

ESTIMATION OF POLITICAL OLIGOPOLY POWER OF DOMESTIC PRODUCERS IN THE KOREAN RAW-MILK MARKET

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Keywords

Political power, market power, dairy, milk

Abstract

This paper estimates the political oligopoly power of domestic raw-milk producers in the Korean dairy market. Domestic raw-milk price for fluid use is decided exogenously by the government. The government announces the reference price of raw-milk price for fluid use to protect the domestic raw-milk producers from the potential market power of domestic dairy processors, because historically many small-sized domestic producers are a relatively weaker group than domestic processors. Here, this study has two questions: one is about how effectively the government protects the producers and the other is about how much the producers exert their political power against the government to raise the reference price in this process. Furthermore, this paper also tests how much the political oligopoly power of domestic producers is affected by the change of domestic political situation which is the inauguration of Korea Dairy Committee in this case. To answer these questions, this paper develops a theoretical model from a social welfare function and empirically estimates the political oligopoly power using the new empirical industrial organization (NEIO) approach.

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1. Introduction

The purpose of this paper is to estimate the degree of the political oligopoly power of domestic raw-milk producers in the Korean raw-milk market by directly estimating the marginal cost with the New Empirical Industrial Organization (NEIO) framework.¹ Furthermore, this paper will explain how the change of domestic political circumstance affects the political oligopoly power of domestic producers in the Korean raw-milk market.

Generally, market power is determined within a market by interactions of interest groups. For example, in an oligopoly, sellers exert their market power against buyers to set price above marginal cost. In this paper, the raw-milk price received by domestic producers is decided not within a market but by the government. The reference price for raw milk is decided by the level of cost for making raw milk and the degree of the political oligopoly power of domestic raw-milk producers.

This paper estimates the political oligopoly power of domestic raw-milk producers against the government when the government sets the reference price for raw milk. In this process, domestic raw-milk producers exert their political power to make the government raise the reference price for raw milk above the marginal cost. The behaviors of the domestic producers are very similar to those under oligopoly. Hence, this study uses the term ‘political oligopoly power.’

Recently, many studies empirically estimate market power, oligopoly or oligopsony power, in the food industry using the NEIO approach.² Before the NEIO approach, many papers focused on the theoretical framework using game theory and explained the relationship among structure, conduct, and performance known as the SCP paradigm. In the NEIO framework, the direct estimation of the degree of imperfect competition is possible by introducing the concept of ‘conjectural variations’ or ‘conduct parameter’ (Kaiser and Suzuki

¹ Bresnahan (1981) and Appelbaum (1982) theoretically develop the NEIO approach, Sexton and Lavoie (2001) apply the NEIO approach in agricultural industries, and Kaiser and Suzuki (2006) discuss the NEIO approach in detail based on the previous literature.

² See, for example, Azzam and Pagoulatos (1990) for the U.S. meat packing industry or Genesove and Mullin (1998) for the sugar industry.

2006). This paper uses a similar framework as the NEIO approach to estimate the political oligopoly power of domestic producers (see the following sections for details).

In recent years, Ahn (2006) estimates the degree of the oligopoly power of domestic processors in the Korean fluid-milk market. But there are some limits on his approach as explained below.

Irrespective of the merits of the NEIO approach in estimating the degree of market power, this approach is criticized for several reasons in empirical application (see Corts 1999).³ First, under an assumption that true data generating process is based on conjectural variation game, wrong estimation of marginal cost could bias the estimate of market power. Although, this bias could be serious, many studies still use an ad hoc functional form in the NEIO approach. For example, see Genesove and Mullin (1998). They demonstrated that the market power estimated by the NEIO approach and the market power calculated by the direct estimation of marginal cost are very close. But, we can see that these two values are significantly different under 5 percent significance level and the estimate by the NEIO approach is underestimated. To reduce a bias, this study uses a more general functional form, trans-log cost function, to estimate the marginal cost of making raw milk.⁴

Second, if the true data generating process is not from a conjectural variation model, then the results of estimation might be meaningless or only meaningful under specific assumptions (Cabral 1995 and Corts 1999). For example, one of their concerns is that if the data generating process is based on a dynamic game, then the estimation result derived from the static CPM can be meaningless. Based on Corts's critique (1999), Kim and Knittel (2004) criticize the NEIO approach that it is not appropriate to cover the real price cost margin by showing the empirical evidence from the California electricity market. This paper compares the estimate of market power parameter from direct estimation of cost and that obtained by the NEIO approach. To harmonize this conflict between these two methods, this study incorporates the directly estimated marginal cost into the NEIO approach.

