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Free entry and welfare with price discrimination

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Abstract

We show that if firms in an industry engage in third-degree price discrimination, the number of firms in the free-entry equilibrium may be inefficiently low. This result is obtained even with set up costs and a price above marginal cost. We discuss the relevant implications that our result has for policy design.

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1 Introduction

The notion that free entry was desirable from a social point of view had long been widespread among economists. However, contributions such as von Weizsaker (1980), Mankiw and Whinston (1986) and Suzumura and Kiyono (1987) questioned this belief, and it is now widely acknowledged that in a market with set up costs, free entry plus price over marginal cost implies excessive entry whenever there is business-stealing, see Mankiw and Whinston (1986). This is because entry is more desirable to the entrant than it is to society, because part of the entrant's revenues is business stolen from incumbent competitors.

Mankiw and Whinston's result is strongest when applied to oligopolies with homogeneous products, and it provides a clear, simple rule to evaluate the effect of entry on welfare. There is an important policy implication that emanates from this result, namely that regulating entry may bring about welfare gains. Some recent contributions, such as Ghosh and Morita (2007a, b) have revisited the issue of social desirability of free entry in a successive vertical oligopoly and in a bilateral oligopoly setting. They find that, contrary to Mankiw and Whinston's initial result, free entry might lead to a socially insufficient number of firms. These contributions highlight the fact that policy design might have to take into account important factors omitted so as to evaluate the social desirability of a policy that limits entry in an industry.

We contribute to this debate by introducing the possibility of competitors engaging in third-degree price discrimination. By combining price discrimination with imperfect competition, we also contribute to the literature on the consequences of price discrimination on competition, reviewed in Stole (2007). We show that if firms in an industry sell to consumers that belong to different segments with different demand elasticities, and firms have the ability to price discriminate, free entry might lead to an insufficient number of firms. Indeed, entry may be insufficient even if in at least one market the price is above marginal cost and there is aggregate business stealing, defined as a reduction in total output per firm.

A necessary condition for free entry to lead to an insufficient number of firms is that there is market expansion in at least one segment with a positive markup. Market expansion in a particular segment may occur since firms react to entry by rearranging the prices that they charge in each submarket: if the price reduction is high enough in a high-margin segment, individual output in this particular segment may increase after entry. We show that the positive impact on welfare of this market expansion may more than offset the negative impact of business stealing in the other segment, even if total output per firm decreases. For instance, consider the restaurant industry, and assume that there are two groups of consumers, which constitute the two demand segments: those that eat à la carte, with low elasticity of demand, and those that choose a fixed-price menu, with high elasticity of demand. For any arbitrary number of firms in the industry, it is reasonable to expect the equilibrium margin to be higher in the former segment than in the latter. Now, following entry, it may be the case that restaurants choose to reduce the margin in the à la carte segment enough to increase the number of à la carte customers in each restaurant, even though the total number of customers per restaurant decreases. Our theoretical result points out that, if this is the case, free entry in this industry may be inefficiently low, provided that the margin in the à la carte segment is high enough.

In addition to presenting our main result in Proposition 1, we discuss two examples using specific demand functions, each emphasizing a particular aspect of our contribution. Our analysis does not invalidate Mankiw and Whinston's result, since it remains valid considering markets in isolation. However, if we consider the industry as a whole and firms are allowed to price-discriminate, it could be the case that business stealing and positive margins are consistent with inefficiently low entry. Thus, a policy that restricts entry that is based exclusively on Mankiw and Whinston's analysis could have detrimental effects on welfare. Hence, the whole purpose of this exercise is to stress the fact that, under non-standard conditions, some welfare calculations may be incorrect and policy design must take into account the specific setting that it is dealing with.

Section 2 presents the model and the fundamental proposition. Section 3 discusses the linear demand examples, and Section 4 presents some conclusions.

2 The model

Assume that consumers may be classified into two groups, giving rise to inverse demand functions $p_1 = P_1(Q_1)$ and $p_2 = P_2(Q_2)$, with $P_i' < 0$, $i = 1, 2$, and where Q_1 and Q_2 are total output levels in segments one and two, respectively. There is an industry with n identical firms. Let q_1^j, q_2^j be firm j's output levels in markets 1 and 2. All firms have the same cost function

$$C\left(q_1^j + q_2^j\right) = F + c\left(q_1^j + q_2^j\right),$$

with $c(0) = 0$, c', $c'' \geq 0$. Since all firms have the same production cost, the equilibrium will be symmetric, with all firms producing q_1 in the first market and q_2 in the second market, and $Q_1 = n \cdot q_1$ and $Q_2 = n \cdot q_2$.

