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MERGER SIMULATION IN AN OPEN ECONOMY*

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Abstract

Recently, competition authorities use merger simulation tools to predict the effects of a merger on price, consumer welfare and social welfare. However, since standard merger simulation tools are developed to predict those effects in a closed economy, they do not consider the role of exports in evaluating merger effects. In an open economy or export-oriented economy, a typical manufacturing industry exhibits quite high shares of export volumes. The welfare effects of merger could be quite different between an open economy and a closed economy. In an open economy, we need to consider exports in evaluating merger effects, and this article provides a framework on how to incorporate the role of exports in a standard Cournot merger simulation model.

Keywords: merger simulation, open economy, merger evaluation
JEL Classification Codes: D4, D8, M3, L13

I. *Introduction*

Antitrust laws prohibit mergers that would substantially lessen competition. Evaluating

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whether a proposed merger has negative effects on consumer and social welfare, antitrust authorities balance between pro-competitive effects such as efficiency gains and anti-competitive effects such as an increase in market power.

Traditionally, we evaluate mergers based on market-shares approaches. These approaches define relevant markets, calculate market shares, and find by how much market concentration index such as Herfindahl Index (also known as Herfindahl-Hirschman Index or HHI) increase from a proposed merger.[1] If the change in the concentration index due to a proposed merger is larger than some specific thresholds, it is most likely that the antitrust agency blocks the proposed merger. For instance, Antitrust authorities in US consider a market to be highly concentrated if the HHI in the market is above 2500. In highly concentrated markets, if a proposed merger increases the HHI by more than 200, it will be presumed to be likely to lessen market competition. (US. DOJ and FTC, Horizontal Merger Guidelines, 2010.)

In a closed economy, there are no export and import between different countries. However, in an open economy, the effects of a merger on social welfare might depend on the volumes of imports and exports. Antitrust agencies consider import volumes as one of the suppliers because import volumes can be good substitutes for domestic outputs. However, we do not count the export volumes when we calculate domestic market shares. The role of export is not clear in market-share-based approaches.[2]

Besides merger evaluation approaches based on market shares, there are several tools to evaluate merger effects. One of the alternative tools is a merger simulation method. These merger simulation methods are tools to 'simulate' mergers and calculate the effects of a merger by comparing pre-merger market outcomes with (simulated) post-merger market outcomes.

For instance, suppose that the demand for a product is $p=1-Q$, and all firms' marginal production costs are zero. Then, by using a Cournot goods competition model, we can calculate pre-merger equilibrium when the number of firms is N. With a merger, the number of firms becomes $N\text{-}1$. We can find post-merger equilibrium. By comparing the pre- and post-merger equilibrium, we predict the effects of a merger on the market price and social welfare.

More advanced merger simulation tools have been developed for differentiated products models, such as Antitrust Logit Model, AIDS (almost ideal demand system) model, PCAIDS (proportional calibrated AIDS), BLP model.[3] Once we have estimates of demand and supply sides parameters, we can predict how a merger affects a market price and social welfare relying on a game theoretic model with the estimates of demand and supply sides parameters.

These standard merger simulation tools are developed to predict the effects of a merger in a closed economy. In a closed economy or a large economy, such as the United States, manufacturing's export shares are not large. However, in a small, open economy or export-

[1] HHI is defined as the sum of the squares of individual firms' market shares. That is, HHI $=\sum s_i^2$.

[2] In order to calculate market shares, we have to define relevant markets. The size of export volume might be related to defining geographical relevant market. One of the 'first-cut' analyses of geographic market delineation is the Elzinga-Hogarty test (1973). By looking at shipment flows between areas X and Y, we can have a 'first-cut' analysis on the relevant geographical markets. However, the Elzinga-Hogarty test has been usually used for domestic geographical market delineation for hospitals and bank industry. Even though the test is useful, it is difficult to apply the test to international geographical market delineation because firms can easily implement price discrimination between domestic and export markets.

[3] For a brief summary of merger simulation methods, see Epstein and Rubinfeld (2004) and Nevo (2000) among others.

oriented economy, a typical manufacturing industry exhibits quite high shares of export. Usually, more than 40% of industry outputs are exported abroad in Korea. The welfare effects of a merger could be quite different among industries with different export volumes.

