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Social efficiency of entry in a vertically related industry[†]

Debasmita Basak

Swansea University, UK

and

Arijit Mukherjee

Nottingham University Business School and CFGE, Loughborough University, UK,
CESifo and INFER, Germany, and RCIE, City University of Hong Kong, Hong Kong

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Abstract: We provide a new perspective to the literature on social desirability of entry by showing that, if the input supplier has market power, social desirability of entry of the final goods producers depends on returns to scale. Entry in the final goods market can be socially insufficient under constant returns to scale technology, but it can be socially excessive under decreasing returns to scale technologies if the cost of entry is low so that the final goods market is sufficiently competitive. Hence, the anti-competitive entry regulation policies are more justifiable if the final goods market is characterised by decreasing returns to scale technologies.

Key Words: Excess entry; Insufficient entry; Decreasing returns to scale

JEL Classifications: L13; L40

Correspondence to: Debasmita Basak,
Section of Accounting, Finance & Economics,
School of Management, Swansea University,
Fabian Way, Swansea SA1 8EN, UK.
Email: d.basak@swansea.ac.uk

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1. Introduction

In a seminal paper, Mankiw and Whinston (1986) show that entry is socially excessive in oligopolistic industries with scale economies and this holds irrespective of the type of technology, such as constant returns or non-constant returns. This “excess-entry theorem”, which may justify the anticompetitive entry regulation policies adopted by many countries,¹ ignored an important aspect, viz., the market power of the input suppliers creating strategic input price determination.² However, in real world, the presence of labour unions or certain key input suppliers, such as the computer chip producer like Intel, may justify market power of the input suppliers in many industries. We show that if the input suppliers have market power, social efficiency of entry of the final goods producers depends on their technologies.

Considering a competitive input market, Mankiw and Whinston (1986) show that entry is socially excessive. Ghosh and Morita (2007a, b) argue that if the input suppliers have market power, the result of Mankiw and Whinston (1986) may not hold and entry can be socially insufficient. We contribute in this literature by showing that if the input supplier has market power, social desirability of entry depends on returns to scale. Entry is socially insufficient under constant returns but it is socially excessive under decreasing returns³ if the cost of entry is sufficiently low. Hence, the policy implication of Mankiw and Whinston (1986) remains in the presence of significant market power of the input suppliers if there are decreasing returns in the final goods production and the cost of entry is sufficiently low.

2. The model and the results

Consider an industry with a large number of symmetric final goods producers, each of whom decides whether or not to enter the market. Entry requires each final goods producer to incur an entry cost $K > 0$. Assume that there exists an input supplier that

¹ Preventing excessive entry was a guiding principle in the Japanese industrial policy in the postwar period (Suzumura and Kiyono, 1987 and Suzumura, 1995).

² One may look at Suzumura and Kiyono (1987), Anderson et al. (1995), Fudenberg and Tirole (2000), Cabral (2004), Ghosh and Saha (2007), Mukherjee (2012), for a representative sample of the papers on social efficiency of entry with competitive input markets.

³ The implications of decreasing returns to scale technologies, which can be motivated by capacity constraints or scarcity of resources, have been discussed extensively in different contexts (Tirole, 1988). Banker et al. (1994) show that decreasing returns may prevail in the software industry. Saal et al. (2007) found constant or decreasing returns in the UK industries. The typical two-digit industries in the US (Basu and Fernald, 1997), three-digit manufacturing industries in Singapore (Kee, 2002), Broadacre industries in Australia (Townsend et al., 1998) appear to have (slightly) decreasing returns to scale.

supplies inputs to all the final goods producers. To illustrate our result in a simple fashion we assume that input supplier unilaterally sets the input price.

Consider the following game. At stage 1, the final goods producers decide whether or not to enter the market. At stage 2, the input supplier determines the input price. At stage 3, the final goods producers, which entered the market, produce outputs simultaneously by purchasing inputs according to their requirements and the profits are realised. We solve the game through backward induction.

For simplicity we assume that the final goods producers have symmetric production technologies and they can transform the inputs to a homogeneous final good at zero cost. We consider the case of constant returns to scale technology in Section 2.1 and the case of decreasing returns to scale technology in Section 2.2.

Assume that the inverse market demand function is $P = a - Q$, where P is price and Q is the total output.

2.1. Constant returns to scale technology

Assume that the production technology of the j th firm, $j = 1, 2, \dots, \infty$, is $L_j = q_j$, where L_j is the amount of input and q_j is the output.

