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Welfare Effects of One-sided Regulation when Internationally Traded Complements are Unregulated[1]

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Abstract: We consider the effects of a one-sided price regulation of one of two complementary inputs. The provider of the regulated component is a domestic firm, while the provider of the other component is a foreign firm. This describes the market structure for several digital information and communication services. We show that one-sided regulation may have negative welfare effects compared to a free market economy unless the regulator has a first-mover advantage. In the latter case, regulation is welfare enhancing regardless of whether the foreign input provider uses linear or non-linear wholesale prices.

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1 Introduction

Until a few years ago, information and communication services were offered through what we may call one-service access networks. Books were provided by bookstores, newspapers were delivered by the paperboy, TV-programs by broadcasting networks, and voice telephony by the telecommunication incumbents. Now we see a technological development where multi-service digital access networks deliver a whole range of content services in addition to conventional telecommunication services. One example is that (broadband) digital access networks distribute digital information services such as premium entertainment (e.g. movies and sport) to the end-users. Consumers then demand a system of complements, i.e. a combination of (broadband) access and premium content. In contrast to conventional telecommunication services, the system consists of several complementary input components produced by vertically separated firms.

Telecommunication incumbents apparently have market power with regard to digital access, and complementary input segments are dominated by other large companies with considerable market power.[2] However, while access to the local network is domestically regulated both on price and quality, complementary bottlenecks are unregulated. Hence, we have a market with one-sided regulation of complementary inputs. Another distinction between the access bottleneck and complements such as premium content is that local access by its very nature is provided locally, while other services typically are offered by multinational foreign firms.

The aim of the present paper is to analyze the implications of one-sided regulation of the domestic bottleneck in the presence of an unregulated foreign complementary bottleneck. Thus, we analyze a game between a domestic regulator and an unregulated foreign input provider. Who gains from one-sided regulation of the domestic input critically depends on the timing of the interaction between the regulator and the foreign input provider. We show that if the regulator, by imposing one-sided regulation, could become a first-mover, such one-sided regulation will enhance do-

[2] Cave and Crandall (2001) give an overview of the wholesale market for premium sport in the US and Europe.

mestic welfare. Put differently, if the regulator is able to commit itself, a binding price cap will always improve domestic welfare. This holds regardless of whether the foreign input provider uses linear or non-linear wholesale prices.

If the domestic regulator cannot credibly commit itself with respect to the price of digital access, a one-sided regulation has an ambiguous effect on welfare. The outcome depends on the degree of differentiation in the retail market and whether the foreign input provider uses linear or non-linear input prices. Indeed, if the regulator cannot ensure that it has a first-mover advantage, the best regulatory policy will often be not to regulate. The reason is that a price cap allows the foreign input provider to set a higher price, resulting in an excessive profit shifting out of the country.

Our paper is related to Economides and Salop (1992), who show that one-sided regulation of one of two complements lowers the end-user price of the composite goods.[3] As in our model, such regulation benefits the provider of the complementary component. However, they abstract from international trade. Therefore they do not consider profit shifting, and find that one-sided regulation is generally welfare enhancing.

The main distinction between our paper and the vast majority of the literature on access price regulation is that we incorporate elements from strategic trade policy. To our knowledge, just a few other papers analyze the relationship between access pricing and international profit shifting. Foros, Kind and Sørgard (2002, 2005) analyze a related market structure, but assume vertical integration between input providers and retailers, and the focus is whether vertically integrated firms have incentives to practice sabotage towards non-integrated retailers. Moreover, while we consider price competition with horizontal differentiation in the present paper, they assume Cournot competition with homogeneous retail services. However, the assumption of price competition and horizontal differentiation seems quite natural in the present context. We observe that retailers offer premium content only to their

[3]Economides and Salop (1992) generalize Cournot (1838), who showed that a merger between two monopolies that provide complementary inputs (zink and copper in order to produce brass) lowers the total end-user price compared to the case with independent firms.

own customers (see e.g. Shapiro and Varian, 1998). This is often called "walled garden strategies", and will by definition create product differentiation.

