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Strategic Regulation Policy in the Internet

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Abstract

Some countries are net importers while others are net exporters of global backbone access, content and other Internet services. At the same time, input components like local access are non-traded. This paper analyzes a non-cooperative regulatory game between net importing and net exporting countries, assuming that the prices of both traded and non-traded Internet services can be regulated. We show that net exporting countries choose a more restrictive regulation of non-traded goods than net importing countries do. We further show that a requirement of international non-discrimination may hurt net importing countries, and give firms producing traded Internet services incentives to invest in quality degradation.

1 Introduction

Local access to the regional telephone network is an essential component in order to get connected to the Internet, and is by definition an internationally non-traded factor of production that must be provided locally. However, the Internet is by its very nature a global industry, where for instance global backbone access and content are essential internationally traded inputs. These Internet services, which are complementary to local access, are typically provided by large firms that serve several countries. The purpose of this article is to analyze the interplay between regulation of non-traded and traded Internet services in a context where one country is a net importer of Internet services and another country is a net exporter. Could one country's price regulation of the non-traded local access input have detrimental effects on the neighboring country's welfare? Would it be beneficial to require that traded Internet services be provided on internationally non-discriminatory terms? And should the price of these services be regulated?

The Internet is often described as having a layered network structure. In the bottom layer we find the physical infrastructure, where local access and access to the core global backbones are essential inputs, and in the higher layers we have applications and content. The market for core backbone access has been dominated by a few American firms, and is an essential input because it provides access to applications and content on an international level. The asymmetry between the United States and Europe is not as clear as before (see Oftel (2001) and OECD (2002)), but at the same time we have observed an increasing intra-European asymmetry, in the sense that some countries have evolved into net exporters of backbone services, while others are net importers.[1] The growth of broadband services may generate even more asymmetry between countries. The content segments for premium sport and entertainment, for instance, are expected to be dominated by a few large firms that serve several countries.[2]

In most countries only the local access price is currently regulated. However,

[1]See Kende (2000), Cave and Mason (2001) and Vanberg (2003) for recent overviews.

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

there is scope for public intervention in other segments of the Internet market as well. In particular, the wholesale markets for backbone connectivity and premium content have been given much attention from antitrust authorities (Cave and Mason, 2001). One rather mild form of intervention is to impose a non-discriminatory requirement, where providers of traded Internet services are required to set identical prices in different countries. A more drastic intervention would be to regulate the price of essential traded Internet services.

In this paper we analyze the consequences of these two kinds of market interventions in a context where one country imports an essential upstream Internet service from another. As in Crémer, Rey and Tirole (2000) we make the assumption that the firm which provides the traded service that is complementary to local access is able to invest in non-price foreclosure of downstream rivals. In line with common observations we also assume that firms in control of essential Internet services (like local and global backbone access) are vertically integrated into the retail segment. This implies that the vertically integrated local access provider must buy the traded Internet service as an upstream good in order to serve the end-user market, and that the vertically integrated upstream provider likewise must buy local access.

As a starting point, we analyze a non-cooperative game where the two countries only regulate local access prices. We show that the countries will differ in their toughness of regulation even though both of them set local access prices to maximize domestic welfare. The country that is a net exporter of the traded Internet service chooses to set the local access price equal to marginal costs. This is in line with a regulatory regime with cost-based local access prices, and ensures low end user prices. The country that is a net importer, though, would choose to set a local access price that exceeds marginal costs. The reason is that by doing so it will force the foreign provider of the traded Internet service to set a lower price. A profit maximizing provider of a traded Internet service will therefore respond by charging different prices in the two countries, but will not invest in non-price foreclosure of its domestic or foreign downstream rivals. However, we show that this changes if there is a requirements of non-discrimination; then the provider of the traded Internet service will instead invest in non-price foreclosure of its domestic downstream rival.

Welfare in this country nonetheless increases, while welfare in the country that is a net importer of the service falls. We further show that the country in which the traded Internet service is produced has an incentive to regulate the price of that good. As a point of departure one might expect that such a regulation would benefit the importing country. However, we show that this need not be true. On the contrary, welfare in the importing country may fall. Finally, we demonstrate that the regulation game between the countries leads to a sort of prisoner's dilemma that is well-known from the literature on strategic trade policy; world welfare would have been higher if the countries cooperated.

The rest of this paper is organized as follows. The formal model is presented in Section 2. In Section 3 we assume that the price of the traded Internet service is set by a profit maximizing firm, while local access prices in the two countries are optimally regulated. Thereafter we analyze the welfare effects of imposing restrictions on the price of the traded service in Section 4, either by imposing a non-discriminatory rule or by combining the non-discriminatory rule with regulation. Section 5 concludes. Mathematical derivations are relegated to the Appendix.

2 The model

The market structure is illustrated in Figure 1, where we use capital letters for country I and small letters for country II. Each country hosts one local access provider (LAP in country I and lap in country II) and two retailers (R_1 and R_2 in country I and r_1 and r_2 in country II). Additionally, there is one upstream firm (UF) that supplies an essential service to the retailers. This firm is located in, and owned by residents of, country I. The retailers use one unit of local access and one unit of the upstream good to produce one unit of the consumer good.[3] We may think of the retailers as providers of broadband access, and the upstream firm as a provider of premium content or backbone access.

The upstream firm is vertically integrated with retailer R_1 in country I and with

[3] To simplify the language we shall consider firm UF as the only upstream supplier, even though the same terminology could also be used for the LAPs.

retailer r_1 in country II. Moreover, LAP is integrated with R_2 and lap is integrated with r_2.[4]

Foros, Kind and Sørgard (2002) analyze an analogous market structure, but focus only on optimal regulation of local access in countries that import essential upstream goods (i.e. country II in the present context). Hence, they do not analyze the regulatory interplay between country I and country II.