If n final goods producers enter the market, the i th final goods producer maximises the following expression to determine its output:

$$\text{Max } \pi_i^{CRS} = (P - w)q_i - K. \quad (1)$$

The equilibrium output of the i th firm is

$$q_i^{CRS} = \frac{a-w}{1+n}. \quad (2)$$

The input supplier maximises the following expression to determine the input price:

$$\text{Max}_w U^{CRS} = (w - c) \sum_{i=1}^n q_i \quad (3)$$

where c represents the marginal cost of input production. The equilibrium input price is $w^{CRS} = \frac{a+c}{2}$.

The equilibrium net profit of the i th final goods producer, $i=1, 2, \dots, n$, which has entered the market is

$$\pi_i^{CRS} = \frac{1}{4} \left(\frac{a-c}{1+n} \right)^2 - K. \quad (4)$$

For analytical convenience, we consider the number of firms as a continuous variable. Hence, entry in the market occurs as long as the net profit of a final goods producer is

non-negative. Given the symmetry of the firms, the free entry equilibrium number of final goods producers is given by $\pi_i^{CRS} = 0$ or

$$\frac{1}{4} \left(\frac{a-c}{1+n} \right)^2 = K. \quad (5)$$

It follows from (5) that, if the cost of entry (i.e., K) falls, the free entry equilibrium number of final goods producers, n , increases.

Now we determine the welfare maximising number of final goods producers, where welfare is the sum of the total net profits of the final goods producers ($\sum \pi_i^{CRS}$), the profit of the input supplier (U^{CRS}) and consumer surplus (CS^{CRS}). Following the literature, we consider the second-best problem of welfare maximisation, i.e., we determine the welfare maximising number of final goods producers subject to Cournot behaviour of the firms. Hence, the social planner can control the number of final goods producers entering the market, but it cannot control the output choice behaviour of the final goods producers.

If n final goods producers produce the final good, it follows from (4) that the total net profit of the n firms is

$$\sum \pi_i^{CRS} = \frac{n}{4} \left(\frac{a-c}{1+n} \right)^2 - nK. \quad (6)$$

The profit of the input supplier is

$$U^{CRS} = \frac{n(a-c)^2}{4(1+n)}. \quad (7)$$

Since the total final goods production is $Q^{CRS} = n \left(\frac{a-c}{1+n} \right)$, the consumer surplus is

$$CS^{CRS} = \frac{Q^2}{2} = \frac{n^2}{8} \left(\frac{a-c}{1+n} \right)^2. \quad (8)$$

The social planner chooses n to maximise social welfare (which is the sum of (6), (7) and (8)):

$$\text{Max}_n SW^{CRS} = \text{Max}_n \frac{n(a-c)^2(4+3n)}{8(1+n)^2} - nK \quad (9)$$

The welfare maximising n is given by

$$\frac{\partial(SW^{CRS})}{\partial n} \equiv \frac{(a-c)^2(2+n)}{4(1+n)^3} - K = 0 \quad (10)$$

It follows from (10) that as the cost of entry (i.e., K) falls, the welfare maximising number of final goods producers increases.

Proposition 1 *If the final goods production technology exhibits constant returns to scale, entry in the final goods market is insufficient.*

Proof: Evaluating $\frac{\partial(SW^{CRS})}{\partial n}$ at the free entry equilibrium number of final goods

producers, i.e., substituting $\frac{1}{4}\left(\frac{a-c}{1+n}\right)^2$ for K into (10), we get that $\frac{\partial(SW^{CRS})}{\partial n} > 0$ since

$$\frac{(a-c)^2(2+n)}{4(1+n)^3} - \frac{1}{4}\left(\frac{a-c}{1+n}\right)^2 = \frac{(a-c)^2}{4(1+n)^3} > 0, \text{ which proves the result. } \blacksquare$$

Entry creates two effects. First, as in Mankiw and Whinston (1986), it creates a “*business-stealing effect*” by lowering the outputs of the incumbent final goods producers. On the other hand, as observed by Ghosh and Morita (2007a, b), entry creates a “*business-creation effect*” in the input sector by raising the total input demand. We find that the latter effect dominates the former effect for social welfare and makes entry less attractive than the socially optimum level. This result affirms the finding of Ghosh and Morita (2007a, b), suggesting that entry is insufficient in a vertically related industry with constant returns to scale technologies.

2.2. Production with decreasing return to scale technology

We now consider the case of decreasing returns to scale technologies for the final goods production. Assume that the technology of the j th final goods producer, $j=1,2,\dots,\infty$, is $\sqrt{L_j} = q_j$ or $L_j = q_j^2$, implying that q_j^2 inputs are required to produce q_j units of the output.