There are also some important distinctions between our study and literature on strategic trade policy. In particular, we focus on the effects of a price cap rather than on the effects of subsidies and tariffs. Moreover, we model a setting with complementary inputs produced by one foreign and one domestic firm, respectively. In contrast, strategic trade policy is typically focusing on downstream competition between domestic and foreign firms producing substitutes, and abstract from possible complementarities. For overviews of the literature on strategic trade policy, see for example Krugman (1989) and Brander (1995).[4]

The article is organized as follows. In the next section we present the model where we compare the market equilibrium with three different regulatory regimes. In Section 4 we offer some concluding remarks.

2 The model

There is one foreign firm, F, and one domestic firm, N, controlling each their essential input. These inputs are supplied to two downstream firms, X_1 and X_2, that sell differentiated consumer goods at prices p_1 and p_2, respectively, in a domestic market. The market structure is shown in Figure 1. We assume that X_1 and X_2 are independent domestic firms, and that they are charged n per unit of the input provided by firm N and f per unit of the input from firm F. Throughout the paper we assume that the only instrument available for the regulator is to regulate the price of local access n. The other input price f and the retail prices p_1 and p_2 are unregulated.

[4] Brander (1995) focus on two modelling approaches; the third-market model and the reciprocal-markets model. In both models it is assumed that firms produce substitutes, while we consider providers of input complements.

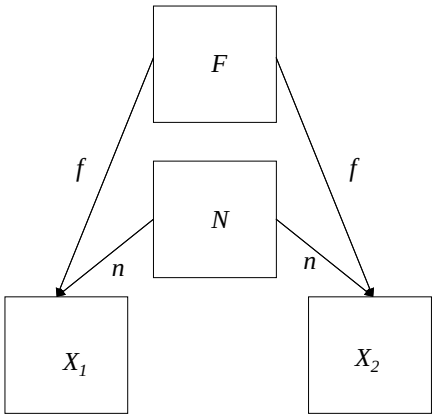

Figure 1: Market structure

Let p_i be the price of good x_i, where $i = 1, 2$, and assume that consumer demand is given by

$$p_i = 1 - x_i - bx_j, \ i = 1, 2 \quad (i \neq j). \tag{1}$$

The parameter b determines the degree of product differentiation, and we assume that $0 \leq b < 1$. If b is close to 1 the products are (almost) perfect substitutes, while they are independent if b equals 0.

Solving (1) with respect to quantities we find the following demand system for the downstream firms:

$$x_i = \frac{1 - b - p_i + bp_j}{1 - b^2}. \tag{2}$$

Using equations (1) and (2) we can express consumer surplus as

$$CS = \frac{1}{2}x_1^2 + \frac{1}{2}x_2^2 + bx_1x_2. \tag{3}$$

In order to produce the final goods the downstream firms need one unit of a service that is supplied by a domestic monopolist N and one unit of a service that is supplied by a foreign monopolist F. The profit levels of the downstream firms may thus be written as

$$\pi_i = (p_i - n - f)x_i. \tag{4}$$

The marginal costs of the domestic and foreign bottleneck inputs are normalized to zero, which means that the profit levels of these firms are equal to

$$\pi_N = n(x_1 + x_2) \tag{5}$$

and

$$\pi_F = f(x_1 + x_2). \tag{6}$$

Firm N and the two downstream firms are owned by domestic consumers, and the country's welfare is given by

$$W = CS + \pi_D, \tag{7}$$

where $\pi_D = \pi_N + \pi_1 + \pi_2$.

In the final stage of the game the two downstream firms compete á-la Bertrand. Inserting for (1) into (4) we find that $\partial \pi_i / \partial p_i = 0$ implies

$$p_i(p_j) = \frac{1 - (1 - p_j)b + n + f}{2}. \tag{8}$$

Since the downstream firms are symmetric we may omit subscripts, and express equilibrium prices and quantities as

$$p = \frac{1 - b + n + f}{2 - b} \tag{9}$$

and

$$x = \frac{1 - n - f}{(1 + b)(2 - b)}. \tag{10}$$

It is easily seen from equation (9) that the equilibrium end user prices approach monopoly prices as b approaches 0, and the perfectly competitive prices as b approaches 1.

Remark: An alternative market structure is one where the domestic input is sold directly from N to the end-users at a regulated price n (while the foreign input is still supplied through the retailers). This corresponds to a market where the digital platform provider offers access directly to end-users, and the end-users then buy complementary components from the other retailers. The qualitative results in the present model will still be valid.