In this article we modify a Cournot merger simulation model in order to incorporate roles of exports. In our model, there are N firms in an open economy. Firms in a small economy are engaged in Cournot competition in the domestic market, while they face a very elastic demand in foreign markets. For simplicity, we assume that firms face a horizontal foreign export price, while it faces a downward demand curve in a domestic market. Firms do price discrimination between domestic and foreign markets and choose their output levels for domestic and export markets, respectively.

This article consists of two parts. In the first part, we solve a modified Cournot model with export and get Nash equilibrium. Also, we show that as the standard third-degree price discrimination, firms choose their domestic and export output levels such that their marginal revenues in the domestic and in foreign markets are equal. Firms` marginal costs affect their total output levels, but not domestic output levels. When a firm`s marginal cost gets lower, the firm produces more, but the increased outputs are exported, and the domestic output level remains the same. However, when an exogenously given export price level increases, firms would export more in overseas and sell less in a domestic market.

The second part of this article provides a simple merger simulation tool, which analyzes the effects of a merger in a presence of export volumes. Suppose that two firms merge with each other. As a standard Cournot model, in the post merger, the combined firm would restrict its output, and the other firms would expand their outputs. In a standard Cournot model without export, firms increase their outputs along their marginal cost curves. However, in an open economy, if they want, firms can increase their domestic output levels simply by reshuffling their outputs between domestic and export markets. The simple Cournot merger simulation tool takes industry demand elasticity, outputs and price levels in domestic and international markets as inputs. With these inputs, the simulation tool predicts the effects of a proposed merger on a market price and social welfares.

The rest of this article is as follows. Section 2 describes the model. In section 3, by analyzing the model, we get Nash Equilibrium and show how a merger affects social welfare. In section 4, we devise a Cournot merger simulation model, which incorporates the role of exports. We find that the merger effects on price, consumer surplus and social welfare are different between closed and open economy, which indicates that we cannot apply the antitrust tools developed in a closed economy to an open economy without some modifications.

II. *Model*

There are N firms in a small economy, selling a homogeneous product. The firms sell their outputs in two separated markets, domestic and export markets. Each firm engages in Cournot competition in the domestic market, and their domestic output levels are denoted by $q=\{q_1,q_2,\cdots,q_N\}'$. The total domestic quantity is $Q_D=q_1+q_2+..+q_N$. The domestic demand curve is denoted by $p_D(Q)$ and is downward sloped, $p_D'(Q)<0$.

The foreign market is much more competitive than the domestic market. For simplicity, we assume that the foreign market is perfectly elastic at price p_F. Firms can export their outputs at p_F, and the export price is exogenously given.[4] The export output levels by the N firms are denoted by $x=\{x_1,x_2,\cdots,x_N\}'$.

Each firm's production cost function is represented by $c_i=\frac{\alpha_i}{2}(q_i+x_i)^2$, where α_i measures each firm's cost parameters The marginal cost of production is $\alpha_i(q_i+x_i)$. The marginal cost of production depends on the cost parameter α_i and the total output level, the sum of domestic outputs and export outputs q_i+x_i. As α_i gets higher, higher is the marginal cost.

Different firms have different domestic advantages in a domestic distribution channels. Some firms have stronger domestic distribution channels than others. Thus, we introduce θ_i, which measures each firm's domestic distribution cost.

By combining these components above, each firm's profit function can be written as follows,

$$\pi_i=p_D(Q)\ q_i+p_F x_i-\frac{\alpha_i}{2}(q_i+x_i)^2-\theta_i\ q_i \qquad (1),$$

where $p_D(Q)q_i$ and $p_F x_i$ denote the revenues from domestic and export markets, respectively. Each firm maximizes its profit function by choosing q_i and x_i. It is one application of the standard third degree price discrimination between domestic and foreign markets. Also, it is a variation of a standard Cournot model, in which a firm has an option to export some of its outputs at the international price, p_F.

We introduce two variables, α_i and θ_i, to represent firms' heterogeneity, with α_i being a production cost parameter and θ_i measuring domestic distribution cost. The reason is as follows. If we have only one dimension of firms' heterogeneity such as α_i, then firms' domestic market shares have one to one mapping with their export volumes. For instance, if firm A's domestic market share is twice larger than that of firm B, then firm A's export volume must be twice larger than firm B's export volumes. The ratio of a firm's domestic sales over its export sales has to be the same across all firms. However, in real world different firms have different ratios of domestic sales over exports.[5] We would like to provide a merger simulation tool in section 4, which would allow different ratios of domestic sales over exports across different firms. So we introduce two dimension of firms' heterogeneity such as α_i and θ_i.