The NEIO approach is criticized because conjectural variations are var-

³ However, theoretical implications of the NEIO approach are greatly appreciable, especially in the welfare analysis (see, for example, Alston, Sexton and Zhang 1997, and Sexton 2000).

⁴ Ahn (2006) uses a linear functional form in his study.

ied over time but the estimate by a static CPM is an average value over the estimation periods. To supplement an estimation result by the NEIO approach, this study calculates the Lerner's Index in each year using the estimated marginal cost to see how it varies over time and explain its variations. Furthermore, this paper reviews several conditions under which Corts's critique can be lessened even when the true data generating is process from a dynamic game.

In section 2, this study explains the raw-milk market in Korea and the changes of political circumstance surrounding domestic producers. Section 3 describes the theoretical framework in which the equation that contains the parameter of the political oligopoly power of domestic producers is derived. Several empirical problems of estimating market power are discussed in section 4. In the following section 5, the political oligopoly power of domestic raw-milk producers is estimated. The estimation results are explained in section 6, and section 7 is a conclusion.

2. Industry background

The raw-milk price received by domestic producers is generally determined by the contracts between domestic raw-milk producers and dairy processors; however, the raw-milk price in the Korean dairy industry is based on the reference price set by the government.⁵ Although the dairy industry is open to the world market with tariffs or tariff rate quotas (TRQs) from 1994, data shows that raw milk is not imported into the Korean dairy market. Hence, the domestic raw-milk market is free from competition with potential entrants from the international market even after market opening.

The Korean government announces this reference price to protect domestic raw-milk producers from the potential market (oligopsony) power of domestic dairy processors.⁶ Basically, the raw-milk price is not determined by the

⁵ The raw-milk price received by domestic producers is basically determined by this reference price and adjusted by milk quality such as the number of germs and cells, and fat ratio.

⁶ The Korean dairy industry is greatly affected by three major dairy processors, the sum of whose shares is almost two thirds of the domestic raw milk market. The three major dairy processors are Seoul, Maeil, and Namyang.

interactions of producers and buyers (dairy processors) in the domestic raw milk market but by the reference price set by the government. The level of this reference price for raw milk is determined by the level cost of making raw milk and the political consideration of the government which is largely affected by the political power of producers.

With the market opening by the WTO's UR agreement in 1994, the continuous complaints of producer groups make the government take some actions to soothe their economic desire. Under these circumstances, the Korea Dairy Committee (KDC) that was financially supported by the government was established in January, 1999. The purpose of the KDC is to make one channel in contracts between producers and processors. The government expects the KDC to collect all domestically-produced raw milk at a given reference price and sell them to domestic dairy processors as a representative of domestic producers. Even though the achievement of the KDC is not satisfactory in making one channel, it might be expected that the domestic producers exert their political power through the KDC.

My interest in this study focuses on two aspects: first, how effectively the government protected domestic raw milk producers before 1999 and, second, how much the political oligopoly power of domestic producers increased after the inauguration of the KDC in 1999. This paper discusses these two questions by using econometric estimation in the following sections.

3. Theoretical Framework

Previous literature, such as Raussers and Foster (1990), Beghin and Foster (1992), and Swinnen and de Gorter (1998), neglected the linkage between political power and market power. In this section, the political oligopoly power of domestic producers in the domestic raw-milk market is parameterized using the social welfare function (SWF), through which this study explicitly specifies the relationship between political weights and political market power. The derived equation for an empirical estimation is used.

As explained above, the reference price for raw milk received by domestic producers is announced by the government. Producer groups may exert their political power to make the government raise this reference price. This

study sets the SWF of a hypothetical social planner in the domestic raw-milk market. The planner considers the welfare of the sellers (producers) and buyers (dairy processors). The reference price for raw milk is determined by the level of weights of the social planner to these two groups. The difference of the reference price and marginal cost of making raw milk represents a level of political oligopoly power of domestic raw-milk producers against the government.