2.1 Market equilibrium

In the first stage firms N and F simultaneously set n and f, respectively. Solving $\partial \pi_N / \partial n = 0 = \partial \pi_F / \partial f$ we find that

$$n = 1/2 - f/2 \equiv n^*(f) \tag{11}$$

and

$$f = 1/2 - n/2 \equiv f^*(n). \tag{12}$$

These are the upstream firms' reaction functions, and in Figure 2 we have drawn the reaction curves. They have negative slope, as is what we should expect in a setting with complementary products and price setting.[5]

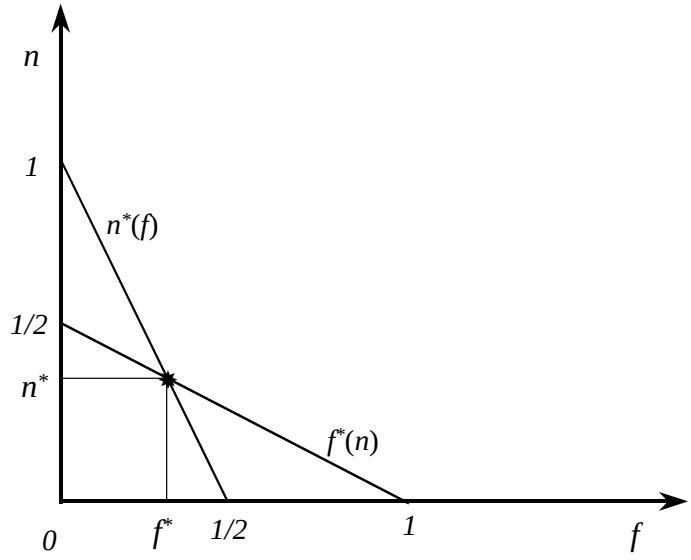

Figure 2: Reaction curves if no regulation

By combining equations (11) and (12) we find that

$$n = f = 1/3, \tag{13}$$

which are denoted by n^* and f^* in Figure 2. Inserting for n and f into (7) and (9) we further have

$$p = \frac{5 - 3b}{3(2 - b)} \tag{14}$$

and

$$W^* = \frac{7 - 4b}{9\,(b + 1)\,(2 - b)^2}. \tag{15}$$

[5] As shown in Bulow *et al.* (1985), with price setting and complementary products the choice variables are typically strategic substitutes. Then each reaction curve has a negative slope, as is the case in our setting.

2.2 One-sided regulation of the domestic upstream good

Let us now introduce regulation. Both in the EU and the US we observe that domestic providers of domestic access face a restrictive price cap. In line with this, we shall assume that the domestic regulator can impose a price cap on the domestic input. In principle it is possible that the government can commit itself to a certain price cap *before* the foreign firm sets its input price. We compare the case of commitment with the outcomes when (i) the foreign firm is better able to commit itself than the regulator and (ii) neither of them are able to commit themselves.[6] In line with this we find it natural to consider three different timings in this section. First we assume that the foreign firm has a first-mover advantage, then that the foreign firm and the regulator set their prices f and n simultaneously, and finally that the regulator has a first-mover advantage.

2.2.1 Ex post regulation

Suppose that the foreign firm is able to commit itself to a certain price f before the regulator chooses n. The regulator sets n such that domestic welfare is maximized. The best the regulator can do is then to set the price n such that the end-user price is equal to domestic marginal costs; $p = f$.[7] This means that n should be chosen according to $p = (1 - b + n + f) / (2 - b) = f$, or

$$n = -(1 - b)(1 - f) \equiv n^o(f). \tag{16}$$

This equation - which we denote the regulator's reaction function - reflects the fact that the price of the domestic input should be set lower the less competitive the downstream market. The optimal value of n is thus strictly increasing in b.

Note also that $n'(f) > 0$ for $b < 1$. The reason for this is that as long as the firms face downward-sloping demand curves it is inoptimal for the downstream firms to pass over an increase in f one-for-one to the consumers. Some of the cost increase

[6] This is in line with what is claimed by Brander (1995, p. 1403): "Most observers find it plausible that governments often have some sort of commitment advantage, but it is important to be alert for circumstances in which the asymmetry may run in the other direction".

