisfactory.

[35] Regarding the patent box, see Haufler and Schindler (2020), for example.

Appendix A: Proof of Lemma 2

This appendix proves Lemma 2.

Proof First, we prove (i) $\widetilde{x}^{*CUP}+\widetilde{y}^{*CUP}<\widetilde{x}^{*TNM}+\widetilde{y}^{*TNM}$. The total supply of the good is

$$\widetilde{x}^{*TNM}+\widetilde{y}^{*TNM}=\frac{2A-c_y}{3a}, \qquad \text{with the TNM method,}$$
$$\widetilde{x}^{*CUP}+\widetilde{y}^{*CUP}=\frac{A\{2(1-t+\widetilde{r}^{*CUP}t)-\widetilde{r}^{*CUP}\}}{a\{3(1-t+\widetilde{r}^{*CUP}t)-\widetilde{r}^{*CUP}\}}, \qquad \text{with the CUP method.}$$

We can then derive the condition that the total supply is greater under the TNM method than under the CUP method:

$$\left(\widetilde{x}^{*TNM}+\widetilde{y}^{*TNM}\right)-\left(\widetilde{x}^{*CUP}+\widetilde{y}^{*CUP}\right)=\frac{(A+c_y)\widetilde{r}^{*CUP}-3(1-t+\widetilde{r}^{*CUP}t)c_y}{3a\{3(1-t+\widetilde{r}^{*CUP}t)-\widetilde{r}^{*CUP}\}}\geq 0$$
$$\iff \widetilde{r}^{*CUP}\geq\frac{3(1-t)c_y}{A+c_y-3tc_y}\equiv r^{CS}. \tag{20}$$

Then, we can verify that the local firm accepts the license offer if the MNE sets r^{CS} because the following holds:

$$\begin{aligned}\widetilde{\Pi}_y^{*CUP}\Big|_{r=r^{CS}}-\widetilde{\Pi}_y^{*TNM}&=\frac{(1-t)(1-r^{CS})A^2(1-t+tr^{CS})^2}{a\{3(1-t+tr^{CS})-r^{CS}\}^2}-\frac{(1-t)(A-2c_y)^2}{9a}\\&=\frac{(1-t)(A-2c_y)}{9a(A+c_y-3tc_y)}\left[(A+c_y)^2-(A-2c_y)(A+c_y-3tc_y)\right]\\&=\frac{(1-t)(A-2c_y)c_y}{3a(A+c_y-3tc_y)}\left[A+c_y+t(A-2c_y)\right]\\&>0\end{aligned} \tag{21}$$

Note that the MNE has an incentive to set the royalty rate as high as possible, because $\partial\widetilde{\Pi}_M^{CUP}/\partial\widetilde{r}^{CUP}=(1-t+\widetilde{r}^{CUP}t)\widetilde{p}\widetilde{x}+\widetilde{p}\widetilde{y}>0$ holds. Eq. (21) suggests that r^{CS} is acceptable for the local firm but is not optimal for the MNE, because $\widetilde{\Pi}_y^{*CUP}=\widetilde{\Pi}_y^{*TNM}$ is not satisfied. Thus, the optimal royalty is greater than r^{CS}. In view of Eq. (20), the optimal royalty results in more total supply under the TNM method than under the CUP method.

Second, we prove (ii) $\widetilde{x}^{*CUP}+\widetilde{y}^{*CUP}<\widetilde{x}^{*TH}+\widetilde{y}^{*TH}$ if $t\leq\frac{1}{3}$. We have

$$\widetilde{\Pi}_y^{CUP} = \left(\frac{1-t}{a}\right)\Psi,\ \widetilde{\Pi}_y^{TNM} = \left(\frac{1-t}{a}\right)\frac{(A-2c_y)^2}{9},$$
$$\text{where } \Psi \equiv \frac{(1-\widetilde{r}^{CUP})A^2(1-t+\widetilde{r}^{CUP}t)^2}{\{3(1-t+t\widetilde{r}^{CUP})-\widetilde{r}^{CUP}\}^2}.$$

