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The Destination Service Tax, Multisided Platform Firms, and Local Firms:

The Role of Tax Havens

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The Destination Service Tax, Multisided Platform Firms, and Local Firms: The Role of Tax Havens

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Abstract

Several countries have implemented a unilateral Digital Services Tax (DST) on revenue from large digital companies. We study how the DST affects competition, consumer prices and tax revenue when a two-sided multinational platform firm competes against a local firm. The platform firm located in a low-tax country (tax haven) derives revenue from exporting a good to its retailer in a high-tax country and by selling advertisement from its tax haven location. The profitability of selling ads is a positive function of how much the retailer sells (network externality). We show that if the network effect between the platform's two sources of revenue is sufficiently strong, the DST reduces consumer prices and profit shifting.

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1 Introduction

A number of countries have implemented a Digital Services Tax (DST), which is a unilateral measure to tax revenue generated by digital companies operating within their jurisdictions, particularly from activities that exploit user participation and data. Digital companies typically sell services, like advertising, through affiliates in low-tax countries. These services are based on the use of products in high-tax countries (such as web browsers or social media platforms), which allow firms to collect user data. This data is valuable to advertisers in the high-tax country. DSTs have generally been seen as a stop-gap measure to immediately address perceived tax base erosion due to the digital economy and lack of tax domicile. The DST taxes typically target large digital companies (often with multinational scope) that may have significant user interaction but limited physical presence in the taxing country.[1]

The literature on the DST is limited and has mostly attracted the attention of legal scholars. Cui (2019), for example, argues that the DST is a more practical and effective legal solution compared to proposals focused on taxing based on a company's "significant digital presence." Cui and Hashimzade (2019) argue that the DST is a tax on location-specific rents and Watanabe (2021) discusses potential issues of double taxation that could arise under the DST and raises concerns about whether the DST might violate World Trade Organization rules. Lassmann et al. (2020) study the effects of taxation on the international online advertising market, using data on Facebook ad prices. Their data encompass a de facto increase in the platform's corporate tax rate in several countries and show that changes in these tax rates create international spillovers. Their empirical model suggests that higher

[1]France was one of the first major economies to implement a DST. The French digital tax applies a 3 percent tax on the revenues from digital services for companies with global revenues of more than €750 million and more than €25 million from within France. In April 2020, the UK implemented a DST. It imposes a 2 percent tax on the revenues of search engines, social media services, and online marketplaces deriving value from UK users, with these businesses needing to generate global revenue of more than £500 million and more than £25 million from UK users. Other countries that have implemented a DST is Italy (2 percent), Austria (5 percent), Turkey (7,6 percent) and India (2 percent). Many of these countries apply the DST to enterprises with worldwide revenues above €750 millions.

corporate taxes reduces the supply of ads to advertisers from countries where taxation increases. In recent paper, Hines Jr (2023) claim that countries have incentives to impose excessively high DST rates because the DST tax falls on foreign firms and because the DST has negligible effect on domestic firms.

To the best of our knowledge, this study is the first to analyze theoretically how the DST affect competition, consumer prices, and tax base erosion through profit shifting. Our starting point of analysis is one with two countries: a high-tax country and a low-tax country (the latter also referred to as a tax haven). A multinational digital platform has its parent firm in the tax haven and a retail affiliate in the high-tax country. The parent exports a product to the affiliate, which competes with a local retailer on price in the high-tax country. The products are imperfect substitutes. The parent also sells advertising in the high-tax country, benefiting from positive network externalities between retail sales and advertising revenue, as increased sales make advertising more attractive. This externality can be understood as the parent firm collecting valuable data for advertisers from its retailer's sales. The high-tax country imposes a DST on advertising revenue generated within its borders, as the parent firm lacks a tax domicile there.

We show that differences in corporate tax rates incentivize the MNE to set a high transfer price thereby inducing a favorable response from the retailer's local competitor. A high transfer price dampens competition. A high transfer price also aligns with the incentive to shift income to the parent company in the tax haven. The DST mitigates the incentive to set a high transfer price since advertising revenue is hurt by high retail prices and correspondingly low sales by the retailer. Taken in isolation, the DST increases competition in the retail market and reduces profit shifting. We show that the interplay between corporate taxes and the DST depends on the strength of the network externality. If the network effect is sufficiently strong, the DST reduces consumer prices and profit shifting.