[7] This can easily be verified by maximization of the welfare function.

will be covered by the firms, and therefore an increase in f requires a higher n in order to maintain marginal cost pricing. This results in a reaction curve with a positive slope for the regulator, as illustrated in Figure 3. Note that the regulator's reaction curve is qualitatively different from the domestic firm's reaction curve (see Figure 2).

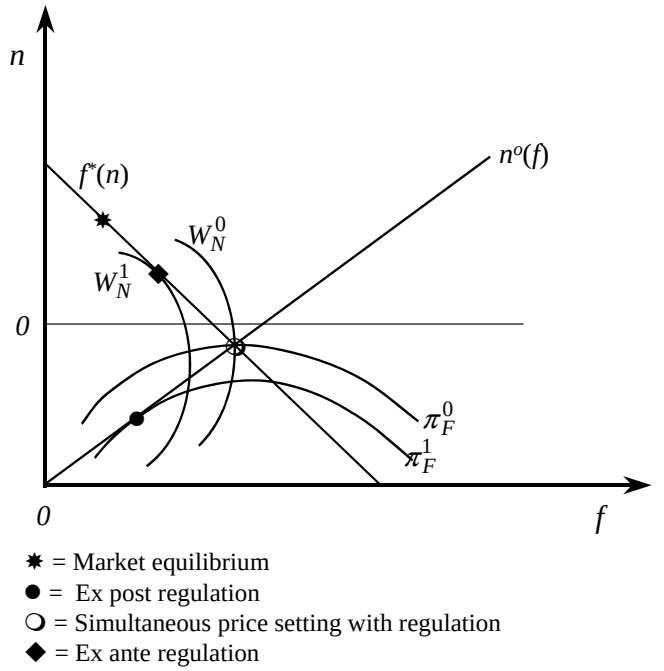

Figure 3: Reaction curves with regulation of the domestic access price

The maximization problem of the foreign firm is to solve $\partial \pi_F / \partial f = 0$ subject to (16). Technically speaking, the foreign firm acts as a Stackelberg leader and chooses the point on the regulator's reaction curve that maximizes its own profit (see Figure 3). The solution to this problem is to set

$$f = 1/2. \tag{17}$$

Inserting for f into (16) we further have

$$n = -(1-b)/2. \tag{18}$$

Since end user prices are equal to domestic marginal costs, it follows that $p = f = 1/2$.

It is easily verified that end-user prices with regulation are lower than without regulation for all $b < 1$. However, the price of the foreign input is higher in the regulatory regime (c.f. equations (13) and (17)). The foreign firm exploits the fact that the regulator will set a low price on the domestic input by increasing its own price. Regulation therefore leads to a higher profit flow from the domestic country to the foreign country, while the profit level falls to zero for the domestic firms.

Inserting for n and f we find that welfare is now equal to:

$$W^{SO} = CS = \frac{1}{4\,(1+b)}. \tag{19}$$

Comparing equations (15) and (19) we find that a necessary and sufficient condition for ex post regulation to improve welfare is that $b < \frac{2}{9}(5 - \sqrt{7})$. Regulation is therefore beneficial if and only if the goods are sufficiently differentiated. This is illustrated by Figure 4, which shows the difference $W^{SO} - W^{*}$ as a function of b. The intuition for the shape of this curve is that the downstream firms set a high mark-up when the goods are highly differentiated, in which case the social planner is able to improve welfare by setting a low value for n (high subsidy). If the goods are close substitutes, on the other hand, the high competitive pressure in the downstream market reduces the need for a subsidy. The net effect of a price cap is then to shift profit to the foreign firm.