III. *Analysis of Nash Equilibrium*

In this section, first, we would derive an individual firm's first-order condition and, then, would get Nash equilibrium by combining these first-order conditions.

[4] In order to simplify the analysis, we assume the perfectly elastic export market. Even though we relax the assumption, we still get the same qualitative results as long as the export market is more elastic than the domestic market.

[5] For instance, the international smartphone market share of Samsung is 27.8% and LG is 6.2%. This makes the ratio of the market share between them approximately 4.5 to 1. However, the domestic market share of Samsung is 46% and LG is 14%, and the ratio between them is approximately 3.3 to 1. We can see that LG has relatively higher market share in the Korea domestic market. These differences may occur from disparity in procuring domestic distribution channels.

1. First-order condition

Firms maximize their profits by choosing domestic and export output levels. Equation (1) shows a firm's profit function. The first-order-conditions with respect to q_i and x_i are as follows,

F. O .C:

$$\frac{\partial \pi_i}{\partial q_i}=p_D+\frac{\partial p_D}{\partial q_i}q_i-\alpha_i(q_i+x_i)-\theta_i=0 \text{ for } i=1, 2, 3,.. \text{N} \tag{2}$$

$$\frac{\partial \pi_i}{\partial x_i}=p_F-\alpha_i(q_i+x_i)=0 \quad \text{for } i=1, 2, 3,.. \text{N} \tag{3}$$

Equations (2) and (3) show the firm's first-order conditions with respect to q_i and x_i, respectively. In a standard third-degree price discrimination in which a firm price discriminates between markets 1 and 2, the profit maximization condition is that the marginal revenues from markets 1 and 2 are equal to marginal production cost. The principle holds here.

Let us interpret equations (2) and (3). Equation (2) can be rearranged as follows,

$$p_D+\frac{\partial p_D}{\partial q_i}q_i=\alpha_i(q_i+x_i)+\theta_i \tag{2'}$$

In a domestic market, a firm engages in a Cournot competition. Given the other firms' output level Q_{-I}, each firm facing a residual domestic demand would set its output level such that its marginal revenue from the domestic market is equal to the marginal production cost plus its domestic distribution cost, θ_i. The left-hand side of equation (2') is the marginal revenues from the residual domestic demand, and the right-hand side is the sum of production and domestic distribution costs.

Because of the export market, the firm has an option to export some of its outputs. Since the export price is exogenously set at p_F, the export price becomes marginal revenue from overseas market. The firm would set its total output level such that the export price is equal to the marginal cost. Rearranging equation (3) shows it.

$$p_F=\mathrm{a}_i(x_i+q_i) \tag{3'}$$

The left hand side above equation is the export price, marginal revenue from overseas sales. The right hand side is the marginal cost of production. From equation (3'), we have the following one.

$$x_i^*+q_i=p_F/a \tag{3''}$$

It shows that firm i' output level $(x_i^*+q_i)$ is determined by p_F/a_I, cost parameters and the export price. By combining equations (2) and (3), we have

$$p_D+\frac{\partial p_D}{\partial q_i}q_i-\theta_i=p_F=\alpha_i(q_i+x_i) \tag{4}$$

Since the export price is fixed, the export price becomes the marginal revenue from export. Because there is a domestic distribution cost, $p_D+\frac{\partial p_D}{\partial q_i}q_i-\theta_i$ is the (distribution-cost-adjusted) marginal revenue from domestic sales.

The interpretation of equation (4) is as follows. The total output level is set such that $(x_i^*+q_i)=p_F/a_i$. Given the total output level, firms need to allocate these outputs between domestic and foreign markets. Since the total output level is fixed, in order to have one more unit of domestic sales, firms need to reduce one unit of export. The export price becomes an opportunity cost of domestic sales. Thus, firms set their domestic output level such as the (adjusted) domestic marginal revenue is equal to p_F.

Also, the marginal production cost is $a_i(q_i+x_i)$. Thus, equation (4) states that the adjusted domestic marginal revenue is equal to the marginal revenue from overseas, which is equal to the marginal production cost. From discussion so far, we observe the following ones.