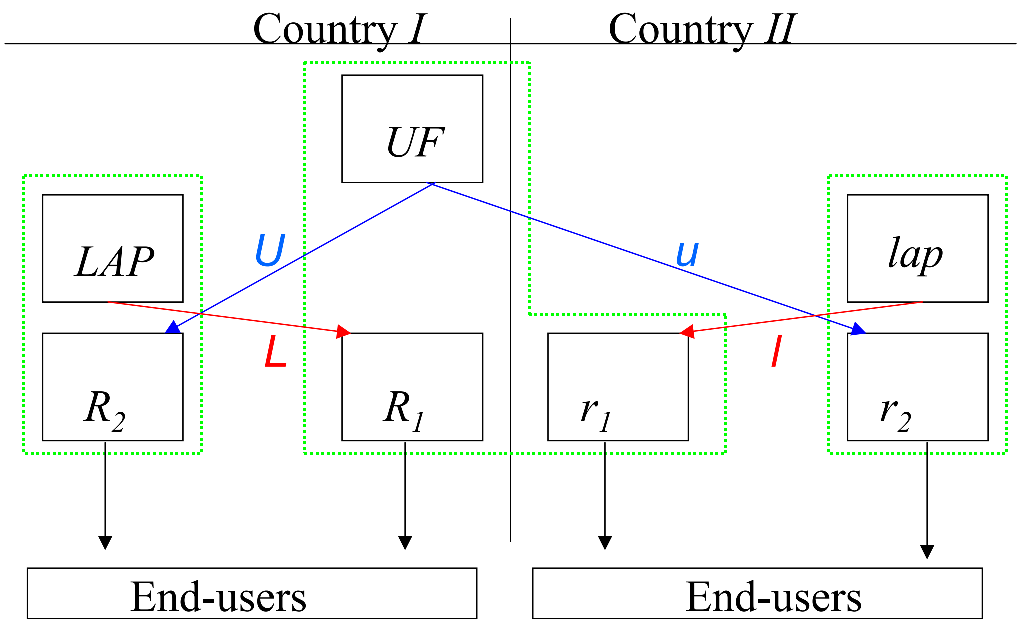

Figure 1: Market structure.

Denote by X_i the output of retailer R_i and by x_i the output of retailer r_i. Let $X \equiv X_1 + X_2$ and $x \equiv x_1 + x_2$, and assume that the inverse demand curves faced by the retailers in the two countries are given by

$$P = \alpha - \beta X \text{ and } p = \alpha - \beta x. \tag{1}$$

As noted by Laffont and Tirole (2000: 140), the current regulation regimes in telecommunications are designed for linear prices. Since the primary focus of this

[4]In most countries telecommunication incumbents provide both local access and Internet connection directly to consumers. Thereby these firms operate both as LAPs and as Internet Service Providers (ISPs). Similarly, we find that major content and backbone providers run their own local ISPs. Therefore it is natural to assume vertical integration, as we do.

paper is on regulatory interplays, we shall therefore abstract from the possibility of using for instance two-part tariffs. More specifically, in country I we assume that retailer R_1 is charged L for local access and retailer R_2 is charged U for the upstream good, while retailers r_1 and r_2 in country II similarly are charged l and u, respectively (the internal prices within each vertically integrated firm are irrelevant). The marginal costs of producing local access and the upstream good are normalized to zero.

It is now useful to note the following:

Remark 1: *Suppose that the markets are served by a monopolist with marginal costs equal to zero. The demand functions then imply that the profit maximizing end-user price in each country is equal to* $\alpha/2$ *(*$P^M = p^M = \alpha/2$*).*

We follow the approach taken by Cremér, Rey and Tirole (2000) in their analysis of possible consequences of a merger between MCI and WorldCom and assume that the upstream firm is able to reduce the quality of the good it provides to its rival downstream firms. To allow for this, we introduce a quality reduction parameter $Q \geq 0$ ($q \geq 0$), which is such that one unit increase in Q (q) reduces the consumers' willingness to pay for the service provided by retailer R_2 (r_2) by one unit. We may then write the profit levels of the vertically integrated local access providers (for whom the internal price of local access is irrelevant) as

$$\Pi_L = (P - U - Q)X_2 + LX_1 \text{ and } \pi_l = (p - u - q)x_2 + lx_1, \tag{2}$$

where LX_1 and lx_1 are the profit that firm LAP and lap, respectively, make from selling local access to the vertically integrated upstream firm. The profit level of the latter is in turn given by

$$\Pi_U = (P - L)X_1 + (p - l)x_1 + UX_2 + ux_2 - C(Q, q). \tag{3}$$

The two first terms on the r.h.s. of equation (3) are downstream profit for firm UF, the two next terms the profit from selling the upstream good to the two downstream rivals, and the last term is the cost of reducing the quality of the upstream good. We may think of this cost factor as covering both technical degradation costs, which may be relatively small, and expenses related to concealing such anti-competitive behavior. In order to obtain closed-form solutions, we shall assume that $C(Q,q) = (\phi/2)Q^2 - (\phi/2)q^2$, where $\phi \geq 0$ is a constant.

Welfare

Using equation (1) we may write consumer surplus as

$$CS = \frac{\beta X^2}{2} \text{ and } cs = \frac{\beta x^2}{2}. \tag{4}$$

Welfare in each country equals the sum of domestic consumer surplus and profit of the domestic firms;

$$W = CS + \Pi_U + \Pi_L \text{ and } w = cs + \pi_l \tag{5}$$

We consider the following game:

Stage 1: The regulator in each country sets local access prices, and the regulator in country I possibly imposes some restrictions on the prices of the upstream good.

Stage 2: Firm UF sets upstream prices and/or quality degradation levels.

Stage 3: The retailers compete in quantities.

Consistent with the regulation policy in most countries, we shall assume that the firms are not required to sell at prices below their long-run incremental costs. In our setting this implies that all regulated prices will be non-negative. In line with current regulation regimes we also assume that end-user prices (P and p) are unregulated.

The game is solved by backward induction. Therefore, let us start by analyzing the last stage of the game.

2.1 Equilibrium quantities and quality levels

We assume that the retailers compete in quantities in the last stage of the game.[5] Solving $\partial\Pi_U/\partial X_1 = \partial\Pi_U/\partial x_1 = \partial\Pi_L/\partial X_2 = \partial\pi_l/\partial x_2 = 0$ we find that downstream

[5]The assumption of Cournot is similar to Crémer et al. (2000). Faulhaber and Hogendorn (2001) have shown that Cournot is a realistic assumption in the retail market for broadband Internet connectivity.

output of firm UF is

$$X_1 = \frac{\alpha + U + Q - 2L}{3\beta} \text{ and } x_1 = \frac{\alpha + u + q - 2l}{3\beta}, \tag{6}$$

while the local access providers have downstream output equal to

$$X_2 = \frac{\alpha + L - 2(U + Q)}{3\beta} \text{ and } x_2 = \frac{\alpha + l - 2(u + q)}{3\beta}. \tag{7}$$

In the second-last stage the upstream firm decides how much it will invest in quality degradation towards the rival retailers, and we assume that Q and q can be set independently of each other. To see how an increase in Q (an increase in q has a similar effect) affects the profitability of the vertically integrated upstream firm we note that:

$$\frac{\partial \Pi_U}{\partial Q} = \underbrace{-\left[\frac{1}{3\beta}U + \phi Q\right]}_{\text{Reduced upstream profit}} + \underbrace{\left[\frac{1}{3}X_1 + \left(\frac{1}{3\beta}\right)(P - U - L)\right]}_{\text{Increased downstream profit}}$$

The first square bracket reflects the fact that upstream profit falls subsequent to an increase in Q. This is true both because demand for the upstream good falls and because it is costly to invest in quality reduction if $\phi > 0$ (this shows that the upstream firm will always set $Q = 0$ unless it is vertically integrated). The second square bracket reflects the fact that a higher Q increases the downstream profit of firm UF, because the domestic downstream rival becomes less competitive.