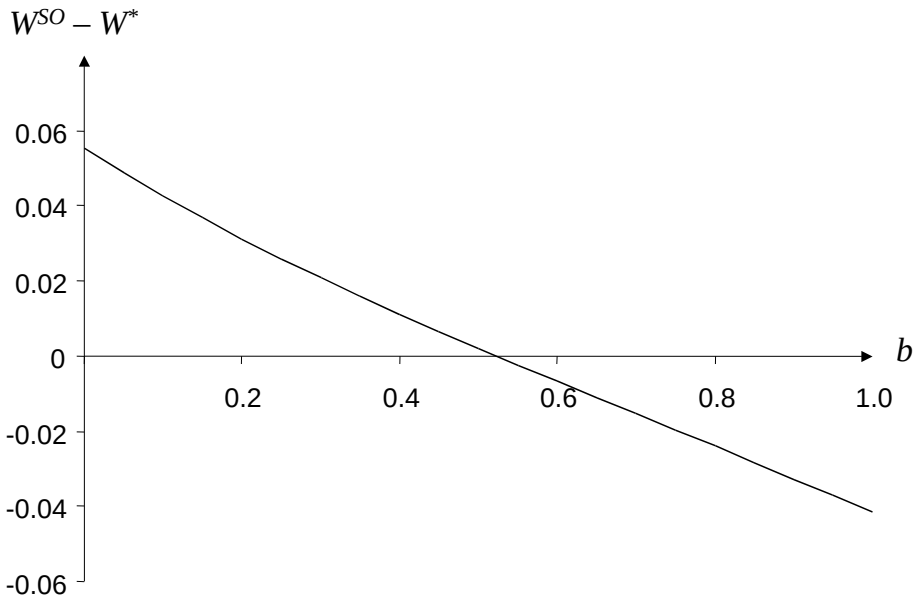

Figure 4: $W^{SO} - W^*$. Ex post regulation

The main insight from the above result is that ex post regulation cannot improve domestic welfare if there is imperfect competition only in the upstream market; there must also be significant market imperfections in the downstream market. In the latter case the gain from reducing the high mark-up in the downstream market outweighs the profit loss out of the country.

However, a regulation regime as described above, where the input from the domestic upstream firm is sold at a price below long-run marginal costs, is rarely observed. The most common regulation regime is instead to allow regulated firms to charge a price which covers their long-run marginal costs, but not to require that they sell at a price lower than this. In the present context this means that the regulator must set a price $n \geq 0$ (while we still have $f = 1/2$). The best ex post regulation is therefore obviously to set $n = 0$. However, this means that the regulator is less able to counterbalance the lack of competition in the downstream market with a low price on the input from the domestic bottleneck owner. In the appendix we therefore show that welfare is always lower with regulation than without regulation if we impose the restriction $n \geq 0$, and that it is equal to

$$W^{SO} = \frac{1}{4}\frac{3-2b}{(2-b)^2(1+b)}. \tag{20}$$

To sum up, we have the following welfare effects of ex post regulation:

Proposition 1: *Ex post regulation of the price of the domestic upstream good is welfare improving if and only if the downstream goods are sufficiently differentiated and the regulated domestic input price is set below long-run marginal costs.*

2.2.2 The regulator and the foreign firm set input prices simultaneously

Suppose that neither the foreign firm nor the regulator can credibly commit themselves with respect to the prices of the upstream goods. This we may model as if f and n are set simultaneously. The foreign firm and the regulator's reaction functions are as before, c.f. equations (12) and (16). From this we find that

$$f = \frac{2-b}{3-b} \tag{21}$$

and

$$n = -\frac{1-b}{3-b}. \tag{22}$$

Recall that the foreign firm committed itself to set $f = 1/2$ under a regime with ex post regulation. Given that $n < 0$, though, the reaction function $f(n)$ tells us that the firm would have preferred $f > 1/2$. This can also be seen from Figure 4, where the ex post regulation solution is not on the foreign firm's own reaction curve. However, the foreign firm is aware of the fact that in the ex post regulation regime a higher f would have led to an increase in n in the next stage (because $n'(f) > 0$). When F is not able to commit itself, as is now the case, the foreign firm cannot induce a strict price cap by setting a low value of f. The foreign firm therefore sets a higher price. It thus follows that both f and n increase relative to the regime with ex post regulation (this is easily seen by comparing equations (17)-(18) and (21)-(22)). Evidently, this is detrimental to the profit level of F. It is also detrimental to domestic welfare. The latter is true because the higher value of f means that end user prices increase ($p = f$), while aggregate domestic industry

profit is in any case equal to zero. In the appendix we further show that we now have

$$W^{SO} = CS = \frac{1}{(1+b)(3-b)^2}, \tag{23}$$

and that this welfare level is lower than the welfare level in the market equilibrium.