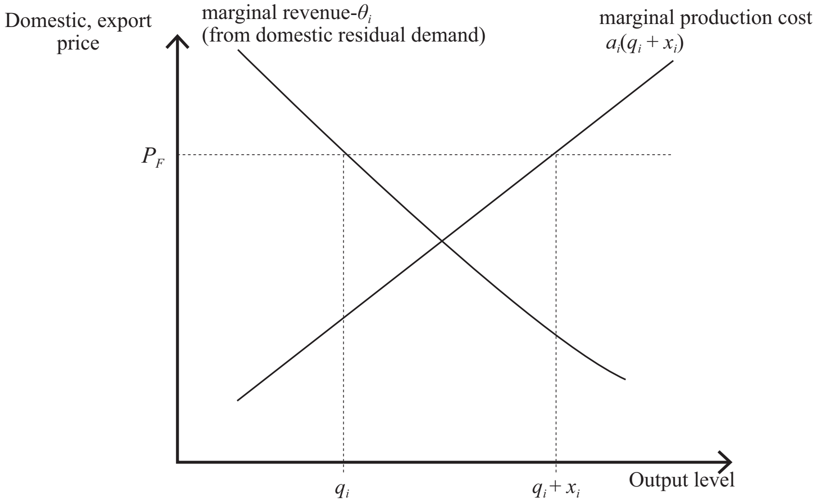
Lemma.

(a) A firm's optimal production level is determined by the cost parameter (a_i) and the export price, i.e., $(x_i^*+q_i)=p_F/a_i$.

(b) Given the output level, a firm allocates the outputs between the domestic and export markets such that the marginal revenues from these two markets are equal.

The following figure summarizes discussions so far and shows how each firm's optimal domestic and export outputs levels are set.

FIGURE 1. EACH FIRM'S OPTIMAL DOMESTIC OUTPUT AND EXPORT LEVEL



In figure 1, the X-axis shows a firm's output levels, while Y-axis shows domestic and export prices. In the diagram, we show a firm's marginal production cost. The diagram includes the adjusted marginal revenue from the domestic market. The profit optimal condition in (equation (3')) states that a firm sets its output level (q_i+x_i) such that the marginal production cost is equal to the export price. Then, given the total output level, a firm sets its domestic output level

q_i such that the (distribution cost adjusted) domestic marginal revenue ($p_D + \frac{\partial p_D}{\partial q_i} q_i - \theta_i$) is equal to p_F.

As figure 1 shows, when the production efficiency gets higher (i.e., a_i gets lower), the total output increases, but the domestic sales remain the same. That is, interestingly, the production cost efficiency affects only export sales, not domestic sales. However, when p_F gets higher, the total output level increases, the domestic output level decreases, and export volume increases. The changes in the export price affect not only a firm's output level, but also output allocations between domestic and export markets.

Corollary.
(1) When the cost parameter (a_i) changes, it affects a firm's output level. When the cost parameter (a_i) gets lower, a firm produces more outputs, and the output would be exported. The changes in the cost parameter (a_i) would not affect output levels in the domestic market.
(2) As the export price changes, it affects both output levels for domestic and export markets. When the export price increases, a firm would sell more in the export market and sell less in the domestic market.

2. Nash Equilibrium

So far, we analyzed an individual firm's first-order condition. From now on, we would combine these first-order conditions and derive a Nash equilibrium. Let us analyze the Nash equilibrium. For simplicity, we assume a linear domestic demand curve, $p = a - bQ$. With a liner demand curve, the first order condition (3) becomes,

$$a - b(q_1 + \cdots + q_i + \cdots q_N) - bq_i - \theta_i = p_F$$

$$=> \frac{1}{b}(a - p_F - \theta_i) = (q_1 + \cdots + 2q_i + \cdots q_N)$$

Combining N firms' first-order conditions, we would get the following matrix form

$$\begin{bmatrix} 2 & 1 \cdots & 1 \\ 1 & 2 \cdots & 1 \\ \vdots & \ddots & \vdots \\ 1 & 1 \cdots & 2 \end{bmatrix} \begin{bmatrix} q_1 \\ q_2 \\ \vdots \\ q_N \end{bmatrix} = \frac{1}{b} \begin{bmatrix} a - p_F - \theta_1 \\ a - p_F - \theta_2 \\ \vdots \\ a - p_F - \theta_N \end{bmatrix}$$