Setting $\partial \Pi_U / \partial Q = 0 = \partial \Pi_U / \partial q$ we have the first-order conditions

$$Q = 2\frac{\alpha - 2(U + L)}{9\phi\beta - 2} \text{ and } q = 2\frac{\alpha - 2(u + l)}{9\phi\beta - 2}. \tag{8}$$

Equation (8) holds if there is an interior solution, where the rival downstream firms are only partly foreclosed through quality degradation. In the appendix we show that this is the case if $\phi > 2/(3\beta)$. If $\phi < 2/(3\beta)$ degradation costs are so low that firm UF may completely foreclose its downstream rivals.

It is easily shown that the upstream firm will not invest in quality degradation ($Q = q = 0$) if it can maximize profit with respect to U and u. This is not surprising, since equations (6) and (7) show that a change in the quality levels has the same output effect as a change in the prices of the upstream good (e.g.,

$\partial X_1/\partial Q = \partial X_1/\partial U = 1/(3\beta)$ and $\partial X_2/\partial Q = \partial X_2/\partial U = -2/(3\beta)$. Thereby it is more profitable for the firm to set a high price for the upstream good than to invest in quality degradation if $\phi > 0$:

Remark 2: *Assume that firm UF maximizes profit with respect both to quality degradation levels and the prices of the upstream good. Then it will set $Q = q = 0$.*

3 Regulation of local access prices only

In this section we shall assume that only local access prices are regulated (at stage 1). At stage 2 firm UF sets profit maximizing upstream prices, which from Remark 2 implies that $Q = q = 0$. Using equations (6) and (7) and solving $\partial \Pi_U/\partial U = \partial \Pi_U/\partial u = 0$, we find[6]

$$U(L) = \frac{\alpha}{2} - \frac{L}{10} \text{ and } u(l) = \frac{\alpha}{2} - \frac{l}{10}. \tag{9}$$

To see the intuition for the reaction functions in equation (9), assume that local access prices at stage 1 are set equal to marginal costs ($L = l = 0$). Then the vertically integrated local access providers will have no cost advantage relative to the upstream firm, which will consequently have an incentive to monopolize the market and set $P^M = p^M = \alpha/2$ (c.f. Remark 1). Firm UF can implement this monopolization strategy by charging the rival downstream retailers at least $\alpha/2$ for the upstream good, so that it becomes unprofitable for these firms to operate in the end-user market. This explains why $U(0) = u(0) = \alpha/2$.

Note from equation (9) that $U'(L) = u'(l) < 0$. This reflects the fact that the upstream good and local access are complements, so that a higher price on local access lowers the profit maximizing prices of the upstream good. The regulator in each country can thus reduce the price of the upstream good by setting the local access price above marginal costs at stage 1. But will it be optimal to do so for a regulator that seeks to maximize domestic welfare? Intuitively, we would not expect

[6] The second-order conditions are equal to $\partial^2\Pi_U/\partial U^2 = \partial^2\Pi_U/\partial u^2 = -10/(9\beta) < 0$, and thus always satisfied.

this to be optimal for the regulator in country I - if L increases by one unit, we see that U will fall by just 1/10 unit. Thereby a higher local access price implies that the perceived marginal cost for the industry increases. This in turn has a negative impact both on aggregate domestic profit and on the end-user price. However, we should expect that the regulator in country II will have an incentive to set the local access price above marginal costs (even though this will lead to a higher consumer price); by doing so it will reallocate profit from the foreign upstream firm to the domestic local access provider.

Formally, solving $L^* = \arg\max W$ and $l^* = \arg\max w$ subject to $L, l \geq 0$ and (9) we find

$$L^* = 0 \text{ and } l^* = 35\alpha/99, \tag{10}$$

from which it follows that $U^* = \alpha/2$, $u^* = 46\alpha/99$ and

$$\Pi_U^* = \frac{551}{1452}\frac{\alpha^2}{\beta},\ W^* = \frac{1465}{2904}\frac{\alpha^2}{\beta} \text{ and } w^* = \frac{37}{198}\frac{\alpha^2}{\beta}. \tag{11}$$

We now have the following result:

Proposition 1: *Suppose that the vertically integrated upstream firm sets the prices U and u. In this case the regulator in country I sets a cost-based local access price ($L^* = 0$), while the regulator in country II sets a local access price above marginal costs ($l^* > 0$).*

The fact that the regulator in country I sets $L^* = 0$ implies that $U^* = \alpha/2$ and $X_2^* = 0$. Thus, firm UF forecloses its domestic downstream rival by setting a high price for the upstream good. The reason why it would be inoptimal for UF to foreclose its downstream rival in country II ($x_2^* > 0$ in equilibrium), is that the relatively high local access price in this country makes the vertically integrated *lap* appear as a low-cost producer. Foreclosing this firm would excessively reduce demand for the upstream good:

Corollary 1 *Suppose that the vertically integrated upstream firm sets the prices U and u, while local access prices are regulated. In this case it is optimal for firm UF to foreclose its domestic downstream rival, but not its foreign downstream rival.*

4 Restrictions on the price of the upstream good

The above analysis highlights the fact that the market power of the upstream supplier reduces the efficiency of regulating the prices of local access. Indeed, the market power of firm UF makes it optimal for the regulator in country II to set a local access price above marginal costs, and allows the upstream firm to become a downstream monopolist in country I. This is an argument for intervening against the price setting of firm UF. Since the upstream good is sold in different countries, it is an open question how this market intervention should take place. One alternative would be to require non-discrimination, meaning that the upstream firm loses the ability to set a higher upstream price at home than abroad. In line with this, we first analyze how a requirement of non-discrimination affects welfare in the two countries, given that the actual upstream price is determined by firm UF. Thereafter we analyze the consequences of letting the regulator in country I set the price of the upstream good. However, also in this case the price of the upstream good must be the same in the two countries, since WTO agreements require regulation to be non-discriminatory.