If we impose the restriction that the regulator cannot choose any $n < 0$, we have the same results as with ex post regulation and $n \geq 0$. The welfare level in this case is already shown to be lower than in the market equilibrium. We thus have:

Proposition 2: *Let us suppose that the foreign firm and the regulator set the prices of the upstream goods simultaneously. Welfare is then lower than in the market equilibrium.*

By comparing Propositions 1 and 2, we see that regulation improves domestic welfare only if the foreign firm is able to commit itself with respect to the price that it charges. The reason is that the foreign firm will use a first-mover advantage to set a relatively low input price (in order to encourage the regulator to set a low input price as well). This implies that the profit loss out of the country is more limited, and the end-users gain from lower prices.

2.2.3 Ex ante regulation

Suppose next that the regulator is able to commit itself with respect to the domestic input price. In this case it is optimal for the regulator to use a less strict regulation of n than in the previous cases we have considered. The reason is that an increase in the price of the domestic upstream good will reduce the price of the foreign upstream good. Formally, the regulator solves

$$\begin{aligned} W^{SO} &= \max_n (CS + \pi_D) \\ \text{s.t. } f(n) &= \frac{1}{2}(1-n). \end{aligned}$$

Technically speaking, the regulator chooses the point on the foreign firm's reaction curve that maximizes domestic welfare (see Figure 3). Since the downstream firms

are symmetric ($x_1 = x_2$), we have

$$\frac{dCS}{dn} = 2x(1+b)\frac{dx}{dn} \tag{24}$$

and

$$\frac{d\pi_D}{dn} = 2\left[1 - 2x(1+b)\right]\frac{dx}{dn} - 2\left[f\frac{dx}{dn} + x\frac{df}{dn}\right], \tag{25}$$

where

$$\frac{dx}{dn} = \frac{\partial x}{\partial f}\frac{df}{dn} + \frac{\partial x}{\partial n}. \tag{26}$$

An increase in n reduces the output from the downstream firms, and the resulting loss of domestic revenues from each downstream good is shown by the first square bracket in (25). Differentiating equation (10) we find that $\partial x/\partial n = -1/\left[(1+b)(2-b)\right]$, while from the reaction function of Firm F we have that $df/dn = -1/2$. Since $\partial x/\partial f = \partial x/\partial n$ we thus see that the total change in x is equal to $dx/dn = -1/\left[2(1+b)(2-b)\right] = (1/2)\partial x/\partial n$. The negative quantity effect of increasing n is thus only half as large with ex ante regulation as when the regulator cannot commit itself (in which case $\partial f/\partial n = 0$).

An increase in n also reduces demand and the equilibrium price of the foreign downstream good. The second square bracket in (25) thus shows the size of the domestic cost saving for each downstream good.

Setting $dW^{SO}/dn = 0$, and inserting for f, dx/dn and $\partial f/\partial n$ we find that

$$W^{S0} = \frac{1}{(1+b)(5-2b)}, \tag{27}$$

and that the prices of the upstream goods are given by

$$n = \frac{1}{5-2b} \tag{28}$$

and

$$f = \frac{2-b}{5-2b}. \tag{29}$$

Note that n is now positive, but lower than the price that the domestic upstream monopolist would prefer as long as $b < 1$. Therefore f is also in this case higher in

the regulated economy than in the market equilibrium. This is illustrated in Figure 3. However, welfare is higher (c.f. equations (15) and (27)). We thus have

Proposition 3: *With imperfect competition,* $0 \leq b < 1$*, the regulator sets* n *such that* $n^* > n > 0$*, which results in* $f > f^*$ *and improved domestic welfare.*

If the downstream goods are differentiated it is thus welfare enhancing for the regulator to partly correct the distortion in the downstream market by setting a price cap on the domestic access price. Note, however, that this is not a very restrictive regulatory regime. The regulator will always set a price that exceeds marginal costs. If it had set a more restrictive price cap, the profit shift to the foreign country would have outweighed the gain for domestic consumers from lower prices.

2.3 An alternative pricing schedule

Above, we have assumed that both input providers use a linear price. For the domestic input provider this is a natural choice, since regulation typically implies that the regulator sets a price cap. In such a case there is a regulated linear price.[8] The foreign firm, though, is not regulated. It is well known from the literature that an upstream firm can do better by charging a two-part tariff than a linear price. Moreover, for inputs like premium content non-linear pricing is regularly observed. In the appendix we have solved the model for the case with a two-part tariff for the foreign firm. It turns out that our main results are robust to such an extension. In particular, we show that ex ante regulation is always beneficial. Moreover, if the foreign firm uses a two-part tariff, ex post regulation is always detrimental to welfare.

