

Raising Rivals' Fixed Costs*

Morten Hviid[†]
University of East Anglia

and

Matthew Olczak[‡]
Aston University

April 2011

Abstract

This paper analyses the strategic use of fixed costs to deter entry or monopolize a market. Having identified a number of credible avenues through which fixed costs can be raised, such as increased regulation, vexatious litigation and increased prices for essential inputs, we show that this may be a profitable strategy, even if it raises the firm's own fixed costs by the same amount. As a strategic increase in fixed costs reduces the number of firms in the industry, it not only leads to a transfer of rents but also to a decrease in welfare.

Keywords: Raising rivals' costs, fixed costs, entry deterrence, monopolization.

JEL Classification Code: L13, L41, L51

*This paper builds on CCP working paper 05-1. We gratefully acknowledge the financial support of the UK Economic and Social Research Council (ESRC). We thank Andrew Gavil, Greg Shaffer and Christopher Wilson for helpful comments. The usual disclaimer applies.

[†]UEA Law School and ESRC Centre for Competition Policy, University of East Anglia, Norwich NR4 7TJ UK; e-mail: m.hviid@uea.ac.uk.

[‡]Economics and Strategy Group, Aston Business School, Aston University, Aston Triangle, Birmingham, B4 7ET and ESRC Centre for Competition Policy, University of East Anglia, Norwich NR4 7TJ UK; e-mail: m.olczak@aston.ac.uk.

1 Introduction

Lately the application of the label “Raising rivals’ costs” to strategic behavior has been widened considerably to cover most of the strategies dealt with in the US under section 2 of the Sherman Act and the exclusionary abuses dealt with in the EU under Article 102 TFEU. This follows a recognition that the effect of most exclusionary strategies is to raise costs of rivals by forcing them to look elsewhere for inputs or outlets for their products, rather than completely barring rivals from participating actively in the market.

The traditional theoretical literature, initiated by Salop and Scheffman (1983), focused directly on the insight that a firm may be able to obtain a strategic advantage by increasing a rival or potential rivals’ costs. The classic RRC model, formalized in Salop and Scheffman (1983 & 1987), argued that, unlike predation, a RRC strategy was more credible, did not require the rival to exit the market and allowed short run gains. They use a dominant firm, competitive fringe setup to show how strategic RRC can be achieved, that a RRC strategy can be profitable and may have a negative or a positive effect on the fringe firm’s profits and on consumer welfare.

However, despite the appeal of RRC as a theoretical idea there has been much debate concerning applications to ‘real-world’ scenarios. First, the existing literature focuses largely on the strategic raising of rivals’ variable costs and as shown in Mason (2002), the scope for such a strategy to be profitable is limited because in many scenarios raising a rival firm’s costs leads to an identical increase in the firm’s own costs. Second, as discussed below, many of the traditional cost raising strategies appear more plausibly to affect fixed rather than variable costs. Raising fixed costs has no effect on firms’ choices of short run strategic actions such as prices and quantities and at a first blush merely serve to transfer rent from one economic actor to another. This overlooks that fixed costs do affect the participation constraint of a firm when these costs are not incurred if the firm exits the industry. The aim of this paper is demonstrate that raising fixed costs can serve as a credible mechanism to exclude some firms to the detriment of competition and hence welfare.

This paper is the first to establish the anti-competitive effects of raising rivals fixed costs formally and within a fully specified oligopolistic framework. Of the two existing contributions, Rogerson (1984) uses a simple example to show that where entrants are non-strategic “quantity takers”, an incumbent with a first mover advantage can profitably deter entry by raising fixed costs. Arguing from aggregate supply functions which are shifted by a reduction in firms caused by an increase in fixed costs, McChesney (1997) shows that total rent in the industry may increase or decrease depending on unmodeled details. Hence the industry as a whole may have an incentive to lobby either for more or less fixed cost raising regulation. Neither contribution models the individual incentive of firms nor the mechanism through which the cost-raising strategy could have the desired effect.

This paper is organized as follows. In section 2 we provide several examples of cost-raising strategies where the most plausible effect is on fixed rather than variable costs. Section 3 uses a simple Cournot duopoly model to demonstrate that if a firm is able to raise fixed costs before a rival decides on whether to be active in the next period, doing so can be an optimal strategy. This requires fixed costs to be in an intermediate range. If they are too low, no firm is deterred from being active and if they are too high, even a successful use of the strategy is not profitable. Section 4 extends the results to more general models of oligopoly competition allowing both for more than two firms and for differentiated products. Finally, section 5 concludes the paper with a discussion of the welfare implications and policy implications of the analysis.

2 Examples of firms raising fixed costs

The most obvious examples of strategies which raises rivals’ costs relate to the costs of doing business, such as complying with regulations or defending yourself against illegal acts by others. However, we can also identify cost raising strategies relating to the costs of procuring necessary inputs. We provide a non-exhaustive set of examples of each type below.