We use the common symbol U^i for the uniform (non-discriminatory) upstream price, where $i = N$ if the price is non-regulated and $i = R$ if it is regulated.

4.1 Non-discrimination requirement

Assume that the regulators in the two countries simultaneously set local access prices (L and l) at stage 1. At stage 2 the upstream firm sets the non-discriminatory upstream price U^N and the level of degradation (Q and q), and at stage 3 the downstream firms set quantities.

We cannot rule out the possibility that the upstream firm will invest in quality degradation towards its downstream rivals abroad or at home if it is required to set a common upstream price in the two countries. From Proposition 1 we may expect that country I will set the local access price equal to marginal costs ($L = 0$), while country II will set a relatively high local access price ($l > 0$). Thereby Corollary 1 indicates that it is profitable for UF to invest in quality degradation towards its domestic downstream rival, but not towards its foreign downstream rival. We therefore set up the following Conjecture:

Conjecture 1: *Suppose that firm UF is required to charge the same upstream price abroad and at home. Then the regulator in country I sets $L = 0$, while the regulator in country II sets $l > 0$. Firm UF chooses to invest in quality degradation towards its domestic rival ($Q > 0$), but not towards its foreign downstream rival ($q = 0$).*

Conjecture 1 is proved in the appendix, where we also show that UF will completely foreclose its domestic downstream rival if the quality degradation costs are so low that $\phi < 2/(3\beta)$, while it will only partly foreclose its domestic downstream rival if $\phi > 2/(3\beta)$. In the former case, with complete foreclosure, we have

$$Q^N(U^N) = \frac{\alpha}{2} - U^N, \tag{12}$$

which is found by setting $X_2 = 0$ and $L = 0$ in equation (6).[7] The first-order condition $\partial\Pi_U/\partial U^N = 0$ further implies that

$$U^N(l) = \frac{\alpha}{2} - \frac{l}{10 + 9\phi\beta} \quad \text{if } \phi < 2/(3\beta). \tag{13}$$

We thus find that U^N is decreasing in l, reflecting the fact that local access and the upstream good are complements. In particular, we see that $U^N(0) = \alpha/2$; if the local access price in country II is equal to marginal costs, firm UF will monopolize the market by setting $U^N = p^M$.

Solving $L^N = \arg\max W$ and $l^N = \arg\max w$ subject to $L, l \geq 0$ and equations (12) and (13), it follows that the welfare maximizing local access prices are given by $L^N = 0$ and

$$l^N = \frac{\alpha}{18} \frac{(7 + 6\phi\beta)(10 + 9\phi\beta)}{11 + 20\phi\beta + 9\phi^2\beta^2} \quad \text{if } \phi < 2/(3\beta). \tag{14}$$

[7]Notice that $Q^N = 0$ if $U^N = \alpha/2$; then the domestic rival would be completely foreclosed through the upstream price, and there is no need to invest in quality degradation.

If $\phi > 2/(3\beta)$ it is no longer profitable for UF to completely foreclose its domestic downstream rival. However, independent of the value of ϕ we have the following result

Proposition 2: *Suppose that the vertically integrated upstream firm is required to set a non-discriminatory price U^N. The larger the quality degradation costs*

a) the higher the upstream price ($\partial U^N/\partial\phi > 0$), and the smaller the quality degradation level ($\partial Q^N/\partial\phi < 0$)

b) the lower the local access price in country II ($\partial l^N/\partial\phi < 0$).

Proof: See Appendix.

The first part of Proposition 2 is intuitively obvious; firm UF can foreclose its domestic rival through investing in quality degradation and through setting a high price for the upstream good. The latter is more profitable the more expensive it is to invest in quality degradation. This is the reason why the upstream price is increasing in ϕ. From this it follows directly that the optimal local access price in country II is decreasing in ϕ, since local access and the upstream good are complements ($\partial U^N/\partial\phi > 0 => \partial l^N/\partial\phi < 0$).

The requirement of non-discrimination forces the upstream firm to invest in costly quality degradation in order to foreclose its domestic downstream rival. One might expect that this would make the upstream firm worse off, and more so the higher is ϕ. However, the opposite is true - the profit level of the upstream firm is increasing in the marginal degradation costs. The reason for this is the fact that the regulator in country II sets a lower local access price the higher is ϕ, which is to the benefit of firm UF. Perhaps somewhat surprisingly, we therefore have $d\Pi_I/d\phi > 0$.

It is easily verified that the non-discriminatory upstream price is somewhere between the relatively high price that firm UF would optimally have chosen domestically and the relatively low price that it would have preferred abroad ($U^* > U^N > u^*$). Since $U^N > u^*$ the requirement of a non-discriminatory price thus has a detrimental effect on welfare in country II. Moreover, since an increase in ϕ leads to a higher upstream price U^N, welfare in country II is strictly decreasing in ϕ.

In the appendix we offer a formal proof of the following:

Proposition 3: *Suppose that the vertically integrated upstream firm is required to set a non-discriminatory price U^N. We then have*

a) Welfare in country I and the profit level of the upstream firm are increasing in the quality degradation costs ($\partial W^N/\partial\phi > 0$, $\partial\Pi_U^N/\partial\phi > 0$), and are higher than if the upstream firm price discriminates ($W^N > W^*$, $\Pi_U^N > \Pi_U^*$).

b) Welfare in country II is decreasing in the quality degradation costs ($\partial w^N/\partial\phi < 0$), and is lower than if the upstream firm price discriminates ($w^N < w^*$).

Note that Proposition 3 implies that the upstream firm has incentives to commit itself not to price discriminate, for instance through writing most-favoured-customer contracts. If it is unable to credibly commit to non-discrimination, the firm may therefore welcome a public requirement of uniform pricing.

4.2 Non-discrimination and input price regulation

Imposing non-discrimination is a rather mild form of restriction on the upstream firm's price. A natural next step would be for country I to regulate the price that firm UF charges for the upstream good.

As above, we assume that the regulators can credibly commit themselves in their regulation policy. At stage 1 the regulator in country I therefore sets L and U^R, and the regulator in country II sets l. We also maintain the assumption that the upstream firm chooses the quality degradation levels at stage 2, and that there is Cournot competition in the end-user markets at the final stage. The Cournot quantities are still given by equations (6) and (7), except that we must replace u and U with U^R.

4.2.1 Low costs of degrading the quality ($\phi < 2/(3\beta)$)

As is the case with non-discrimination, the upstream firm completely forecloses its domestic rival if $\phi < 2/(3\beta)$, and the regulator in country I sets $L = 0$ (see Appendix).