We define total welfare as gross consumer surplus generated minus total production costs. Hence,

$$W(n) = \int_0^{n \cdot q_1} P_1(s)ds + \int_0^{n \cdot q_2} P_2(t)dt - n \cdot (F + c(q_1 + q_2)).$$

Computing the derivative with respect to n, we obtain

$$W'(n) = p_1 \cdot \left(q_1 + n\frac{\partial q_1}{\partial n}\right) + p_2 \cdot \left(q_2 + n\frac{\partial q_2}{\partial n}\right) - c(q_1 + q_2) - nc'(q_1 + q_2)\left(\frac{\partial q_1}{\partial n} + \frac{\partial q_2}{\partial n}\right) - F.$$

Now, defining individual profits as

$$\pi(n) = p_1 q_1 + p_2 q_2 - c(q_1 + q_2) - F$$

rearranging terms,

$$W'(n) = \pi(n) + n\frac{\partial q_1}{\partial n}(p_1 - c'(q_1 + q_2)) + n\frac{\partial q_2}{\partial n}(p_2 - c'(q_1 + q_2)). \tag{1}$$

Define business stealing as

$$\frac{\partial (q_1 + q_2)}{\partial n} < 0$$

Notice that our definition of business stealing considers the combination of both markets. Indeed, it could be the case that there is business stealing in one of the markets, but not in the other market. Further assume that there is free entry in the industry, i.e. $\pi(n) = 0$. If this is the case, Proposition 1 presents the basic result of this note:

Proposition 1. *The free-entry equilibrium may lead to an insufficiently low number of firms, even in the presence of business stealing if*

$$\frac{\partial q_1}{\partial n} > 0 \text{ and } \left|\frac{\partial q_1}{\partial n}(p_1 - c')\right| > \left|\frac{\partial q_2}{\partial n}(p_2 - c')\right|.$$

Proof. It is clear from equation (1) that with free entry, which makes the first term be zero, we obtain

$$W'(n) = n\left(\frac{\partial q_1}{\partial n}(p_1 - c') + \frac{\partial q_2}{\partial n}(p_2 - c')\right).$$

If output per firm increases in the first market, then it has to decrease in the second market. Since prices can not be below marginal cost, then $W'(n) > 0$ as long as $\left|\frac{\partial q_1}{\partial n}(p_1 - c')\right| > \left|\frac{\partial q_2}{\partial n}(p_2 - c')\right|$. Therefore, entry will be insufficient if the assumptions made in this proposition are satisfied. □

Our result applies to combinations of markets with different enough demand elasticities. An extreme situation is the case when the second market is perfectly competitive. Notice that when this is the case, equation (1) reads

$$W'(n) = n\frac{\partial q_1}{\partial n}\left(p_1 - c'\left(q_1 + q_2\right)\right). \tag{2}$$

whose sign depends on whether individual output increases or decreases with the number of firms, given that firms price above marginal cost. Therefore, if the first market is not perfectly competitive, entry will be insufficient as long as individual output levels increase with the number of active firms. In order for this to happen, we need an increasing marginal cost and the ability to price discriminate. Next section presents an example using linear demand functions, where there exist parameter values for which individual output levels in the non-competitive market increase with the number of firms in the industry. This makes the number of active firms in the free-entry equilibrium inefficiently low.

3 Examples

This section discusses two examples that illustrate our basic result. First, we consider the existence of a competitive segment, and second, we propose a semi-collusive arrangement that shows that, with market expansion, free entry may lead to insufficient entry, even if marginal costs are zero.

3.1 Example 1

Assume first two market segments with inverse demand functions

$$p_1 = a - Q_1 \text{ and } p_2 = a - \frac{Q_2}{r}.$$

In the first market segment, firms compete à la Cournot, whereas in the second segment, we assume for simplicity that firms are price takers. Firms' costs are given by $c(q_1 + q_2) = F + c \cdot (q_1 + q_2)^2$. Firms maximize profits, which are defined as:

$$\pi = (a - Q_1)q_1 + p_2 q_2 - \left(F + c \cdot (q_1 + q_2)^2\right).$$

where q_1 and q_2 denote individual output levels in the first and the second market segments, respectively. Computing the derivative with respect to q_1 and q_2, we find that:

$$\frac{\partial \pi}{\partial q_1} = a - Q_1 - q_1 - 2c \cdot (q_1 + q_2) = 0; \qquad \frac{\partial \pi}{\partial q_2} = p_2 - 2c \cdot (q_1 + q_2) = 0.$$

