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Do Anti–Dumping Rules Facilitate the Abuse of Market Dominance?

by
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Do Anti–Dumping Rules Facilitate the Abuse of Market Dominance? ⋆

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Abstract

We discuss the effects of AD–protection in a standard Dixit model of entry deterrence. In an AD–regime, the newcomer is constrained by a minimum–price rule in addition to existing irreversible entrance costs. For minimum prices which lie below the Stackelberg one, we find that AD–rules distort competition. We show that AD–protection increases the advantages of entry deterrence for a wide range of combinations of sunk costs and minimum prices. When entrance costs are high, consumer welfare is lower in an AD–regime than under free trade. Consequently, AD–protection facilitates the abuse of market dominance.

Key words: Anti–dumping, abuse of market dominance, strategic firm behaviour
JEL–Classification: F14, L40

1 Introduction

Anti–dumping (AD-) actions are legitimate measures permitted under Article VI GATT/WTO rules, and are by now the most frequently employed instrument of ’contingent protection’ [1]. Over the past decade, almost 2,500 AD cases were investigated and notified to the GATT. Of these, almost 50 per cent were initiated by

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[1] Contingent protection refers to anti–dumping and countervailing duties (Article VI) and emergency protection under the GATT–WTO’s principal safeguards clause (Article XIX).

the four 'traditional' user countries [2] and approximately 40 per cent by developing countries as Mexico, South Africa or India. [3] Hence, AD–protection is a global phenomenon. The effects of AD–measures therefore deserve scrutiny.

The rational of AD–laws is to protect domestic competition from 'unfairly' low priced imports. However, a large and still growing body of literature has argued that it is not dumping but AD–policy, which undermines competition as AD–rules have unintended, anti–competitive side–effects. Here, the bulk of the literature has concentrated on the 'collusive impact' of anti–dumping, i.e. on only one particular type of competition restricting behaviour. [4]

The objective of this paper is to analyse whether AD-policy facilitates the 'abuse of a dominant market position', which is another form of anti–competitive business conduct. According to an OECD-definition, a firm abuses its dominance, if "it is systematically restricting the ability of actual or potential competitors to serve consumers, and is doing this without at the same time achieving efficiencies benefiting consumers." (OECD, 2000, p. 2) The main question we pose in this paper is how AD–rules alter the capability of incumbent firms to defend their monopoly position vis–a–vis *potential* competition, in other words how AD–legislation affects the contestability of a market.

To analyse this question, we employ a variant of the well–known Dixit model of entry deterrence where an incumbent firm and a potential foreign rival interact. [5] We compare two different regimes: a free trade regime as well as an AD–regime. Under free trade, market access of the potential foreign entrant is restricted only due to the existence of sunk costs. Under AD–rules, the newcomer additionally faces a price restriction, which forbids him to undercut an exogenously specified minimum price.

[2] They are the European Union (EU), Australia, the United States (US) and Canada.

[3] These numbers are taken from UNCTAD (2000). A number of recent studies have also documented the recent increase in the global importance of anti–dumping. See e.g. Miranda et al. (1998), Kempton et al. (1999) as well as Finger and Schuknecht (1999).

[4] For example, Prusa (1992) and Panagariya and Gupta (1998) demonstrate how AD legislation can be used to *reach* collusive agreements, Fischer (1992), Reitzes (1993), Prusa (1994), Steagall (1995) and Pauwels et al. (1997) show how contingent protection may facilitate *tacit collusion* , while Staiger and Wolak (1989) as well as Hartigan (2000) discuss how AD-rules affect the ability to *sustain* collusion among domestic and foreign firms.

[5] See Dixit (1980). There is a considerable amount of trade policy literature which applies the capacity commitment approach, or variations on it, to analyse entry-deterring behaviour. See the papers by Brander and Spencer (1987), Dixit and Kyle (1985), Ishibashi (1991) and Campbell (2000). Neither one of this paper has applied the framework of Dixit. Moreover, most of the papers assume that the foreign firm is the incumbent and hence discuss the role of trade policy to 'promote', instead of deter entry. The exemption is Campbell (2000) who discusses the effects of an import quota on entry–deterring behaviour in a Milgrom and Roberts type model.

The paper proceeds as follows: in section 2, we describe the indispensable institutional and legal framework of AD–legislation and explain why AD–rules serve to establish minimum prices. In section 3 we briefly present Dixit's model. The effects of the minimum price rule are analysed in section 4. We discuss our main results in section 5. Section 6 concludes.

2 Institutional and legal background

Article VI of the GATT–1994 and the WTO–AD–Agreement (ADA) allow its signatories to impose duties on imports if two conditions are met: first, products are dumped, i.e. introduced into the commerce of the importing country at less than their 'normal' or 'fair' value. Second, dumping causes 'material' injury to the domestic firm. The ADA requires that AD–duties must be higher than the dumping margin (i.e. the difference between the normal value and the import price). Moreover, their imposition is only allowed after dumping and injury have been proven in a formal investigation, initiated by an application by or on behalf of the domestic industry. [6]

In section 4, we model AD–legislation as a minimum price rule which forbids the foreign firm to undercut the 'normal value' or the 'fair price' of the product. Moreover, we assume that the normal value is exogenous to domestic and foreign firms. In the following, we briefly explain the reasons for these two assumptions.

The assumption that AD–legislation de facto establishes a minimum price, has two reasons: first, WTO rules explicitly envisage the *direct* introduction of import minimum prices through the negotiations of so–called price undertakings. According to Article 8.1 ADA, authorities have the discretion to terminate or suspend proceedings without imposing duties if an exporter commits to "revise its prices [...] so that the authorities are satisfied that the injurious effect of the dumping is eliminated". [7] Moreover and secondly, minimum prices may also be established *indirectly*: For example, in the US, no duties as such are levied, but exporters are required to make cash deposits: if no dumping is found in a review investigation one year later, the exporter receives a full refund of the cash deposit, including interest. Hence, exporters have strong incentives to adjust their prices to the minimum price in order to avoid the duty payment. [8]

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[6] The term 'material injury' is not precisely defined in multilateral trade rules. In fact, the ADA lists 15 injury indicators, whereas an affirmative finding can be established even if none of these indicators points towards the existence of material injury, as article 3.4 ADA explicitly states that no factor can give decisive guidance.

[7] See Moore (2000b) and Pauwels and Springael (2000) for a review of the practice of undertaking-acceptance in the US and the EU respectively.

[8] The situation is different in the EU, where a prospective duty system is employed: the

The assumption that the minimum price, i.e. the normal value of the product in question, is exogenous to the foreign firm, at first glance, seems to contradict the usual definition of price–dumping. In fact, article 2.1 ADA indicates that national authorities should preferably establish the normal value of the similar product on the basis of the exporter's home market price. This seems to imply that the foreign firm always has the option to avoid dumping by sufficiently raising the price he charges on his domestic market. However, if there are "not enough sales in the 'ordinary' course of trade in the domestic market of the exporting country" (ADA, Article 2.2), authorities may choose between two alternative methods of normal value calculation. The first alternative is to 'construct' the normal value, which involves adding a 'reasonable' profit margin to the production costs in the foreign local market. The second alternative is to establish the fair value on the basis of the foreign producer's export price to a third country. Obviously, national authorities have considerable discretion (and firms little direct influence besides lobbying) in determining the reasonableness of a certain profit margin, or the choice of an adequate third country. It follows that — at least in all cases where dumping is not defined as price dumping [9] —, it is sensible to assume that the normal value is a politically specified minimum price, which is exogenously imposed on the firms. [10]

3 The Basic Model

A variant of the Dixit (1980) model is applied to analyse the effects of AD–regulations in the form of a minimum–price rule. Although it is well understood, we present it elaborately as the analysis of the model below closely follows the Dixit one.

level of the duties is set on the basis of past performance and applies to all future exports until the AD order expires. However, exporters can apply for a review and claim refunds if they can show they are dumping no longer. Moreover, the Commission can impose additionally (retroactive) tariffs if the foreign firm continues to dump. Again, there are considerable incentives for foreign firms to refrain from undercutting the minimum price.

[9] Even in this case, the normal value is frequently established on the basis of the 'facts available', if foreign firms are found to only partially co–operate in the investigation process. In this case, home market prices are determined on the basis of rough allegations of the complaining domestic industry. See Palmeter (1991) and Moore (2000a) for more details as well as for reasons why firms frequently fail to co–operate with AD–authorities during the investigation process.

[10] Finger (1993, p. viii) also concludes that "dumping is whatever you can get the government to act against under the anti–dumping law".

3.1 Demand, Cost and Profit Functions

We consider a two–stage model of perfect information. In the first period t_1, a domestic firm (H) operates on the market. It has the opportunity to extend its production capacity k_H. At the end of the first period, a foreign firm (F) decides whether to enter the market or not. In the second period t_2, both firms simultaneously choose the quantities. In deciding on the next period's capacity level, the domestic firm anticipates both the entry decision of the foreign firm and the outcome of the second–stage quantity game. Similarly, when the foreign firm decides on entrance, it anticipates the outcome of the second–stage game.

The firms face a time–invariant demand function. It is assumed to be linear, so that the inverse demand function can be written as

$$p(q_H, q_F) = a - b(q_H + q_F), \tag{1}$$

where q_H and q_F denote the quantities supplied by the domestic and foreign firm respectively. The parameter a is the reservation price.

In the first period t_1, the domestic firm can expand its capacity k_H. One unit of capacity can be used to produce one unit of the consumption good. When the incumbent's output in t_2 is less than the previously installed capacity, it incurs a constant unit cost c and fixed costs of rk_H to maintain the capacity.Given the domestic firm maintains a capacity level k_H at the beginning of t_2 but wishes to produce more than k_H units of output, it has to further extend the capacity level. This causes costs of $r(q_H - k_H)$ in addition to the production costs when $q_H < k_H$. Therefore, the incumbent's cost function for the entry period t_2 reads

$$C_H = \begin{cases} cq_H + rk_H & \text{if } q_H < k_H, \\ (c+r)q_H & \text{if } q_H = k_H. \end{cases} \tag{2}$$

When the previously installed capacity level is sufficient for the desired output, the marginal costs are c. In contrast, the latter equal $c + r$ when the firm chooses to extend the capacity in the second period. Hence, the incumbent's possibility to install capacity in the pre–entry period t_1 gives him a cost advantage.

In t_1, the foreign firm is not present in the market, so that it has to install the required capacity when entering the market. For the foreign firm, the operating costs are $c + r$ per unit of output. However, entering the domestic market is associated with irreversible expenses z. As the domestic firm is already operating in the market, it has already made this investment. The foreign firm's cost function can be written as

$$C_F = (c+r)q_F + z. \tag{3}$$

Both firms face a two–stage decision problem. In the first stage, the incumbent chooses the next period's capacity level and the foreign firm decides whether to enter. Conditional on the strategies chosen in the first period, the second stage is formed by the simultaneous quantity choice of both firms. Each firm will take the actions, which promise the highest profits, where the profit function is given by

$$\pi_i = p(q_H, q_F)q_i - C_i \quad i = H, F. \tag{4}$$

In selecting the own quantity, the forms regard the opponents quantity as given. The firms' best response function can be derived by

$$q_i = \frac{S - q_j}{2}, \quad i = H, F, \quad i \neq j, \tag{5}$$

where $S =: (a - c - r)/b$ is the total quantity when the price equals the marginal costs $c + r$.

3.2 The Strategies

The incumbent has two advantages over a potential entrant. By installing capacity in the pre–entry period, he commits himself to a certain output. This gives him a cost advantage as the next period's marginal costs are lower. Yet, he has also a strategic advantage as the first move gives him the possibility to choose his most desired outcome.

In deciding on the capacity level, the domestic firm has several options. Given the threat of entry is credible, the incumbent may defend its market by installing a capacity level rendering a non–positive profit for the potential entrant. Alternatively, the domestic firm may allow entrance. In this situation he acts as the Stackelberg leader.

Whenever the incumbent chooses the latter option, he picks a point on the foreign firm's reaction function, which maximises his own profit. Inserting the entrant's reaction function into the incumbent's profit and maximising the latter with respect to the quantity results in $q_H^S = S/2$. The entrant's output can be derived with the $q_F^S = S/4$. In a Stackelberg situation, the domestic firm's profit is given by

$$\pi_H^{FS} = \frac{b}{2}\left(\frac{S}{2}\right)^2, \tag{6}$$

were the superscript F stands for free trade and indicates that no AD–regulation exists. The superscript S marks variables specific for a Stackelberg outcome. Similarly, entrant earns profits of $\pi_F^S = b(S/4)^2 - z$. Clearly, the foreign firm only enters the market if he receives a positive profit. Accordingly, for entrance costs satisfying

$$z \geq z^B =: b(S/4)^2,$$

the exporting firms stays out of the market and entry is blocked. For those entry barriers, the threat or entrance is not credible, so that the domestic firm behaves as a monopoly.

If the domestic firm decides to defend its market, he chooses a capacity in t_1 and an equivalent output in t_2, so that entry becomes unprofitable for the potential exporting firm. The best response to every possible output level of the incumbent is given by equation (5). This results in a profit of $\pi_F = b(S - q_H)^2/4 - z$. It can be shown that the profit is non–positive, when the following inequality holds:

$$q_H \geq k_H^{FD} =: S - 2\sqrt{\frac{z}{b}}, \tag{7}$$

where the superscript D denotes 'deterring' and k_H^{FD} is the limit capacity in the free–trade situation. If the foreign firm observes an installed capacity level of $k_H \geq k_H^{FD}$ and believes that the incumbent fully utilises this capacity level in case of an entry, it will stay out of the market. Entry would result in non–positive profits so that the entry is deterred whenever $k_H \geq k_H^{FD}$.

Whether the incumbent deters or allows entry depends on the profit associated with the appropriate alternative. Let π_H^{FD} denote the profit resulting from the deterrence strategy. Then, the incumbent defends his market as long as $\pi_H^{FD} > \pi_H^{FS}$, where π_H^{FS} is given in equation (6).