The optimal $\widetilde{r}^{CUP}$ is determined by

$$\Delta\widetilde{\Pi}_y \equiv \widetilde{\Pi}_y^{CUP} - \widetilde{\Pi}_y^{TNM} = \left(\frac{1-t}{a}\right)\left(\Psi - \frac{(A-2c_y)^2}{9}\right) = 0. \tag{22}$$

Suppose that the domestic tax rate is zero under the CUP method. Then, the optimal royalty rate is the same as the one in the benchmark case $\widetilde{r}^{*CUP}\big|_{t=0} = \widetilde{r}_y^*$. This is because there is no tax avoidance motive. Thus, $\widetilde{x}^{*CUP} + \widetilde{y}^{*CUP} = \widetilde{x}^{*TH} + \widetilde{y}^{*TH}$ holds at $t = 0$. We next examine how $\widetilde{x}^{*CUP} + \widetilde{y}^{*CUP}$ changes as t increases. We have

$$\frac{\partial\Psi}{\partial t} = \frac{2(1-\widetilde{r}^{CUP})^2A^2(1-t+\widetilde{r}^{CUP}t)\widetilde{r}^{CUP}}{\{3(1-t+t\widetilde{r}^{CUP})-\widetilde{r}^{CUP}\}^3} > 0.$$

We can also show

$$\frac{\partial\Psi}{\partial\widetilde{r}^{CUP}} = \left[\frac{A^2(1-t+\widetilde{r}^{CUP}t)}{\{3(1-t+t\widetilde{r}^{CUP})-\widetilde{r}^{CUP}\}^3}\right] \times \Big[-(1-t)(1-\widetilde{r}^{CUP})(1-t+\widetilde{r}^{CUP}t)$$
$$-2(1-t)\left(\widetilde{r}^{CUP}-(1-\widetilde{r}^{CUP})^2t\right) \quad -2t\left(\widetilde{r}^{CUP}\right)^2\Big] < 0 \text{ if } 0 < t \le \frac{1}{3}. \tag{23}$$

To show Eq. (23), we examine the inside of the second square brackets.

$$\begin{aligned} F(\widetilde{r}^{CUP};t) \equiv & -(1-t)(1-\widetilde{r}^{CUP})(1-t+\widetilde{r}^{CUP}t) \\ & -2(1-t)\left(\widetilde{r}^{CUP}-(1-\widetilde{r}^{CUP})^2t\right) - 2t\left(\widetilde{r}^{CUP}\right)^2 \\ = & -t(3t-1)\left(\widetilde{r}^{CUP}\right)^2 + (6t+1)(t-1)\widetilde{r}^{CUP} - (3t-1)(t-1). \end{aligned}$$

$F(0;t) = -(3t-1)(t-1)$ and $F(1;t) = -2$. Thus, if $t < \frac{1}{3}$, $F(\widetilde{r}^{CUP};t) < 0$ holds for $\widetilde{r}^{CUP} \in [0,1]$. If $t = \frac{1}{3}$, $F(\widetilde{r}^{CUP};\frac{1}{3}) = -2\widetilde{r}^{CUP} < 0$ holds for $\widetilde{r}^{CUP} \in (0,1]$. Noting that the inside of the first square brackets is positive, we can confirm Eq. (23). Therefore, as t increases in the range of $(0, \frac{1}{3}]$, the MNE increases $\widetilde{r}^{CUP}$ to achieve Eq. (22). That is, the optimal royalty rate is increasing in t in the range of $(0, \frac{1}{3}]$. In addition, we can confirm

$$\frac{\partial(\widetilde{x}^{*\mathrm{CUP}} + \widetilde{y}^{*\mathrm{CUP}})}{\partial t} = \frac{-(1-\widetilde{r}^{*\mathrm{CUP}})\widetilde{r}^{*\mathrm{CUP}}A}{a\{3(1-t+t\widetilde{r}^{*\mathrm{CUP}})-\widetilde{r}^{*\mathrm{CUP}}\}^2} < 0,$$
$$\frac{\partial(\widetilde{x}^{*\mathrm{CUP}} + \widetilde{y}^{*\mathrm{CUP}})}{\partial\widetilde{r}^{*\mathrm{CUP}}} = \frac{-(1-t)A}{a\{3(1-t+t\widetilde{r}^{*CUP})-\widetilde{r}^{*\mathrm{CUP}}\}^2} < 0.$$