Oster (1982) was first to formalize the idea that a firm may be able to use regulation

strategically. There is an extensive and well established literature on lobbying for regulation, see for example Michaelis (1994), where two political parties compete for campaign contributions by firms in an industry subject to regulation. In addition, McWilliams et al.(2002) provide a large number of examples of regulation which increases rivals' costs and Shaffer (1995) a more general survey for the interaction between firms and governments when it comes to regulation. McChesney (1997) provides a wealth of examples of rent-seeking behavior which will have the effect of raising rivals fixed costs.

Another, less discussed, form of raising rival s' costs of doing business is to initiate vexatious litigation¹ against a rival or potential rival.² In the EU, the possibility of vexatious litigation by a dominant firm has been acknowledged in the courts. In *BBI/Boosey & Hawkes*³ it was alleged that a dominant firm has pursued vexatious litigation against a competitor in order to deter entry and that this was an abuse. However, as pointed out by Preece (1999), the Commission decision relate only to interim measures so that it was not until the CFI's decision in *Promedia v Commission*⁴ that it was established that litigation by a dominant firm could in certain circumstances be an abuse. The decision also limits the situations in which such an allegation could successfully be made. According to Preece (1999) only predatory litigation would amount to an abuse, i.e. litigation which solely had the aim to prevent entry or to force a firm to exit. Although it may therefore be possible for a victim of this form of RRC to defeat it in court, it is challenging to establish that litigation is truly aimed at disadvantaging the defendant rather than to right a wrong. Hence vexatious litigation remains a plausible strategy and clearly raises fixed rather than variable costs.

A classic example of raising the costs of essential inputs, going back at least to Williamson (1968), is the negotiation of higher wages for key personnel. However, increasing the wages in one firm would only affect rivals if such labor input was in short supply and crucial to production. However if it was so crucial to the success of a firm, one

¹These are sometimes known as spurious litigation, nuisance suits or sham suits.

²On the more general misuse of competition law to harm rivals, see for example Baumol and Ordover (1985) and Miller and Pautler (1985).

³Commission Decision 87/500, [1987] O.J. L286/36.

⁴T111/96 *ITT Promedia NV v E. C. Commission* [1998] 5 C.M.L.R. 491.

would expect employers to want to lock-in the workers as far as possible, treating them more like fixed costs than variable costs.⁵ There are many other examples of key input in which one firm through its purchasing strategy could push up the fixed cost of that input to all firms. For example in Shaffer (2005, p.3), "Slotting allowances raise rivals' costs because they are the means by which the dominant firm bids up the price of an essential input (the retailers' shelf space)". Similarly, the holding of land banks of sites in particularly well suited locations will raise the cost of entry or expansion of rivals.⁶

These examples illustrate that raising fixed costs is a feasible strategy which moreover has been employed in a range of sectors. Two common features of these strategies will be important for the relevance of our theory. First, in many of the examples the action to raise costs is available only to a single well placed firm or group of firms. Second, other firms can generally avoid the fixed costs by not being active in the industry.

3 Formalizing the effect of fixed costs in a Cournot model

Consider a standard symmetric Cournot duopoly model satisfying the necessary conditions for the Cournot equilibrium to be unique and stable. Denote equilibrium quantities by $q_i^c = q_j^c = q^c$. Let gross profit of firm i before fixed costs be given by $\Pi_i(q_i, q_j)$, and let $Br_i(q_j)$ be the best reply of firm i given by the solution to

$$\frac{\partial \Pi_i(q_i, q_j)}{\partial q_i} = 0$$

Consider the profit of firm i along its best reply function and note that this is decreasing in q_j because

$$\frac{\partial \Pi_i(Br_i(q_j), q_j)}{\partial q_j} = \frac{\partial \Pi_i(q_i, q_j)}{\partial q_i} \frac{dBr_i(q_j)}{dq_j} + \frac{\partial \Pi_i(q_i, q_j)}{\partial q_j} = \frac{\partial \Pi_i(q_i, q_j)}{\partial q_j} < 0$$

⁵Whilst long-term labor contracts are unusual, long terms relationships through implicit contracts may be less so, especially with key personnel. For example, Prendergast (1998) points out that many of the incentive mechanisms used by firms require a long-term relationship between firm and worker.