Using the equation (5) together with (2) in the profit function and noting that q_F equals zero when entry is deterred, yields

$$\pi_H^{FD} = 2b\sqrt{\frac{z}{b}}\left(S - 2\sqrt{\frac{z}{b}}\right). \tag{8}$$

Comparing both profits shows that $\pi_H^{FD} > \pi_H^{FS}$ when z is higher than $z^{DL} =: bS^2(3 - 2\sqrt{2})/32$ and lower than $z^{DU} =: bS^2(3 + 2\sqrt{2})/32$ (cf. appendix). As $z^{DU} > z^B$, $z \geq z^{DU}$ are irrelevant.

Depending on the level of the entrance costs, the incumbent can employ three strategies. When entrance costs are high, i.e for $z \in [z^B, \infty)$, entry by an exporting firm is not credible, so that the domestic firm behaves as a monopolist. In this situation, he produces $q_H^m = S/2$ and receives the monopoly profit $\pi_H^m = b(S/2)^2$. If the entry barrier is lower, i.e. for $z \in [z^{DL}, z^B)$, the incumbent finds it profitable to deter entry. He produces the quantity equivalent to the capacity specified in equation (7) and balance a profit of π_H^{FD}. For entrance costs satisfying $z \in [0, z^{DL})$, the domestic firm allows the foreign firm to enter the market. Then, he produces the quantity of the Stackelberg leader $S/2$ and receives π_H^{FS}.

4 The Model with a Anti–Dumping Regulation

This section introduces an AD–regulation specifying a normal value into the above described model. It is assumed that the AD–measures are enforced whenever the market price is lower than an exogenously specified norm price p^n. However, in models with perfect information, the AD–measures need never be executed. Rather, the normal value imposes an additional restriction to the firms. Apart from the normal value, the model is identical to the one presented in the previous section.

It is reasonable to assume that the norm price is higher than the market price under perfect competition $c+r$, but lower than the monopoly price p^m, i.e. $p^n \in [c+r, p^m]$. After the foreign firm has entered the market, AD–measures cannot be enforced as long as the market price p exceeds the norm price, i.e. if $p \geq p^n$. This establishes a price restriction influencing the foreign firm's entry decision. As the firms set quantities, it is convenient to transform the price restriction into an equivalent quantity restriction. Employing the inverse demand curve (1), each norm price has a corresponding norm quantity Q^n, $Q^n = (a - p^n)/b$. It follows that the price restriction $p \geq p^n$ is satisfied if the total quantity supplied Q is lower than the norm quantity, i.e. when

$$Q \leq Q^n. \tag{9}$$

It can also be assumed that the norm quantity will take a higher value than the monopoly quantity Q^m and lower than the competitive one S. Hence, the valid range for the norm quantity is $Q^n \in [S/2, S]$.

4.1 The Entrant's Reaction Function

In the second stage of the game, the foreign firm chooses its quantity q_F, so that profits are maximised. As opposed to the last section, two situations can be distinguished: when the price restriction or equivalently the quantity one are constraining and when it has no effect. Maximising the profit function subject to the quantity restriction given in equation (9) yields the exporting firms reaction function with (cf. appendix)

$$q_F = \begin{cases} b(S - q_H)/2 & \text{if } q_F < Q^n - q_H, \\ Q^n - q_H & \text{else.} \end{cases} \tag{10}$$

The upper line specifies the behaviour of the entrant if the quantity restriction is ineffective. It is identical to the one in equation (5). It shows that the entrant responds to an increase of the incumbent's quantity by 2 units with a reduction of one unit. When the quantity restriction is binding, the second line is relevant. Then, the exporting firm's reduction in production has to meet the incumbent's increase in output. Otherwise, the market price would fall below the normal value and the AD–measures would be enforced.

4.2 The Incumbent's Options

It is worth mentioning that the incumbent decides whether the price restriction is binding or not, due to his first–mover advantage. As a consequence, the domestic firm can choose between two sets of strategies: the free–trade and the AD–strategies. We refer to free–trade actions whenever the incumbent behaves as though no AD–regulation exists, i.e. when the latter is ineffective. In contrast, AD–strategies are those when the domestic firm chooses a capacity, so that the price restriction becomes binding. As the free–trade strategies were presented in the last section, we focus on the AD–ones here.

When the quantity restriction (9) is binding, the entrant's reaction function is given by the lower line in equation (10). It follows that the incumbent's profit reads $\pi_H^P = (S - Q^n)q_H$ and is valid when $q_H \geq 2Q^n - S$. In addition, the quantity supplied by the domestic firm will not exceed the norm quantity, so that $q_H \leq Q^n$. The appendix shows that the incumbent's optimal output is given by

$$q_H = Q^n \quad \text{if} \quad q_H \in [2Q^n - S, Q^n]. \tag{11}$$

The equality between the incumbent's output and the norm quantity results as the profit function fails to be strictly concave in the quantity q_H when the restriction (9) is binding. The intuition behind this result is simple. The incumbent knows exactly that expanding the output by one unit will induce the exporting firm to reduce his output by the same amount. When the entrant responds differently, AD–measures are enforced. As a consequence, the price cannot drop below the normal value. In addition, equation (11) shows that no entry occurs as long as the price restriction is binding. Inserting (11) into the profit function and noting that q_F is zero yields the incumbent's profit with

$$\pi_H^{PS} = bq_F^* Q^n. \tag{12}$$

However, the domestic firm need not produce the norm quantity to prevent market entry. The best response of the exporting firm to an arbitrary level of output q_H is given by the lower line of equation (10). The corresponding profit is $\pi_F = b(S - Q^n)(Q^n - q_H) - z$. Accordingly, the entrant would earn non–positive profits when actually entering the market if

$$q_H \geq k_H^{PD} =: Q^n - \frac{z}{b}\frac{1}{q_F^*}, \quad q_F^* = S - Q^n, \tag{13}$$

where q_F^* is the foreign firm's output which is determined by the intersection of the reaction functions (10) for the cases when the restriction is binding and not binding. Here, k_H^{PD} is the limit capacity under AD–rules. Therefore, entry is deterred for the incumbent's quantities specified in (13). When the incumbent chooses an output level equal to the entry deterring capacity, his profits are

$$\pi_H^{PD} = b\left(q_F^* + \frac{z}{b}\frac{1}{q_F^*}\right)\left(Q^n - \frac{z}{b}\frac{1}{q_F^*}\right). \tag{14}$$

Given the quantity restriction is binding, whether the incumbent chooses to produce a quantity equivalent to the norm quantity or to the entry deterring capacity in (13) depends on which alternative promises the higher profit. Therefore, the domestic firm selects the entry deterring capacity, whenever $\pi_H^{PD} > \pi_H^{PS}$. Comparing both profit functions shows that the incumbent produces the entry deterring quantity for entry barriers z lower than $\tilde{z} =: bq_F^* q_H^*$ (cf. appendix). $q_H^* =: 2Q^n - S$ is the incumbent's output associated with the point at which the reaction function for situations with a binding and a non–binding quantity restriction intersect.

Similar to the situation with no AD–regulation, the AD–strategy chosen by the domestic firm depends on the entrance costs z. Given that the price restriction is binding, the incumbent produces the entry deterring quantity for low entry barriers, i.e. for $z \in [0, \tilde{z})$. When the entrance costs are higher, i.e. if z lies in the interval $[\tilde{z}, z^B)$. As a firm can never receive a higher profit than the monopoly one and the entrance is blocked for $z \in [z^B, \infty)$, the incumbent produces the monopoly quantity in those situations.

5 Anti–dumping regulations as entry barriers

5.1 The effects of a minimum–price rule

Until now, we accepted the fact that some levels of the normal value are binding and others are ineffective for each entry barrier z. To determine the effects of the AS–regulation, we have to answer the question which levels of the norm quantity and, hence, which normal values are constraining.

In general, the quantity restriction can be regarded as completely ineffective when firms behave as though no AD–regulation exists. This involves two prerequisites: (i) the minimum–price rule has to be physically ineffective and (ii) the normal value has to leave the firms' strategic behaviour unaffected. For a given entry barrier, case (i) requires the norm quantity to be higher than the total quantity supplied in a free–trade situation. Henceforward, we refer to norm quantities satisfying case (i) as physically ineffective ones. However, there may be situations in which the existence of an AD–regulation change the firms' strategic behaviour although the restriction is physically ineffective. Accordingly, case (ii) requires that the firms behave as if no restriction exists. For a given entry barrier, we refer to norm quantities satisfying case (ii) as being strategically ineffective. As a consequence, normal values for which case (i) and (ii) are met, are completely ineffective.

In a free–trade situation, the domestic firm applies three different strategies: behaving as a monopoly, deterring or allowing entry. As the entrance is blocked for high entry barriers, i.e. for $z \in [z^B, \infty)$, the incumbent has a monopoly. The total quantity supplied equals the monopoly output $S/2$. The domestic firm deters entry when $z \in [z^{DL}, z^B)$, so that the total output is equivalent to the entry deterring capacity $S - 2\sqrt{z/b}$. For low entrance costs, i.e. for $z \in [0, z^{DL})$, the incumbent allows entry, so that the total output equals the Stackelberg quantity $3S/4$. Therefore, the norm quantity is physically ineffective if

$$Q^n \in \begin{cases} [3S/4, S) & \text{for } z \in [0, z^{DL}), \\ [S - 2\sqrt{z/b}, S) & \text{for } z \in [z^{DL}, z^B), \\ [S/2, S) & \text{for } z \in [z^B, \infty). \end{cases} \tag{15}$$

It is also worth mentioning that the maximal quantity the incumbent produces to defend the domestic market exceeds the total output in a Stackelberg situation. This can be seen by replacing the entry barrier z by the definition of z^{DL} in equation (7) and noting that $3\sqrt{2}S/4$ is higher than $3S/4$, the Stackelberg quantity. This result suggests that norm quantities $Q^n \geq 3\sqrt{2}S/4$ are ineffective for all levels of the entry barrier. However, it is shown below that this conclusion is misleading as it neglects the second condition being met.

Requirement (ii) refers to the strategic behaviour of both firms. In examining which set of normal values are strategically ineffective for a given entry barrier, we only have to analyse the incumbent's profits. This can be seen by noting that the domestic firm has the first–mover advantage to choose a capacity and, hence, a quantity in the pre–entry period t_1. The foreign firm observes the incumbent's decision and optimally responds. Accordingly, the domestic firm chooses the AD–strategies whenever doing so yields the higher profit than applying the free–trade strategies.

Proposition 1 *Let* $z_u^c =: (q_F^*/2)^2$, $z_l^d =: bq_F^*(\sqrt{q_F^*} - \sqrt{S})^2$, $z_l^a =: bq_F^*(S(2-\sqrt{2}) - q_F^*)$, *and* $z_u^a =: bq_F^*(S(2+\sqrt{2}) - q_F^*)$. *Then, the set of entry barriers where the incumbent applies the AD–strategies is given by*

$$z \in \begin{cases} [0, z_u^c) & \text{if} \quad Q^n \in \left[\frac{S}{2}, \frac{S}{8}\left(6 - \sqrt{1 + 2\sqrt{2}}\right)\right) \\ [0, z_l^d) & \text{if} \quad Q^n \in \left[\frac{S}{8}\left(6 - \sqrt{1 + 2\sqrt{2}}\right), \frac{S}{4}(2 + \sqrt{2})\right) \\ [z_l^a, z_l^d) & \text{if} \quad Q^n \in \left[\frac{S}{4}(2 + \sqrt{2}), \frac{S}{8}(6 - \sqrt{2} + 2^{7/4})\right) \\ [z_l^a, z_u^a) & \text{if} \quad Q^n \in \left[\frac{S}{8}(6 - \sqrt{2} + 2^{7/4}), S\right) \end{cases} \tag{16}$$

PROOF. See appendix.

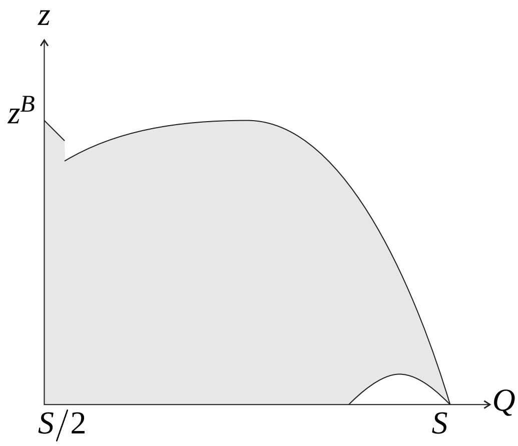

Figure 1. Situations with strategically effective AD–rules

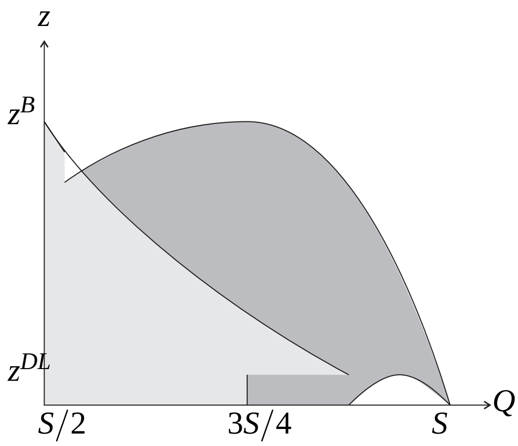

Figure 2. Situations with strategically effective but physically ineffective AD–rules

This proposition determines the combinations of the entry barrier and the norm quantities which alters the strategic behaviour of the firm in presence of an AD–regulation. The information given in proposition 1 is illustrated in figure 1. The grey shaded area marks the combinations of z and Q^n where the domestic firm earns higher profits when adopting the AD–strategies. Consequently, the white areas show the combinations of z and Q^n where the incumbent finds it profitable to apply the free–trade strategies. Consequently, those combinations of z and Q^n show where the AD–regulation is strategically ineffective. The white area to the lower right site of the figure shows that market entry occurs for certain norm values.