Eqs.(21) and (22) imply that an increase in t in the range of $(0, \frac{1}{3}]$ increases the total supply under the CUP method directly and indirectly. The indirect increase is through an increase in $\widetilde{r}^{CUP}$ caused by the increase in t. Thus, we obtain $\widetilde{x}^{*CUP} + \widetilde{y}^{*CUP} < \widetilde{x}^{*TH} + \widetilde{y}^{*TH}$ if $0 < t \leq \frac{1}{3}$.

Lastly, with respect to (iii) $\widetilde{x}^{*TH} + \widetilde{y}^{*TH} < \widetilde{x}^{*TNM} + \widetilde{y}^{*TNM}$, Proposition 2 (ii) of San Martin and Saracho (2010) proves that consumer surplus with licensing is lower than without licensing. Thus, the TNM method increases the total supply, i.e., $\widetilde{x}^{*TH} + \widetilde{y}^{*TH} < \widetilde{x}^{*TNM} + \widetilde{y}^{*TNM}$. □

Appendix B: Derivation of $\upsilon^{*CUP} = c_y$

This appendix shows that the per-unit royalty equals c_y with the CUP method in the case of licensing by means of a per-unit royalty.

Proof With Eq. (13), the MNE's post-tax profits under CUP are given by

$$\begin{aligned}\Pi_M^{CUP} &= (1-t)(p-\upsilon^{CUP})x + \upsilon^{CUP}(x+y) \\ &= \left(\frac{1-t}{4a}\right)\left(A + \frac{t\upsilon^{CUP}}{1-t}\right)^2 + \upsilon^{CUP}\frac{B-\upsilon^{CUP}}{2b},\end{aligned}$$

where υ is the per-unit royalty. Then, we obtain

$$\frac{\partial \Pi_M^{CUP}}{\partial \upsilon^{CUP}} = \left(\frac{t}{2a}\right)\left(A + \frac{t\upsilon^{CUP}}{1-t}\right) + \frac{B-2\upsilon^{CUP}}{2b},$$

which is positive if $\upsilon^{CUP} < B/2$. The local firm accepts the licensing contract offered by the MNE only if $\upsilon^{CUP} \leq c_y$ holds. Therefore, if $B - 2c_y > 0$ holds, the optimal CUP per-unit royalty is $\upsilon^{*CUP} = c_y$. □

Appendix C: Proof of Lemma 3

This appendix proves Lemma 3 with the demand function (16).

Proof Under the TNM method, Eq. (18) holds. Under the CUP method, we obtain

$$\begin{aligned}\widetilde{x}^{CUP} &= \frac{A}{3a} + \frac{(1+t)\widetilde{\upsilon}^{CUP}}{3a(1-t)}, \widetilde{y}^{CUP} = \frac{A}{3a} - \frac{(2-t)\widetilde{\upsilon}^{CUP}}{3a(1-t)}. \\ \widetilde{\Pi}_M^{CUP} &= \frac{1-t}{9a}\left(A + \frac{(1+t)\widetilde{\upsilon}^{CUP}}{1-t}\right)^2 + \frac{\widetilde{\upsilon}^{CUP}}{3a}\left(A - \frac{(2-t)\widetilde{\upsilon}^{CUP}}{1-t}\right).\end{aligned} \tag{24}$$

Then, we have

$$\frac{\partial \widetilde{\Pi}_M^{CUP}}{\partial \widetilde{v}^{CUP}} = \frac{(5+2t)A}{9a} - \frac{2(5-5t-t^2)\widetilde{v}^{CUP}}{9a(1-t)}.$$