In setting a SWF, giving different weights to different interest groups by a social planner leads to a different policy preference function (De Gorter and Swinnen 2002). The SWF of a social planner in the domestic raw milk market is constructed as

$$SWF = w\pi_f + (1-w)\pi_p, \quad (0 \leq w \leq 1)$$

where π_f is the surplus of domestic producers who produce raw milk, π_p is the profit of domestic processors who use raw milk to make dairy products and sell them to domestic consumers, and w is the weight of the social planner to the domestic producers. The SWF can be expressed as

$$(1) \quad \begin{aligned} SWF &= w\pi_f + (1-w)\pi_p \\ &= w\{P_{fl}^f Q_T^f - C(Q_T^f)\} \\ &\quad + (1-w)[\{P_{fl}^r(Q_{fl}^r) - (P_{fl}^f + c_{fl})\}Q_{fl}^r + \{P_{pro}^r(Q_{pro}^r) - (P_{pro}^f + c_{pro})\}Q_{pro}^r] \end{aligned}$$

where P_{fl}^f is the reference price for raw milk received by domestic producers, Q_T^f is the domestically-produced total raw milk, $C(Q_T^f)$ is the cost function of domestic producers, $P_{fl}^r(Q_{fl}^r)$ is the consumer price for fluid milk, J^r is the marginal cost of the processors to make fluid milk, Q_{fl}^r is the consumption of fluid milk, $P_{pro}^r(Q_{pro}^r)$ is the consumer price for processed milk, P_{pro}^f is the raw-milk price for processed use, c_{pro} is the marginal cost of the processors to make processed milk, and Q_{pro}^r is the consumption of processed milk. This study uses “pro” to indicate all processed-milk products.

The objective of the social planner is to maximize (1) with respect to the reference price for raw milk (P_{fl}^f). We can derive the optimal reference price for raw milk using a two stage game. In the first stage, the government announces the producer price for raw milk which is determined by the political

oligopoly power of domestic producers. In the following second stage, given this price, domestic processors decide the amount of dairy products they sell and consumer price which is determined by their market (oligopoly) power against consumers. We can solve this problem by backward induction. Inserting the solution of the second stage into the original problem, we get

$$(2) \quad \begin{aligned} \text{Max}_{P_{fl}^f} \text{SWF} = & w \{ P_{fl}^f Q_T^f(P_{fl}^f) - C(Q_T^f(P_{fl}^f)) \} \\ & + (1-w) \left[\left\{ -\frac{\partial P_{fl}^r}{\partial Q_{fl}^r} (Q_{fl}^r(P_{fl}^f))^2 \xi_{fl} \right\} + \left\{ -\frac{\partial P_{pro}^r}{\partial Q_{pro}^r} (Q_{pro}^r(P_{pro}^f))^2 \xi_{pro} \right\} \right] .^7 \end{aligned}$$

From the first order condition of this problem with respect to P_{fl}^f , we obtain

$$(3) \quad \begin{aligned} & w \left\{ Q_T^f(P_{fl}^f) + P_{fl}^f \frac{\partial Q_T^f}{\partial P_{fl}^f} - \frac{\partial C}{\partial Q_T^f} \frac{\partial Q_T^f}{\partial P_{fl}^f} \right\} \\ & + (1-w) \left\{ -2 \frac{\partial P_{fl}^r}{\partial Q_{fl}^r} \xi_{fl} Q_{fl}^r(P_{fl}^f) \frac{\partial Q_{fl}^r}{\partial P_{fl}^f} - 2 \frac{\partial P_{pro}^r}{\partial Q_{pro}^r} \xi_{pro} Q_{pro}^r(P_{pro}^f) \frac{\partial Q_{pro}^r}{\partial P_{fl}^f} \right\} = 0 \end{aligned}$$

Using the equations (A.2) and (A.3) in the appendix, this is simplified to

$$\begin{aligned} w \left\{ Q_T^f + P_{fl}^f \frac{\partial Q_T^f}{\partial P_{fl}^f} - \frac{\partial C}{\partial Q_T^f} \frac{\partial Q_T^f}{\partial P_{fl}^f} \right\} &= (1-w) \{ 2Q_{fl}^r(P_{fl}^f) + 2Q_{pro}^r(P_{fl}^f) \} \\ &= 2(1-w)Q_T^f \end{aligned}$$