Proposition 1 and, hence, figure 1 do not require the norm quantities to be physically ineffective. Using the information given in equation (15) together with the one stated in proposition 1 ensues in figure 2. Here, the dark grey shaded area displays the combinations of the entry barrier and the norm quantity where the domestic firms chooses the AD–strategies although the minimum–price regulation is physically ineffective. The white areas show combinations of z and Q^n for which the corresponding minimum–price rule proves to be completely ineffective.

The existence of an AD–regulation may also affect the total quantities supplied. When no AD–regulation exists, the total quantity produced is given by

$$Q^F = \begin{cases} \frac{3}{4}S & \text{for} \quad z \in [0, z^{DL}), \\ S - 2\sqrt{\frac{z}{b}} & \text{for} \quad z \in [z^{DL}, z^B). \end{cases} \tag{17}$$

The first line applies whenever the foreign firm enters the market due to low entry barriers and both firms play a Stackelberg game. The second line is associated to situations in which the domestic firm finds it profitable to deter entry. Since the incumbent is a monopoly when $z > z^B$ independent of the existence or non–existence of AD–regulations, we do not consider these cases here. Similarly, we can summarise the total quantities produced whenever the AD–regulation proves to be binding:

$$Q^P = \begin{cases} Q^n - \frac{z/b}{q_F^*} & \text{for} \quad z \in [0, \tilde{z}), \\ Q^n & \text{for} \quad z \in [\tilde{z}, z^B). \end{cases} \tag{18}$$

We define a situation to be pro–competitive whenever $Q^P > Q^F$.

Proposition 2 *Let $z_a = bq_F^*(4Q^n - 3S)$ and z^{DL}, z_l^a, z_u^a be defined as above. Then, the set of entry barriers where the incumbent applies the AD–strategies and a pro–competitive situation is given can be determined with*

$$z \in \begin{cases} [0, z_a) & \text{for} \quad Q^n \in \left[\frac{3}{4}S, \frac{S}{16}\left(14 - \sqrt{2^{5/2} - 2}\right)\right), \\ [0, z^{DL}) & \text{for} \quad Q^n \in \left[\frac{S}{16}\left(14 - \sqrt{2^{5/2} - 2}\right), \frac{S}{4}(2 + \sqrt{2})\right), \\ [z_l^a, z^{DL}) & \text{for} \quad Q^n \in \left[\frac{S}{4}(2 + \sqrt{2}), \frac{S}{8}(6 - \sqrt{2} + 2^{7/4})\right), \\ [z_l^a, z_u^a) & \text{for} \quad Q^n \in \left[\frac{S}{8}(6 - \sqrt{2} + 2^{7/4}), S\right). \end{cases} \tag{19}$$

PROOF. See appendix.

Again, the proposition does not require the minimum–price rule to be physically ineffective. However, it is easy to see that z_u^c and z_u^a have smaller values than z^{DL} in the relevant range of the norm quantities. As a consequence, the combinations of z and Q^n stated in proposition 2 refer to situations, in which the AD–regulation is physically ineffective. Hence, they describe situations where no entry occurs although it were possible.

5.2 Discussion

As mentioned above, the maximum quantity that the domestic firm produces to defend the market in absence of an AD–regulation equals $3\sqrt{2}S/4$. This suggests that

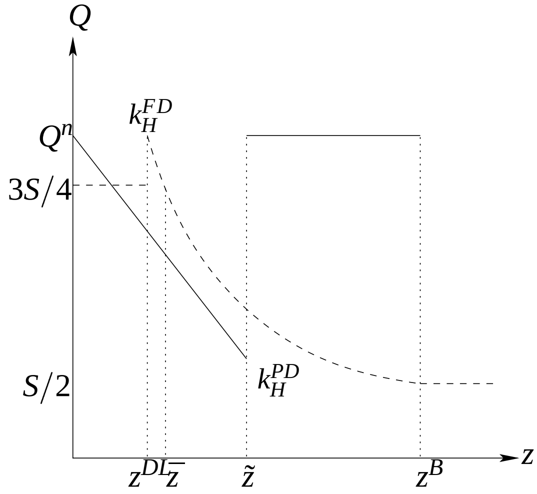

Figure 3. Total quantities supplied in a free–trade and an AD–situation

normal values corresponding to higher norm quantities are completely ineffective for all levels of the entrance costs. However, an immediate result of proposition 1 is that there is no normal value in the range $(p^c, p^m]$, which is neither physically nor strategically ineffective for all entry barriers. Reversely stated, every normal value different from the price under perfect competition distorts the market outcome for at least some levels of the entry barrier.

This also implies that reducing the entry barriers for foreign firms is not sufficient to ensure market entrance. It can be illustrated by focussing on the special case of $z = 0$. With no entrance costs for the foreign firm, the incumbent finds it unprofitable to defend the home market in a free–trade situation. When an AD–regulation exists, market entry occurs only if the normal value corresponds to norm quantities stated in the two lower lines of equation (16). The lowest norm quantity where market entry is possible, exceeds the total Stackelberg quantity of $3S/4$. As a consequence, even if no market barriers exist, entry occurs only for specific normal values. In addition, these normal values have to be considerably lower than the price in a Stackelberg situation. This implies that even 'innocent' looking minimum prices have a distorting effect on competition.

The main subject of this paper is to show whether AD–rules facilitate the abuse of market dominance. The abuse of market dominance requires that entrance and consumer's welfare are restricted. It is worth mentioning that the domestic firm abuses its incumbency even under free trade. The incumbent's ability to do so depends solely on the level of sunk costs. This can be seen in figure 3. In the latter, the dashed graph illustrates the total quantity supplied in a free–trade situation. For low entry barriers, i.e. for $z \in [0, z^{DL})$, the incumbent finds it profitable to allow entry since the limit capacity is high. For higher entrance costs, i.e. for $z \in [z^{DL}, z^B)$, no market entry occurs. Yet, if the level of the entrance barrier is in the interval $[z^{DL}, \bar{z})$ the incumbent does not abuse its dominant position, as the total quantity supplied exceeds the one in a Stackelberg situation. Therefore, the consumer's welfare is higher even though no market entry occurs. However, for all entrance costs $z \in [\overline{z}, z^B)$, the domestic firm abuses its dominant position since neither market entry occurs nor is the total quantity supplied higher than the Stackelberg one.

In the anti–dumping regime, however, the profitability of a deterrence strategy depends on the interaction between the level of sunk costs and the level of the minimum price. To analyse this case, it is convenient to distinguish between low–entry–cost situations, i.e. $z \in [0, z^{DL})$, and high–entry–cost ones, i.e. for $z \in [z^{DL}, z^B)$.

Concerning the first prerequisite, figure 2 demonstrates that entry is deterred for some normal values although it would be generally allowed in the free–trade regime for the low–entry–cost case. Therefore, it can be concluded that entry deterrence is facilitated for those normal values. In the high–entry–cost cases, entrance is deterred in both regimes. However, the counter–conclusion of proposition 2 shows that whenever the normal value is such that the incumbent chooses the AD–strategies, the entry deterring quantity is lower as compared to the free–trade regime. Again, deterring entry is facilitated for those normal values.

All cost intervals specified in proposition 2 belong to low–entry–cost cases. Surprisingly, we find a pro–competitive effect increasing the consumer's welfare for most situations, in which entry is deterred under AD–rules but not under free trade as a consequence of this proposition. [11] Figure 3 illustrates this situation. However, these effects require the normal value to be lower than the free–trade price, i.e. here the one of the Stackelberg situation. This corresponds to norm quantities higher than the total quantity in a Stackelberg game, which can be seen in figure 3. In particular, we find a pro–competitive effect increasing the consumer welfare for a combination of low entrance costs and moderate normal values. For those combinations, the incumbent does not abuse its dominant position even though no market entry occurs.

In contrast, for the high–entry–cost case, the total quantity produced is lower when the incumbent applies the AD–strategies as compared to the free–trade situation. Again, figure 3 illustrates this result. [12] Hence, it is easier for the incumbent to deter entry in an AD–regime. Consequently, the AD–rules produce an anti–competitive effect. If entrance costs are high, entry deterrence under free trade ensues in a lower consumer welfare. Yet, the total quantity produced is still higher than under AD–protection. Accordingly, AD–rules facilitate the abuse of market dominance.

[11] As proposition 2 in combination with figure 2 illustrates, there exists a small set of combinations of z and Q^n, for which we find a anti–competitive effect.
[12] In the latter, it is important to note that for $z \in [\tilde{z}, z^B)$ the domestic firm will not choose the AD–strategy so that the appropriate segment of the graph is irrelevant.

6 Conclusion

Our analysis has important implications for the interface between trade policy and competition policy. The current administration of AD–legislation as minimum–price protection is frequently inconsistent with the objective of a competition friendly international trading system, in which both policy fields support each other in maintaining market access and market contestability. We have shown that minimum–price protection not only alters the strategic interactions among actual competitors, but additionally among incumbents and potential competitors. Hereby, even seemingly 'innocent' minimum prices, i.e. minimum prices, which are equal or below the competitive price (i.e. the 'true normal value') distort the behaviour of firms. Examples comprise the market deterrence for low entry costs and the abuse of market dominance for high entry costs. Hence, our analysis suggests that avoiding undesirable anti–competitive side effects of anti–dumping policy is not only a matter of removing biases and distortions in the calculation of the normal or fair value of the product.

The argument can be further strengthened. The entry may consist of two components: administrative and non–administrative ones. Examples for the former may be trade tariffs etc. One may argue that the level of the administrative entry costs can be determined so that the AD–legislation can at least in principle find normal values, which are physically and strategically inefficient. In contrast, non–administrative entrance costs, as e.g. establishing a distribution network for the products or gaining consumer confidence, are market specific. They may vary between industries. In addition, one may find it impossible to determine the level of the relevant entrance costs. Yet, if the level of the entrance costs is uncertain it is impossible to determine the normal value which leaves the market undistorted.

Appendix

A Reaction functions and entry deterrence

A.1 The foreign firm's reaction function

As a Stackelberg follower, the foreign firm maximises its profits given the output of the domestic firm q_H. The profit maximisation is constrained by the quantity restriction (9). Using the profit function (4) and the cost function (3), the Lagrange function reads:

$$L = b(S - q_H - q_F)q_F - z + \lambda(Q^n - q_H - q_F),$$

where λ is the shadow price. The first–order conditions can be obtained with

$$\begin{aligned} b(S - q_H - 2q_F) &= \lambda, \\ Q^n - q_F - q_H \geq 0 \quad &\text{and} \quad \lambda(Q^n - q_H - q_F) = 0. \end{aligned}$$

If the shadow price equals zero, the restriction is not binding and $q_F = (S - q_H)/2$. If the shadow price is positive, the restriction is binding. In that case, $q_F = Q^N - q_H$.

A.2 The domestic firm's reaction function

When the quantity restriction is ineffective, the incumbent's maximisation problem reads

$$\begin{aligned} \max_{q_H} \quad \pi_H^F &= \frac{b}{2}(S - q_H)q_H, \\ \text{s.t. } q_H &\leq 2Q^n - S. \end{aligned}$$

The Lagrangian is given by $L = b(S - q_H)q_H/2 + \lambda(2Q^n - S - q_H)$. Applying the method of Kuhn–Tucker, the first–order conditions can be written as

$$\begin{aligned} \frac{b}{2}(S - 2q_H) &= \lambda, \\ 2Q^n - S \geq q_H \quad &\text{and} \quad \lambda(2Q^n - S - q_H) = 0. \end{aligned}$$

If the shadow price is zero, the inequality restriction is satisfied and the incumbent chooses $q_H = S/2$. We need not to consider the case when the inequality is not satisfied as this situation is subject of the following maximisation problem.

Given that the quantity restriction is binding, the domestic firm's maximisation problem reads

$$\begin{aligned} \max_{q_H} \quad \pi_H^P &= b(S - Q^n)q_H, \\ \text{s.t. } q_H &\geq 2Q^n - S, \\ q_H &\leq Q^n. \end{aligned}$$

Here, the Lagrangian can be written as $L = b(S - Q^n)q_H + \lambda(q_H - 2Q^n + S) + \mu(Q^n - q_H)$. The first–order conditions can be derived with

$$\begin{aligned} b(S - Q^n) &= \mu - \lambda, \\ q_H - 2Q^n + S \geq 0 \quad &\text{and} \quad \lambda(q_H - 2Q^n + S) = 0, \\ Q^n - q_H \geq 0 \quad &\text{and} \quad \mu(Q^n - q_H) = 0 \end{aligned}$$

Assume $q_H > 2Q^n - S$, then, λ equals zero. From the first of the first–order conditions follows that $\mu = b(S - Q^n)$ and consequently $q_H = Q^n$. Let q_H equal $2Q^n - S$.