Assume that the second order condition $(5-5t-t^2>0)$ holds. This assumption implies $t < (3\sqrt{5}-5)/2 \approx 0.854\,1$. If an interior solution exists, it is

$$\widetilde{v}_I^{CUP} = \frac{(1-t)(5+2t)A}{2(5-5t-t^2)}.$$

We need to check if firm Y has an incentive to accept the MNE's licensing offer with the above per-unit royalty. Since the revenues of firm Y are increasing in its output, the upper bound of $\widetilde{v}^{CUP}$ which firm Y is willing to take the offer is determined by

$$\widetilde{y}|_{\lambda=1} = \frac{A}{3a} - \frac{(2-t)\widetilde{v}^{CUP}}{3a(1-t)} \geq \frac{A-2c_y}{3a} = \widetilde{y}|_{\lambda=0} \iff \widetilde{v}^{CUP} \leq \frac{2(1-t)c_y}{2-t} \equiv \widetilde{v}_U^{CUP}.$$

We can readily verify $\widetilde{v}_I^{CUP} > \widetilde{v}_U^{CUP}$. Thus, substituting $\widetilde{v}^{*CUP} = \widetilde{v}_U^{CUP}$ into Eq. (24), we obtain

$$\widetilde{x}^{*CUP} = \frac{A}{3a} + \frac{2(1+t)c_y}{3a(2-t)}, \widetilde{y}^{*CUP} = \frac{A-2c_y}{3a} = \widetilde{y}^{*TNM}.$$

We can also easily verify $\widetilde{x}^{*CUP} > \widetilde{x}^{*TNM}$.

We next derive $\widetilde{x}^{*TH}$ and $\widetilde{y}^{*TH}$. Without the ALP, the post-tax profits are given by

$$\widetilde{\Pi}_M^{TH} = (1-t)(\widetilde{p}-\widetilde{v}_x)\widetilde{x} + \widetilde{v}_x\widetilde{x} + \lambda\widetilde{v}_y\widetilde{y} = (1-t)\left(\widetilde{p} + \frac{t\widetilde{v}_x}{(1-t)}\right)\widetilde{x} + \lambda\widetilde{v}_y\widetilde{y},$$
$$\widetilde{\Pi}_y^{TH} = (1-t)\left\{\lambda(\widetilde{p}-\widetilde{v}_y)\widetilde{y} + (1-\lambda)(\widetilde{p}-c_y)\widetilde{y}\right\}.$$

Note $\widetilde{p}-\widetilde{v}_x \geq 0$ holds, because the MNE has no incentive to report negative revenues in the domestic country. If both firms produce, the equilibrium outputs are

$$\widetilde{x}^{TH} = \frac{A+\widetilde{v}_y+\frac{2t\widetilde{v}_x}{1-t}}{3a}, \quad \text{and} \quad \widetilde{y}^{TH} = \frac{A-2\widetilde{v}_y-\frac{t\widetilde{v}_x}{1-t}}{3a}, \qquad \text{if } \lambda = 1,$$
$$\widetilde{x}^{TH} = \frac{A+c_y+\frac{2t\widetilde{v}_x}{1-t}}{3a}, \quad \text{and} \quad \widetilde{y}^{TH} = \frac{A-2c_y-\frac{t\widetilde{v}_x}{1-t}}{3a}, \qquad \text{if } \lambda = 0.$$

With $\lambda = 1$, the MNE's post-tax profits are

$$\widetilde{\Pi}_M^{TH}\Big|_{\lambda=1} = \left[\frac{(1-t)}{9a}\left(A + \frac{2t\widetilde{v}_x}{1-t} + \widetilde{v}_y\right)^2 + \frac{\widetilde{v}_y}{3a}\left(A - \frac{t\widetilde{v}_x}{1-t} - 2\widetilde{v}_y\right)\right],$$

which is increasing in both $\widetilde{v}_x$ and $\widetilde{v}_y$. Thus, noting $\widetilde{p} = \widetilde{v}_x$, we obtain $\widetilde{v}_x^* = \left(\frac{1-t}{3-2t}\right)(A+c_y)$ and $\widetilde{v}_y^* = c_y$ and the outputs are given by

$$\widetilde{x}^{*TH} = \frac{(A + c_y)}{a(3 - 2t)}, \quad \widetilde{y}^{*TH} = \frac{A(1 - t) - (2 - t)c_y}{a(3 - 2t)}.$$