With simultaneous price setting by the regulator and the foreign firm, regulation has an ambiguous effect on welfare when the foreign firm is allowed to set a two-part tariff. If products are sufficiently close substitutes regulation results in lower welfare, while regulation is welfare improving if the products are sufficiently differentiated.

[8] Even if the provider of domestic access typically has high fixed costs and low marginal costs, the regulated access price is a linear price (see e.g. Laffont and Tirole, 2000, and Vogelsang, 2003).

The intuition for the ambiguity is analogous to the explanation given for the ambiguity with ex post regulation in the case of linear input prices. When products are sufficiently differentiated, there will be a high markup. Then a price cap on the regulated domestic input leads to a substantial reduction in the dead weight loss, which outweighs the profit shift out of the country. Otherwise, regulation yields an excessive profit flow to the foreign firm.

3 Concluding remarks

While domestic providers of access to digital distribution platforms have faced a restrictive regulatory regime, few other dominant firms in the market for digital information and communication services have been regulated. This raises the question: Will a restrictive regulation of domestic digital access still make sense? We find that in order to ensure such one-sided regulation of domestic access to be welfare enhancing, the regulator should make sure that it has a first-mover advantage. If the regulator can commit itself to the domestic input price prior to the foreign complementor deciding the input price, the regulator can prevent excessive profit shifting by setting a high domestic access price.

The outcome that a high access price may be optimal in order to prevent profit shifting raises the question of whether there is a need for a global two-sided regulation. Such obligations may take place through WTO agreements that reduce the scope for foreign firms to abuse their international market power. However, it remains to be seen whether international cooperation on antitrust policy is a realistic solution, since the host country of internationally dominant firms typically will have conflicting interests to those of importing countries.

4 Appendix

Proof of equation (20)

With ex post regulation and the restriction $n \geq 0$ we find that $p = (3 - 2b) \,/\, [2(2 - b)]$

and $x = 1/\left[2(1+b)(2-b)\right]$. We thus have

$$\begin{aligned} \pi_1 &= \pi_2 = \frac{1-b}{4\left(2-b\right)^2\left(1+b\right)} \text{ and} \\ CS &= \frac{1}{4\left(2-b\right)^2\left(1+b\right)}. \end{aligned}$$

Using that $\pi_N = 0$, and inserting for π_1, π_2 and CS, we find (20). The difference between welfare in the regulated and the unregulated economy (equations (20) and (15)) is then equal to

$$W^{SO} - W^* = -\frac{1+2b}{36\left(2-b\right)^2\left(1+b\right)} < 0.$$

Proof of equation (23)

When the foreign firm and the regulator set the prices f and n simultaneously, we find that $x = 1/\left[\left(1+b\right)\left(3-b\right)\right]$. Inserting for this into equation (3) we find equation (20). The difference between welfare in the regulated and the unregulated economy (equations (20) and (15)) is then equal to

$$W^{SO} - W^* = -\frac{\left(3-2b\right)\left(9+2b(b-4)\right.}{9\left(1+b\right)\left(3-b\right)^2\left(2-b\right)^2} < 0.$$

Two-part tariff by the foreign firm

Assume that the foreign firm is able to set a two-part tariff $T_i = A + f_i x_i$, where $A \geq 0$ is a fixed fee. The foreign firm then has the following profit function:

$$\pi_F = f(x_1 + x_2) + 2A,$$

while the profit level of the downstream firms is equal to

$$\pi_i = \left(p_i - f - n\right)x_i - A. \tag{30}$$

The participation constraint for firm i requires that $\pi_i \geq 0$.

The outcome of the last stage, where the downstream firms compete in prices, is still given by equation (9).

Market equilibrium

To find market equilibrium, we solve $n = \arg\max \pi_n$ and $\{f, A\} = \arg\max \pi_F$ simultaneously, subject to (9) and $\pi_i \geq 0$. This yields

$$n = \frac{2-b}{4-b},\ f = \frac{b}{4-b} \text{ and } A = \frac{1-b}{(1+b)(4-b)^2}.$$

Welfare in the home country is now equal to

$$W^* = \frac{5-2b}{(1+b)(4-b)^2}. \tag{31}$$

It is straight forward to verify that we have $\pi_i = 0$ in equilibrium. The foreign firm thus sets the fixed fee such that the participation constraint of the downstream firms is binding.