Since the upstream firm's domestic rival is completely foreclosed, the value of U does not affect the domestic consumer price in country I. When the regulator in country I sets U at stage 1, maximization of welfare and maximization of profit for the vertically integrated upstream firm are thus equivalent; $U^R = \arg\max W = \arg\max \Pi_U$. Consequently, we find that the first-order condition

$$U^R(l) = \frac{\alpha}{2} - \frac{l}{10 + 9\phi\beta}$$

is the same in this case as when firm UF sets a uniform upstream price (c.f., equation (13)). However, the sequence of moves is now different, since U, L and l are set simultaneously at stage 1 by the regulators (while the upstream price was set at stage 2 in the context without regulation). Thereby country II cannot strategically set a relatively high value of l in order to enforce a low price of the upstream good. We thus find that maximization of welfare w in country II with respect to l yields

$$l^R = \frac{\alpha}{3} < l^N. \tag{15}$$

Combining $U^R(l)$ and l^R we further have

$$U^R = \frac{\alpha}{6}\frac{28 + 27\phi\beta}{10 + 9\phi\beta} > U^N. \tag{16}$$

The quality degradation level is equal to $Q^R = \alpha/2 - U^R = \alpha\,(10 + 9\phi\beta)\,/3$. We consequently have $\partial Q^R/\partial\phi < 0$ and $\partial U^R/\partial\phi > 0$; higher degradation costs make it optimal to increase the upstream price and invest less in quality degradation.

Equation (15) shows that the local access price in country II is independent of ϕ when the upstream price is regulated. This means that higher degradation costs unambiguously reduce the profit level of the vertically integrated upstream firm. Nonetheless, the profit level of firm UF is higher when the upstream price is regulated than when it is unregulated, since $l^R < l^N$ and $U^R > U^N$. This further implies that regulation of the upstream price has a positive welfare effect in country I and a negative welfare effect in country II:

Proposition 4: *Suppose that at stage 1 the regulator in country I sets L and U and the regulator in country II sets l. For $\phi < 2/(3\beta)$ we then have* *a) Firm UF completely forecloses its domestic downstream rival through quality degradation, but does not foreclose its foreign downstream rival.*

b) Welfare in country I and the profit level of the upstream firm are decreasing in the quality degradation costs ($\partial W^R/\partial\phi < 0$, $\partial \Pi_U^R/\partial\phi < 0$), but are higher than if the upstream price is unregulated ($W^R > W^N > W^*$, $\Pi_U^R > \Pi_U^N > \Pi_U^*$).

c) Welfare in country II is decreasing in the quality degradation costs ($\partial w^R/\partial\phi < 0$), and is lower than if the upstream price is unregulated ($w^R < w^N < w^*$).

Proof: See Appendix.

Note that the difference between the results in Proposition 3 and Proposition 4 is solely due to the fact that we have assumed *ex ante* regulation (so that U^R is set at stage 1, while U^N is set at stage 2). It is straight forward to show that $U^R \equiv U^N$ if regulation does not change the timing of the game and $\phi < 2/(3\beta)$.

4.2.2 High costs of degrading the quality ($\phi > 2/(3\beta)$)

If $\phi > 2/(3\beta)$ it is too expensive for the vertically integrated upstream firm to completely foreclose its domestic rival, which means that we will have $X_2 > 0$. In this case the regulator in country I and the vertically integrated upstream firm have different interests; other things equal, the regulator prefers a low value of U in order to reduce domestic consumer prices. The solution to stage 1 is still $L = 0$ and $l = \alpha/3$, but we now have

$$U^R = \frac{\alpha}{3} + \frac{2\alpha}{3}\frac{207\phi\beta - 82}{891\phi^2\beta^2 + 108\phi\beta - 212}. \tag{17}$$

From (17) we find $\partial U/\partial\phi < 0$. In words, the more expensive it is to foreclose the domestic rival through quality degradation, the lower the regulator in country I will set the upstream price. This reflects the fact that an increase in ϕ reduces the upstream firm's profitability of imposing quality degradation, and allows the regulator to reduce the upstream price. Thus there will be competition between the two retailers in country I, and the end-user price will fall. In the Appendix we further show the following:

Proposition 5: *Suppose that at stage 1 the regulator in country I sets L and U and the regulator in country II sets l. For $\phi > 2/(3\beta)$ we then have that*

a) Firm UF only partly forecloses its domestic downstream rival, and does not foreclose its foreign downstream rival.

b) Welfare in country I is increasing in quality degradation costs ($\partial W^R/\partial \phi > 0$), and is higher than without regulation ($W^R > W^N > W^*$).

c) Welfare in country II is increasing in quality degradation costs ($\partial w^R/\partial \phi > 0$), but is lower than without regulation if $\phi < \bar{\phi} \approx 3/(4\beta)$.

The results in Proposition 4 and 5 for country II are illustrated in Figure 2. The horizontal curve labelled "discr." measures welfare in country II if firm UF sets the upstream prices and price discriminates between the countries, while the curve "non-discr" shows welfare if the firm does not price discriminate. Finally, the curve labelled "regulated" shows welfare in country II if the upstream price is regulated by country I. If ϕ is "large", the upstream firm has weak incentives to invest in quality degradation. Thus, the regulator in country I enforces a strict price regulation of the upstream good. This is to the benefit of country II, which consequently has higher welfare with than without regulation of U if $\phi > \bar{\phi}$. For "low" values of ϕ, on the other hand, the upstream firm has strong strategic incentives to invest in quality degradation. Given that this harmful strategy cannot be prevented, the best the regulator in country I can do is to allow the upstream firm to charge a relatively high upstream price. This is detrimental to country II, which consequently has lower welfare level with than without regulation if $\phi < \bar{\phi}$.