Hence, $q_H < Q^n$ and μ equals zero. It follows from the first of the first–order conditions that $\lambda = b(Q^n - S)$. The latter expression should be positive, i.e. $Q^n > S$ is required. Yet, this contradicts the initial assumption that the norm quantity can reasonably be assumed to be from the interval $[S/2, S]$. Accordingly, q_H always equals the norm quantity Q^n when the quantity restriction is binding. Then, the reaction function for the domestic firm can be written as

$$q_H = \begin{cases} S/2 & \text{if } q_H < 2Q^n - S \\ Q^n & \text{if } q_H \geq 2Q^n - S \end{cases}$$

A.3 Entry deterrence under free trade

The incumbent chooses to deter entry as long as $\pi_H^{FD} > \pi_H^{FS}$. Let x be defined as $x =: z/b$. Using x in equation (8) together with (6), the condition becomes $2\sqrt{x}(S - 2\sqrt{x}) > (S/2)^2/2$. Rearranging yields $2\sqrt{x}S > 4x + (S/2)^2/2$. This is equivalent to $4xS^2 > (S/2)^4/4 + 16x^2 + 4x(S/2)^2$. By applying the quadratic completion, this inequality can be written as $S^4/8 > (4x - 3S^2/8)^2$. The latter expression is equivalent to $S^2/(2\sqrt{2}) > |4x - 3S^2/8|$. Using the definition of x renders two solutions to the inequality

$$z < b\frac{S^2}{32}(3 + 2\sqrt{2})$$
$$z > b\frac{S^2}{32}(3 - 2\sqrt{2})$$

A.4 Entry deterrence under anti–dumping regulations

Using the definitions of the profit functions π_H^{PD} and π_H^{PS} shows that the former is larger than the latter, whenever $(q_F^* + z/(bq_F^*))(Q^n - z/(bq_F^*)) > q_F^* Q^n$. Collecting terms yields $(z/b)(Q^n/q_F^*) - (z/b)^2/(q_F^*)^2 - z/b > 0$. This is equivalent to $(bq_F^* q_H^* - z)z/(bq_F^*)^2 > 0$. It follows $\pi_H^{PD} > \pi_H^{PS}$ for entry barriers $z < \tilde{z} =: bq_F^* q_H^*$.

B Proof of proposition 1

The proof is consists of several steps. First, the set of entry barriers is determined for which the incumbent's profit with an AD–regulation exceeds the one in a free–trade situation. Subsequently, 3 different cases are identified. Each case corresponds to a set of norm quantities. For each of those cases it is verified whether the profit under AD–protection is higher then the appropriate one under free–trade.

B.1 Comparison of the profit functions

B.1.1 $\boldsymbol{\pi_H^{PD}}$ and $\boldsymbol{\pi_H^{FS}}$

Let y be defined as $y =: q_F^* + z/(bq_F^*)$. Then, the profit π_H^{PD} given in equation (14) can be written as $\pi_H^{PD} = bSy - by^2$. π_H^{FS} was defined in (6). $\pi_H^{PD} > \pi_H^{FS}$ if and only if $Sy - y^2 > (S/2)^2/2$ is satisfied. Using the quadratic completion, the inequality can be written as $(S/2)^2/2 > (y - S/2)^2$. It follows that

$$\frac{S}{2\sqrt{2}} > \left| y - \frac{S}{2} \right|. \tag{B.1}$$

This inequality is satisfied for $y < S(2+\sqrt{2})/4$ and $y > S(2-\sqrt{2})/4)$. Using the definition of y it can be seen that (B.1) holds for values of the entrance costs $z < z_u^a$, $z_u^a =: bq_F^*(S(2+\sqrt{2})/4 - q_F^*)$, and $z > z_l^a$, $z_l^a =: bq_F^*(S(2-\sqrt{2})/4 - q_F^*)$. Hence, $\pi_H^{PD} > \pi_H^{FS}$ whenever

$$z \in [z_l^a, z_u^a]. \tag{B.2}$$

B.1.2 $\boldsymbol{\pi_H^{PS}}$ and $\boldsymbol{\pi_H^{FS}}$

The profit functions π_H^{PS} and π_H^{FS} were defined in equations (12) and (6). $\pi_H^{PS} > \pi_H^{FS}$ if and only if $SQ^n - Q^{n2} > (S/2)^2/2$. Applying the quadratic completion, the latter inequality can be written as $(S/2)^2/2 > (Q^n - S/2)^2$. This is equivalent to

$$\frac{S}{2\sqrt{2}} > \left| Q^n - \frac{S}{2} \right|. \tag{B.3}$$

This inequality is satisfied for all norm quantities $Q^n < Q_u^b$, $Q_u^b =: S(2+\sqrt{2})/4$, and $Q^n > Q_l^b$, $Q_l^b =: \frac{S}{4}(2-\sqrt{2})$. As $Q_l^b < S/2$, inequality (B.3) holds for all

$$Q^n \in [S/2, Q_u^b). \tag{B.4}$$

B.1.3 $\boldsymbol{\pi_H^{PD}}$ and $\boldsymbol{\pi_H^{FD}}$

Again, let y and x be defined as $y =: q_F^* + x/q_F^*$ and $x =: z/b$. Then, equation (14) and (8) can be simplified to $\pi_H^{PD} = bSy - by^2$ and $\pi_H^{FD} = 2b\sqrt{x}S - 4bx$. Applying the quadratic completion, the profit functions can be written as $\pi_H^{PD} = b((S/2)^2 - (y - S/2)^2)$ and $\pi_H^{FD} = b((S/2)^2 - (2\sqrt{x} - S/2)^2)$, so that $\pi_H^{PD} > \pi_H^{FD}$ if and only if $(S/2)^2 - (y-S/2)^2 > (S/2)^2 - (2\sqrt{x} - S/2)^2$. This corresponds to $(2\sqrt{x} - S/2)^2 > (y - S/2)^2$. It follows that

$$\left| 2\sqrt{x} - \frac{S}{2} \right| > \left| y - \frac{S}{2} \right| \tag{B.5}$$

The inequality has 4 potential solutions depending on whether $2\sqrt{x} - S/2$ and $y - S/2$ are positive or negative. The former term is positive if $2\sqrt{x} > S/2$. Solving this inequality with respect to the z shows that $z > b(S/4)^2 = z^B$. Accordingly, $2\sqrt{x} < S/2$ if $z < z^B$. The latter term is positive if $y > S/2$. Solving for z gives $z > bq_F^* q_H^*/2 = \tilde{z}/2$. Hence, $y - S/2 < 0$ if $z < \tilde{z}/2$.

Inequality (B.5) has 4 potential solutions: (1) $y < 2\sqrt{x}$ for $z > z^B$ and $z > \tilde{z}/2$, (2) $y > 2\sqrt{x}$ for $z < z^B$ and $z < \tilde{z}/2$, (3) $y < S - 2\sqrt{x}$ for $z < z^B$ and $z > \tilde{z}/2$, and (4) $y > S - 2\sqrt{x}$ for $z > z^B$ and $z < \tilde{z}/2$. Each of the possible solutions yield different ranges for the entry barriers z.

(1) $y < 2\sqrt{x}$

Using the definition of y this inequality can be rearranged to ${q_F^*}^2 + 2x + x^2/{q_F^*}^2 < 4x$. This is equivalent to $(q_F^* - x/q_F^*)^2 < 0$. This inequality cannot be satisfied for z from the real line. Hence, $\pi_H^{PD} < \pi_h^{FD}$ for For the first inequality there is no solution for $z > z^B$ and $z > \tilde{z}/2$.

(2) $y > 2\sqrt{x}$

By analogy, we find that $y > 2\sqrt{x}$ corresponds to $(q_F^* - x/q_F^*)^2 > 0$ which is always satisfied. Therefore, $\pi_H^{PD} > \pi_H^{FD}$ for all $z < \tilde{z}/2$ and $z < z^B$.

(3) $y < S - 2\sqrt{x}$

$y < S - 2\sqrt{x}$ is equivalent to $4x < S^2 - 2Sy + y^2$. Using the definition of y yields $4x < S^2 - 2S(q_F^* - x/q_F^*) + {q_F^*}^2 + 2x + x^2/{q_F^*}^2$. Collecting terms gives $0 < {q_F^*}^2(S - q_F^*)^2 + x^2 - 2q_F^*(S + q_F^*)$. Applying the quadratic completion renders $0 < {q_F^*}^2[(S - q_F^*)^2 - (S + q_F^*)^2] + [x - q_F^*(S + q_F^*)]^2$. This is equivalent to $4{q_F^*}^3 S < [x - q_F^*(S + q_F^*)]^2$. It follows $2\sqrt{{q_F^*}^3 S} < |x - q_F^*(S + q_F^*)|$. Using the definition of x and solving the latter inequality for z shows that $\pi_H^{PD} > \pi_H^{FD}$ is satisfied for

$$
\begin{aligned}
z &> z_l^d =: bq_F^*(\sqrt{q_F^*} + \sqrt{S})^2, \\
z &< z_u^d =: bq_F^*(\sqrt{q_F^*} - \sqrt{S})^2.
\end{aligned} \tag{B.6}
$$

as long as $z \in [\tilde{z}/2, z^B]$.

(4) $y > S - 2\sqrt{x}$

By analogy, we find that $\pi_H^{PD} > \pi_H^{FD}$ if $z < z_l^d$ and $z > z_u^d$ as long as $z \in [z^B, \tilde{z}/2]$.

B.1.4 π_H^{PS} and π_H^{FD}

Again, let x be defined as $x =: z/b$. Applying the quadratic completion to equations (12) and (8) ensues in $\pi_H^{PS} = (S/2)^2 - (Q^n - S/2)^2$ and $\pi_H^{FD} = (S/2)^2 - (2\sqrt{x} - S/2)^2$. It follows that $\pi_H^{PS} > \pi_H^{FD}$ if and only if $(S/2)^2 - (Q^n - S/2)^2 > (S/2)^2 -$

$(2\sqrt{x}-S/2)^2$. This corresponds to

$$\left|2\sqrt{x}-\frac{S}{2}\right| > Q^n - \frac{S}{2}. \tag{B.7}$$

In the last paragraph it has been shown that $2\sqrt{x}-\frac{S}{2}$ is positive (negative) if $z > z^B$ ($z < z^B$). For $z > z^B$, the inequality (B.7) is equivalent to $2\sqrt{x} > Q^n$. For $z < z^B$, (B.7) yields $2\sqrt{x} < S - Q^n$. Using the definition of x and solving for z gives

$$z \begin{cases} > z_l^c =: b(Q^n/2)^2 & \text{for } z > z^B \\ < z_u^c =: b(S-Q^n)^2/4 & \text{for } z < z^B. \end{cases} \tag{B.8}$$

Depending on the norm value p^n and, hence, the norm quantity Q^n, there are three different situations: case 1: $\tilde{z} < z^{DL} < z^B$, case 2: $z^{DL} < \tilde{z} < z^B$ and case 3: $z^{DL} < z^B < \tilde{z}$. For each case, we first determine the set of norm quantities for which it is defined. Subsequently, we specify the set of entry barriers z for which the profit is higher when the AD–strategies are applied as compared to the free–trade strategies.

B.2 *Case 1:* $\tilde{z} < z^{DL} < z^B$

B.2.1 *The set of norm quantities*

Using the definitions of q_F^* and q_H^* and applying the quadratic completion in the definition of $\tilde{z}$ yields $\tilde{z} = 2(S^2/16-(Q^n-3S/4)^2)$. z^{DL} is given by $z^{DL} = bS^2(3-2\sqrt{2})/32$ and is always lower than z^B. Therefore, $z < z^{DL}$ if and only if $S^2/16-(Q^n-3S/4)^2 < S^2(3-2\sqrt{2})/64$. Collecting terms gives $S^2(1+2\sqrt{2})/64 < (Q^n-3S/4)^2$. This is equivalent to $S\sqrt{1+2\sqrt{2}}/8 < |Q^n-3S/4|$. Hence, $\tilde{z} < z^{DL}$ for norm quantities satisfying $Q^n > S(6+\sqrt{1+2\sqrt{2}})/8$ and $Q^n < S(6-\sqrt{1+2\sqrt{2}})/8$, or equivalently,

$$\begin{aligned} Q^n \in & Q_l^I =: \left[\frac{S}{2}, \frac{S}{8}(6-\sqrt{1+2\sqrt{2}})\right), \\ Q^n \in & Q_u^I =: \left[\frac{S}{8}(6+\sqrt{1+2\sqrt{2}}), S\right). \end{aligned} \tag{B.9}$$

B.2.2 π_H^{PD} *and* π_H^{FS}

In section B.1.1 it has been shown that $\pi_h^{PD} > \pi_H^{FS}$ for entrance costs belonging to the interval $z \in [z_l^a, z_u^a)$. As π_H^{PD} is only relevant in the range of $z \in [0, \tilde{z}]$ and $\tilde{z} < z^{DL}$ by assumption in present case, we have to consider whether z_l^a positive or negative and whether z_u^a is smaller or larger than $\tilde{z}$.

Using the definition of z_l^a shows that the latter is negative if $bq_F^*[S(2-\sqrt{2})/4 - q_F^*] < 0$. Since q_F^* is positive as long as $Q^n < S$, the inequality is equivalent to $S(2-\sqrt{2})/4 < q_F^*$. Applying the definition of q_F^* and solving for the norm quantity yields $Q^n < S(2+\sqrt{2})/4$. Hence, $z_l^a < 0$ for all norm quantities

$$Q^n \in A^I =: \left[\frac{S}{2}, \frac{S}{4}(2+\sqrt{2})\right]. \tag{B.10}$$

Since $Q_l^I \subset A^I$, $z_l^a < 0$ for all $Q^n \in Q_l^I$. Similarly, it can be shown that $Q_u^I \cap A^I = \varnothing$ so that $z_l^a > 0$ for all $Q^n \in Q_u^I$.

By applying the definition of z_u^a and $\tilde{z}$ it can be seen that $z_u^a < \tilde{z}$ if $bq_F^*[S(2+\sqrt{2})/4 - q_F^*] < bq_F^* q_H^*$. Replacing q_H^* by its definition and solving the latter inequality for the norm quantity renders $Q^n > S(2+\sqrt{2})/4$. Therefore, $z_u^a < \tilde{z}$ for all norm quantities satisfying

$$Q^n \in \tilde{A}^I =: \left[\frac{S}{4}(2+\sqrt{2}), S\right). \tag{B.11}$$

Since $Q_l^I \cap \tilde{A}^I = \varnothing$, $z_u^a > \tilde{z}$ for all $Q^n \in Q_l^I$. By analogy, we find that $Q_u^I \subset \tilde{A}^I$ so that $z_u^a < \tilde{z}$ for all $Q^n \in Q_u^I$.