⁶Land banks held by major grocery chains was one of the issues considered in the 2006 UK Competition Commission market inquiry into the groceries market. See http://www.competition-commission.org.uk/rep_pub/reports/2008/fulltext/538.pdf.

which implies that for a given fixed cost F , there exist a level of output q such that $\Pi_i(Br_i(q), q) - F = 0$ with the property that for all $q_j > q$, $Br_i(q_j) = 0$. Figure 1 shows the best reply curve of firm i and in particular the effect that fixed costs have in the standard Cournot best reply diagram. The heavy line shows firm i 's best reply:

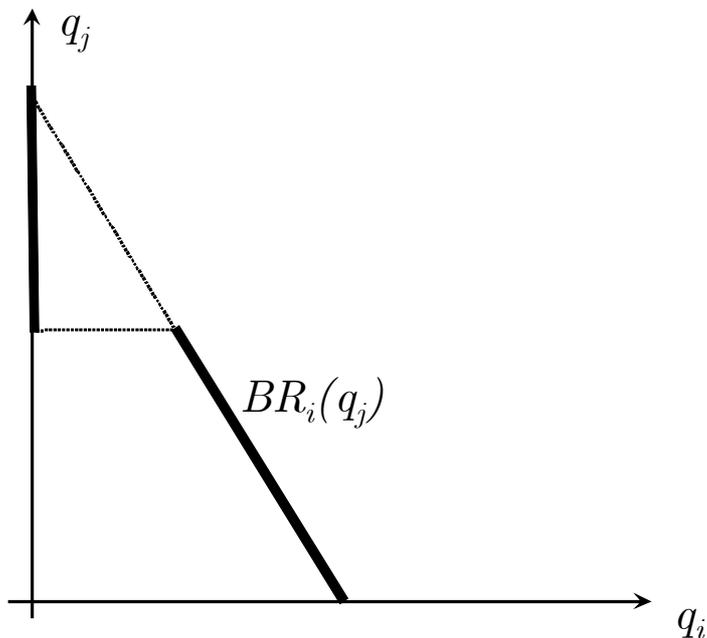


Figure 1: Best reply of Firm i when it has positive fixed costs

Note that the level of fixed costs determine where the discontinuity at q arises. The larger is the fixed costs, the closer to the q_i axis is the discontinuity.

In keeping with the examples discussed above, where the action is often taken either by one well placed firm or by a group of firms together, we will assume that one of the firms has the ability to raise the costs of both firms before they chose their output.

The structure of the game is that firm 1 first chooses whether or not to take a discrete action which raises both firms' fixed costs. Both firms observe this and then choose the level of output to produce simultaneously. We can define three important levels of fixed costs. Let q^m be the monopoly level of output which solves $Br_i(0) = 0$ and note that standard conditions ensure that $2q^c > q^m > q^c$ i.e. industry output is higher with two active firms than with monopoly. First, the level of fixed costs where the best reply to

the monopoly output level by the rival is not to produce and hence incur the fixed costs is

$$\hat{F} \equiv \Pi_i(Br_i(q^m), q^m)$$

Second, the level of fixed costs where the best reply to the Cournot equilibrium output level by the rival is not to produce and hence incur the fixed costs is

$$\tilde{F} \equiv \Pi_i(Br_i(q^c), q^c)$$

Finally, let \bar{F} be the level of costs where no firm is profitable. Note that $\bar{F} > \tilde{F} > \hat{F}$. Proposition 1 then identifies the set of Nash equilibria as a function of F .

Proposition 1 *The set of equilibria available depends on the level of fixed costs, F in the following way:*

- i) For low levels of fixed costs, $0 \leq F < \hat{F}$, the Cournot equilibrium is the unique equilibrium.*
- ii) For medium levels of fixed costs, $\hat{F} \leq F < \tilde{F}$, there are three equilibria; firm 1 as a monopolist, firm 2 as a monopolist or the Cournot equilibrium.*
- iii) For high levels of fixed costs, $\tilde{F} \leq F < \bar{F}$, there are two equilibria; firm 1 as a monopolist and firm 2 as a monopolist.*
- iv) For very high levels of fixed costs, $\bar{F} \leq F$, no firm is active.*

Proof: For $\bar{F} \leq F$, even a single firm cannot produce profitably and hence there is no equilibrium with active firms. This establishes iv). For $\hat{F} \leq F < \bar{F}$, there exist a $q' \in [q^c, q^m]$ such that $F = \Pi_i(Br_i(q'), q')$ and hence for all $q \in [q', q^m]$, the best reply to q is to produce zero. The best reply to the rival producing zero, is q^m and hence $(q^m, 0)$ and $(0, q^m)$ are both equilibria. Finally, for $0 \leq F < \tilde{F}$, $\Pi_i(Br_i(q^c), q^c) > 0$ by definition and hence (q^c, q^c) is an equilibrium. Combining these gives us i) to iii). ■

The intuition behind Proposition 1 can be explained diagrammatically. Figure 2 illustrates the case with medium levels of fixed costs where there are three possible equilibria, i.e. two where only one firm is active and one in which both i and j are active.