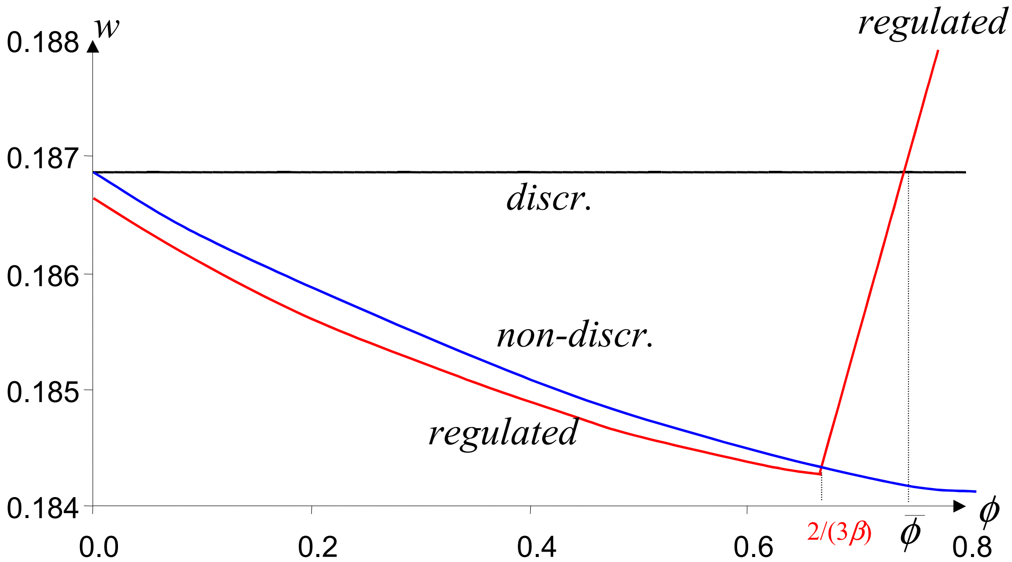

Figure 2: Welfare in country II

Figure 3 shows how the profit level of the upstream firm depends on quality degradation costs and price regimes. First, as stated in Proposition 3, the firm makes a higher profit if it cannot price discriminate between the countries than if it is able to do so. Second, if ϕ is not too large, the upstream firm makes a higher profit if it is price regulated than if it is unregulated. This is due to the fact that ex ante regulation of the upstream price implies that country II cannot utilize the complementarity between the upstream good and local access to enforce a low price of the input provided by firm UF. However, regulation harms the upstream firm for sufficiently high values of ϕ, because the regulator in country I prefers a relatively low upstream price in order to reduce the domestic consumer price.

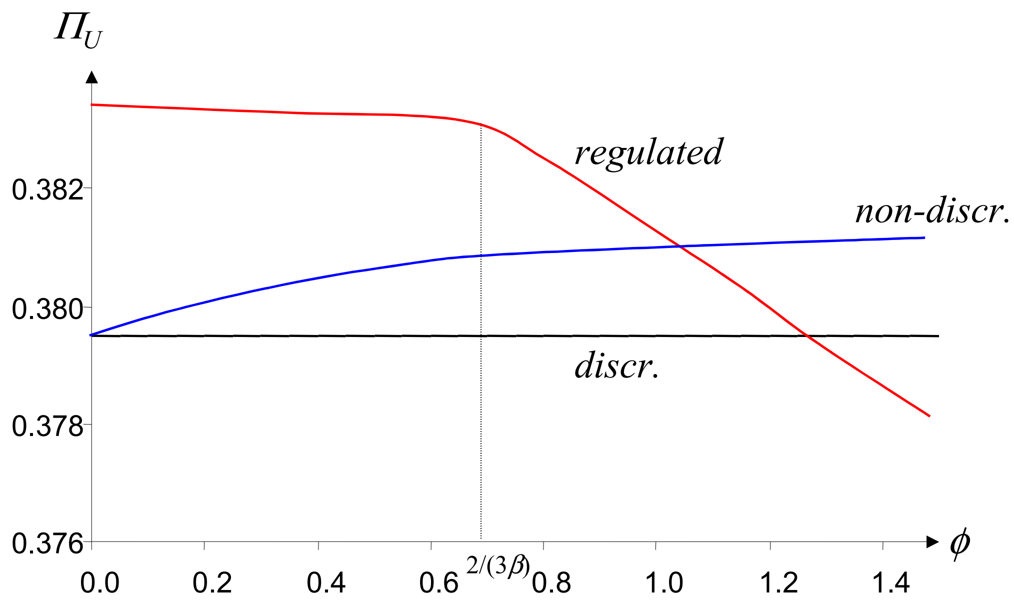

Figure 3: Profit for the vertically integrated upstream firm.

As shown above, country II sets $l = \alpha/3$ independent of the value of ϕ when the price of the upstream good is regulated. The fact that the local access price thereby is above marginal costs implies that the consumer price in country II will be relatively high. In isolation this imposes a welfare loss for the country. However, the loss on the consumer side is outweighed by a gain on the domestic producer side; the high local access price means that the local access provider captures profit from the foreign upstream provider. In the same manner country I sets a relatively high price for the upstream good in order to capture more profit in country II. This is most easily seen from equation (17), which shows that $\lim_{\phi=\infty} U^R = \alpha/3$. Thus, even if quality degradation is prohibitively expensive the regulated upstream price will be above marginal costs. Profit-stealing motives consequently imply that country I will set a relatively high price for the traded upstream good, while country II will set a relatively high price for the complementary non-traded local access component. This is detrimental for aggregate welfare in the two countries. In particular, it is straight forward to show that

Proposition 8: *Suppose that quality degradation costs are prohibitively high ($\phi = \infty$). Joint welfare for country I and II will then be higher if the countries agree to set $U^R = L^R = l^R = 0$ than if the regulated prices are set non-cooperatively.*

Both countries would prefer to shift profits to its own country. Therefore country I sets $U > 0$ to extract profits from the firms and consumers in country II, while country II sets $l > 0$ to extract profits from the upstream firm located in country I. But prices above marginal costs generate deadweight losses. A cooperation between the regulatory authorities would therefore lead to a more restrictive regulatory policy and increased joint welfare for those two countries. Indeed, a non-cooperative regulation game implies that the countries will end up in a kind of prisoner's dilemma outcome that is well-known from the literature on strategic trade policy (see Brander and Spencer, 1984 and Brander, 1995).

5 Some concluding remarks

The Internet is a complex industry with a mixture of services provided locally and globally. This raises important questions concerning not only the interplay between firms, but also the interplay between regulatory authorities in different countries. Although our model is quite stylized, the lessons to be learned should be of more general interest.

First, international asymmetries may lead to large regulatory differences even on non-traded goods. Some countries may find it optimal with cost-based local access prices, while others will set local access prices relatively high. This illustrates that if countries differ in their structural characteristics - in our case in their net trade position for Internet services - then this may lead to very different solutions in different countries, although all countries are assumed to share the goal of maximizing domestic welfare.

Second, providers of traded Internet services may have incentives to commit themselves not to price discriminate. We have further shown that price regulation and requirements of uniform pricing may lead firms to use other instruments than price to discriminate between buyers in different countries, instruments that can often be more costly both for the firms and for the society as a whole.