Result 1 *If $Q^n \in Q_l^I$, $\pi_H^{PD} > \pi_H^{FS}$ for all entrance costs from the interval $z \in [0, \tilde{z})$. If $Q^n \in Q_u^I$, $\pi_H^{PD} > \pi_H^{FS}$ for all entry barriers lying in the range of $z \in [z_l^a, z_u^a]$.*

B.2.3 π_H^{PS} and π_H^{FS}

We know from section B.1.2 that $\pi_H^{PS} > \pi_H^{FS}$ whenever $Q^n \in [S/2, Q_u^b]$ with $Q_u^b = S(2+\sqrt{2})/4$. Since $Q_l^I \subset [S/2, S(2+\sqrt{2})/4]$ $\pi_H^{PS} > \pi_H^{FS}$ for all norm quantities satisfying $Q^n \in Q_l^I$. Similarly, as $Q_u^I \cap [S/2, S(2+\sqrt{2})/4] = \varnothing$, $\pi_H^{PS} < \pi_H^{FS}$ for all norm quantities $Q^n \in Q_u^I$.

Result 2 *If $Q^n \in Q_l^I$, $\pi_H^{PS} > \pi_H^{FS}$ for all entry barriers $z \in [\tilde{z}, z^{DL})$. If $Q^n \in Q_u^I$, $\pi_H^{PS} < \pi_H^{FS}$ for all $z \in [z_u^a, z^{DL}]$.*

B.2.4 π_H^{PS} and π_H^{FD}

Independent of the existence of an AD–regulation, the incumbent is a monopoly whenever $z > z^B$. Therefore, we need only to consider situations in which $z < z^B$. The results of section B.1.4 show that $\pi_H^{PS} > \pi_H^{FD}$ if $z < z_u^c =: (S - Q^n)^2/4$. On the other hand, π_H^{FD} applies only to the range of $z \in [z^{DL}, z^B)$. Hence, we have to show whether z_u^c is smaller or larger than z^{DL}.

Using the definitions for z_u^c and z^{DL} implies that $z_u^c < z^{DL}$ if $(S - Q^n)^2/4 < S^2(3 - 2\sqrt{2})/32$. Solving this inequality for Q^n ensues in $Q^n > S(6+\sqrt{2})/8$. It follows that $z_u^c < z^{DL}$ for all norm quantities satisfying

$$Q^n \in C^I =: \left[\frac{S}{8}(6+\sqrt{2}), S\right] \tag{B.12}$$

As $Q_u^I \subset C^I$, $\pi_H^{PS} < \pi_H^{FD}$ for all $Q^n \in Q_u^I$. Similarly, we find that $Q_l^I \cap C^I = \varnothing$, so that $\pi_H^{PS} > \pi_H^{FD}$ in the range of $z \in [z^{DL}, z_u^c)$ for all $Q^n \in Q_l^I$.

Result 3 *If $Q^n \in Q_l^I$, $\pi_H^{PS} > \pi_H^{FD}$ $z \in [z^{DL}, z_u^c)$. If $Q^n \in Q_u^I$, $\pi_H^{PS} < \pi_H^{FD}$ for $z \in [z^{DL}, z^B)$.*

Result 4 *If $Q^n \in Q_l^I$, the incumbent applies the AD–strategies in the range of $z \in [0, z_u^c)$. If $Q^n \in Q_u^I$, the domestic firm uses the AD–strategies for $z \in [z_l^a, z_u^a)$.*

B.3 *Case 2:* $z^{DL} < \tilde{z} < z^B$

B.3.1 *The set of norm quantities*

From section B.2 we know that $\tilde{z} < z^{DL}$ for $Q^n \in Q_l^I \cup Q_u^I$. Therefore, $\tilde{z} > z^{DL}$ for $Q^n \in Q_{DL}^{II} =: S \setminus (Q_l^I \cup Q_u^I)$.

At the same time, we require z to be lower than z^B. In section B.2 it was also shown that $\tilde{z}$ can be written as $\tilde{z} = 2(S^2/16 - (Q^n - 3S/4)^2)$. With the definition of z^B it can be seen that $\tilde{z} < z^B$ if $S^2/16 - (Q^n - 3S/4)^2 < (S/4)^2/2$. Collecting terms yields $(S/4)^2/2 < (Q^n - 3S/4)^2$ which is equivalent to $S/(4\sqrt{2}) < |Q^n - 3S/4|$. Solving the latter inequality for Q^n shows that $\tilde{z} < z^B$ for norm quantities satisfying $Q^n \in Q_{BL}^{II} =: [S/2, S(6-\sqrt{2})/8)$ and $Q^n \in Q_{BU}^{II} =: [S(6+\sqrt{2})/8, S)$. Combining the restrictions for $z^{DL} < \tilde{z}$ and $\tilde{z} < z^B$ shows that $z^{DL} < \tilde{z} < z^B$ for

$$\begin{aligned} Q^n \in Q_{DL}^{II} \cap Q_{BL}^{II} = Q_l^{II} &=: \left[\frac{S}{8}(6 - \sqrt{1+2\sqrt{2}}), \frac{S}{8}(6-\sqrt{2})\right) \\ Q^n \in Q_{DL}^{II} \cap Q_{BU}^{II} = Q_u^{II} &=: \left[\frac{S}{8}(6-\sqrt{2}), \frac{S}{8}(6+\sqrt{1+2\sqrt{2}})\right) \end{aligned} \tag{B.13}$$

B.3.2 π_H^{PD} and π_H^{FS}

Section B.1.2 has demonstrated that for entry barriers belonging to $z \in [z_l^a, z_u^a]$ $\pi_H^{PD} > \pi_H^{FS}$. As π_H^{PD} is only defined for $z \in [0, \tilde{z})$. Therefore, we have to determine when $z_l^a < 0$ and when $z_u^a > z^{DL}$.

The last section has verified that $z_l^a < 0$ whenever $Q^n \in A^I$. As $Q_l^{II} \subset A^I$, we find that $z_l^a < 0$ for all norm quantities $Q^n \in Q_l^{II}$. By analogy, $z_l^a > 0$ for all $Q^n \in Q_u^{II}$ since $Q_u^{II} \cap A^I = \varnothing$.

To check whether z_u^a lies to the right or to the left of z^{DL} we compare z_u^a and z_l^d. If $z_u^a < z_l^d$ then z_u^a lies necessarily to the left of z^{DL}. With the definitions of z_u^a and z_l^d, it can be found that $z_u^a < z_l^d$ if $S(2+\sqrt{2})/4 - q_F^* < q_F^* - 2\sqrt{q_F^* S} - S$. Collecting terms gives $2\sqrt{q_F^* S} < 2q_F^* + S(2-\sqrt{2})/2$. This is equivalent to $4q_F^* S < 4{q_F^*}^2 + S^2(2-\sqrt{2})^2/16 + 4q_F^* S(2-\sqrt{2})/4$. Applying the quadratic completion gives $S^2 8\sqrt{2}/16 < (2q_F^* - S(2+\sqrt{2})/4)^2$. Takeing square roots renders $S2^{7/4}/4 < |2q_F^* - S(2+\sqrt{2})/4|$. Solving for q_F^* shows that $z_u^a < z_l^d$ whenever $q_F^* > S(2+\sqrt{2}+2^{7/4})/8$ or $q_F^* < S(2+\sqrt{2}-2^{7/4})/8$. With the definition of q_F^*, the conditions can be transformed to $Q^n < S(6-\sqrt{2}-2^{7/4})/8$ and $Q^n > S(6-\sqrt{2}+2^{7/4})/8$. The first solution is irrelevant as Q^n needed to be smaller than $S/2$ to satisfy the condition. Hence $z_u^a < z_l^d$ if $Q^n \in A^{II} =: [S(6-\sqrt{2}+2^{7/4})/8, S)$. As $Q_l^{II} \cap A^{II} = \varnothing$, $z_u^a > z_l^d$ and, therefore, $z_u^a > z^{DL}$ for all $Q^n \in Q_l^{II}$. We find also that $Q_u^{II} \cap A^{II} = A_u^{II} =: [S(6-\sqrt{2}+2^{7/4})/8, S(6+\sqrt{1+2\sqrt{2}})/8)$. It follows that $z_u^a < z_l^d$ and $z_u^a < z^{DL}$ whenever $Q^n \in A_u^{II}$. Let A_l^{II} be defined as $A_l^{II} =: [S(6+\sqrt{2})/8, S(6-\sqrt{2}+2^{7/4})/8)$. Then, $z_u^a > z_l^d$ and $z_u^a > z^{DL}$ for all $Q^n \in A_l^{II}$.

> **Result 5** *If $Q^n \in Q_l^{II}$, $\pi_H^{PD} > \pi_H^{FS}$ for entry barriers from $[0, z^{DL})$. If $Q^n \in A_u^{II}$, $\pi_H^{PD} > \pi_H^{FS}$ whenever $z \in [z_l^a, z_u^a)$. If $Q^n \in A_l^{II}$, $\pi_H^{PD} > \pi_H^{FS}$ for entrance costs satisfying $z \in [z_l^a, z^{DL})$.*

B.3.3 π_H^{PS} and π_H^{FS}

The last paragraph has shown that $z_u^a > z^{DL}$ for $Q^n \in (Q_l^{II} \cup A_l^{II})$. On the other hand, π_H^{PS} applies to ranges $z \in [\tilde{z}, z^B)$. Yet, this case presupposes that $\tilde{z} > z^{DL}$, so that a comparison between π_H^{PS} and π_H^{FS} is not necessary for norm quantities from Q_l^{II} and A_l^{II}. Therefore, we only have to determine whether π_H^{PS} is smaller or larger than π_H^{FS} for $Q^n \in A_u^{II}$. As $[S/2, S(2+\sqrt{2})/4] \cap A_u^{II} = \varnothing$, $\pi_H^{PS} < \pi_H^{FS}$ for all $Q^n \in A_u^{II}$.

> **Result 6** *If $Q^n \in A_u^{II}$, $\pi_H^{PS} < \pi_H^{FS}$ for all $z \in [z_u^a, z^{DL})$.*

Result 7 *If $Q^n \in Q_l^{II}$, the incumbent applies the AD–strategies for $z \in [0, z_l^d)$. If $Q^n \in A_u^{II}$, the AD–strategies are profitable for $z \in [z_l^a, z_u^a)$. If $Q^n \in A_l^{II}$, the domestic firm decides for the AD–strategies whenever $z \in [z_l^a, z_l^d)$.*

B.4 *Case 3: $\mathbf{z^{DL} < z^B < \tilde{z}}$*

B.4.1 *The norm quantities*

From section B.3 we know that $\tilde{z} < z^B$ for $Q^n \in (Q_l^{II} \cup Q_u^{II})$. Therefore, $\tilde{z} > z^B$ for $Q^n = S \setminus (Q_l^{II} \cup Q_u^{II}) = Q^{III} =: [S(6-\sqrt{2})/8, S(6-\sqrt{2})/8)$.

B.4.2 *$\boldsymbol{\pi_H^{PD}}$ and $\boldsymbol{\pi_H^{FS}}$*

Section B.1.1 has shown that $\pi_H^{PD} > \pi_H^{FS}$ for all entrance costs belonging to the range $[z_l^a, z_u^a]$. Again, we have to determine whether z_l^a is positive or negative and whether z_u^a lies to the right or to the left of z^{DL}.

From section B.2 we know that $z_l^a < 0$ for $Q \in [S/2, S(2+\sqrt{2})/4)$. Since $[S/2, S(2+\sqrt{2})/4) \cap Q^{III} = A_l^{III} =: [S(6-\sqrt{2})/8, S(2+\sqrt{2})/4)$, it follows that $z_l^a < 0$ for all $Q^n \in A_l^{III}$. Let A_u^{III} be defined as $A_u^{III} =: Q^{III} \setminus A_l^{III}$. Then, $z_l^a > 0$ for all $Q^n \in A_u^{III}$.

As in the last section, $z_u^a > z^{DL}$ if $z_u^a < z_l^d$. In the last section, it has also be shown that $z_u^a < z_l^d$ if and only if $Q^n \in A^{II}$. Since $A_l^{III} \cap A^{II} = \varnothing$, $z_u^a > z_l^d$ and $z_u^a > z^{DL}$ for all A_l^{III}. Similarly, we find that $A_u^{III} \cap A^{II} = \varnothing$, so that $z_u^a > z_l^d$ and $z_u^a > z^{DL}$ for all A_l^{III}.

Result 8 *If $Q^n \in A_l^{III}$, $\pi_H^{PD} > \pi_H^{FS}$ for all $z \in [0, z^{DL})$. If $Q^n \in A_u^{III}$, $\pi_H^{PD} > \pi_H^{FS}$ whenever $z \in [z_l^a, z^{DL})$.*

B.4.3 *$\boldsymbol{\pi_H^{PD}}$ and $\boldsymbol{\pi_H^{FD}}$*

Since this case presupposes that $\tilde{z} > z^B$ and π_H^{PD} is defined for $z \in [0, \tilde{z})$, we only need to compare π_H^{PD} and π_H^{FD} apart from the one between π_H^{PD} and π_H^{FS}. The last section has also shown that $z_u^a > z^{DL}$ for all $Q^n \in (A_l^{III} \cup A_u^{III})$.