The outline of the paper is as follows. In Section 2 we outline the model, while in Section 3 we study how the MNE and its competitor in the local markets behave. In Section 4 we consider public policy given the interplay between corporate taxes, the DST and competition in the retail market.

Section 6 sums up our results.

2 The model

A two-sided multinational platform firm has a parent firm located in country h, which is a low-tax country (tax haven). The parent produces good x at constant marginal costs c, which we normalize to zero. It exports good x to its affiliate b which is a retailer located in high-tax country b. The export price (transfer price) is denoted q. If the transfer price deviates from the true cost of the exported product (that is if $q \neq 0$), the parent firm incurs costs associated with concealing the true transfer price equal to $\gamma C(q)x$, where we assume that concealment costs arise from the application of the standard OECD Comparable Uncontrolled Price (CUP) method.[2] The concealment cost is convex in the deviation from the arm's length transfer price (i.e., convex in q) and proportional to the volume of internal trade x. Formally, we have the following properties: $C(0) = 0$, $C'(q) > 0$ if $q > 0$, and $C'(q) < 0$ if $q < 0$, and $C''(q) > 0$. Finally, γ is a constant cost parameter that captures strictness of the tax planning regulation. For example, laxer rules with more loopholes reduce γ and effective concealment costs.

The retailer in country b (firm b) faces a local competitor (firm b^*). In the continuation, an asterisk $(*)$ denotes variables for firm b^*. Firms b and b^* sell x and x^* units at prices p and p^*. Price is the strategic variable in market b. The two firms' products in country b are imperfect substitutes. The revenue functions of affiliate b and its competitor are $r_b(p, p^*)$ and $r_b^*(p^*, p)$, respectively. The sold quantities depend negatively on the own price, but positively on the price of the other firm, that is, $\frac{\partial x}{\partial p} < 0$, $\frac{\partial x}{\partial p^*} > 0$ and $\frac{\partial x^*}{\partial p} > 0$, $\frac{\partial x^*}{\partial p^*} < 0$. We invoke the usual assumption that the own price effect on demand dominates the effect of a change in the product price of the competing firm, that is, $\left|\frac{\partial x}{\partial p}\right| > \left|\frac{\partial x}{\partial p^*}\right|$. In addition, we assume $\left|\frac{\partial^2 r_b^*}{\partial p^2}\right| > \left|\frac{\partial^2 r_b^*}{\partial p \partial (p^*)}\right|$, that is, the direct price effect on marginal revenue is stronger in absolute terms than the

[2]The CUP method works by comparing the price charged for a product or service in a controlled transaction with the price charged in an uncontrolled transaction (between independent parties) involving comparable products or services under similar circumstances.

cross-price effect.[3]

Affiliate h sells advertising space a to advertisers in country b at a price p_a. There are network externalities between good x and good a meaning that the willingness to place advertisement increases when the trade volume x increases: $\frac{\partial p_a(a,x)}{\partial x} > 0$. Consider good x as something akin to a web browser, a PC game, or a newspaper. The more viewers, gamers, or readers that purchase good x, the more profitable it becomes to target this group with advertisements, and therefore, the higher the willingness to pay for placing such an ad.

Since good x is sold through a retailer in country b, affiliate b is according to international tax law subject to corporate tax in country b. The corporate tax rate is given by t_b. Similarly, the affiliate in country h pays corporate tax t_h on its profits reported in country h. As country h is assumed to be a tax haven, we have $t_b > t_h$. Furthermore, country b levies a Digital Services Tax (DST) denoted by tax rate τ on revenue generated by harvesting data from the consumption of good x in country b that firm h must pay. The DST is aimed at taxing advertising revenue arising from advertisers located in country b in firms that do not (necessarily) have a physical presence in country b.

After-tax profit by affiliate b is

$$\pi_b = (1 - t_b)[r_b(p, p^*) - qx(p, p^*)]. \tag{1}$$

For simplicity, we assume that the local competitor in b also has constant marginal costs that are normalized to zero. Moreover, we assume that it is no platform firm and does not earn ad revenues. Hence, the after-tax profit function of the local competitor reads

$$\pi_b^* = (1 - t_b)r_b^*(p^*, p). \tag{2}$$

[3]Note that this assumption is always fulfilled for linear demand functions and $\left|\frac{\partial x}{\partial p}\right| > \left|\frac{\partial x}{\partial p^*}\right|$.

