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More competitors or more competition? Market concentration and the intensity of competition *

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Abstract

We present a model of competitive interaction among n symmetric firms producing a homongeous good that includes both Bertrand and Cournot competition as special cases. In our model the intensity of competition is captured by a single parameter – the perceived slope of competitors' supply functions. We show that total welfare increases monotonically with the intensity of competition and the number of competitors. We then examine how the intensity of competition affects the gains from changing the number of competitors.When competition is intense, most of the gains from extra competition are captured with the entry of a small number of firms and subsequent gains from entry are small. Conversely, when the intensity of competition is small, a reduction in the number of firms can have a large impact on welfare.

Key-words: Competition intensity; number of competitors; mergers.

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1 Introduction

A common problem in competition regulation is that measures designed to promote more competitive behavior in a market may lead to the exit of some firms, and therefore to an outcome that may be less competitive on standard

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measures. For example, by making particular types of behaviour, such as disclosing information about pricing strategies, illegal so as to prevent possible coordination, competition law might actually lead to a decline in the number of firms in a particular industry.[1] A related problem is that regulators with limited resources must decide whether to allocate those resources to measures that facilitate entry or to measures designed to promote more competitive behavior by existing firms.

Competition regulators have little guidance from standard one-shot models of homogenous-product oligopoly on how to solve the trade-off between emphasising entry (or the number of firms in a market) and emphasising more competitive behaviour by firms already in the marketplace. Indeed, the two standard one-shot homogenous-product models provide strong, and diametrically opposed, answers. In the Cournot model, the equilibrium price is a monotonically decreasing function of the number of firms, so that an increase in the number of competitors is always beneficial. However, the only way, within the model, to interpret the concept of 'more competitive behavior', is to consider the possibility of a collusive agreement to implement the joint monopoly outcome.[2] Hence, provided such collusion can be prevented, the primary focus in a Cournot world should be on reducing market concentration. The Bertrand model provides the opposite answer. Provided there are at least two firms in the market, the outcome will be the same as in the perfectly competitive case. So, if regulatory effort can encourage the emergence of Bertrand behavior, the number of firms is irrelevant. In this instance, putting effort into reducing barriers to entry would be futile.

One response is to abandon the one-shot, homogeneous product setting. In dynamic settings, it is possible to consider a range of issues such as predatory pricing. (See, for example, Bolton, Brodley & Riordan (2000, 2001)). A second response is to consider models where products are differentiated. (See, for example, Tirole (1988, Chapters 2 and 7) and Anderson, De Palma and Thisse (1992)). However, these models do not yield any simple way of characterizing the trade-off between competitors and competition.

In this paper, we examine this trade-off within the framework of competition in linear supply schedules. (See, for example, Grossman(1981), Rob-

[1] A variation of this problem has been labeled by Bork (1978) as the *antitrust paradox* which refers to the potential effects of competition law in discouraging competitive behaviour. For example, a strict prohibition of predatory pricing can lead firms to refrain from reducing prices for fear of prosecution. However, price declines are one of the key outcomes of increased competition.

[2] Collusive agreements between a subset of firms may be considered, but, as Salant, Switzer and Reynolds (1983) show, these will not be profitable. Menezes and Quiggin (2011) reconsider the SSR result in the context of more general strategy spaces.

son(1981), Turnbull(1983), Klemperer and Meyer(1989), Grant and Quiggin (1996), Vives (2011) and Menezes and Quiggin (2011)). This framework provides a simple characterization of the competitiveness of the market in terms of the slope of the supply curves making up each firm's strategy space. The elasticity of the residual demand curve facing each firm is determined by the elasticity of market demand and the slope of its rivals' supply curves.

In this setting, and assuming that firms are identical, the problem may be analyzed in terms of two parameters: n, the number of firms, and β the(common) slope of the supply curves that make up their strategy space. The Cournot and Bertrand solutions arise as special cases. We show that total welfare increases monotonically with the intensity of competition and the number of competitors. We then examine how the intensity of competition affects the gains from changing the number of competitors. When competition is intense, most of the gains from extra competition are captured with the entry of a small number of firms and subsequent gains from entry are small. Conversely, when the intensity of competition is small, a reduction in the number of firms can have a large impact on welfare.

2 The Model

We begin by examining a standard oligopoly problem with linear demand, and n symmetric firms, producing output at constant marginal cost ($c_1 = c_2 = ... = c_n = c << 1$). Assume:

$$p = 1 - [q_1 + ... + q_n] \tag{1}$$

The strategy space for each firm consists of all linear supply schedules with a given slope β. More precisely, and following Menezes and Quiggin (2011), we specify the strategic choice for firm i as a choice of supply schedules, determined by the strategic variable α_i as follows:

$$q_i = (\alpha_i - \frac{c}{n}) + \beta(p - c) \tag{2}$$

where the strategic variable α_i is a scalar variable representing upward or downward shifts in supply and $\beta \geq 0$ is an exogenous parameter reflecting the intensity of competition. The slope of the residual demand curve facing any given firm is determined by the slopes of the market demand schedule and of the supply schedules of other firms. The parameter β may, therefore, be interpreted as representing the aggressiveness of competition in the market. We normalize firm i's supply schedule by $\frac{c}{n}$ in order to simplify the characterization of the equilibrium price.