Result 9 *If $Q^n \in (A_l^{III} \cup A_u^{III})$, $\pi_H^{PD} > \pi_H^{FD}$ for all $z \in [z^{DL}, z_l^d)$.*

Result 10 *If $Q^n \in A_l^{II}$, the incumbent uses the AD–strategies for all $z \in [0, z_l^d)$. If $Q^n \in A_u^{III}$, the domestic firm applies the AD–strategies rule is binding whenever $z \in [z_l^a, z_l^d)$.*

B.5 Summary of the results

Combining the results 4, 7, and 10 yields that the incumbent applies the AD–strategies whenever

$$z \in \begin{cases} [0, z_u^c) & \text{for} \quad Q_l^I \\ [0, z_l^d) & \text{for} \quad Q_l^{II} \\ [0, z_l^d) & \text{for} \quad A_l^{III} \\ [z_l^a, z_l^d) & \text{for} \quad A_u^{III} \\ [z_l^a, z_l^d) & \text{for} \quad A_l^{II} \\ [z_l^a, z_u^d) & \text{for} \quad A_u^{II} \\ [z_l^a, z_u^d) & \text{for} \quad Q_u^I \end{cases} \tag{B.14}$$

Some of the intervals for the norm quantities can be joined. This simplifies the upper expression to

$$z \in \begin{cases} [0, z_u^c) & \text{for} \quad [S/2, S(6-\sqrt{1+2\sqrt{2}})/8) \\ [0, z_l^d) & \text{for} \quad [S(6-\sqrt{1+2\sqrt{2}})/8, S(2+\sqrt{2})/4) \\ [z_l^a, z_l^d) & \text{for} \quad [S(2+\sqrt{2})/4, -s(6-\sqrt{2}+2^{7/4})/8) \\ [z_l^a, z_u^d) & \text{for} \quad [S(6-\sqrt{2}+2^{7/4})/8, S) \end{cases} \tag{B.15}$$

C Proof of proposition 2

The proof of proposition 2 follows the same logic than the one of proposition 1. First, the set of entrance costs is determined for which the total quantity under a binding AD–regulation is higher than the one under free trade. Subsequently, for each of the three cases (cf. below), it is verified which set of norm quantities correspond to the set of entrance costs. Finally, we determine the set of norm quantities for which we have a pro–competitive effect and the where the norm quantities are not strategically ineffective.

Figure C.1 and C.2 present the total quantities under free trade and a binding AD–regulation which are given in equation (17) and (18). As $\tilde{z}$ depends on the norm quantity we can distinguish three cases: (1) $\tilde{z} < z^{DL} < z^B$, (2) $z^{DL} < \tilde{z} < z^B$, and (3) $z^{DL} < z^B < \tilde{z}$.

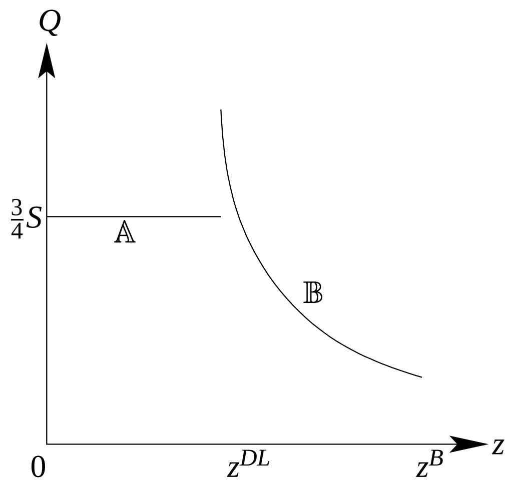

Figure C.1. Total quantity supplied under free trade

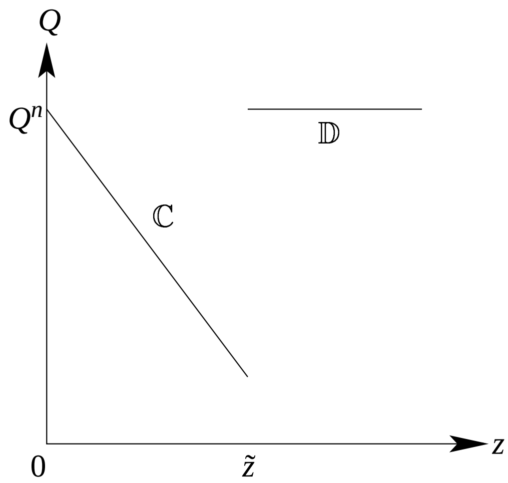

Figure C.2. Total quantity supplied under AD–rules

For case (1), we have to compare (a) graph $\mathbb{A}$ and $\mathbb{C}$, (b) graph $\mathbb{A}$ and $\mathbb{D}$ and (c) graph $\mathbb{B}$ and $\mathbb{D}$ as $\tilde{z}$ lies to the left of z^{DL}.

Case (2) describes situations in which $\tilde{z}$ lies to the right of z^{DL}, so thath we have to compare (a) graph $\mathbb{A}$ and $\mathbb{C}$, (b) graph $\mathbb{B}$ and $\mathbb{C}$ and (c) graph $\mathbb{B}$ and $\mathbb{D}$.

In case (3) $\tilde{z}$ lies to the right of z^B so that a comparison between (a) $\mathbb{A}$ and $\mathbb{C}$ and (b) $\mathbb{B}$ and $\mathbb{C}$ is necessary.

C.1 Comparison of the total quantities

The total quantities supplied under free trade and under a constraining AD–regulation are given in equations (17) and (18). In this section, we determine for which sets of the entrance costs $Q^P > Q^F$. Due to the cases identified above we need the following 4 comparisons.

C.1.1 $\mathbb{A}$ *and* $\mathbb{C}$

The segment $\mathbb{A}$ corresponds to the Stackelberg quantitiy $3S/4$ and $\mathbb{C}$ to $Q^n - z/(bq_F^*)$. $\mathbb{C} > \mathbb{A}$ if and only if $Q^n - z/(bq_F^*) > 3S/4$. This is equivalent to $z < z_a =: b(4Q^n - 3S)q_F^*$. Therefore, $\mathbb{C} > \mathbb{A}$ for entrance costs satisfying

$$z \in [0, z_a]. \tag{C.1}$$

C.1.2 $\mathbb{A}$ *and* $\mathbb{D}$

The segment $\mathbb{D}$ is associated to Q^n. Therefore, $\mathbb{D} > \mathbb{A}$ as long as

$$Q^n > \frac{3}{4}S. \tag{C.2}$$

C.1.3 $\mathbb{B}$ *and* $\mathbb{D}$

The graph $\mathbb{B}$ corresponds to the $S - 2\sqrt{z/b}$ and $\mathbb{D}$ to the norm quantity. Accordingly $\mathbb{D} > \mathbb{B}$ if $Q^n > S - 2\sqrt{z/b}$. Solving for the entrance costs gives $z > z_u^c = b(q_F^*/2)$, where z_u^c was defined in section 1. It follows that $\mathbb{D} > \mathbb{B}$ as long as the entrance costs satisfy

$$z \in [z_u^c, \infty). \tag{C.3}$$

C.1.4 $\mathbb{B}$ *and* $\mathbb{C}$

The segment $\mathbb{B}$ is associated with $S - 2\sqrt{z/b}$ and $\mathbb{C}$ with $Q^n - z/(bq_F^*)$. Therefore, $\mathbb{C} > \mathbb{B}$ if $Q^n - z/(bq_F^*) > S - 2\sqrt{z/b}$. Noting that $q_F^* = S - Q^n$, the inequality can be written as $0 > {q_F^*}^2 - 2q_F^*\sqrt{z/b} + z/b$. This is eqivalent to $0 > (q_F^* - \sqrt{z/b})^2$ which has no solution for entrance costs on the real line. Accordingly, $\mathbb{B} > \mathbb{C}$ for all z.

C.2 Case (1): $\tilde{z} < z^{DL} < z^B$

It has been shown in section B.2 that $\tilde{z} < z^{DL} < z^B$ as long as the norm quantity belong either to Q_l^I or Q_u^I specified in equation (B.9). Figrue C.3 illustrates the situation in case (1).

C.2.1 $\mathbb{A}$ *and* $\mathbb{C}$

In section C.1.1 it was shown that $\mathbb{C} > \mathbb{A}$ and, hence, $Q^P > Q^F$ whenever $z \in [0, z_a]$ with $z_a = bq_F^*(4Q^n - 3S)$. It can be seen in figure C.3, that $z \in [0, \tilde{z})$ is also required.

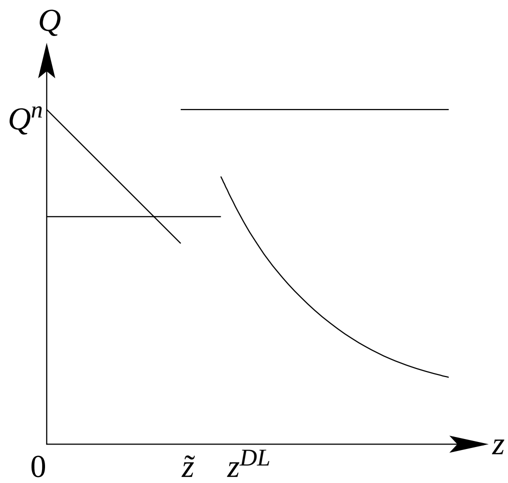

Figure C.3. Case (1)

As $[0,z_a) = \varnothing$ for $Q^n \in [S/2, 3S/4)$ and $[S/2,3S/4) \cap Q_l^I = Q_l^I$ it follows that $Q^F > Q^P$ for all $Q^n \in Q_l^I$. Similarly, we find that $[S/2,3S/4) \cap Q_u^I = \varnothing$, so that $Q^P > Q^F$ for all $Q^n \in Q_u^I$.

At least in principle, $\tilde{z}$ may lie to the right of z_a in which case $\mathbb{A}$ and $\mathbb{C}$ do not cross in the valid range of z. Using the definitions of $\tilde{z}$ and z_a shows that $\tilde{z} > z_a$ if $q_F^* q_H^* > q_F(4Q^n - 3S)$. Employing the definition of q_H^* and rearranging yields $Q^n < S$ which is satisfied for all Q^n per assumption. Therefore, $\tilde{z} > z_a$ for all $Q^n \in (Q_l^I \cup Q_u^I)$.

Result 11 *If $Q^n \in Q_l^I$, $Q^F > Q^P$ for entry barriers from $[0,\tilde{z})$. If $Q^n \in Q_u^I$, $Q^P > Q^F$ whenever $z \in [0,z_a)$.*

C.2.2 $\mathbb{D}$ and $\mathbb{A}$

According to section C.1.2, $\mathbb{D} > \mathbb{A}$ and therefore also $Q^P > Q^F$, if $Q^n \in [3S/4, S)$. In addition, it can be seen in figure C.3 the relevant range of the entrance costs is $z \in [\tilde{z}, z^{DL})$.

As $[3S/4,S) \cap Q_l^I = \varnothing$, $Q^F > Q^P$ for all $z \in [\tilde{z}, z^{DL})$. By analogy, we find that $[3S/4,S) \cap Q_u^I = Q_u^I$, so that $Q^P > Q^F$ for all $z \in [\tilde{z}, z^{DL})$.

Result 12 *If $Q^n \in Q_l^I$, $Q^F > Q^P$ for entrance costs from $[\tilde{z}, z^{DL})$. If $Q^n \in Q_u^I$, $Q^P > Q^F$ whenever $z \in [\tilde{z}, z^{DL})$.*

C.2.3 $\mathbb{B}$ and $\mathbb{D}$

Section C.1.3 has shown that $\mathbb{D} > \mathbb{B}$ and, hence, $Q^P > Q^F$ as long as $z \in [z_u^c, \infty)$ with $z_u^c = b(q_F^*/2)^2$. In addition, we know from figure C.3 that $z \in [z^DL, z^B)$ is the valid range for this comparison. Now, we have to determine the intersection of $[z_u^c, \infty)$ and $[z^{DL}, z^B)$. It is first shown that $z_u^c < z^B$ and subsequently, that $z^{DL} < z_u^c$.

Using the definitions of z_u^c and z^B, it can be seen that $z_u^c < z^B$ if $(q_F^*/2)^2 < (S/4)^2$. Applying the definition of q_F^* and solving for the norm quantity yields $Q^n > S/2$, which is true by our initial assumption. Therefore, $z_u^c < z^B$ for all norm quantities in the valid range.

Similarly, it can be seen that $z^{DL} < z_u^c$ whenever $S^2(3-2\sqrt{2})/32 < (q_F^*/2)^2$. As $3-2\sqrt{2} = (\sqrt{2}-1)^2$, the inequality is identical to $S(2-\sqrt{2})/4 < S - Q^n$. Solving for the norm quantity gives $Q^n < S(2+\sqrt{2})/4$. Since $[S/2, S(2+\sqrt{2})/4) \cap Q_l^I = Q_l^I$ we find that $z^{DL} < z_u^c$ for all $Q^n \in Q_l^I$. $z^{DL} > z_u^c$ for all $Q^n \in Q_u^I$ since $[S/2, S(2+\sqrt{2})/4) \cap Q_u^I = \varnothing$. It follows that $[z_u^c, \infty) \cap [z^{DL}, z^B) = [z_u^c, z^B)$ for $Q^n \in Q_l^I$ and $[z_u^c, \infty) \cap [z^{DL}, z^B) = [z^{DL}, z^B)$ for $Q^n \in Q_u^I$.

Result 13 *If $Q^n \in Q_l^I$, $Q^P > Q^F$ for $z \in [z_u^c, z^B)$. If $Q^n \in Q_u^I$, $Q^P > Q^F$ whenever $z \in [z^{DL}, z^B)$.*

Combining results 11–13 we find:

Result 14 *If $Q^n \in Q_l^I$, $Q^P > Q^F$ for $z \in [z_u^c, z^B)$. If $Q^n \in Q_u^I$, $Q^P > Q^F$ whenever $z \in [0, z_a) \cup [\tilde{z}, z^B)$.*

C.3 Case (2) $z^{DL} < \tilde{z} < z^B$

It has been shown in section B.3 that $z^{DL} < \tilde{z} < z^B$ as long as the norm quantity belong either to Q_l^{II} or Q_u^{II} specified in equation (B.13). Figure C.4 illustrates the situation in case (2).

C.3.1 $\mathbb{A}$ and $\mathbb{C}$

By figure C.4, this comparison is valid for $z \in [0, z^{DL})$. The entrance costs have to satisfy $z \in [0, z_a)$ for Q^P to be higher than Q^F.

