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Cournot Competition and Corruption of an Entire Industry

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Abstract

This paper shows that sufficient competition does not necessarily promote corruption of an entire industry. In particular, when the costs of anti-pollution measures are decreased, exit from the market did not occur at all even though producers attempting to maximize sales are given a mission to undertake anti-pollution measures at their own expense.

Keywords: Market structure, Corruption, Cournot equilibrium, Sales maximization, Anti-pollution measures.

JEL Classification: D73, L13, O1

1 Introduction

Many households in rural areas of developing countries that have limited employment opportunities earn their livings from mining and refining of gold. According to the estimation of Veiga and Baker (2004) in UNIDO Global Mercury Project (2002 2007), during that time, 1016 million workers were engaged in mining and refining of gold worldwide. Of these, 3045

This study considers two types of producers obliged to consider human health and the environment: parties that engage in the bribery of officials and the like and those who continue producing without considering the Minamata Convention, and parties that produce while instituting anti-pollution measures. Here, we examine the question of whether sufficient competition within industries results in corruption affecting entire industries comprising these two types of producers.

While Rose-Ackerman (1975) and Ades and Di Tella (1999) are well known as contributors to literature concerning the relationship between market structure and corruption, results directly related to the problem addressed in this study are contained in Basu et al. (2013). Their results demonstrate that sufficient Cournot competition corrupts entire industries. In contrast, this study indicates the complete opposite results when anti-pollution measures are dependent on the number of producers.

This study is organized as follows. The next section presents the model. Section 3 derives the Cournot equilibrium. Finally, Section 4 discusses the conclusions and their implications.

2 Model

With $N \geq 2$ producers producing homogenous goods, the production quantity of the i-th producer is represented as q_i, where$i = 1, \cdots, N$ The inverse demand function is defined as follows:

$$p = a - b \sum_{i=1}^{n} q_i \tag{1}$$

where p represents the price of the product and a and b are each positive constants.

This study focuses on the behavior of producers given two types of missions: sales maximization and anti-pollution measures. If a in Equation (1) is sufficiently large (or the fixed and assumed marginal costs are sufficiently small), the gist of the conclusions remain unchanged even after assuming profit maximization, as demonstrated by Basu et al. (2013). Hence, the objective function of producer i is defined as follows:

$$S_i = pq_i - \theta_i m(n) \tag{2}$$

where $m > 0$ represents the cost of anti-pollution measures. θ_i represents the attributes of producer$i$ and, if the cost burden can be avoided by a bribe (assuming corruption; for purposes of simplification, a value of 0 is assigned) that is less than the cost of pollution measures, $\theta_i = 0$, whereas $\theta_i = 1$ assuming no corruption.

3 Competiton and Corruption

Based on the above settings, Cournot competition between n producers is considered. Using Equations (1) and (2) in the previous section to find equilibrium production output q_i for producer i results in the following:

$$q_i^* = \frac{a - b\sum_{j\neq i} q_j^*}{2b} \, (i, j = 1, \cdots, n) \tag{3}$$

When this is aggregated for all i, we obtain the following results:

$$\sum_{i=1}^{n} q_i^* = \frac{na}{(n+1)\, b} \tag{4}$$

To obtain equilibrium price p^*, substituting this into Equation (1) results in the following:

$$p^* = a - \frac{na}{n+1} \tag{5}$$

By substituting q_i and p^* into Equation (2), the condition of producer i in the Cournot equilibrium is determined as follows:

$$S_i^* = \frac{a}{n+1}\left(\frac{a - b\sum_{j\neq i} q_j^*}{2b}\right) - \theta_i m\,(n) \tag{6}$$

Because this is a function of n, when R_i^* is placed as the first item on the right-hand side of Equation (6), the result is as follows:

$$R_i^* = \frac{a\left(a - b\sum_{j\neq i} q_j^*\right)}{6b} > 0 \tag{7}$$

When $n \to \infty$, the result is as follows:

$$\lim_{n\to\infty} a - \frac{na}{n+1} = \lim_{n\to\infty} a - \frac{a}{1+\frac{1}{n}} = a - a = 0 \tag{8}$$

Hence, if the cost of anti-pollution measures is a constant positive smaller than R_i^*, there exists $\bar{n}$ producers where $S_i^* = 0$ or $R_i^* = m$ (namely, $\bar{n} = \frac{aq_i^*}{m} - 1$). If $n < \bar{n}$, then producers not involved in corruption are able to commit to anti-pollution policies (See Figure 1).