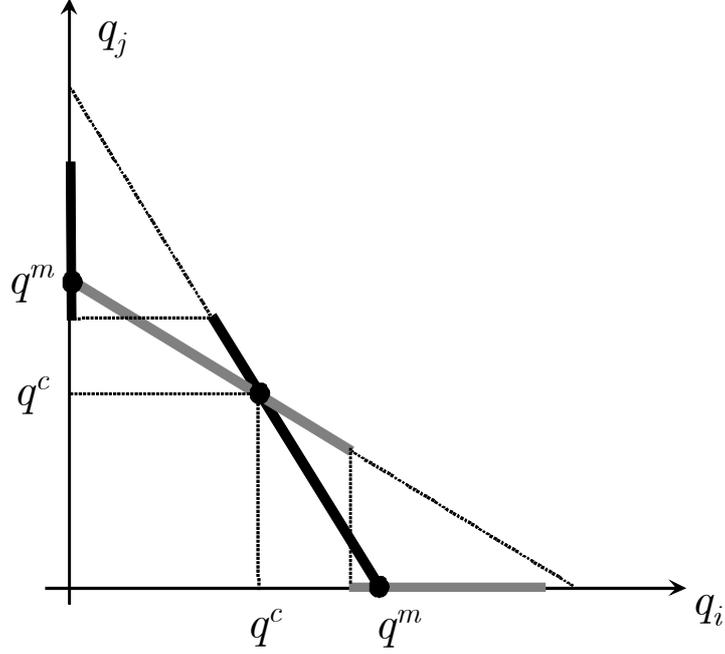


Figure 2: The case where $\hat{F} \leq F < \tilde{F}$.

Starting out with the set of equilibria shown in Figure 2, If the fixed costs were increased sufficiently, it is clear that first the Cournot equilibrium would fail to exist and eventually the asymmetric monopoly equilibria would fail as well. Similarly, if from the starting point in Figure 2, the fixed costs were reduced, the Cournot equilibrium would remain while the asymmetric monopoly equilibrium would after a point fail to exist.

Note that in two cases, medium and high levels of fixed costs, we find multiple equilibria. To select the best prediction of an outcome of the game, it is useful to be able to rank these equilibria. As the next two lemmas show, we are always able to do so.

Lemma 1 *For a medium level of fixed costs, $\hat{F} \leq F < \tilde{F}$, firm i prefers the monopoly equilibrium with fixed costs F and $q_i = q^m$ to the Cournot equilibrium with zero fixed costs, which again is preferred to the monopoly equilibrium with fixed costs F and $q_i = 0$.*

Proof: First note from proposition 1 that with fixed costs in this range, there are three equilibria. Of these, clearly the Cournot equilibrium with fixed costs is dominated by the Cournot equilibrium with zero fixed costs. Since Cournot profits before fixed costs

are assumed positive, this equilibrium dominates the monopoly outcome where the firm produces nothing. The only remaining element of the proof is to demonstrate that with fixed costs in the range, $\Pi_i(q^m, 0) - F > \Pi_i(q^c, q^c)$. Note that aggregate industry profits are higher with one monopoly firm than two Cournot firms, $\Pi_i(q^m, 0) > 2\Pi_i(q^c, q^c)$ which we can write as $\Pi_i(q^m, 0) - \Pi_i(q^c, q^c) > \Pi_i(q^c, q^c)$. Since $F < \Pi_i(q^c, q^c)$ in this range, this completes the proof. ■

Lemma 2 *For a high level of fixed costs, $\tilde{F} \leq F < \bar{F}$, there exists a level of fixed costs, $F^* \equiv \Pi_i(q^m, 0) - \Pi_i(q^c, q^c)$ such that for $\tilde{F} \leq F < F^*$, firm i prefers the monopoly equilibrium with positive fixed costs F and $q_i = q^m$ to the Cournot equilibrium with zero fixed costs, which again is preferred to the monopoly equilibrium with positive fixed costs F and $q_i = 0$. On the other hand, for $F^* \leq F < \bar{F}$, firm i prefers the Cournot equilibrium with zero fixed costs to the monopoly equilibrium with positive fixed costs F and $q_i > 0$, which again is preferred to the monopoly equilibrium with fixed costs F and $q_i = 0$.*

Proof: The second part is obvious since Cournot profits are positive and the profits with zero production is zero. Consider the net difference between the monopoly with fixed costs and Cournot without, defined as $\Delta(F) \equiv \Pi_i(q^m, 0) - F - \Pi_i(q^c, q^c)$. First note that $F^* > \tilde{F}$ as, using the definition of \tilde{F} , $\Delta(\tilde{F}) = \Pi_i(q^m, 0) - 2\Pi_i(q^c, q^c) > 0$. Secondly note that $F^* < \bar{F}$ as, using the definition of \bar{F} , $\Delta(\bar{F}) = -\Pi_i(q^c, q^c) < 0$. As $\Delta(F)$ is decreasing in F there must be an intermediate value, F^* , such that $\Delta(F^*) = 0$. ■

The key difference between the two lemmas is that with high fixed costs where these are high enough, even being a monopolist does not compensate for the cost increase.