If n final goods producers enter the market, the i th final goods producer, $i=1,2,\dots,n$, maximises

$$\text{Max } \pi_i^{DRS} = (a - Q)q_i - wq_i^2 - K. \quad (12)$$

The equilibrium output of the i th final goods producer is

$$q_i^{DRS} = \frac{a(1+2w)^{-1}}{1+n(1+2w)^{-1}}. \quad (13)$$

The input supplier maximises the following expression to determine w :

$$\text{Max}_w U^{DRS} = (w - c) \sum_{i=1}^n q_i^2. \quad (14)$$

The equilibrium input price is $w^{DRS} = \frac{1}{2}(1 + n + 4c)$. Hence, the equilibrium profit of the input supplier is $U^{DRS} = \frac{n}{8}\left(\frac{a^2}{1+n+2c}\right)$, the profit of the i th final goods producer

that entered the market is $\pi_i^{DRS} = \frac{a^2(3+n+4c)}{8(1+n+2c)^2} - K$ and the consumer surplus is $CS^{DRS} = \frac{Q^2}{2} = \frac{1}{8} \left(\frac{na}{1+n+2c} \right)^2$.

The free entry equilibrium number of final goods producer is given by $\pi_i^{DRS} = 0$ or

$$\frac{a^2(3+n+4c)}{8(1+n+2c)^2} = K. \quad (15)$$

It follows from (15) that a lower K increases the free equilibrium number of final goods producers.

Now determine the welfare maximising number of firms, which is determined by maximising the following expression:

$$\text{Max}_n SW^{DRS} = \text{Max}_n \frac{a^2 n(4+3n+6c)}{8(1+n+2c)^2} - nK. \quad (16)$$

The welfare maximising number of firms is given by

$$\frac{\partial(SW^{DRS})}{\partial n} \equiv \frac{a^2(2+n+3cn+7c+6c^2)}{4(1+n+2c)^3} - K = 0 \quad (17)$$

It follows from (17) that a lower K increases the welfare maximising number of final goods producers.

Proposition 2: *If the production technology exhibits decreasing return to scale, entry in the final goods market is excessive (insufficient) if the cost of entry is sufficiently low (high) so that the free entry equilibrium number of firms $n > (<) \sqrt{2(1+2c+2c^2)} - 1 \equiv n^*$.*

Proof: We get that $\frac{\partial^2(SW^{DRS})}{\partial n^2} = -\frac{a^2(5+2n+6cn+16c+12c^2)}{4(1+n+2c)^4} < 0$ and evaluating

$\frac{\partial(SW^{DRS})}{\partial n}$ at the free entry equilibrium number of final goods producers, i.e.,

substituting $\frac{a^2(3+n+4c)}{8(1+n+2c)^2}$ for K into (17), we get that $\frac{\partial(SW^{DRS})}{\partial n} < (>) 0$ for

$\frac{a^2(2+7c+6c^2+n+3cn)}{4(1+n+2c)^3} < (>) \frac{a^2(3+n+4c)}{8(1+n+2c)^2}$ or $n > (<) n^* \equiv \sqrt{2(1+2c+2c^2)} - 1$, implying

that entry is excessive (insufficient) for $n > (<) n^* \equiv \sqrt{2(1+2c+2c^2)} - 1$. Since the free entry equilibrium number of firms is negatively related to the cost of entry, excessive (insufficient) entry occurs, i.e., $n > (<) n^*$, for sufficiently low (high) cost of entry. ■

The intuitions for Proposition 2 also follows from the trade-off between the “*business-stealing effect*” and “*business-creation effect*” as discussed in Proposition 1 with an exception that, under decreasing returns to scale technology, the input price increases with the number of final goods producers, thus strengthening the business-stealing effect. If the cost of entry is low so that the final goods market is sufficiently competitive, i.e., $n > n^*$, a new entrant creates significant business-stealing effect by reducing the profits of a large number of incumbent final goods producers, thus creating excessive entry. However, if the cost of entry is high, the business-stealing effect is not so strong to outweigh the business-creation effect and entry is insufficient in this situation.

3. Conclusion

We show that the production technology plays an important role in determining social efficiency of entry of the final goods producers if the input supplier has market power. Entry in the final goods market can be socially insufficient under constant returns to scale technology but it can be socially excessive if the cost of entry is low. Hence, the anti-competitive entry regulation policies are more justifiable in a vertically related industry if the final goods market is characterised by decreasing returns to scale technologies.

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