Note that these are the equilibrium outputs whether or not the local firm accepts the MNE's licensing offer, because $\widetilde{v}_y^* = c_y$ holds. $\widetilde{y}^{*TH} > 0$ if and only if $c_y < \frac{A(1-t)}{2-t}$. With $c_y < \frac{A(1-t)}{2-t}$, we have $\widetilde{x}^{*CUP} - \widetilde{x}^{*TH} = -\frac{t}{3(3-2t)a}\left\{2A - \left(\frac{5-4t}{2-t}\right)c_y\right\} < 0$. Moreover, it is also straightforward to show $\widetilde{y}^{*CUP} = \widetilde{y}^{*TNM} > \widetilde{y}^{*TH}$; $\widetilde{x}^{*TNM} + \widetilde{y}^{*TNM} < \widetilde{x}^{*TH} + \widetilde{y}^{*TH}$; and $\widetilde{x}^{*CUP} + \widetilde{y}^{*CUP} < \widetilde{x}^{*TH} + \widetilde{y}^{*TH}$ if $c_y < \frac{A(1-t)}{2-t} < \frac{A(2-t)}{7-5t}$. With $c_y \geq \frac{A(1-t)}{2-t}$, the monopoly equilibrium arises. When the MNE's subsidiary becomes a monopolist, the MNE's post-tax profits are

$$\begin{aligned}\widetilde{\Pi}_M^{TH} &= \left(\widetilde{p} + \frac{t\widetilde{v}_x}{(1-t)}\right)\widetilde{x} = \frac{1}{a}\left(\frac{A}{2} - \frac{t\widetilde{v}_x}{2(1-t)} + \frac{t\widetilde{v}_x}{(1-t)}\right)\left(\frac{A}{2} - \frac{t\widetilde{v}_x}{2(1-t)}\right) \\ &= \frac{\left(A - At + t\widetilde{v}_x\right)^2}{4a(1-t)^2},\end{aligned}$$

which is increasing in $\widetilde{v}_x$. Noting $\widetilde{p} - \widetilde{v}_x \geq 0$, we obtain $\widetilde{p}^{*TH} = \widetilde{v}_x^{*TH} = c_y$. This implies that $\widetilde{x}^{*TNM} + \widetilde{y}^{*TNM} < \widetilde{x}^{*CUP} + \widetilde{y}^{*CUP} < \widetilde{x}^{*TH} + \widetilde{y}^{*TH}$ if $c_y \geq \frac{A(1-t)}{2-t}$. □

Appendix D: Imperfect substitution

We have seen the contrasting effects of the ALP by considering two extreme cases: no substitutability and perfect substitutability. This appendix shows that results are similar with imperfect substitutability.

Let us consider the Cournot competition with the following linear demand $p_x = A - ax - \gamma ay$ and $p_y = A - ay - \gamma ax$, where $\gamma \in [0, 1]$ represents degree of substitutability of the goods. The two goods are independent if $\gamma = 0$ holds and are homogeneous if $\gamma = 1$.

Figure 7 shows how an increase in γ affects the threshold η^L and the welfare effects of the ALP with two different MCs of the local firm with $t = 0.3$.[36] In the upper figure in Fig. 7, the threshold η^L under a larger (smaller) MC of the local firm is drawn with the dashed (solid) curve. The thresholds increase in the degree of substitutability γ because higher substitutability makes the gains from the strategic use of royalty setting larger and thus licensing to the local firm is more beneficial for the MNE.

To see the opposite effects of the ALP as in Figs. 2 and 4, let's consider the case where η is sufficiently high. With $\eta = 0.95$, the equilibrium licensing strategy is non-licensing except for the case with small MC ($c = 1/40$) and sufficiently large γ. At $\gamma = 0$, $\Delta W = W^{TNM} - W^{TH} < 0$ because consumers' loss due to non-licensing dominates tax revenue from the MNE. As a larger γ generates stronger incentive for

[36] The following parameter values are set: $A = 1$, $a = 1$.

strategic use of royalty setting under the case without the ALP. Hence, consumers' gains from the ALP become the dominant effect when γ is high. Therefore, we can confirm a threshold of γ at which $\Delta W = 0$ holds, which is drawn with the vertical lines in the bottom figure.