We are now able to state the set of subgame perfect equilibria where firm 1 decides whether or not to raise the level of fixed costs.

Proposition 2 *For low levels of fixed costs, $F < \hat{F}$, and sufficiently high levels of fixed costs such that $F^* < F$, the unique subgame perfect equilibrium involves no cost raising and the equilibrium is Cournot. For intermediate levels of costs $\hat{F} \leq F < F^*$, there are two subgame perfect equilibria, one characterized by cost raising and the monopoly output*

level $(q_1, q_2) = (q^m, 0)$, and the other characterized by no cost raising and Cournot output levels, $(q_1, q_2) = (q^c, q^c)$.

Proof: For $F < \hat{F}$, the equilibrium always involve the firms choosing the Cournot level of outputs and since profit is decreasing in F , the only subgame perfect equilibrium involves setting fixed costs to zero. For $F > F^*$, we know from lemma 2 that no firm has an incentive to raise rivals' costs and hence again, Cournot is the unique subgame perfect Nash equilibrium. For $\hat{F} \leq F < F^*$, use lemma 1 and 2 to note that if firm 1 believes that raising fixed costs is followed by any other equilibrium in the quantity subgame than $q_2 = 0$, it would prefer to set $F = 0$. However, if firm 1 believes that raising fixed costs is followed by the equilibrium in the quantity subgame where $q_2 = 0$, then raising fixed costs is optimal. This establishes the multiplicity of subgame perfect equilibria for the intermediate levels of fixed costs. ■

For very low fixed costs, firm 2 cannot be excluded so that firm 1 faces a straightforward choice between Cournot profits with and without positive fixed costs. For higher levels of fixed costs, it is possible to exclude firm 2 but at a cost. If these costs are high enough, any benefits of monopoly over Cournot is wiped out. The cases which are interesting are where the level of fixed costs is at an intermediate level. Here, even restricting attention to subgame perfect equilibria where we require the action in each subgame to be a best reply in that subgame, we cannot rule out multiple equilibria, one of which involves the cost raising strategy and monopolization while the other does not.

As is well known, subgame perfection is not always a sufficiently strong equilibrium refinement to rule out all implausible equilibria. Note that the Cournot equilibrium (with no cost raising) in proposition 2 is based on firm 1's, belief that firm 2 would respond to firm 1 raising costs by choosing to produce the monopoly level of output (or, for some cost levels as defined in Proposition 1(ii), the Cournot level). However, firm 2 would only ever do this if it believed that firm 1 would follow up raising costs by producing nothing and exiting the market (or by producing the Cournot output). Such beliefs do not seem sensible but subgame perfection does not rule out irrational beliefs. To do so we need to employ the reasoning behind forward induction. Forward induction requires a firm to

rationalize a prior move of a rival. In this case, firm 2 must consider what could have motivated 1 and what subsequent move by 1 could make that action rational. In this case, 2 can only rationalize the strategic choice of a higher F by 1 producing the monopoly output. We can think of 1's choice to raise the rival's costs including a communication about the output level that 1 will choose.⁷

Proposition 3 *For intermediate levels of fixed costs, $\hat{F} \leq F < F^*$, forward induction selects a unique equilibrium in which firm 1 will raise costs and produce the monopoly level of output while firm 2 exits the market, i.e. fixed costs are raised and $(q_1, q_2) = (q^m, 0)$.*

Proof: Assume $\hat{F} \leq F < F^*$ and recall from proposition 1 that for those values of F we have multiple equilibria whenever firm 1 chooses to raise fixed costs. With multiple possible equilibria, the prediction of an outcome depends on the probability the two players attach to their rival playing one of the three strategies which could form part of an equilibrium, q^m , q^c , and 0. Focus on firm 2 who could be expected to look at the decision of whether or not to raise fixed costs as a guide to firm 1's intentions. Thus we refine the set of equilibria using forward induction. If firm 1 intended to choose q^c it never makes any sense for 1 to raise fixed costs in the first stage. Thus observing positive fixed costs, firm 2 must rule out $q_1 = q^c$. Moreover, If firm 1 intended to follow raising fixed costs with $q_1 = 0$, it would have done better choosing $F = 0$ as the payoff from the Cournot equilibrium with no fixed costs is greater than zero. This leaves firm 2 with only one possible inference from observing positive fixed costs namely that firm 1 plans to choose $q_1 = q^m$ in which case the best reply of firm 2 is $q_2 = 0$. Given firm 2's beliefs, firm 1's choice is between $F = 0$ leading to it earning Cournot profits and raising rivals' fixed costs, leading to it earning monopoly profits minus the implied fixed costs. From lemma 1, the optimal choice for firm 1 is then as given in the proposition. ■