The matrix form can be represented by

$$\Lambda q = \frac{1}{b} \Omega$$

$$\text{where } \Lambda = \begin{bmatrix} 2 & 1 \cdots & 1 \\ 1 & 2 \cdots & 1 \\ \vdots & \ddots & \vdots \\ 1 & 1 \cdots & 2 \end{bmatrix} \text{ and } \Omega = \begin{bmatrix} a - p_F - \theta_1 \\ a - p_F - \theta_2 \\ \vdots \\ a - p_F - \theta_N \end{bmatrix}$$

We derive the following equilibrium domestic output levels.

$$q^{*}=\frac{1}{b}\Lambda^{-1}\Omega \tag{5}$$

From exogenous variables such as (a, b, p_F, θ_i), we can calculate the domestic output vector q. Then, let us calculate export vector x. From equation (3), we can get an individual firm's export level given q_i. From the domestic output vector q, by rearranging equation (3), we have

$$x_i^{*}=\frac{p_F}{\alpha_i}-q_i \tag{6}$$

Thus, we get the export vector. These output vectors q and x are Nash equilibrium.

In sum, given a domestic demand function, cost parameters (a, θ_i) and an export price, we can solve the equilibrium outputs in domestic and foreign markets.

IV. *Analysis of Merger Effects*

This section will analyze the effects of merger on a domestic price. We start with a symmetric case, in which all N firms have the same α_i and θ_i. In this symmetric case, we would provide analytic solutions to the effects of a merger. Second, for asymmetric cases in which different firms have different values of α_i and θ_i, we would provide a Cournot-based merger simulation to predict merger effects in an open economy.

1. Symmetric Cases

We investigate the effects of a merger on the domestic price in an open economy when all firms have the same α_i and θ_i. Since all firms have the same α_i and θ_i, we will denote α and θ without subscript. Let us first solve an analytic solution in the symmetric case. By using symmetry we can get equilibrium from equations (5) and (6). The equilibrium outputs are as follows,

$$q_i=\frac{1}{(N+1)b}(a-p_F-\theta)$$

and

$$x_i=\frac{p_F}{\alpha}-\frac{1}{(N+1)b}(a-p_F-\theta)$$

Then, the aggregated domestic output is $Q_D=\frac{N}{(N+1)b}(a-p_F-\theta)$. The domestic price becomes as follows,

$$p_D=\frac{a}{(N+1)}+\frac{N}{(N+1)}(p_F+\theta) \tag{7}$$

The domestic price depends on the number of firms and the export price. As the number of firms increases, the competition among them gets increase, and the market price decreases. Also, when the export price increases, firms allocate more outputs for export and decrease domestic sales outputs. Thus, when the export price increases, the domestic price increases. As section 2 shows, the cost parameter (the values of a) affects only the total production level, not the domestic output level.

When two firms merge with each other, as in a standard Cournot model, the number of firms decreases, and the domestic market price increases. Since the domestic price is a function of the number of firms, N, we are able to estimate the effect of merger on the domestic price by differentiating equation (7) with respect to N. Differentiating equation (7) with respect to N yields,

$$\frac{dp_D}{N}=\frac{(-a+(p_F+\theta)(N^2+N+1))}{(N+1)^2}$$

The equation above shows how a domestic price changes with the number of firms and the export price.[6]

When two firms merge, the number of firms decreases, and other firms react to the decrease by increasing their outputs. Other firms' output expansion would alleviate the decrease in the number of firms. When other firms increase their outputs more, the size of the domestic price increase would be smaller. Thus, the other firms' output expansion is important in evaluating the effect of merger on a domestic price change. The following figure shows how a non-merging firm reacts to an output restriction by a merging firm.

[6] Since the number of firms is an integer, the equation above shows the merger effects approximately. The following table shows how the domestic price increase depends on the foreign export price.