As $[0, z_a) = \varnothing$ for $Q^n \in [S/2, 3S/4)$ and $[S/2, 3S/4) \cap Q_l^{II} = Q_l^{II}$, $Q^F > Q^P$ for all

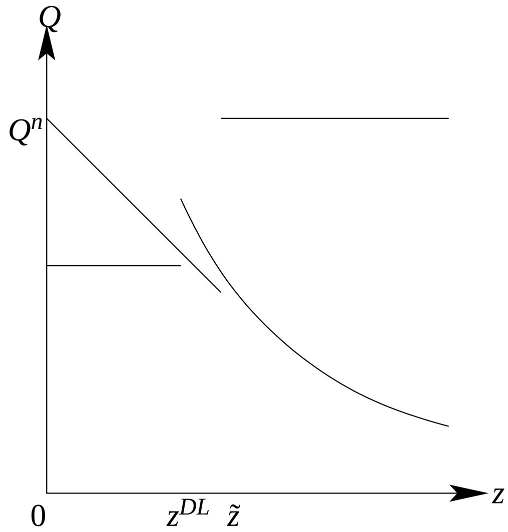

Figure C.4. Case (2)

$Q^n \in Q_l^{II}$. We find also that $[S/2, 3S/4) \cap Q_u^{II} = \varnothing$ so that $[0, z_a)$ is non–empty. z_a may lie to the right or to the left of z^{DL}. Using the definitions or z_a and z^{DL}, it can be seen that $z^{DL} > z_a$ if $S^2(3 - 2\sqrt{2})/32 > (S - Q^n)(4Q^n - 3S)$. This is equivalent to $S^2(3 - 2\sqrt{2})/32 > 7Q^nS - 4Q^{n2} - 3S^2$. Applying the quadratic completion, this inequality can be written as $S^2(3-2\sqrt{2})/32 > S^2/16 - (2Q^n - 7S/4)^2$. The latter is identical to $|2Q^n - 7S/4| > S\sqrt{2^{5/2} - 2}/8$. Solving for Q^n shows that $z^{DL} > z_a$ for $Q^n \in [S(14 + \sqrt{2^{5/2} - 2})/16, S)$ and for $Q^n \in [S/2, S(14 - \sqrt{2^{5/2} - 2})/16)$. Since $[S(14 + \sqrt{2^{5/2} - 2})/16, S) \cap Q_u^{II} = \mathbb{A}_u^{II}$, $z^{DL} > z_a$ for this range. It follows that $Q^P > Q^F$ for $Q^n \in \mathbb{A}_u^{II}$ and $z \in [0, z^{DL})$. Let $\mathbb{A}_l^{II} =: [S(6 + \sqrt{2})/8, S(14 - \sqrt{2^{5/2} - 2})/16)$. Then, $z^{DL} < z_a$ for $Q^n \in \mathbb{A}_l II$. As a consequence, $Q^P > Q^F$ for $Q^n \in \mathbb{A}_l^{II}$ and $z \in [0, z_a)$.

> **Result 15** *If $Q^n \in Q_l^{II}$, $Q^F > Q^P$ for $z \in [0, z^{DL})$. $Q^P > Q^F$ if $Q^n \in \mathbb{A}_l^{II}$ and $z \in [0, z^{DL})$ and if $Q^n \in \mathbb{A}_u^{II}$ and $z \in [0, z_a)$.*

C.3.2 $\mathbb{B}$ and $\mathbb{C}$

In figure C.4 it can be seen that this comparison is valid for the range of $z \in [z^{DL}, \tilde{z})$. Section C.1.4 has demonstrated that $Q^F > Q^P$ for every range of entry barriers. We find therefore the following result.

> **Result 16** *$Q^F > Q^P$ for all $Q^n \in (Q_l^{II} \cup Q_u^{II})$ and $z \in [z^{DL}, \tilde{z})$.*

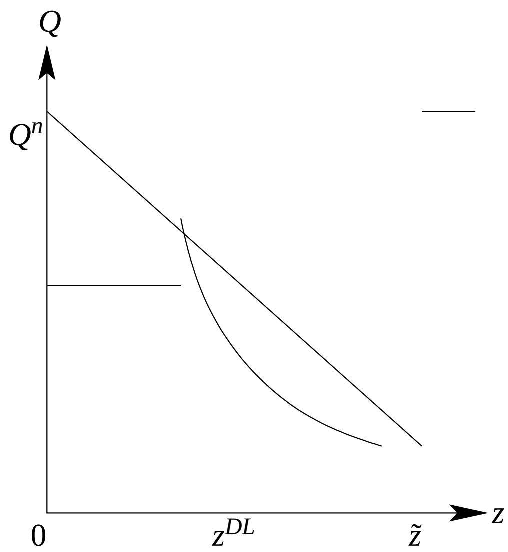

Figure C.5. Case (3)

C.3.3 $\mathbb{B}$ and $\mathbb{D}$

By figure C.4, the relevant range is here $z \in [\tilde{z}, z^B$. From section C.1.3 we know that $Q^P > Q^F$ as long as $z \in [z_u^c, \infty)$.

For case (1) we have demonstrated that $z_u^c < z^B$ for all $Q^n < S$, which is satisfied by the initial assumption on the valid range of the norm quantity. However, z_u^c may lie to the left or to the right of $\tilde{z}$. Applying the definition of $\tilde{z}$ and z^B, it can be seen that $\tilde{z} < z_u^c$ if $q_F^* q_H^* < (q_F^*/2)^2$. Using the definitions of q_F^* and q_H^* and solving for Q^n, shows that $\tilde{z} < z_u^c$ when $Q^n \in [S/2, 5S/9)$.

Since $[S/2, 5S/9) \cap Q_l^{II} = \mathbb{C}_l^{II} =: [S(6 - \sqrt{1 + 2\sqrt{2}})/8, 5S/9)$, $Q^P > Q^F$ for all $Q^n \in \mathbb{C}_l^{II}$ and $z \in [z_u^c, z^B)$. Let $\mathbb{C}_u^{II} =: [5S/9, S(6 - \sqrt{2})/8)$. Then, $Q^P > Q^F$ for all $Q^n \in \mathbb{C}_u^{II}$ and $z \in [\tilde{z}, z^B)$. Similarly, as Since $[S/2, 5S/9) \cap Q_u^{II} = \varnothing$, $Q^P > Q^F$ for all $Q^n \in Q_u^{II}$ and $z \in [\tilde{z}, z^B)$.

Result 17 *$Q^P > Q^F$ if $Q^n \in \mathbb{C}_l^{II}$ and $z \in [z_u^c, z^B)$ and if $Q^n \in \mathbb{C}_u^{II}$ and $z \in [\tilde{z}, z^B)$. For $Q^n \in Q_u^{II}$, $Q^P > Q^F$ whenever $z \in [\tilde{z}, z^B)$.*

Summarising results 15–17 we find the following result.

Result 18 *$Q^P > Q^F$ for the combinations of $Q^n \in \mathbb{C}_l^{II}$ and $z \in [z_u^c, z^B)$, $Q^n \in \mathbb{C}_u^{II}$ and $z \in [\tilde{z}, z^B)$, $Q^n \in \mathbb{A}_l^{II}$ and $z \in [0, z^{DL}) \cup [\tilde{z}, z^B)$, $Q^n \in \mathbb{A}_u^{II}$ and $z \in [0, z_a) \cup [\tilde{z}, z^B)$,*

C.4 Case (3): $z^{DL} < z^{B} < \tilde{z}$

In section B.4 is has been shown that case (3) is valid for $Q^n \in Q^{III}$. The situation is illustrated in figure C.5.

C.4.1 $\mathbb{A}$ and $\mathbb{C}$

Again, we have to compare the segment $\mathbb{A}$ and $\mathbb{C}$. From section C.1.1 we know that $Q^P > Q^F$ as long as $z \in [0, z_a)$. In addition, $z \in [0, z^{DL})$ as it can be seen in figure C.5.

The interval $[0, z_a)$ is nonempty as long as $Q^n \in [S/2, 3S/4)$. As $Q^{III} \cap [S/2, 3S/4) = \mathbb{Q}_u^{III} =: [S(6-\sqrt{2})/8, 3S/4)$, $Q^F > Q^P$ for all $Q^n \in \mathbb{Q}_u^{III}$. Similarly, we find that for $Q^{III} \setminus [S/2, 3S/4) = \mathbb{Q}_u^{III} =: [3S/4, S(6-\sqrt{2})/8)$ the set $[0, z_a)$ is nonempty. From section C.2 we know that $z^{DL} > z_a$ for $Q^n \in [S(14+\sqrt{2^{5/2}-2})/16, S)$ and for $Q^n \in [S/2, S(14-\sqrt{2^{5/2}-2})/16)$. $\mathbb{Q}_u^{III} \cap [S/2, S(14-\sqrt{2^{5/2}-2})/16) =: \mathbb{A}_u^{III} = [3S/4, S(14-\sqrt{2^{5/2}-2})/16)$, so that $Q^P > Q^F$ for all $Q^n \in \mathbb{A}_u^{III}$ and $z \in [0, z_a)$. Therefore, $Q^P > Q^F$ for all $Q^n \in \mathbb{A}_l^{III} =: [S(14-\sqrt{2^{5/2}-2})/16, S(6+\sqrt{2})/8)$ and $z \in [0, z^{DL})$.

It has also been shown in section C.1.4 that $Q^F > Q^P$ for all z. Accordingly, we can summarise the results in

> **Result 19** *$Q^P > Q^F$ for the combinations of $Q^n \in \mathbb{A}_l^{III}$ and $z \in [0, z_a)$ and $Q^n \in \mathbb{A}_u^{II}$ and $z \in [0, z^{DL})$.*

Combining the results 4, 8, and 9 shows that there is a pro–competitive effect, whenever

$$z \in \begin{cases} [z_u^c, z^B) & \text{for} \quad Q_l^I \\ [z_u^c, z^B) & \text{for} \quad \mathbb{C}_l^{II} \\ [\tilde{z}, z^B) & \text{for} \quad \mathbb{C}_u^{III} \\ [0, z_a) & \text{for} \quad \mathbb{A}_l^{III} \\ [0, z^{DL}) & \text{for} \quad \mathbb{A}_i^{II} \\ [0, z^{DL}) \cup [\tilde{z}, z^B) & \text{for} \quad A_l^{II} \\ [0, z_a) \cup [\tilde{z}, z^B) & \text{for} \quad A_u^{II} \\ [0, z_a) \cup [\tilde{z}, z^B) & \text{for} \quad Q_u^I \end{cases} \tag{C.4}$$

C.5 The strategically effective combinations

To find the combinations of z and Q^n for which we have pro–competitive effect where the AD–regulation is not strategically ineffective, we have to find the intersection set of (B.14) and (C.4)

C.5.1 The interval $\mathbf{Q_l^I}$

Here, we have to compare $[0, z_u^c)$ and $[z_u^c, z^B)$. It can be seen that $[0, z_u^c) \cap [z_u^c, z^B) = \varnothing$.

C.5.2 The interval $\mathbf{Q_l^{II}}$

Here, we have to compare $[0, z_l^d)$ and $[z_u^c, z^B)$ for $\mathbb{C}_l^{II}$ and $[0, z_l^d)$ and $[\tilde{z}, z^B)$ for $\mathbb{C}_u^{II}$.

$\mathbb{C}_l^{II}$: $z_l^d > z_u^c$ if $q_F^*(\sqrt{q_F^*} - \sqrt{S})^2 > (q_F^*/2)^2$. This is equivalent to $q_F^* - 2\sqrt{q_F^* S} + S > q_F^*/4$. Rearranging yields $3q_F^*/4 + S > 2\sqrt{q_F^* S}$. Collecting terms and applying the quadratic completion gives $(3q_F^*/4 - 5S/3)^2 > 16S^2/9$. This is equivalent to $|3q_F^*/4 - 5S/3| > 4S/3$. The only valid solution to this inequality is $Q^n \in [5S/9, S)$. However, as $[5S/9, S) \cap \mathbb{C}_l^{II} = \varnothing$ it follows that $[0, z_l^d) \cap [z_u^c, z^B) = \varnothing$.

$\mathbb{C}_u^{II}$: $z_l^d > \tilde{z}$ if $(S - Q^n)(\sqrt{S - Q^n} - \sqrt{S})^2 > (S - Q^n)(2Q^n - S)$, which is equivalent to $3(S - Q^n) > 2\sqrt{(S - Q^n)S}$. It follows that $9(S^2 - 2Q^n S + Q^n) > 4(S^2 - Q^n S)$. Rearranging and employing the quadratic completion renders $(3Q^n - 7S/3)^2 > 4S^2/9$, which is identical to $|3Q^n - 7S/3| > 2S/3$. The only valid solution to this inequality is $Q^n \in [S/2, 5S/9)$. Since $[S/2, 5S/9) \cap \mathbb{C}_u^{II} = \varnothing$ it follows that $[0, z_l^d) \cap [\tilde{z}, z^B) = \varnothing$.

C.5.3 The interval $\mathbf{Q_l^{III}}$

Since $A_l^{III} \cap \mathbb{A}_l^{III} = \mathbb{A}_l^{III}$, we have to show first whether $[0, z_l^d) \cap [0, z_a)$ is empty or nonempty. $z_l^d > z_a$ if $(S - Q^n)(\sqrt{S - Q^n} - \sqrt{S})^2 > (S - Q^n)(4Q^n - 3S)$. This is equivalent to $5(S - Q^n) > 2\sqrt{S(S - Q^n)}$. It follows that $25(S - Q^n)^2 > 4S(S - Q^n)$. The only solution to the inequality is $Q^n \in [0, 21S/25)$ which is a subset of $\mathbb{A}_l^{III}$. Therefore, $[0, z_a) \subset [0, z_l^d)$ for $Q^n \in \mathbb{A}_l^{III}$.