Finally, after-tax profit by the tax haven affiliate h is

$$\pi_h = (1 - t_h)[qx(p, p^*) + (1 - \tau)p_a(a, x(p, p^*))a - \gamma C(q)x(p, p^*)]. \quad (3)$$

Importantly, the affiliate in h only decides on the volume of advertisements to be placed at price $p_a(a, x(p, p^*))$, not on the transfer price q.

The headquarters (henceforth HQ) of the MNC decides on the transfer price with the aim of maximizing world-wide income after tax Π, but delegates authority to its affiliates in countries h and b to decide on the quantity and prices, respectively, for the final goods. Such delegation of authority is widespread among MNCs and in the wider business community.[4] The benefit of delegation is a central theme in the Industrial Organization (IO) literature, where a principal (here the HQ) may benefit from hiring an agent (here firms h and b) and giving him or her the incentive to maximize something other than the welfare of the principal.[5]

The game we consider is one where the HQ first announces its transfer price q. Then affiliate b and its competitor set prices p and p^*. As shown by Bulow et al. (1985) and Fudenberg and Tirole (1991), adopting a commitment strategy can allow the firm to influence its competitor's actions in a favorable way. In our setting, the commitment strategy will be the setting of the transfer price by the HQ.

The model has two stages and is solved by backward induction. The timing is as follows. At stage 1, the HQ of the MNC decides on the transfer price q on good x by maximizing global after-tax profits equal to $\Pi = \pi^h + \pi^b$. At stage 2, affiliates h and b maximize their profit by setting the optimal ad volume a and the optimal good price p, respectively, taking the transfer price as given. Simultaneously, the local firm b^* sets its price p^*, observing the given transfer price q of the MNC. In the next section, we solve the model.

[4] A substantial body of literature thoroughly documents and explores the extent of decentralization in various industries and within MNCs, see e.g., Grandstand (1992), Almeida (1996), Papanastasiou and Pearce, 2005. Graham et al. (2015) provide a survey of decision-making authority within firms.

[5] See, e.g., Vickers (1985), Sklivas (1987), Fershtman and Judd (1987), and Katz (1991).

3 Solving for optimal firm behavior

In this section, we solve for the optimal behavior of the MNC's affiliates, the local firm, and the HQ of the MNC by backward induction.

3.1 Ad volume and price competition

At stage 2, the MNC affiliate in country b maximizes its profits by solving

$$\max_{p} \pi_b = (1 - t_b)[r_b(p, p^*) - qx(p, p^*)]. \tag{4}$$

The first-order condition follows as

$$\frac{\partial \pi_b}{\partial p} = 0 \qquad \rightarrow \qquad \frac{\partial r_b}{\partial p} = q\frac{\partial x}{\partial p}. \tag{5}$$

The marginal return from selling good x is set equal to marginal costs of transfer payments in the optimum.

The local competitor chooses its price by maximizing

$$\max_{p^*} \pi_b^* = (1 - t_b) r_b^*(p, p^*), \tag{6}$$

and the first-order condition is

$$\frac{\partial \pi_b^*}{\partial p^*} = 0 \qquad \rightarrow \qquad \frac{\partial r_b^*}{\partial p^*} = 0. \tag{7}$$

It states that the marginal return equals marginal costs (normalized to zero).

Finally, the advertisement division in country h chooses the ad volume a such that

$$\max_{a} \pi_h = (1 - t_h)[qx(p, p^*) + (1 - \tau)p^a(p_a, x(p, p^*))a - \gamma C(q)x(p, p^*)]. \tag{8}$$

This implies a first-order condition

$$\frac{\partial \pi_h}{\partial a} = 0 \qquad \rightarrow \qquad p_a(a, x(p, p^*)) + \frac{\partial p_a}{\partial a}a = 0, \tag{9}$$

where once again, marginal return is equal to marginal costs (normalized to zero).

To complete the analysis at stage 2, we provide some comparative-static results. Obviously, there is no direct effect of tax policy on the behavior of affiliates b and h and the local competitor b^*. All effects run via the transfer price q only. These effects result as follows, see Appendix A for the formal derivations. A change in the transfer price q implies

$$\frac{dp}{dq} = \frac{\frac{\partial x}{\partial p}\frac{\partial^2 r_b^*}{\partial (p^*)^2}U_a}{|H|} > 0, \tag{10}$$

as $U_a < 0$ and $|H| < 0$. An increase in the transfer price increases marginal costs for the affiliate in country b. Therefore, it is optimal for this affiliate to increase its price p.