In addition, Fig. 8 shows the contrast effects of the ALP with $t = 0.5$ as in Figs. 3 and 6. Likewise in the upper figure of Fig. 7, the threshold of η^L is upward sloping. With $\eta = 0.1$, the MNE always licenses the technology to the local firm and the welfare effect is illustrated in the bottom figure of Fig. 8. At $\gamma = 0$, the effect of the ALP is always positive due to tax revenue from the MNE without any consumers' losses. A larger γ, however, generates strategic motive for royalty manipulation and total supply by the firms declines. As γ is higher, this consumer's losses tend to dominate tax revenue from the MNE and harmful ALP realizes. Thus again, we can see a thresholds of γ at which $\Delta W = W^{CUP} - W^{TH} = 0$ holds.

Appendix E: Product innovation

One may think that the results in the main analysis change with a patent for a new product, because the MNE seems to have no incentive for technology licensing which creates competitors. However, if such a monopoly situation induces a local potential firm to enter the market by developing its own technology through R&D or imitation, the MNE is likely to license its own technology to the local firm to obtain licensing revenues.

Suppose that the MNE develops a new technology to produce a brand new good at constant MC which is normalized to zero. On the other hand, the local firm is a potential entrant by developing their technology by incurring fixed R&D cost F. R&D successfully develops a new technology to produce the good at zero MC with the probability $\rho \in (0, 1)$ and fails with probability $1 - \rho$. The firms face the linear inverse demand function $\widetilde{p} = A - a(\widetilde{x} + \widetilde{y})$ as shown in Eq. (16). Again, we assume the Cournot duopoly after licensing as in Sect. 4.

As the outcome of R&D investment is probabilistic, the MNE and local firm determine their decision based on expected revenues. That is, the followings are, respectively, the condition that the local firm accepts the take-it-or-leave-it offer and the condition that MNE grants its technology patent to the local firm:

$$E(\Delta\pi_y) \equiv (1-t)(1-r_y)\widetilde{p}\widetilde{y} - \left(\frac{\rho(1-t)A^2}{9a} - F\right) \geq 0,$$

$$E(\Delta\Pi_M) \equiv \{(1-t)(1-r_x)\widetilde{p}\widetilde{x} + r_x\widetilde{p}\widetilde{x} + r_y\widetilde{p}\widetilde{y}\} - \left\{\frac{(1-\rho)A^2}{4a} + \frac{\rho A^2}{9a}\right\} \geq 0.$$

The conditions tell two features of the modified model. First, as R&D becomes less successful, the entry of the local firm is less likely and the MNE can set higher royalty rate to the local firm. Hence, with small ρ , the optimal royalty is unity and the monopoly outcome can arise. Second, the effect of higher ρ has two opposite impacts on MNE's revenues. On the one hand, higher probability of successful R&D increases the MNE's expected gains from licensing due to reduction in the expected