Next, we have to compare $[0, z_l^d)$ and $[0, z^D L)$ for the set $A_l^{III} \cap \mathbb{A}_u^{III} = [S(14 - \sqrt{2^{5/2} - 2})/16, S(2 + \sqrt{2})/4)$. $z_l^d > z_a$ if $q_F^*(\sqrt{q_F^*} - \sqrt{S})^2 > S^2(\sqrt{2} - 1)^2/32$. This can be written as $(q_F^* - \sqrt{q_F^* S})^2 > S^2(\sqrt{2} - 1)^2/32$. The latter is equal to $|q_F^* - \sqrt{q_F^* S}| > S(2 - \sqrt{2})/8$. This inequality has two potential solutions: $q_F^* - S(2 - \sqrt{2})/8 > \sqrt{q_F^* S}$ and $\sqrt{q_F^* S} > q_F^* + S(2 - \sqrt{2})/8$

$\boldsymbol{q_F^* - S(2-\sqrt{2})/8 > \sqrt{q_F^* S}}$: The inequality can be rewritten to ${q_F^*}^2 - 2q_F^* S(2-\sqrt{2})/8 + S^2(2-\sqrt{2})^2/64 > Sq_F^*$. Collecting terms and seeking the quadratic completion renders $(q_F^* - S(6-\sqrt{2})^2/8)^2 > S^2(8-2\sqrt{2})/16$. It follows that $|q_F^* - S(6-\sqrt{2})^2/8| > S\sqrt{8-2\sqrt{2}}/4$. Solving for the norm quantity gives only one valid solution: $Q^n > S(2+\sqrt{2}+2\sqrt{8-2\sqrt{2}})/8$. However, this solution lies outside the range of $A_l^{III} \cap \mathbb{A}_u^{III}$.

$\boldsymbol{\sqrt{q_F^* S} > q_F^* + S(2-\sqrt{2})/8}$: Rewriting the inequality yields $Sq_F^* > {q_F^*}^2 + 2q_F^* S(2-\sqrt{2})/8 + S^2(2-\sqrt{2})^2/64$. Rearranging and applying the quadratic completion gives $S^2 2^{7/2}/64 > (q_F^* - S(2+\sqrt{2})/8)^2$, which is equivalent to $S2^{7/4}/8 > |q_F^* - S(2+\sqrt{2})/8|$. Solving for Q^n shows that the inequality is satisfied for $Q^n \in [S(6-\sqrt{2}-2^{7/4})/8, S/2, S(6-\sqrt{2}+2^{7/4})/8)$. As $A_l^{III} \cap \mathbb{A}_u^{III}$ is a subset of the latter interval, $z_l^d > z^{DL}$ for all $Q^n \in (A_l^{III} \cap \mathbb{A}_u^{III})$.

Finally, we have to compare $[z_l^a, z_l^d)$ and $[0, z^{DL})$ for $A_u^{III} \cap \mathbb{A}_u^{III} = A_u^{III}$. From section 1 we know that $z_l^a > 0$ for A_u^{III}. We also know that $z_l^d > z^{DL}$ for $Q^n \in [S(6-\sqrt{2}-2^{7/4})/8, S/2, S(6-\sqrt{2}+2^{7/4})/8)$. Since A_u^{III} is a subset of the latter, $z_l^d > z^{DL}$ whenever $Q^n \in A_u^{III}$. As a consequence, $[z_l^a, z_l^d) \cap [0, z^{DL}) = [z_l^a, z_l^d)$ for all $Q^n \in A_u^{III}$.

C.5.4 $\boldsymbol{Q_u^{II}}$

First, we have to compare $[z_l^a, z_l^d)$ and $[0, z^{DL})$ for $A_l^{II} \cap \mathbb{A}_l^{II} = A_l^{II}$. Again, we know from section 1 that $z_l^a > 0$ for A_l^{II}. As $z_l^d > z^{DL}$ for norm quantities $Q^n \in [S(6-\sqrt{2}-2^{7/4})/8, S/2, S(6-\sqrt{2}+2^{7/4})/8) \supset A_l^{II}$, $[z_l^a, z_l^d) \cap [0, z^{DL}) = [z_l^a, z_l^d)$.

Next, we have to compare $[z_l^a, z_u^a)$ and $[0, z^{DL})$ for $A_u^{II} \cap \mathbb{A}_l^{II}$. The results of section 1 show that $z_l^a > 0$ for all Q_u^{II} and, therefore, also for $A_u^{II} \cap \mathbb{A}_l^{II}$, which is a subset of Q_u^{II}. $z_u^a > z^{DL}$ if $q_F^*(S(2+\sqrt{2})/4 - q_F^*) > S^2(3-2\sqrt{2})/32$. Seeking for the quadratic completion yields $S^2 8\sqrt{2}/64 > (q_F^* - S(2+\sqrt{2})/8)^2$. This is equivalent to $S2^{7/4}/8 > |q_F^* - S(2+\sqrt{2})/8|$. Solving for Q^n renders $Q^n \in [S(6-\sqrt{2}-2^{7/4})/8, S(6-\sqrt{2}+2^{7/4})/8]$. However this interval lies below $A_u^{II} \cap \mathbb{A}_l^{II}$ so that $z_u^a < z^{DL}$ for all $Q^n \in A_u^{II} \cap \mathbb{A}_l^{II}$. It follows that $[z_l^a, z_u^a) \cap [0, z^{DL}) = [z_l^a, z_u^a)$ whenever $Q^n \in A_u^{II} \cap \mathbb{A}_l^{II}$.

Now, we compare $[z_l^a, z_u^a)$ and $[0, z_a)$ for $Q^n \in \mathbb{A}_u^{II}$. Again, $z_l^a > 0$ for $Q^n \in \mathbb{A}_u^{II}$ as it has been verified in section 1. $z_u^a > z_a$ if $q_F^*(S(2+\sqrt{2})/4 - q_F^*) > q_F^*(4Q^n - 3S)$. This is identical to $S(2+\sqrt{2})/4 - q_F^* > 4Q^n - 3S$. Solving for Q^n shows that $z_u^a > z_a$ if $Q^n \in [S(10+\sqrt{2})/12, S)$. Since $\mathbb{A}_u^{II} \subset [S(10+\sqrt{2})/12, S)$, $[z_l^a, z_u^a) \cap [0, z_a) = [z_l^a, z_u^a)$ for $Q^n \in \mathbb{A}_u^{II}$.

Finally, we have to compare $[z_l^a, z_l^d)$ and $[\tilde{z}, z^B)$ for A_l^{II} and $[z_l^a, z_u^d)$ and $[\tilde{z}, z^B)$ for A_u^{II}.

$\boldsymbol{A_l^{II}}$: $z_l^d < \tilde{z}$ when $q_F^*(\sqrt{q_F^*} - \sqrt{S})^2 < q_F^* q_H^*$. This is identical to $q_F^* + S + 2\sqrt{q_F^* S} <$

$(2Q^n - S)$. Using the definition of q_F^* this simplifies to $3q_F^* < 2\sqrt{q_F^* S}$ and, thus, $9(S^2 - 2Q^n S + Q^{n2} < 4S(S - Q^n)$. Seeking the quadratic completion yields $(3Q^n - 7S/3)^2) < 4S^2/9$. The latter is equal to $|3Q^n - 7S/3| < 2S/3$. The solution of the latter inequality is given by $Q^n \in [5S/9, S)$. As $A_l^{II} \subset [5S/9, S)$, $[z_l^a, z_l^d) \cap [\tilde{z}, z^B) = \varnothing$ for all $Q^n \in A_l^{II}$.

$\boldsymbol{A_u^{II}}$: $z_u^a < \tilde{z}$ if $q_F^*(S(2+\sqrt{2})/4 - q_F^*) < q_F^* q_H^*$. Solving for Q^n renders $Q^n \in [S(2+\sqrt{2})/4, S)$. Since $A_u^{II} \subset [S(2+\sqrt{2})/4, S)$, $[z_l^a, z_u^a) \cap [\tilde{z}, z^B) = \varnothing$ for all $Q^n \in A_u^{II}$.

C.5.5 $\boldsymbol{Q_u^I}$

Here we have to compare $[z_l^a, z_u^a]$ and $[0, z_a]$. Again, $z_l^a > 0$ for Q_u^I by the results of section 1. From the last section we know that $z_u^a > z_a$ if $Q^n \in [S(10+\sqrt{2})/12, S)$. As $Q_u^I \subset Q^n \in [S(10+\sqrt{2})/12, S)$, $[z_l^a, z_u^a] \cap [0, z_a] = [z_l^a, z_u^a]$ whenever $Q^n \in Q_u^I$.

We know also from the last section that $z_u^a < \tilde{z}$ when $Q^n \in [S(2+\sqrt{2})/4, S)$. Since $Q_u^I \subset [S(2+\sqrt{2})/4, S)$ it follows that $[z_l^a, z_u^a] \cap [\tilde{z}, z^B) = \varnothing$ for all $Q^n \in Q_u^I$.

Summarising the results shows that set of entrance costs z where the incumbent applies the AD–strategies and a pro–competitive situation is given can be determined with

$$z \in \begin{cases} [0, z_a) & \text{for} \quad Q^n \in \left[\frac{3}{4}S, \frac{S}{16}\left(14 - \sqrt{2^{5/2} - 2}\right)\right), \\ [0, z^{DL}) & \text{for} \quad Q^n \in \left[\frac{S}{16}\left(14 - \sqrt{2^{5/2} - 2}\right), \frac{S}{4}(2+\sqrt{2})\right), \\ [z_l^a, z^{DL}) & \text{for} \quad Q^n \in \left[\frac{S}{4}(2+\sqrt{2}), \frac{S}{8}(6 - \sqrt{2} + 2^{7/4})\right), \\ [z_l^a, z_u^a) & \text{for} \quad Q^n \in \left[\frac{S}{8}(6 - \sqrt{2} + 2^{7/4}), S\right). \end{cases}$$

References

Antidumping Agreement, 1995. Agreement on the implementation of article VI of the general agreement on tariffs and trade 1994. In: World Trade Organization (Ed.), The Results of the Uruguay Round of Multilateral Trade Negotiation. The Legal Texts, Geneva.

Brander, J. A., Spencer, B., 1987. Tariffs and the extraction of foreign monopoly rents under potential entry. In: Bhagwati, J. N. (Ed.), International Trade: Selected Readings. MIT–Press, Cambridge (MA), pp. 141–160.

Campbell, N., 2000. Import quotas and entry deterrence. Australian Economic Papers 30 (2), 153–157.

Dixit, A. K., 1980. The role of investment in entry–deterrence. Economic Journal 90, 95–106.

Dixit, A. K., Kyle, A. S., 1985. The use of protection and subsidies for entry promotion and deterrence. American Economic Review 75 (1), 139–153.
Finger, M. J. (Ed.), 1993. Antidumping: How It Works and Who Gets Hurt. University of Michigan Press, Ann Arbor.
Finger, M. J., Schuknecht, L., 1999. Market access advances and retreat: The uruguay round and beyond. http://econ.worldbank.org/docs/959.pdf (November).
Fischer, R., 1992. Endogenous probability of protection and firm behaviour. Journal of International Economics 32 (1–2), 149–163.
Hartigan, J., February 2000. An antidumping law can be procompetitive. Pacific Economic Review 5 (1), 5–14.
Ishibashi, K., 1991. The role of tariffs in entry deterrence under international monopoly. Keio Economic Studies 28 (2), 13–30.
Kempton, J., Holmes, P., Stevenson, C., 1999. Globalisation of anti–dumping and the EU. SEI Working Paper No. 32, University of Sussex.
Miranda, J., Torres, R., Ruiz, M., 1998. The international use of antidumping: 1987–1997. Journal of World Trade 32 (5), 5–71.
Moore, M. O., 2000a. "facts available" dumping allegations: When will foreign firms cooperate in antidumping petitions? http://gwis2.circ.gwu.edu/˜mom/bia.pdf.
Moore, M. O., 2000b. VERs and price undertakings under the WTO. http://gwis2.circ.gwu.edu/˜mom/ver_undertaking.pdf.
OECD, 2000. Competition and trade effects of abuse of dominance. COM/DAFFE/CLP/TD21/FINAL, paris, http://www.oecd.org/ech/index_2.htm.
Palmeter, D. N., 1991. The antidumping law: A legal and administrative nontariff barrier. In: Boltuck, R., Litan, R. E. (Eds.), Down in the Dumps: Administration of the Unfair Trade Laws. Brooking Institution, Washington, pp. 65–89.
Panagariya, A., Gupta, P., 1998. Anti–dumping duty versus price negotiations. The World Economy 21 (8), 1003–1020.
Pauwels, W., Springael, L., 2000. The welfare effects of an anti–dumping duty and of a price–undertaking in the context of the european anti–dumping policy. UFSIA, University of Antwerp, Belgium.
Pauwels, W., Vandenbussche, H., Weverbergh, M., 1997. Strategic behaviour under european antidumping duties. CEPR Working Paper No. 1565, London.
Prusa, T. J., 1992. Why are so many antidumping petitions withdrawn? Journal of International Economics 33 (1–2), 1–20.
Prusa, T. J., 1994. Pricing behaviour in the presence of antidumping law. Journal of Economic Integration 9 (2), 260–289.
Reitzes, J., 1993. Antidumping policy. International Economic Review 34 (4), 745–763.
Staiger, R., Wolak, F. A., 1989. Strategic use of antidumping law to enforce tacit international collusion. NBER Working Paper No. 3016, Cambridge (MA).
Steagall, J., 1995. Strategic Behaviour and the US. Unfair Trade Statutes, New

York.
UNCTAD, 2000. Impact of anti–duming and countervailing duty actions. Background note by the UNCTAD Secretariat, Geneva, http://www.unctad.org/en/docs/c1em14d2.en.pdf.