Ex post regulation

With ex post regulation, the foreign firm sets f and A at stage 1, and the regulator sets n at stage 2. In this case we have two participation constraints; $\pi_i \geq 0$ and $W \geq 0$. The second one is new, and says that the foreign firm cannot set f and S so high that the country would benefit from closing down the sector (the regulator can do this by choosing a sufficiently high value of n).

Given that the participation constraints are fulfilled, the best the regulator can do at the second stage is to set n such that $p = f$ (as in the case considered in the main text). Then equation (16) still holds:

$$n = -(1-b)(1-f).$$

At stage 1 firm F solves $\{f, A\} = \arg\max \pi_F$, subject to (9), (16), $\pi_i \geq 0$ and $W \geq 0$. The solution to this maximization problem is

$$\begin{aligned} b &\geq 1/2 : f = \frac{b-1/2}{b} \text{ and } A = \frac{1-b}{4(1+b)b^2}, \\ b &\leq 1/2 : f = 0 \text{ and } A = \frac{1}{2(1+b)} \end{aligned}$$

which in turn implies that

$$\begin{aligned} b &\geq 1/2 : W = \frac{b-1/2}{2(1+b)b^2} > 0 \text{ and } \pi_i = 0 \\ b &\leq 1/2 : W = 0 \text{ and } \pi_i = \frac{1/2-b}{1+b} > 0. \end{aligned} \tag{32}$$

There is relatively fierce competition between the downstream firms if $b > 1/2$. This puts an effective limit on the size of the tariffs that the foreign firm can set at stage 1 without making the downstream firms close down their operations. Therefore the constraint $\pi_i \geq 0$ is binding. Intuitively, this reduces the market power that the foreign firm has over the regulator, and ensures that $W > 0$. However, for $b < 1/2$ competition between the downstream firms is so weak that their profits cannot be driven down to zero without violating the constraint $W \geq 0$. This explains why we have $\pi_i > 0$ and $W = 0$ when the goods are sufficiently differentiated. Thus, even though the downstream firms make a positive profit, the country as a whole will have no surplus from the industry.[9] Note that this resembles the standard textbook result that if a firm with a first-mover advantage uses a two-part tariff, it can extract all the benefit from operating a market.

By comparing welfare in market equilibrium with welfare under ex post regulation, we find that the latter is welfare improving for $b \geq 1/2$ if

$$\frac{\left[(10b-37)b+40\right]b-16}{4(4-b)^2(1+b)b^2} > 0,$$

which is never true. For $b < 1/2$, we have that $W = 0$ with ex post regulation and $W^* > 0$ in market equilibrium. Consequently, ex post regulation is always detrimental to welfare when the foreign firm uses a two-part tariff.

Simultaneous price setting

If f, A and n are set simultaneously, we find that

$$n = \frac{1-b}{3-b} \text{ and } f = \frac{b}{3-b},$$

while welfare is equal to

$$W = \frac{3-2b}{(1+b)(3-b)^2}. \tag{33}$$

Comparing (31) and (33) shows that regulation is welfare improving if and only if:

$$b < \frac{4-\sqrt{10}}{2} \approx 0.42.$$

[9] We then have $\pi_n = -(\pi_1 + \pi_2 + CS)$.

Regulation thus has a positive welfare effect if the products are sufficiently differentiated, but is otherwise detrimental.

Ex ante regulation

With ex ante regulation the foreign firm sets f and A at stage 2. The constraint $\pi_i \geq 0$ is binding, and we find that the response functions for the foreign firm are

$$f(n) = \frac{1-n}{2}b \text{ and } A = \frac{(1-b)(n-1)^2}{4(1+b)}.$$

Maximization of welfare at stage 1 then yields

$$n = \frac{1}{3},\ f = \frac{b}{3} \text{ and } A = \frac{1-b}{9(1+b)},$$

which implies that the welfare level is given by

$$W = \frac{1}{3(1+b)}. \tag{34}$$

By comparing equations (31) and (34), we find that ex ante regulation improves welfare if:

$$\frac{(1-b)^2}{3(1+b)(4-b)^2} > 0.$$

It easily seen that this condition is always met as long as $b < 1$.

5 References

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