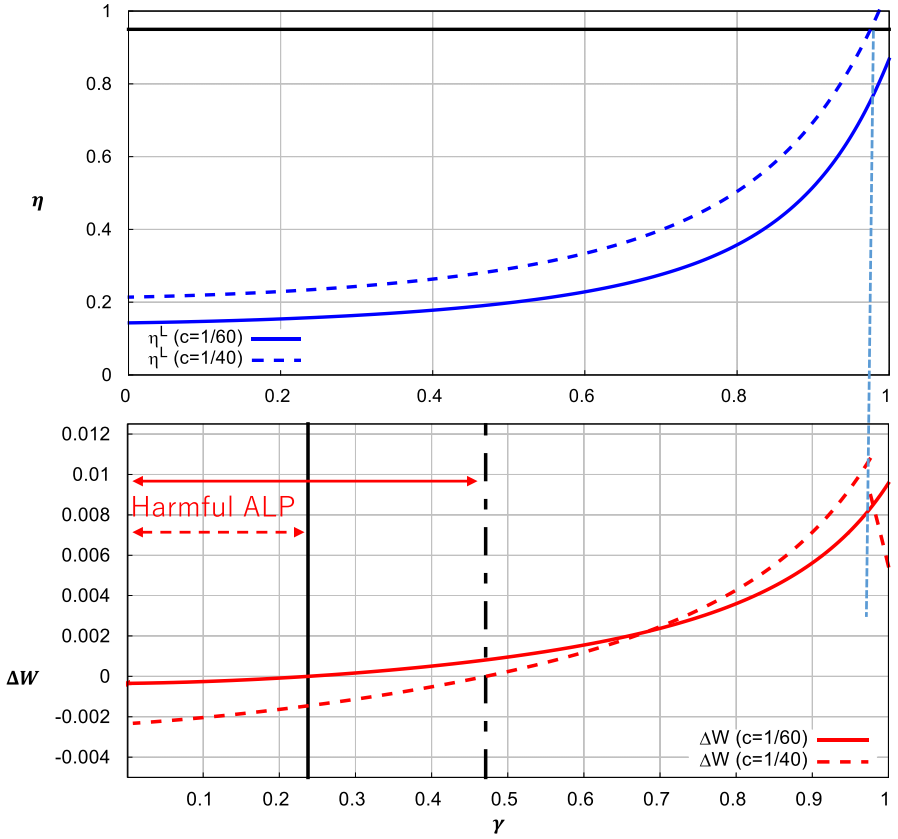


Fig. 7 Imperfect substitutability and welfare effects of the ALP with $t = 0.3$

revenue under non-licensing, captured by the second bracket of $E(\Delta\Pi_M)$. On the other hand, the higher probability of successful R&D decreases royalty rate for the local firm and subsequently reduces the MNE's post-tax profits under licensing. Hence, the total impact is ambiguous depending on the size of ρ

The above discussion is illustrated in Fig. 9.[37] All the four curves in the figure show the MNE's expected gains from licensing $E(\Delta\Pi_M)$ over probability of successful R&D ρ. The solid curve represents the case without the ALP while the dashed curves depict those with the ALP at different levels of η.

Without the ALP, when probability of successful R&D is sufficiently low, the monopoly outcome due to $r_y = 1$ occurs, which is steep part of the solid curve in the area under lower ρ. However, a higher ρ makes the royalty lower than unity. In the middle size of ρ, a higher probability increases the expected gains from licensing due to the reduction in the MNE's expected revenue under non-licensing. However,

[37] The following parameters are set: $A = 1$, $a = 1$, $t = \frac{3}{10}$, and $F = \frac{1}{500}$.