The benefit of using forward induction is that it directly focuses on the inference that firms may make from observing the behavior of others. The key insight is that as a strategy, raising fixed costs makes no sense unless the firm which does so also plans to

⁷For the use of forward induction for this purpose, see for example Bagwell and Ramey (1996).

monopolize the market. The implications of proposition 3 is that for a wide level of fixed costs, a firm with the ability to raise fixed costs both to itself and to its rival would have an incentive to do so. Combining this result with the examples provided in section 2 demonstrates that raising rivals fixed costs is a real possibility with real implication for the functioning of some market and their overall welfare.

4 Generalizations

While the homogeneous goods Cournot duopoly model used in the previous section allows the most straightforward demonstration of the effects of raising fixed costs, the results are not limited to Cournot quantity setting nor to homogeneous products.

The extensions to the homogeneous goods Bertrand case is almost trivial given the existing literature. To see this, consider Dasgupta and Stiglitz (1988), who show that with any level of fixed costs, if the entry decision in a homogeneous goods Bertrand model is sequential, the outcome is monopoly. The same logic would then, combined with forward induction, work for exit, giving us the very extreme result that if one firm can raise fixed costs, however trivially, it would do so, so long as these costs were below the monopoly profit level.

In the remainder, we will maintain the assumption that there is one firm who has the ability to raise rivals' fixed costs and that this action is observable to rivals prior to their decision on whether or not to remain active and pay the same fixed cost or exit without. We will assume that there are $n \geq 2$ firms in the industry and in addition endogenize the number of firms in the industry. Define the base-line fixed costs, \underline{F} , as the level of fixed costs absent any cost-raising strategies. Note that the level of \underline{F} will determine the maximum number of firms which could be accommodated in the industry. Once there is a positive level of base line fixed costs, $\underline{F} > 0$, then it follows that there must be an endogenous maximal number of firms, n^* , who can be in the industry even if no firm raises fixed costs further.

Let $\pi(k)$ be the per-firm profit when there are k firms in the industry.

Lemma 3 *Assume that base line fixed costs are positive⁸, $\underline{F} > 0$. A sufficient condition for a firm who is expecting to remain active in the industry to raise fixed costs to exclude a rival is that per-firm profits, $\pi(k)$, is convex in the number of firms, k .*

Proof: Assume free entry and define n^* as above. In that case $F > \pi(n^* + 1)$. Hence the following inequality relating to current profits of $\pi(n^*) - F$ must hold

$$0 \leq \pi(n^*) - F < \pi(n^*) - \pi(n^* + 1)$$

If the firm increased fixed costs to \hat{F} to drive out one further firm, profits would be given by

$$\pi(n^* - 1) - \hat{F} = \pi(n^* - 1) - \pi(n^*)$$

since $\hat{F} \geq \pi(n)$ is needed to force exit and the remaining firms would want \hat{F} as small as possible. Raising the fixed costs to \hat{F} is strictly profitable if

$$\pi(n - 1) - \hat{F} > \pi(n) - F$$

Note that a sufficient (but not necessary) condition for this is that

$$\pi(n - 1) - \pi(n) > \pi(n) - \pi(n + 1)$$

which we can write as

$$\frac{1}{2} [\pi(n - 1) + \pi(n + 1)] > \pi(n)$$

which is exactly the condition for $\pi(k)$ to be convex. ■

There are two implications of the lemma. For any equilibrium number of firms n^* , or equivalently any \underline{F} , there exists an $F \in [0, \pi(1)]$ such that it is profitable to raise the fixed costs to F to exclude a firm. Secondly, a marginal increase in fixed costs is always profitable if it excludes another firm.

⁸The case where $\underline{F} = 0$ provide a very different result, namely that for $n > 2$ it is never worthwhile to raise rivals' fixed costs. The intuition for the result is that since with free entry there is nothing restricting the number of firms, for any given initial finite n , any firm contemplating raising fixed costs to reduce the number of firms to $n - 1$, is essentially doing it not from n but from an infinitely larger number. Even though the profit of each firm is very small when n is very large, so is the incremental increase in profits from reducing the number of firms by one. This result only occurs in the limit when there are infinitely many firms.

For the majority of oligopoly models, per-firm profits is a convex function of the number of firms. This is for example true for all Cournot models and, as demonstrated in the appendix, for differentiated goods Bertrand models. The intuition is simple. Essentially when one more firm is added two things happen to the per-firm profits. First, there are more firms sharing the total profits and second with more firms competition is more intense and hence total profits is also decreased.