Since the firms in market x compete in prices, and prices are strategic complements, the rival firm will increase its price in response to an increase of the transfer price of the MNC as well. Indeed, our comparative-static analysis confirms that

$$\frac{dp^*}{dq} = \frac{|H_{p^*q}|}{|H|} = -\frac{\frac{\partial x}{\partial p}\frac{\partial^2 r_b^*}{\partial p \partial (p^*)}U_a}{|H|} > 0. \tag{11}$$

as $\frac{\partial^2 r_b^*}{\partial p \partial (p^*)} > 0$.

Finally, a higher transfer price has a negative effect on the ad volume:

$$\frac{da}{dq} = \frac{|H_{aq}|}{|H|} = \frac{\frac{\partial x}{\partial p}}{|H|}\left(\frac{\partial^2 p_a}{\partial a \partial x}a + \frac{\partial p_a}{\partial x}\right)\left[\frac{\partial^2 r_b^*}{\partial p \partial p^*}\frac{\partial x}{\partial p^*} - \frac{\partial^2 r_b^*}{\partial (p^*)^2}\frac{\partial x}{\partial p}\right] < 0, \tag{12}$$

as $\frac{\partial^2 p_a}{\partial a \partial x} > 0$ from the network externality and the own-price effects dominate the cross-price effects. Intuitively, a higher transfer price reduces the effect of the network externality because the sale of good x decreases. This turns advertisement less profitable. Therefore, the optimal volume in the advertisement market shrinks.

3.2 Transfer pricing with network effects

Turning to stage 1, the HQ maximizes global after-tax profits by setting the optimal transfer price according to

$$\begin{aligned}\max_{q}\Pi &= \pi_h + \pi_b \\ &= (1-t_h)[qx(p,p^*) + (1-\tau)p^a a(p_a, x(p,p^*)) - \gamma C(q)x(p,p^*)] \\ &+ (1-t_b)[r_b(p,p^*) - qx(p,p^*)], \end{aligned} \tag{13}$$

where $a = a(q)$, $p = p(q)$, and $p^* = p^*(q)$.

Making use of the Envelope theorem, i.e., $\frac{\partial \pi_h}{\partial a} = 0$ and $\frac{\partial \pi_b}{\partial p} = 0$ from the choices on stage 2 and collecting terms, the corresponding first-order condition results as

$$\begin{aligned}\frac{\partial \Pi}{\partial q} &= \frac{\partial \pi_h}{\partial p}\frac{\partial p}{\partial q} + \frac{\partial \pi_h}{\partial p^*}\frac{\partial p^*}{\partial q} + \frac{\partial \pi_h}{\partial q} + \frac{\partial \pi_b}{\partial a}\frac{\partial a}{\partial q} + \frac{\partial \pi_b}{\partial p^*}\frac{\partial p^*}{\partial q} + \frac{\partial \pi_b}{\partial q} \\ &= [(t_b - t_h) - (1-t_h)\gamma C'(q)]\, x(p,p^*) \\ &+ (1-t_b)\left(\frac{\partial r_b}{\partial p^*} - q\frac{\partial x}{\partial p^*}\right) + (1-t_h)\,[q - \gamma C(q)]\left(\frac{\partial x}{\partial p}\frac{\partial p}{\partial q} + \frac{\partial x}{\partial p^*}\frac{\partial p^*}{\partial q}\right) \\ &+ (1-t_h)(1-\tau)\frac{\partial p_a}{\partial x}a\left(\frac{\partial x}{\partial p}\frac{\partial p}{\partial q} + \frac{\partial x}{\partial p^*}\frac{\partial p^*}{\partial q}\right) = 0, \end{aligned} \tag{14}$$

where $\frac{\partial x}{\partial p}\frac{\partial p}{\partial q} + \frac{\partial x}{\partial p^*}\frac{\partial p^*}{\partial q} < 0$ because $\left|\frac{\partial x}{\partial p}\right| > \left|\frac{\partial x}{\partial p^*}\right|$ and $\frac{dp}{dq} > \frac{dp^*}{dq} > 0$, see equation (A.8). Consequently, the total effect of a higher transfer price q is a reduction of sales of good x.