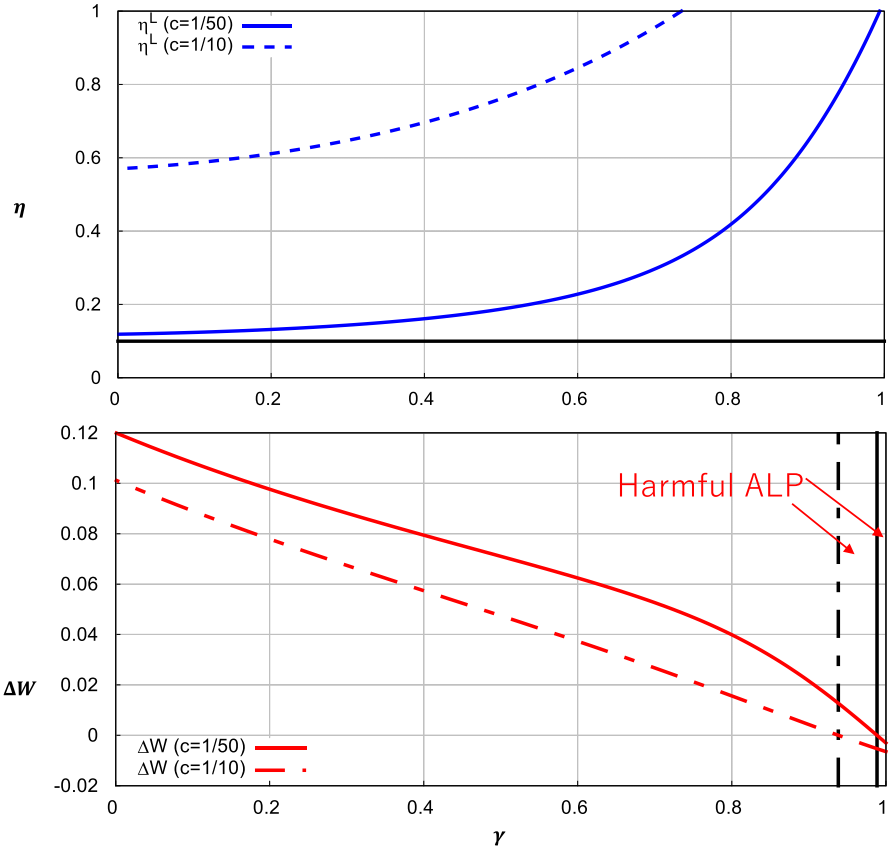


Fig. 8 Imperfect substitutability and welfare effects of the ALP with $t = 0.5$

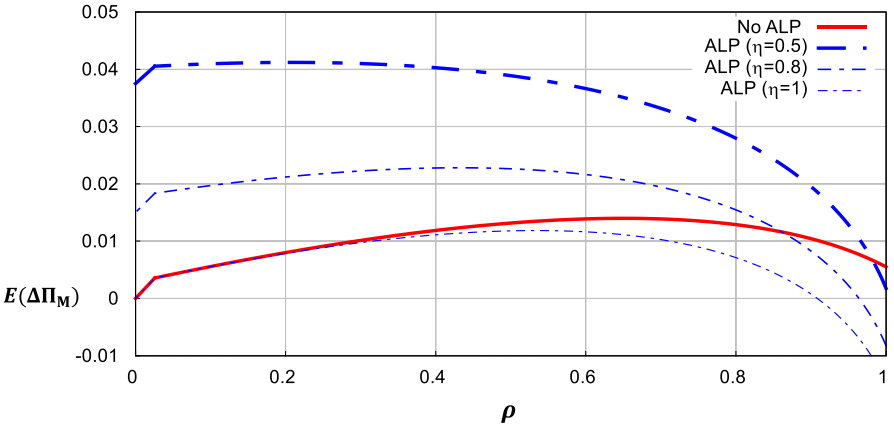


Fig. 9 Probability of successful product innovation and licensing decision

a further higher likelihood of successful R&D magnify the effect of lower royalty to the local firm and thus $E(\Delta\Pi_M)$ is lower. In short, due to the above counteracting impacts of an increase in probability of successful R&D, the curves are hump-shaped. Even with the negative effect on the MNE's gains from licensing, the figure shows $E(\Delta\Pi_M) \geq 0$ implying that the MNE always licenses its technology to the local firm without the ALP as in Sect. 4.

With the ALP, similar shapes of the MNE's expected gains from licensing are depicted where the thinnest one shows the MNE's expected profits of licensing under $\eta = 1$ and the thickest shows that under $\eta = 0.5$. Intuitively, the MNE's expected revenue under non-licensing becomes smaller under lower η because such stricter TNM method does not allow the MNE to save tax. Therefore, The MNE's expected gains from licensing are greater as η is smaller.

Moreover, under the ALP, it is impossible for the MNE to discriminate royalty rate and thus the strategic use of royalty setting is also weakened, which implies the gains from licensing are likely to be smaller under the ALP than those without the ALP. This negative aspect has greater impacts when the likelihood of successful R&D is more likely because the strategic royalty is further downwardly distorted because of the local firm's smaller gains from taking the licensing offer. In Fig. 9, this point is captured by the steeper dashed curve than the solid curve under higher ρ. As a result, the figure shows the existence of the case where the MNE's expected gains from licensing are negative in the presence of the ALP and the MNE stops licensing only after the ALP is introduced when both sufficiently high η and ρ hold. Hence, our results obtained in Sect. 4 are robust even with product innovation as long as R&D for a new technology is highly successful.

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