On the other hand, when $m \geq R_i^*$, anti-pollution measures are not implemented when $n \geq \bar{n}$, regardless of the attributes of the producer. Regarding the latter, when $n \to \infty$, $p^* = 0$, which results in $S_i^*(\infty) = -\theta_i m$, and the entire industry becomes corrupt according to the Cournot limit theorem. The conclusion is summarized as follows.

Proposition 1. When the costs of anti-pollution measures are fixed, sufficient competition promotes corruption of the entire industry.

Clearly, the gist of the conclusion remains unchanged even when m is a non-decreasing function of the number of producers. If it is an increasing function, then the result is fewer number of producers committing to anti-pollution measures compared with when it is a constant function.

(Figure 1: The case of fixed cost)

However, if m is a decreasing function of the number of producers, in contrast, a possibility exists that all producers may commit to anti-pollution measures. Figure 2 is one example of this.

(Figure 2: The case of variable cost)

When the costs of anti-pollution measures are fixed and while the number of producers is $S_i^* > 0$, when the cost of anti-pollution measures depends on the number of producers, the result may be $S_i^* > 0$ for all producers. Hence, the following conclusion is reached.

Proposition 2 When the cost of anti-pollution measures is a decreasing function, sufficient competition does not necessarily promote corruption of the entire industry.

4 Conclusion

Because recycled metal products constitute approximately 30% of the market,the problem of using mercury in gold mining and refining needs to be solved quickly.

The major implications of this study are twofold. First, even though managers of companies that commercialize gold production in the mining and refining sectors are given the dual missions of maximizing sales and implementing anti-pollution measures amidst sufficient competition, it does not necessarily encourage corruption of the entire industry. Second, the decreasing cost of utilizing mercury-free refining technologies in refining gold, such as utilizing receptacles that confine mercury vapors, serve to prevent corruption of the entire industry through sufficient competition.

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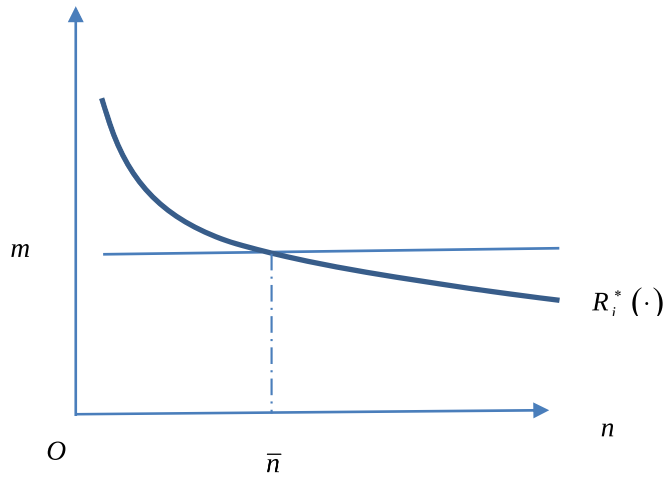

Figure 1. The case of fixed cost

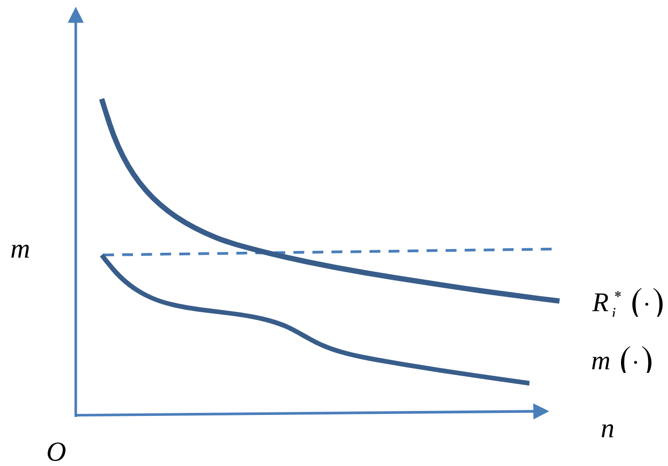

Figure 2. The case of variable cost