The second line of equation (14) represents the standard profit shifting motive. Higher marginal tax savings, net of marginal tax planning costs, foster transfer pricing. The third line captures the classic strategic effect under delegation. A higher transfer price mitigates price competition on stage 2 and allows for larger after-tax profits of the MNC (and affiliate b), see the first term in that line. This delegation effect gets corrected by the fact that a reduced sales volume of good x reduces after-tax revenues from intra-firm trade, but also reduces total tax planning costs in affiliate h, see the second term in the third line.

Eventually, the network effect enters the transfer price considerations in

the last line of equation (14). This new effect counteracts the standard delegation effect, as it calls for a lower transfer price. A lower transfer price fosters price competition on stage 2, the sold quantity in market x increases such that the network externality increases and allows for exploiting more profits in the advertisement market.

Interestingly, the network effect not only counteracts the delegation effect. Given that MNCs place their network affiliates in tax havens, see, e.g., Google,[6] the network effect also mitigates the choice of tax-motivated transfer prices. Whether the network effects reduces the *volume* of profit shifting is not clear, however, as it increases the sales of the good in which transfer pricing takes place. Hence, the total effect depends on whether the price effect (on q) dominates the volume effect (on x).

4 Public policy under network effects

Given our model and the newly identified network effect in transfer pricing, how does a DST then affect firms' behavior, tax planning, and market structure? Totally differentiating the first-order condition (14) for the transfer price q and a change in the DST rate τ leads to

$$\frac{dq}{d\tau} = \frac{(1-t_h)\frac{\partial p_a}{\partial x} a \left(\frac{\partial x}{\partial p}\frac{\partial p}{\partial q} + \frac{\partial x}{\partial p^*}\frac{\partial p^*}{\partial q} \right)}{\frac{\partial^2 \Pi}{\partial q^2}} > 0, \tag{15}$$

as $\frac{\partial^2 \Pi}{\partial q^2} < 0$ from the second-order condition.

Thus, the DST leads to a higher transfer price. The effect works via the network externality only and the intuition is as follows:[7] The DST makes the advertisement market less attractive so that the network externality matters less. Therefore, as the network effect weakens, the MNC sets a higher transfer

[6] Under the infamous 'Double-Irish-Dutch Sandwich', Google shifted all advertisement revenues generated via its search engine to Bermuda.

[7] If one models more classic corporate income taxes in which not all costs (of capital) are tax deductible, additional distortions and effects arise. As in the relevant markets marginal costs are close to zero, however, and to focus on the network effect, it is preferable to model the corporate taxes as economic-profit taxes.

price and focuses more on profits in the retail market.

Evaluating the DST in light of our results in the previous section, there are a couple of surprising and relevant effects. A DST-induced higher transfer price *fosters* profit shifting for a given sales volume in market x. The effect on total profit shifting, qx, however, is ambiguous as the higher transfer price triggers lower sales of good x. The stronger focus of the MNC on the retail market strengthens the delegation effect, mitigates price competition, and shrinks supply in market x due to higher prices by all firms involved (i.e., $\frac{dp}{dq} > 0$ and $\frac{dp^*}{dq} > 0$). This is good news for the local competitor of the MNC as its profits increase. In contrast, there are twice bad news for consumers in country b. The DST not only reduces supply in the (network) market falling under the DST (i.e., $\frac{da}{dq}\frac{dq}{d\tau} < 0$). The induced network distortions come with welfare losses from reduced competition and larger market imperfection in the 'non-DST' good as well.

In sum, the upsides of the DST are from point of view of country b that the country relocates (advertisement) tax base from country h and protects its local firm against price competition with the MNC. These benefits face relevant costs, however, as the DST harms market efficiency and consumers in *all* markets and potentially fosters profit shifting in the 'non-DST' market.