The assumption of linear demand and supply schedules simplifies the analysis without any substantive loss of generality. The crucial assumption is that the strategy space for each firm consists of a family of smooth non-intersecting concave supply schedules, including all potentially optimal price-quantity pairs. Given this assumption, non-linear demand and supply curves can always be replaced with the linear approximation applicable at the unique equilibrium. Next we compute the equilibrium price and quantity outcomes as a function of β and n.

Replacing (2) into (1) yields:

$$p = \frac{1-(\alpha_1+\alpha_2+...+\alpha_n)}{1+n\beta} + c \tag{3}$$

Firm 1's profits are:

$$\begin{aligned}
\Pi_1 &= (p-c)q_1 = (p-c)(1-p-\sum_{j=2}^{n} q_j) \\
&= (p-c)\left[1-p-\sum_{j=2}^{n}(\alpha_j - \frac{c}{n}) - (n-1)\beta(p-c)\right] \\
&= (p-c)\left[1-p-\sum_{j=2}^{n}\alpha_j - \frac{n-1}{n}c - (n-1)\beta(p-c)\right]
\end{aligned}$$

Maximising:

$$\frac{\partial \Pi_1}{\partial \alpha_1} = \frac{\partial \Pi_1}{\partial p}\frac{\partial p}{\partial \alpha_1} = \left[1-2p+c-\sum_{j=2}^{n}\alpha_j + \frac{n-1}{n}c - 2\beta(p-c)(n-1)\right]\frac{\partial p}{\partial \alpha_1}$$

So for $\frac{\partial \Pi}{\partial \alpha_1} = 0$:

$$\sum_{j=2}^{n}\alpha_j = 1 + c[1+\frac{n-1}{n}] - p[2+2\beta(n-1)] + 2\beta c(n-1) \tag{4}$$

Using symmetry $\alpha_1 = \alpha_2 = ... = \alpha_n = \alpha^*$ and replacing (3) into (4) yields

$$\alpha^* = \frac{1+\beta(n-2)}{[(n+1)+n\beta(n-1)]} + \frac{1+n\beta}{n[(n+1)+n\beta(n-1)]}c \tag{5}$$

Replacing (5) into (3) yields:

$$p^* = \frac{1}{[(n+1)+n\beta(n-1)]} + \frac{n+n\beta(n-1)}{[(n+1)+n\beta(n-1)]}c \tag{6}$$

Now replacing (6) into (2) yields:

$$q_1^* = q_2^* = \ldots = q_n^* = q^* = \frac{(1+\beta(n-1))(1-c)}{(n+1)+n\beta(n-1)} \tag{7}$$

So that

$$Q^* = n\frac{(1+\beta(n-1))(1-c)}{(n+1)+n\beta(n-1)} \tag{8}$$

and

$$\pi^* = \frac{(1+\beta(n-1))(1-c)^2}{[(n+1)+n\beta(n-1)]^2}$$

Remark 1 *$\beta = 0$ represents the Cournot equilibrium:*

$$\begin{aligned} p^* &= \frac{1+nc}{(n+1)} \\ Q^* &= \frac{n}{n+1}(1-c) \end{aligned}$$

and as $\beta \to \infty$ we obtain the Bertrand equilibrium:

$$\begin{aligned} p^* &\to c \\ Q^* &\to 1-c \end{aligned}$$

Our main result relates the number of competitors and the intensity of competition to welfare.

Proposition 2 *Welfare is increasing in β and n.*

Proof. We first show that output is increasing in β and n.

$$\begin{aligned} \cdot\frac{\partial Q^*}{\partial \beta} &= \frac{n(n-1)}{([(n+1)+n\beta(n-1)])^2}(1-c) > 0 \\ \cdot\frac{\partial Q^*}{\partial n} &= \frac{1+\beta(2n-1)}{([(n+1)+n\beta(n-1)])^2}(1-c) > 0 \end{aligned}$$

Since $p = 1 - Q$, price is decreasing, and welfare increasing, in β and n. ■

For $\beta = 0$, we have:

$$\cdot\frac{\partial p^*}{\partial \beta}|_{\beta=0} = -\frac{n(n-1)}{(n+1)^2}(1-c)$$

so that the effect of a small increment in β from zero on prices increases with n. That is, when the intensity of competition is initially low, the gains from an increase in intensity rise monotonically with the number of competitors.