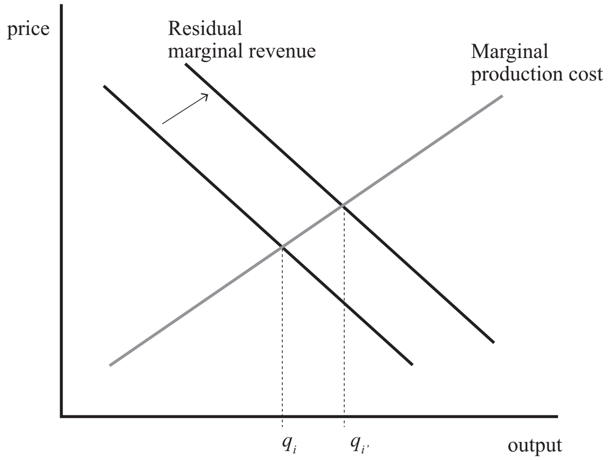
TABLE. DOMESTIC PRICE INCREASE IN AN OPEN ECONOMY

N \ p_F	0.2	0.3	0.4	0.5
3	16.7%	12.3%	5.2%	4.3%
4	11.1%	8.0%	3.1%	2.5%
5	8.0%	5.6%	2.0%	1.7%
6	6.1%	4.2%	1.4%	1.2%
7	4.8%	3.2%	1.1%	0.9%
8	3.8%	2.6%	0.8%	0.7%
9	3.2%	2.1%	0.7%	0.6%
10	2.7%	1.8%	0.5%	0.5%
11	2.3%	1.5%	0.5%	0.4%

Note: Since θ_i measures relative strength of each firm's domestic sale channel over export, we assume that all θ_i are zero in this symmetric case. Also, for calculation, we assume that the value of a, the Y-axis of a linear demand function is one.

For instance, suppose that the export price is 0.5 and the number of firms is three. When two firms merge with each other, the domestic price increases only by 4.3%. As usual, when the number of firms is small, the effect of merging

FIGURE 2. NON MERGING FIRMS' REACTION TO AN INCREASE IN RESIDUAL MARGINAL REVENUES



The figure above shows a non-merging firm's marginal revenue in a domestic market; export price, and the marginal production cost. When two firms merge, the firms' joint outputs decrease. Thus, other firms' marginal revenues from domestic sales increase. As figure 2 shows, as non-merging firms' marginal revenues in a domestic market increase (i.e, the adjusted domestic marginal revenue curve shifts right), they would sell more quantities in a domestic market. The domestic output level increases from q_i to $q_{i'}$.[7]

When two firms merge, other firms' output expansion could be different between in a closed economy and an open economy. Figure 3 shows the differences.

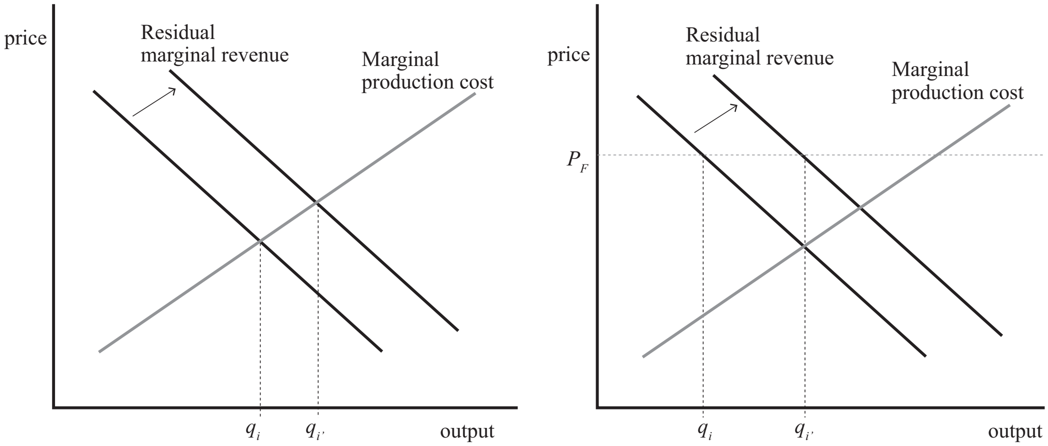
In the closed economy, firms can increase their domestic sales only if they produce more outputs, which incurs production costs. However, in an open economy, they can reshuffle between exports and the domestic sales. Firms can increase their domestic sales by reducing export volumes, and the opportunity cost of increasing domestic sales is the export price, p_F. Thus, firms behave as if their marginal cost curve is flat. When the merged firm restricts its output level, other firms more easily expand their output level by reshuffling their sales between the domestic and overseas markets when firms export some of their outputs, which alleviate the initial output reductions by merging firms.