Finally, our results point to the importance of international coordination of regulatory policy. We find that competition between countries leads to a battle for capturing profits, and that the final outcome might be a regulatory regime that is less restrictive than what would be in the common interest of the countries. This is not a question of whether governments should be involved or not, as is the case in most of the discussion concerning the related topic strategic trade policy. On the contrary, there is a broad consensus that governments should be involved in and regulate (segments of) the Internet industry. However, our analysis suggests that there will be gains from international coordination - but that this may come at the expense of national sovereignty.

In this paper we have assumed that there is only one traded Internet service, and that the price of this good is set unilaterally by the exporting country in case of regulation (rather than being the outcome of, e.g., some bargaining game). It would be interesting to relax on both these assumptions. In particular, it might be useful to consider a setting with several providers of essential traded Internet services, and analyze the interplay between such firms. However, this we will leave for future research.

6 References

Brander, J. A. 1995: 'Strategic Trade Policy', Chapter 27 in G. E. Grossman and K. Rogoff (eds.): *Handbook of International Economics*, Volume 3, North-Holland.

Brander, J. A. and B. J. Spencer. 1984. "Tariff Protection and Imperfect Competition", in Henryk Kierzkowski (ed): *Monopolistic Competition and International Trade*, Oxford University Press. Reprinted in Gene Grossman (ed.) Imperfect Competition and International Trade (1992) MIT Press: Cambridge, Mass.

Cave, M. and R.W. Crandall. 2001. Sport Rights and the Broadcasting Industry, *The Economic Journal*, 111, F4-26.

Cave, M. and R. Mason. 2001. The Economics of the Internet: Infrastructure and Regulation, *Oxford Review of Economic Policy,* 17(2), 188-210.

Crémer, J. P. Rey and J. Tirole. 2000. Connectivity in the Commercial Internet, *Journal of Industrial Economics*, XLVIII, 433-472.

Faulhaber, Gerald R. and Christiaan Hogendorn. 2000. "The Market Structure of Broadband Telecommunications." *Journal of Industrial Economics* XLVIII: 305-329.

Foros, Ø., H.J. Kind and L. Sørgard. 2002. Access Pricing, Quality Degradation and Foreclosure in the Internet, *Journal of Regulatory Economics*, 22(1), 59-83.

Kende, M. 2000. The Digital Handshake: Connecting Internet Backbones. OPP WP 32, Federal Communications Commission.

OECD. 2002. Internet Traffic Exchange and the Development of End-to-End International Telecommunication Competition. DST/ICCP/TISP(2001)5/FINAL.

Oftel. 2001. Effective Competition Review of Internet Connectivity, 23 August 2001.

Vanberg, M. 2003. Internet Regulation: Monopolistic Bottlenecks in the Internet Service Markets?, WP, ZEW, Mannheim.

7 Appendix

Proof of Conjecture 1

Equilibrium if $\phi < 2/(3\beta)$

For sufficiently low values of ϕ firm UF either sets $Q = 0$ ($q = 0$) or chooses Q (q) such that there is complete foreclosure; $X_2 = 0$ ($x_2 = 0$). We now have to analyze four different cases; that UF imposes quality degradation in both countries, in just one of them, or in none.

Case i: Quality degradation in both countries.

Suppose that the regulators expect that the upstream firm will completely foreclose its downstream rival in each country. If this is true, firm UF will choose quality degradation levels Q and q such that $X_2 = x_2 = 0$. Using equation (7) and setting $\partial\Pi_U/\partial U = 0$ we then find respectively

$$Q = \max\{0, (\alpha + L - 2U)/2\} \text{ and } q = \max\{0, (\alpha + l - 2U)/2\} \quad (18)$$

$$U = 7\alpha/12. \quad (19)$$

At stage 1 the regulators in the two countries simultaneously solve $\max_L W$ and $\max_l w$ subject to (18) and $L, l \geq 0$, from which it follows that $L = 0$ and $l = \alpha/3$. The regulator in country II thus sets a local access price above long-run marginal costs ($l = \alpha/3 > 0$) in order to capture some of $UF's$ profit potential in this country, even though this comes at the expense of a relatively high consumer price. The regulator in country I, on the other hand, sets a low local access price ($L = 0$) in order to minimize the domestic deadweight loss (profit shifts between LAP and UF are of no concern for country I, since both firms are owned by domestic residents).

Inserting for $l = \alpha/3$, $L = 0$ and $U = 7\alpha/12$ we have

$$\Pi_U = \frac{52 - \phi\beta}{144}\frac{\alpha^2}{\beta}. \tag{20}$$

Case ii: No quality degradation in any country

Assume that the regulators expect that UF will not invest in quality degradation in any country ($Q = q = 0$). Given no quality degradation, the upstream firm maximizes profit at stage 2 by setting $U = \alpha/2 - (L + l)/20$. This in turn implies that the regulators will set $L = 0$ and $l = 410\alpha/1197$ at stage 1. However, this cannot be an equilibrium - if ϕ is sufficiently low, it is clear that firm UF would like to invest in quality degradation towards its domestic downstream rival. Thereby it could monopolize the domestic market. It is straight forward to prove this formally, by assuming that UF deviates from $Q = 0$ and instead forecloses its domestic rival when observing $L = 0$ and $l = 410\alpha/1197$. We then find that profit in this latter case is higher than without foreclosure. Thus, it would not be rational for the regulators to expect $Q = q = 0$.

Case iii: Quality degradation only in Country I

Next, suppose that the regulators expect that UF will completely foreclose its domestic rival, but not foreclose its foreign rival. We then have $q = 0$ and $Q = (\alpha + L - 2U)/2$. Solving $\max_U \Pi_U$ we find

$$U = \frac{10\alpha - 2l + 9\phi\beta\alpha + 9\phi\beta L}{2(10 + 9\phi\beta)}, \tag{21}$$

which implies that the regulators will set $L^N = 0$ and l^N as stated in equation (14). Inserting for the factor prices we now have

$$\Pi_U^N = \frac{20\,088\phi^4\beta^4 + 89\,118\phi^3\beta^3 + 147\,732\phi^2\beta^2 + 108\,455\phi\beta + 29\,754}{648(9\phi\beta + 11)^2(1 + \phi\beta)^2}. \tag{22}$$