The precise implication of lemma 3 depends on whether the increase in fixed costs arising from a cost raising strategy is endogenous or exogenous. Focus on the action of a firm who is guaranteed to remain active in the industry if it raises fixed costs of all firms. Where the amount is endogenous, fixed costs would be raised all the way to the point where only one firm remain active, that is, the point at which $\pi(2) - \underline{F} - F = 0$. Where the amount is endogenous, but has an upper bound, fixed costs would be raised such that as many firms as possible are excluded, with the fixed cost set so as to just exclude the marginal firm. If the amount by which fixed costs can be raised is exogenous, fixed costs would be raised to this level unless it is high enough to remove the gains from monopolization. Thus if one firm has a clear first mover advantage, there is a strong incentive for such a firm to attempt to raise fixed costs and it would be willing to do so to the point where the industry is completely monopolized. We summarize this in a final proposition.

Proposition 4 *When one firm can raise rivals' fixed costs, if this level of costs is exogenous, forward induction selects the cost raising equilibrium as long as this level of fixed costs is below that where a monopolist would prefer oligopoly with n^* firms and base line fixed costs to monopoly with the raised fixed costs. If the level of fixed costs is chosen endogenously, forward induction selects a unique equilibrium which the first mover chooses the level of fixed costs which exactly excludes a duopoly firm, thereby monopolizing the market.*

5 Conclusion

We have shown that strategies to raise fixed costs are plausible, worthwhile for firms, and detrimental to consumer welfare and hence worthy of scrutiny by competition authorities. In contrast to dominant firm strategies that can raise a rival's variable costs, impair its ability to compete, and thereby facilitate the exercise of power over price, raising rival's fixed costs is more likely to deter rival entry or lead to rival exit. In other words, the strategy is more likely to alter the structure of the affected market rather than simply induce an increase (or stabilization) of price. From the point of view of consumers, the observed result may be the same – the dominant firm gains power over price; but in the case of raising a rival's fixed costs, the power may be more durable, because it is more likely to lead to exit and more permanently alter conditions of entry. It is therefore clear that the effect of raising fixed costs is not just to transfer wealth from one group to another. In addition, while all the analysis assumes that the firms are equally efficient, it is possible to show that most of the results remain even if we assume that the firm who can choose whether or not to raise fixed costs is relatively less efficient than other firms. Thus raising rivals' fixed costs could result in more efficient firms being excluded from the market. This would be a second and additional source of inefficiency.

Combining the theory with the examples discussed in section 2, we can point to several policy implications arising from the paper. Firstly, as suggested by OFT (2002), regulation can have an adverse effect on competition in certain scenarios and therefore that policy makers should consider this impact on the industry. Regulatory impact assessments should be alert to the possibility that firms may be appearing to argue against their own narrow best interest, not because they are public spirited, but because this can confer a benefit to them by reducing the number of competitors. Secondly, courts and authorities should be alert to the possibility that vexatious litigation can amount to an abuse of dominance and hence be caught by competition law. Thirdly, with respect to the examples in section 2 where the fixed costs of essential inputs are raised, the main message in this paper is that just because many of these strategies do not affect marginal

costs does not imply that they can not have anti-competitive effects.

Finally, this paper has focused on the strategic increase in fixed costs to deter entry or force a rival to exit the industry. There is however, at least one possible alternative motive for a raising fixed costs strategy, suggested in Durham et al. (2004), which is worth noting and may provide avenues for further research. If at least part of the fixed costs is sunk, then firms may prefer to stay in the industry and make losses rather than immediately exit the industry. A change in industry conduct i.e. a move towards more collusive behavior however, would potentially allow all firms to continue to make positive profits, thus leading to an inefficient number of firms in the industry. Therefore, the motive for raising industry wide fixed costs could be to change conduct in the industry rather than to attempt to force a rival to exit the industry. This is similar to the idea in Mason (2002) which provides an alternative rationale for a RRC strategy by showing that in a dynamic setting a symmetric increase in variable costs can be profitable for all firms if it leads to a subsequent reduction in competition. An experiment conducted by Durham et al. (2004) using a double-auction experiment in a Bertrand setting, found some evidence that when large fixed costs were present, price signalling behavior took place to attempt to reduce competition, enabling firms to remain profitable.