So far we have analyzed the symmetric case. In the next subsection, we would provide a merger simulation tool to predict the welfare effects of mergers in an asymmetric case in which different firms have different parameter values of α_i and θ_i.

two firms on a domestic price is larger. Also, when p_F is higher, the export volume is larger, and the domestic sales volume is smaller. Thus, when p_F is higher, since domestic sales volumes are smaller, higher is the domestic price. When two firms merge, the price change percentage is relatively small because the price level itself is high.

[7] As long as firms make some export, the increase of the marginal revenue does not affect total output levels. However, even though the total output level does not change, there is reallocation between export and domestic sales.

FIGURE 3. THE LEFT-SIDE GRAPH SHOWS THE EFFECT OF AN INCRASE IN MARGINAL REVENUE IN A CLOSED ECONOMY, WHILE THE RIGHT SIDE SHOWS IT IN AN OPEN ECONOMY



2. Asymmetric Cases: Merger Simulation in an Open Economy

Competition authorities use merger simulation tools to predict the effects of a merger on prices and social welfare. Let us briefly explain procedures of a merger simulation. The key is that if we know parameters of a market demand and firms' cost, we can 'simulate' a merger and evaluate the effects of the simulated merger. That is, in order to simulate a merger, we need to have demand and cost parameters. Thus, procedures of a merger simulation consist of two parts. The first part is to 'recover' parameters of demand and cost from observed industry data such as market prices and output levels. The second part is to 'simulate' a merger by using the recovered data from the first part, relying on a game theoretic model.

Then, in the first part, how can we recover demand and cost parameters? We make a reasonable assumption on competition modes such as a Cournot, Bertrand competition mode.[8] Based on the assumed competition mode, we derive firms' profit-maximizing conditions, and these firms' profit maximizing conditions are denoted by first-order-condition.[9] The first-order condition is basically a mapping from cost parameters to output levels. Thus, by reversing the one-to-one mapping between cost parameters to output levels, we are able to recover the firms' cost parameters from the firms' output. After recovering the firms' cost parameters, in the second part of merger simulation, we can simulate a merger to predict the effects on prices and social welfares.

Here, we modify a standard Cournot merger simulation model in order to consider export

[8] These merger simulation models vary depending on the market competition modes (such as Cournot quantity competition or Bertrand pricing competition) and demand estimation/calibrations method. The simplest model is a Cournot merger simulation for homogenous goods.

[9] For instance, in a Cournot equilibrium, a firm's profit maximizing first-order-condition is $p(Q)-c_i-q_i\frac{\partial P}{\partial Q}=0$

volumes. As explained above, in the first part we recover the firms' cost parameters from observed industry data. The required industry data for a merger simulation are $\{p_F, x, Q_D, \varepsilon\}$, where ε denotes the domestic demand elasticity. We can observe the export price, domestic output levels, and export volumes. We have to estimate demand elasticity or use demand elasticity estimated from previous studies. From the industry data, we would recover the firms' cost and domestic distribution efficiency, $\{\alpha_i, \theta_i\}$. We can do it by using the firms' first order conditions.

Second, by using the recovered parameters, we simulate the modified Cournot model to predict the Post merger domestic price, domestic production, and export volume, $\{p_D, x, Q_D\}$.[10, 11]

The detailed steps are as follows.

(1) Recovering the domestic demand parameters.

We observe (ε, Q_D, p_D) in a domestic market. From the observation, we first recover parameters of a domestic demand function. In order to recover parameters of a demand curve, we have to assume demand function curvatures. In this model, for simplicity, we assume a linear demand curve, $p_D = a - b\, Q_D$.

From the fact $\varepsilon = \frac{\partial Q}{\partial p}\frac{p}{Q} = -b\frac{p}{Q}$, we can get the value of b since we have the demand elasticity, the domestic price, and the total domestic output level.

Then, from $p_D = a - b\, Q_D$, we can get the value of a since we know the domestic price and outputs. Therefore, we can recover demand parameters $\{a, b\}$ from the demand elasticity, and aggregated domestic market price and quantity.