Assume that, with free entry, there are n firms in the industry. Of course, the value of n is a function of F: the greater F, the smaller the number of entering firms. In that case, the price in the perfectly competitive segment is:

$$p_2 = a - \frac{n q_2}{r}.$$

This way, we solve for q_1 and q_2 to obtain:

$$q_1 = \frac{an}{n(c(2r+2)+1) + 2cr + n^2}, \qquad q_2 = \frac{ar(1+n)}{n(c(2r+2)+1) + 2cr + n^2}.$$

Deriving individual firm output $q_1 + q_2$ with respect to n, we see that the derivative is always negative, that is, there is always business stealing. Specifically,

$$\frac{\partial (q_1 + q_2)}{\partial n} = -\frac{a\,(n^2 r + 2\,n\,r + r + n^2)}{(2\,c\,n\,r + 2\,c\,r + n^2 + 2\,c\,n + n)^2} < 0$$

However, computing the derivative of q_1 with respect to n yields the following expression:

$$\frac{\partial q_1}{\partial n} = \frac{a\,(2\,c\,r - n^2)}{(2\,c\,n\,r + 2\,c\,r + n^2 + 2\,c\,n + n)^2}$$

When F, r, or c are large enough to allow for a free-entry equilibrium number of firms n such that $n < \sqrt{2rc}$, we have that

$$\frac{\partial q_1}{\partial n} > 0 \text{ and } p_2 - c' = 0$$

(recall that the second market is competitive). Applying the result in Proposition 1, there is insufficient entry. For example, when $a = r = 10$, $c = 1$ and $F = 0.2$, it may be easily seen that the free-entry equilibrium involves two active firms. However, when $n = 2$, we find that $\frac{\partial q_1}{\partial n} \approx 0.0198 > 0$ and the firm prices above marginal cost in the non-competitive market. Specifically, the price in the non-competitive segment is 0.9429, whereas marginal cost is 0.9143, which is of course equal to the price in the competitive segment. Applying Proposition 1 and ignoring the integer constraint, welfare would increase by increasing the number of firms relative to the free entry equilibrium, which involves two active firms.

3.2 Example 2

In our second example, consider firms having access to technology that allows them to produce at zero marginal cost. Let fixed costs be F, identical for all firms. Assume that market demand may be split into two segments. Demand in the first segment is $p = a - Q$, and assume any arbitrary functional form for the demand function in the second segment. Recall that Mankiw and Whinston (1986) did not introduce any assumption regarding whether or not the oligopoly is cooperative. We assume that firms agree to produce an individual output given by

$$q_i = 1 + \frac{1}{n}$$

and output sold by each firm in the first and second segments are, respectively,

$$q_{i1} = 1 - \frac{r}{n}, \quad q_{i2} = \frac{r+1}{n}$$

Firms give away their production in the second segment, thus charging a zero price. Notice that entry implies business stealing, specifically in the second segment. In this example, entry leads to market expansion in the first segment, whereas total output, and thus welfare in the second segment, is independent of the number of firms in the industry. For instance, if the demand function in the first segment is $p = 9 - Q$, $r = 0.7$, and the fixed entry cost is $F = 5$, individual profits and welfare (excluding the second market) are

$$\pi(n) = (9 - (n - 0.7)) \cdot \left(1 - \frac{0.7}{n}\right) - 5 \text{ and } W(n) = 9 \cdot (n - 0.7) - \frac{(n - 0.7)^2}{2} - 5n$$

Therefore, since $\pi(3) = \frac{41}{300}$ and $\pi(4) = -\frac{119}{400}$, then there will be three firms operating in the free-entry equilibrium, whereas the optimal number of firms is five, with $W(5) = \frac{891}{200}$.

4 Conclusions

This note contributes to the literature that analyzes the social desirability of entry and is intended to qualify the strong policy recommendation emanating from the analysis in Mankiw and Whinston (1986). In particular, we show that, if firms are able to price discriminate, business stealing and a positive margin may be consistent with insufficient entry. In order for this to happen, it is necessary to have some market expansion in at least one of the demand groups as new firms enter. This result could aid in the design and evaluation of policies that limits entry in a given industry.

5 References

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