Can country b do better? An alternative in our set-up is to tighten rules against tax planning, e.g., by enforcing stricter controlled-foreign-company rules that target passive income in tax havens.[8] In our setting, such a reform can be captured by a larger parameter γ of tax planning costs. Totally differentiating the first-order condition (14), the effect of stricter regulation on the transfer price is

$$\frac{dq}{d\gamma} = \frac{(1-t_h)C'(q)x(p,p^*) + C(q)\left(\frac{\partial x}{\partial p}\frac{\partial p}{\partial q} + \frac{\partial x}{\partial p^*}\frac{\partial p^*}{\partial q}\right)}{\frac{\partial^2 \Pi}{\partial q^2}} \gtrless 0, \tag{16}$$

[8]Controlled Foreign Company (CFC) rules are regulations that aim to prevent multinational companies from avoiding taxes in their home countries by shifting profits to low-tax or no-tax jurisdictions through foreign subsidiaries. These rules ensure that the income earned by a foreign subsidiary is taxed in the parent company's home country, even if the income has not been repatriated.

The effect of stricter transfer pricing regulation on the transfer price is ambiguous. Two opposing effects ar at play in the numerator. The first term is the after tax cost of abusive transfer pricing. This term is positive. The second term is the effect of a change in the transfer price on product prices weighted by transfer pricing costs. This is a strategic effect of transfer pricing under delegation not captured previously in the literature. This term is negative under price competition. It is clear from the numerator that the shape of the cost function matters for the end outcome. If tax planning costs are sufficiently convex and the marginal tax planning costs are sizeable, the transfer price will fall and profit shifting is reduced when regulation becomes stricter.

To conclude, both policy interventions come with costs and benefits, and it is an empirical question which intervention is preferable. Apparently, the choice is between reducing traditional profit shifting and fostering market efficiency on the one hand versus reducing 'homeless profits' in the network market on the other hand. Our conjecture, to be tested in future research, is that relying on more traditional tax planning regulation and foregoing the relocation of the 'homeless' tax base in the 'DST market' is less costly and has larger net benefits than imposing a DST.

5 Conclusions

We set up a model that allows us to study how the DST tax affects behaviour of a two-sided multinational platform firm. Our set up is one with a multinational digital platform firm that has has its parent firm located in a tax haven country and an affiliate in the form of a retailer in a high-tax country. The parent firm exports a product to its retailer, who sells it in the high-tax country, competing on price with a local retailer. Based on its retailer's sales in the high-tax country, the parent firm sells advertisement to customers in the high-tax country. There is a positive network externality between sales of the exported good in the high-tax country and advertising revenue as increased sales by the retailer makes it more attractive to buy advertising. One way to interpret this externality is that the sales by its

retailer allows the parent firm to collect data that is valuable to advertisers in the high-tax country.

Our modelling allows us to study the interaction between the DST, corporate taxes and the incentives facing the MNE and its competitior. We derive two main results. First, all else equal, the DST increases competition in the retail market and reduces profit shifting. Since there is a positive network externality between sales of the exported good in the high-tax country by the retailing affiliate and advertising revenue, the DST induces the MNE to lower its retail price thereby intensifying competition.

Second, the MNE derives income from three sources: profit shifting to save taxes, retail profits, and advertising revenue from the parent company. We demonstrate that the interaction between corporate taxes, the DST, and these revenue sources is critical. If the network effect is sufficiently strong, the DST lowers consumer prices (increasing competition) and reduces profit shifting.

A Comparative statics

Totally differentiating the first-order conditions (5), (7), and (9) delivers

$$\left(\frac{\partial^2 r_b}{\partial p^2} - q\frac{\partial^2 x}{\partial p^2}\right)dp + \left(\frac{\partial^2 r_b}{\partial p \partial p^*} - q\frac{\partial^2 x}{\partial p \partial p^*}\right)dp^* - \frac{\partial x}{\partial p}dq = 0, \quad \text{(A.1)}$$

$$\frac{\partial^2 r_b^*}{\partial p \partial p^*}dp + \frac{\partial^2 r_b^*}{\partial (p^*)^2} = 0, \quad \text{(A.2)}$$

$$U_p dp + U_{p^*}dp^* + U_a da = 0, \quad \text{(A.3)}$$

where $U_a = \frac{\partial^2 P - a}{\partial a^2}a + 2\frac{\partial p_a}{\partial a} < 0$ from second-order conditions and $U_p = \frac{\partial p_a}{\partial x}\frac{\partial x}{\partial p} + \frac{\partial^2 p_a}{\partial a \partial x}\frac{\partial x}{\partial p}a < 0$ from the positive network externality and $\frac{\partial x}{\partial p} < 0$. In contrast, $U_{p^*} = \frac{\partial p_a}{\partial x}\frac{\partial x}{\partial p^*} + \frac{\partial^2 p_a}{\partial a \partial x}\frac{\partial x}{\partial p^*}a > 0$ as $\frac{\partial x}{\partial p^*} > 0$.