In sum, we have the following,

$$a = p_D + b\, Q_D = p_D - \varepsilon\frac{Q}{p}$$

$$b = -\varepsilon\frac{Q}{p}$$

We recover demand parameters (a, b) in this step.

Example 1. For instance, suppose that we have the following data; $q = \{65, 60, 50, 55\}$, $x = \{60, 50, 40, 35\}$, demand elasticity e$=1.2$, $p_D = 60$, and $p_F = 40$. With a linear demand $p = a - bQ$, we recover the values of a and b, and the values of a and b are 110 and 0.2174, respectively.

(2) Recovering firms' cost parameters, α_i and θ_i.

In this step we would recover firms' efficiency parameters α_i and θ_i. Let us review equations (5) and (6) in section 3.

[10] As the domestic price changes, the demand elasticity could change along the curvature of the demand function.

[11] p_F does not change between before-and after- merger.

$$q=\frac{1}{b}\Lambda^{-1}\begin{bmatrix} a-p_F-\theta_1 \\ a-p_F-\theta_2 \\ \vdots \\ a-p_F-\theta_N \end{bmatrix} \tag{5}$$

$$x_i{}^{*}=\frac{p_F}{\alpha_i}-q_i \tag{6}$$

Equation (5) shows us how an individual firm's optimal domestic output level is determined. In equation (5), we have already known the values of q, a, b, and p_F. Thus, from equation (5), we can recover the parameter values of θ_i, domestic distribution efficiency parameter. Equation (6) shows us how an individual firm's optimal export level is determined. We have already known the values of x_i, q_i and p_F. Thus, from equation (6), we can recover a parameter value of a_i.

In sum, we have driven equations (5) and (6) in section 3, which represent firms' profit maximization conditions. From the equations, we are able to recover firms' cost parameters, α_i and θ_i,

(3) Efficiency gains from merger

In step 2 above, we are able to recover firms' cost parameters. When two firms merge, the new, merged firm's cost parameter would be the weighted average of the previous two merging firms' cost parameters, or the merged new firm's cost parameter is the lower value of the two merging firms' parameters. That is, we can set

$$\theta_m=\frac{x_1}{x_1+x_2}\theta_1+\frac{x_2}{x_1+x_2}\theta_2,\ \text{and}\ \alpha_m=\frac{(q_1+x_1)}{(q_1+x_1)+(q_2+x_2)}\alpha_1+\frac{(q_2+x_2)}{(q_1+x_1)+(q_2+x_2)}\alpha_2$$

or

$$\theta_m=\min(\theta_1,\theta_2)\ \text{and}\ \alpha_m=\min(\alpha_1,\alpha_2)$$

(4) Computing post-merger equilibrium.

Once the firms' cost parameters have been recovered, we can calculate the post-merger equilibrium and evaluate the merger based on the calculated post-merger equilibrium. We can find the new equilibrium quantities and price with the new efficiency parameters.

By taking these four steps (1)-(4) above, we can conduct the merger simulation, which considers the role of exports in an open economy. We would compare the prediction by the standard Cournot simulation model with the prediction by our Cournot merger simulation mode, which incorporates exports.

Example 1 (*continued*). We have the following data; $q=\{65, 60, 50, 55\}$, $x=\{60, 50, 40, 35\}$, demand elasticity e$=1.2$, $p_D=60$, and $p_F=40$. With a linear demand $p=a-bQ$, we recover the values of a and b, and the values of a and b are 110 and 0.2174, respectively. Firms' cost parameters α_i are $=\{0.32, 0.36, 0.44, 0.44\}$. Suppose that the merging firm's efficiency level is the minimum of the two merging firms, that is $\alpha_m=\min(\alpha_1,\alpha_2)$. Then, the standard Cournot simulation model, which does not consider the role of exports, predicts the post-merger domestic price to be 68, which implies the price increases by 13%. However, the simulation model with exports predicts the post-merger domestic price to be 63, and, thus, the predicted price change is 5%, which is different from the prediction by the standard merger simulation.

V. *Conclusion*

In a small, export-oriented economy such as Korea, manufacturers export quite a high share of their productions. Firms usually engage in the third-degree price discrimination between overseas and domestic markets. In this article we provide a simple Cournot merger simulation tool, which incorporates the role of exports. We find that merger effects on consumer welfare and price could be different, depending on export situations.

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