APPENDIX: Bertrand model with differentiated products

To consider the effect on the number of firms and hence the number of products in a differentiated goods oligopoly, the derived demand function must allow for the number of variants to vary. Consider the following quadratic utility function where the consumer has a preference for diversity

$$U(q_0; q_i, i \in \{1, \dots, N\}) = K + \alpha \sum_{i=1}^N q_i - \frac{\beta}{2} \sum_{i=1}^N q_i^2 - \frac{\gamma}{2} \sum_{i=1}^N \sum_{j \neq i}^N q_i q_j + q_0$$

where $\beta \geq \gamma$, q_0 is the composite outside good and q_i is the i 'th variant. Maximizing this utility function subject to a budget constraint yields the following set of linear demand functions

$$q_i = \frac{1}{\beta + \gamma(N-1)} \left[\alpha - \frac{\beta + \gamma(N-2)}{(\beta - \gamma)} p_i + \frac{\gamma}{(\beta - \gamma)} \sum_{j \neq i}^N p_j \right], \quad i \in [1, N].$$

Normalizing marginal costs to zero, we can find the equilibrium price levels and hence the equilibrium profit as a function of the number of firms N

$$\pi(N) = \alpha^2 \frac{(\beta - \gamma)(\beta + \gamma(N-2))}{(\gamma(N-3) + 2\beta)^2(\beta + \gamma(N-1))} - F$$

The key question is whether this per-firm profit function is convex in the number of firms. Differentiate twice to get

$$\frac{d^2\pi}{dN^2} = \frac{2\alpha^2\gamma^2(\beta - \gamma)}{(\beta - \gamma + N\gamma)^3(2\beta - 3\gamma + N\gamma)^4} \Psi$$

where Ψ can be written as

$$\begin{aligned} \Psi &= [1 + (N-2)(11 - 9N + 3N^2)] \gamma^3 + [37 - 34N + 9N^2] \beta\gamma^2 \\ &+ [9N - 18] \beta^2\gamma + [3\beta - 2\gamma] \beta^2 \end{aligned}$$

As each term in a square bracket is positive for $N \geq 2$, it follows that for $N \geq 2$, $\frac{d^2\pi}{dN^2} > 0$ and hence per-firm profit is convex as required in lemma 3 so that the results in proposition 4 hold.

BIBLIOGRAPHY

- Bagwell, K. and G. Ramey, 1996, "Capacity, entry, and forward induction", *RAND Journal of Economics* 27, 660-680.
- Baumol, W.J. and Ordover, J.A., 1985, "Use of antitrust to subvert competition", *Journal of Law and Economics* 28, 247-65.
- Dasgupta, P. and J. E. Stiglitz, 1988, "Potential competition, actual competition, and economic welfare", *European Economic Review* 32, 569-577.
- Durham, Y., McCabe, K., Olson, M. A., Rassenti, S. and Smith, V., 2004 "Oligopoly competition in fixed cost environments", *International Journal of Industrial Organization*, 22, 147-162.
- Mason, R., 2002, "Cost-raising strategies in a symmetric, dynamic duopoly" *Journal of Industrial Economics* 50, 317-335.
- McChesney, F.S., 1997, *Money for Nothing*, Harvard and London: Harvard University Press.
- McWilliams, A., D. D. Van Fleet and K. Cory, 2002, "Raising rivals' costs through political strategy: An extension of the resource-based theory", *Journal of Management Studies* 39, 707-723.
- Michaelis, P., 1994, "Regulate us, please! On strategic lobbying in Cournot-Nash oligopoly", *Journal of Institutional and Theoretical Economics* 150, 693-709.
- Miller, J.C. and Pautler, P., 1985, "Predation: the changing view in economics and the law", *Journal of Law and Economics*, 28, May, pp. 495-502.
- Office of Fair Trading (OFT), 2002, "*Guidelines for competition assessment – A guide for policy makers completing regulatory impact assessment*".
- Oster, S., 1982, "The strategic use of regulatory investment by industry sub-groups", *Economic Inquiry* 20, 604-618.
- Preece, S., 1999, "ITT Promedia v. E.C. Commission: establishing an abuse of predatory litigation?", *European Competition Law Review* 20, 118-122.
- Prendergast, C., 1998, "What happens within firms? A survey of empirical evidence on compensation policies," in J. Haltiwanger, M. E. Manser and R. Topel: *Labor Statistics Measurement Issues. Studies in Income and Wealth*, vol. 60. Chicago and London: University of Chicago Press, 329-54.

- Rogerson, W.P., 1984, "A note on the incentive for a monopolist to increase fixed costs as a barrier to entry", *Quarterly Journal of Economics* 101, 399-402.
- Salop, S.C., and Scheffman, D.T., 1983, "Raising rivals' costs: Recent advances in the theory of industrial structure", *American Economic Review* 73, 267-271.
- Salop, S.C., and Scheffman, D.T., 1987, "Cost-raising strategies", *The Journal of Industrial Economics* 36, 19-33.
- Shaffer, B. 1995, "Firm-level responses to government regulation: Theoretical and research approaches", *Journal of Management* 21, 495-514.
- Shaffer, G., 2005, "Slotting Allowances and optimal product variety," *Advances in Economic Analysis & Policy*, 5(1), Article 3.
- Williamson, O.E., 1968, "Wage Rates as a barrier to entry: the Pennington case in perspective", *Quarterly Journal of Economics* 85, 85-116.