Collecting terms leads to

$$\begin{pmatrix} \frac{\partial^2 r_b}{\partial p^2} - q\frac{\partial^2 x}{\partial p^2} & \frac{\partial^2 r_b}{\partial p \partial p^*} - q\frac{\partial^2 x}{\partial p \partial p^*} & 0 \\ \frac{\partial^2 r_b^*}{\partial p \partial p^*} & \frac{\partial^2 r_b^*}{\partial (p^*)^2} & 0 \\ U_p & U_{p^*} & U_a \end{pmatrix} \begin{pmatrix} dp \\ dp^* \\ dp_a \end{pmatrix} = \begin{pmatrix} \frac{\partial x}{\partial p} \\ 0 \\ 0 \end{pmatrix} dq, \quad \text{(A.4)}$$

and from the second-order conditions, it follows for the main determinant of the Hessian matrix H that

$$|H| = U_a \cdot \left[\frac{\partial^2 r_b^*}{\partial (p^*)^2} \left(\frac{\partial^2 r_b}{\partial p^2} - q \frac{\partial^2 x}{\partial p^2} \right) - \frac{\partial^2 r_b^*}{\partial p \partial p^*} \left(\frac{\partial^2 r_b}{\partial p \partial p^*} - q \frac{\partial^2 x}{\partial p \partial p^*} \right) \right] < 0. \tag{A.5}$$

Then, the comparative-static effects of a change in the transfer price imply

$$\frac{dp}{dq} = \frac{|H_{pq}|}{|H|} = \frac{\frac{\partial x}{\partial p} \frac{\partial^2 r_b^*}{\partial (p^*)^2} U_a}{|H|} > 0. \tag{A.6}$$

and

$$\frac{dp^*}{dq} = \frac{|H_{p^* q}|}{|H|} = -\frac{\frac{\partial x}{\partial p} \frac{\partial^2 r_b^*}{\partial p \partial (p^*)} U_a}{|H|} > 0. \tag{A.7}$$

as $\frac{\partial^2 r_b^*}{\partial p \partial (p^*)} > 0$. Importantly, it holds

$$\frac{dp}{dq} > \frac{dp^*}{dq} > 0 \quad \text{as} \quad \left| \frac{\partial^2 r_b^*}{\partial p^2} \right| > \left| \frac{\partial^2 r_b^*}{\partial p \partial (p^*)} \right|. \tag{A.8}$$

Finally, we have

$$\frac{da}{dq} = \frac{|H_{aq}|}{|H|} = \frac{\frac{\partial x}{\partial p}}{|H|} \left(\frac{\partial^2 p_a}{\partial a \partial x} a + \frac{\partial p_a}{\partial x} \right) \left[\frac{\partial^2 r_b^*}{\partial p \partial p^*} \frac{\partial x}{\partial p^*} - \frac{\partial^2 r_b^*}{\partial (p^*)^2} \frac{\partial x}{\partial p} \right] < 0, \tag{A.9}$$

where $\frac{\partial^2 p_a}{\partial a \partial x} > 0$ from the network externality. As we have $\left| \frac{\partial x}{\partial p} \right| > \left| \frac{\partial x}{\partial p^*} \right|$, and the own-price effect on marginal revenue also is stronger than the cross-price effect, i.e., $\left| \frac{\partial^2 r_b^*}{\partial (p^*)^2} \right| > \left| \frac{\partial^2 r_b^*}{\partial p \partial p^*} \right|$, a higher transfer price q reduces the optimal volume of advertisement and $\frac{da}{dq} < 0$.

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Several countries have implemented a unilateral Digital Services Tax (DST) on revenue from large digital companies. We study how the DST affects competition, consumer prices and tax revenue when a two-sided multinational platform firm competes against a local firm. The platform firm located in a low-tax country (tax haven) derives revenue from exporting a good to its retailer in a high-tax country and by selling advertisement from its tax haven location. The profitability of selling ads is a positive function of how much the retailer sells (network externality). We show that if the network effect between the platform's two sources of revenue is sufficiently strong, the DST reduces consumer prices and profit shifting.

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