3 Changes in the number of competitors

We now consider the effect of changes in the number of competitors. Since most interest arises when the number of competitors is small, it is important to consider integer effects. We may tabulate the relevant values, for $n = 1, 2, 3, 4$, after which there is little loss in treating n as a continuous variable

n	P	Q	$\frac{\partial p^*}{\partial \beta}$
1	$\frac{1}{2} + \frac{1}{2}c$	$\frac{1}{2} - \frac{1}{2}c$	$0/NA$
2	$\frac{1}{3+2\beta} + \frac{2+2\beta}{3+2\beta}c$	$\frac{2+2\beta}{3+2\beta} - \frac{2+2\beta}{3+2\beta}c$	$-\frac{2}{(3+2\beta)^2}$
3	$\frac{1}{4+6\beta} + \frac{3+6\beta}{4+6\beta}c$	$\frac{3+6\beta}{4+6\beta} - \frac{3+6\beta}{4+6\beta}c$	$-\frac{6}{(4+6\beta)^2}$
4	$\frac{1}{5+12\beta} + \frac{4+12\beta}{5+12\beta}c$	$\frac{4+12\beta}{5+12\beta} - \frac{4+12\beta}{5+12\beta}c$	$-\frac{12}{(5+12\beta)^2}$

Note that whether the impact of β on the equilibrium price increases or decreases with n depends on the value of β. For example, for sufficiently low β, its impact on the equilibrium price increases as the number of firms increases from two to three. That is, the benefit from marginal increase in the degree of competition from a Cournot market structure increases as the number of firms increases.

Alternatively, we can also look at

$$\begin{aligned} p(\beta, n) - p(\beta, n+1) &= \frac{1}{(n+1) + n\beta(n-1)} - \frac{1}{(n+2) + \beta n(n+1)} \\ &\quad + c\left(\frac{n + n(n-1)\beta}{(n+1) + n\beta(n-1)} - \frac{(n+1) + n(n+1)\beta}{(n+2) + \beta n(n+1)}c\right) \end{aligned}$$

Note that, for $\beta = 0$, we have

$$p(0, n) - p(0, n+1) = \left(\frac{1}{(n+1)(n+2)}\right)(1 - c)$$

In particular, note that if β is large, the duopoly solution will be near Bertrand. So, all the gains of increasing n will be captured in the move from monopoly to duopoly, and subsequent gains must be small. That is, if competition is aggressive, most of the gains from extra competition are captured with the entry of a small number of firms.

4 Implications for regulation

Formal analysis of competition regulation in the case of oligopoly with homogeneous products has focused, to a large extent, on the case of Cournot-Nash equilibrium. In this framework, the entry of new competitors always improves welfare, with the extent of the welfare improvement depending solely on the elasticity of market demand.

When the intensity of competition is taken into account,however, the results of a Cournot-Nash analysis may be called into question. On the one hand, we might expect that an increase in the number of competitors n will be associated with an increase in the intensity of competition β. The idea here is that Cournot oligopoly involves an element of implicit collusion, where it is assumed that competitors will not respond to a higher market price by increasing their own output. The greater the number of firms, the more difficult it will be to sustain implicit collusion.

On the other hand, regulatory measures designed to increase the number of competitors may, in some circumstances, reduce the intensity of competition. Most obviously, restrictions on predatory competition, designed to drive competitors out of business, may also restrict price competition, or facilitate implicit collusion, between incumbent firms.

Thus, in oligopoly settings, the intensity of competition is at least as important as the number of competitors. In many cases, these two market characteristics will be substitutes in policy terms. Either a large n or a large β will be sufficient to ensure near-competitive outcomes. In other cases, however, increases in the number of competitors and in the intensity of competition may reinforce each other.

5 Concluding comments

The central theme of this note is that, in analysing oligopoly problems, it is important to consider the strategy space available to firms. The standard Cournot and Bertrand equilibrium concepts represent polar cases, which provide some insights, but do not allow consideration of the interaction between the parameters of the strategy space and other variables such as the number of firms in the industry.

This is an instance of a more general problem in the application of game theory to economics (Menezes and Quiggin 2007, 2010). While extensive attention has been paid to equilibrium concepts and their refinement, the specification of the strategy space has commonly been treated in a casual fashion. The problems with an arbitrary specification of the strategy space are particularly severe in the context of policy applications. Not only may the equilibrium outcome be mis-specified, but policy interventions may affect the strategy space available to firms. If this aspect of policy is neglected, misleading conclusions may be drawn.

By considering a range of possible strategy spaces, this paper highlights the biases that strategy space selection can lead to in terms of the potential trade-off between the number of competitors and the intensity of competition.

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