We have shown that there does not exist any equilibrium where UF does not foreclose any of its downstream rivals (case ii), and it can be shown that there does not exist any equilibrium where UF forecloses only its foreign downstream rival. Comparing the case where UF forecloses both the foreign and the domestic downstream rivals (case i) to the case where only the domestic rival is foreclosed we find that $\Pi_U^N > \Pi_U$. Firm UF will thus not invest in quality degradation of its foreign downstream rival, but will completely foreclose its domestic downstream rival for sufficiently low values of ϕ. In this case we have

$$W^N = \frac{26\,649\phi^4\beta^4 + 118\,278\phi^3\beta^3 + 196\,170\phi^2\beta^2 + 144\,095\phi\beta + 39\,555}{648\,(9\phi\beta + 11)^2\,(1+\phi\beta)^2}\frac{\alpha^2}{\beta} \tag{23}$$

and

$$w^N = \frac{117\phi^2\beta^2 + 264\phi\beta + 148}{72\,(9\phi\beta + 11)\,(1+\phi\beta)}\frac{\alpha^2}{\beta}. \tag{24}$$

Equilibrium if $\phi \geq 2/(3\beta)$

It can be shown that firm UF will set $q = 0$ for all values of ϕ. This is intuitively obvious; since UF will not invest in foreclose of its foreign rival even when $\phi < 2/(3\beta)$ it will not do so when ϕ is larger either. However, for sufficiently high values of ϕ it is too expensive for UF to completely foreclose its domestic rival as well. Using the reaction functions $Q(L,l)$ and $U(L,l)$ which are found by solving $\partial\Pi_U/\partial Q = 0$ and $\partial\Pi_U/\partial U = 0$ at stage 2, we find that the regulators at stage 1 will set

$$L^N = 0 \text{ and } l^N = \frac{2\,(123\phi\beta - 38)\,(45\phi\beta - 14)}{9\,(189\phi\beta - 58)\,(19\phi\beta - 6)}\alpha. \tag{25}$$

Inserting for this into $Q(L,l)$ and $U(L,l)$ we find

$$U^N = \frac{2\left(7803\phi^2\beta^2 - 4884\phi\beta + 764\right)}{9\,(189\phi\beta - 58)\,(19\phi\beta - 6)}\alpha \text{ and } Q^N = \frac{2\,(123\phi\beta - 38)}{9\,(189\phi\beta - 58)\,(19\phi\beta - 6)}\alpha. \tag{26}$$

The second-order conditions can be shown to hold for $\phi\beta > 14/45 \approx 0.31$. Inserting for (25) into equation (6) we find

$$X_2^N = \frac{(123\phi\beta - 38)\,(3\phi\beta - 2)}{9\,(189\phi\beta - 58)\,(19\phi\beta - 6)}\frac{\alpha}{\beta} > 0 \text{ if } \phi\beta > 2/3,$$

which shows that the domestic downstream rival will be completely foreclosed if $\phi < 2/(3\beta)$, but only partly foreclosed for higher values of ϕ.

Proof of Proposition 2

For $\phi < 2/(3\beta)$ we can use equations (12), (13) and (14) to find that $\partial U^N/\partial\phi > 0$, $\partial Q^N/\partial\phi < 0$ and $\partial l^N/\partial\phi < 0$. From equations (25) and (26) we find that the same holds for $\phi > 2/(3\beta)$. Q.E.D.

Proof of Proposition 3

For $\phi < 2/(3\beta)$ we find from equations (22), (23) and (24) that $\partial\Pi_U^N/\partial\phi > 0$, $\partial W^N/\partial\phi > 0$ and $\partial w^N/\partial\phi < 0$. Comparing (11) and (22), (23) and (24) we find $W^N > W^*$, $\Pi_U^N > \Pi_U^*$ and $w^N < w^*$.

The proof of Proposition 3 for $\phi > 2/(3\beta)$ is similarly found by using equations (11), (25) and (26) together with (5).

Proof of Proposition 4

The first part of Proposition 4 is proved by following the same procedure as in the proof of Corollary 1, except that the upstream price is now set at stage 1. For $\phi < 2/(3\beta)$ we then find l^R and U^R as given by equations (15) and (16), which can be used together with equations (3) and (5) to prove parts *b*) and *c*) of Proposition 4.

Proof of Proposition 5

For $\phi > 2/(3\beta)$ we find that $\partial\Pi_U/\partial Q$ implies (c.f., equation 8))

$$Q = 2\frac{\alpha - 2(U+L)}{9\phi\beta - 2}. \tag{27}$$

The second-order condition is $\partial^2\Pi_I/(\partial Q^2) = -(9\phi\beta - 2)/(9\beta)$. The quality reduction level Q is thus given by (27) if $(9\phi\beta - 2) > 0$ for $X_i, x_i, Q \geq 0$. It is now useful to define $y = \phi\beta$. Inserting for this, and using equation (27), we now find that $\max\limits_{U,L}\{W\}$ and $\max\limits_{l}\{w\}$ imply that in an equilibrium with only partial foreclosure we have $L^R = 0$, $l^R = \alpha/3$ and

$$U^R = \frac{\alpha}{3}\frac{891y^2 + 522y - 376}{891y^2 + 108y - 212}. \tag{28}$$

From this it further follows that

$$X_2^R = \frac{\alpha}{9\beta}\frac{(y-58/99)\,(y-2/3)}{\left(y+\frac{6-8\sqrt{37}}{99}\right)\left(y+\frac{6+8\sqrt{37}}{99}\right)} \text{ and } Q^R = \frac{2\alpha}{27}\frac{(y-58/99)}{\left(y+\frac{6-8\sqrt{37}}{99}\right)\left(y+\frac{6+8\sqrt{37}}{99}\right)}, \tag{29}$$

which are both non-negative iff $y \geq 2/3$, or $\phi \geq 2/(3\beta)$. The vertically integrated upstream firm thus completely forecloses its domestic downstream rival through quality degradation if $\phi < 2/(3\beta)$, while it otherwise chooses only partial foreclosure.

For $\phi > 2/(3\beta)$ we have $W^R = \frac{\alpha^2}{18\beta}\frac{8415y^2+668y-1844}{891y^2+108y-212}$ with

$$\frac{\partial W^R}{\partial \phi} = \frac{16\alpha^2}{9}\frac{(99y-31)\,(99y-58)}{(891y^2+108y-212)^2} > 0. \tag{30}$$

We further find $w^R = \frac{2\alpha^2}{3\beta}\frac{264\,627y^4+2673y^3-90\,855y^2-9000y+11\,428}{(891y^2+108y-212)^2}$, which implies that

$$\frac{\partial w^R}{\partial \phi} = 6\alpha^2\frac{(20\,493y^2-16\,236y+3892)\,(297y^2-102y-16)}{(891y^2+108y-212)^3} > 0. \tag{31}$$

Comparing w^R with welfare when the upstream price is unregulated (equation (11)), it follows that regulation of U increases welfare in country II iff $\phi > \bar{\phi} \approx 0.75$. Q.E.D.