Therefore, the reference price for raw milk of this game is derived as

$$(4) \quad P_{fl}^f = \left(\frac{5w-2}{w} \right) \left(-\frac{\partial Q_T^f}{\partial P_{fl}^f} \right) Q_T^f + \frac{\partial C}{\partial Q_T^f} = \varpi \left(-\frac{\partial Q_T^f}{\partial P_{fl}^f} \right) Q_T^f + MC_f.$$

With no political power, $\varpi=0$, of the domestic raw-milk producers, domestic producers are paid a perfectly competitive price (MC_f). The maximum price for raw milk received by producers is monopoly price, when $\varpi=1$, given by

$$\left(-\frac{\partial P_{fl}^r}{\partial Q_{fl}^r} \right) Q_{fl}^f + MC_f.$$

⁷ Refer to the appendix for the derivation of the second stage solution.

4. Empirical considerations

One of the representative indexes showing a degree of imperfect competition is the Lerner's index. It is defined as the difference between price and marginal cost, that is

$$L = \frac{P - mc}{P}.$$

To reflect the responsiveness of demand side, the Adjusted Lerner's index is re-defined as

$$adj\ L = \frac{P - mc}{P} \eta,$$

where η is the price elasticity of demand.⁸

In a conduct parameter method (CPM), the pricing equation in an industry under a static oligopoly is known as

$$P = -P'\theta Q + mc,$$

where P is the price, Q is the quantity demanded in the industry, P' is a partial derivative of price with respect to quantity demanded, θ is a conjectural elasticity, and mc is the average marginal cost of the industry. θ lies in between 0 and 1. If it is 0, the industry is perfectly competitive. If it is 1, the structure of the industry is a monopoly or perfectly colluding. And if it lies between zero and one, the industry is oligopoly. We can re-express θ as

$$(5) \quad \theta = \frac{P - mc}{-P'Q} = \frac{P - mc}{P} \eta$$

and we can interpret θ as the Adjusted Lerner's index. Furthermore, θ in equation (5) is the same as ϖ in equation (4).

We can obtain the degree of political oligopoly in two ways. One way is to estimate the cost function, through which we can directly calculate the marginal cost and the Lerner's index. The other way is to use the NEIO ap-

⁸ η is multiplied to adjust the difference between price and marginal cost. For example, if price cost margin is large under inelastic demand curve, we need to scale it down by multiplying η . This is because the large price cost margin is calculated from the steep slope of demand curve rather than strong market power.

proach which is widely used in the agricultural IO field. If we know the marginal cost of an industry, it will be easy to calculate the degree of imperfect competition in an industry using the Lerner's Index. However, in many cases, we do not have much information about the cost side. In those cases, we resort to the NEIO technique.

Even though the NEIO approach is widely used in the empirical agricultural IO field, there are several shortcomings to be considered when applying this technique.⁹ First, under an assumption that a true data generating process comes from a conjectural variation game, it is very conclusive to obtain exact estimates for P' and mc to get a correct estimate θ in equation (5). To obtain the estimate of mc is more crucial than to get that of P' . If we obtain the estimate that is very close to a real marginal cost, we can calculate the Lerner's Index correctly. Another information for the slope of demand curve (P') reveals us how much we need to adjust the Lerner's Index, i.e., how much of the price cost margin is derived from the real market power and not from the responsiveness of demand side.

Previous studies in the NEIO approach use an ad hoc functional form for estimating marginal cost and assume marginal cost is constant with respect to quantity (does not vary with quantity sold). Even though Bresnahan (1982) shows how θ can be correctly identified under the nonlinearity of marginal cost with respect to quantity, it is hard to estimate empirically and interpret. This study will use a more generalized functional form (trans-log cost function) to estimate marginal cost to reduce this kind of bias in this study.

Second, the more fundamental problem of the NEIO approach is in the structure of the real data generating process. The market power parameter obtained by the NEIO is estimated under an assumption that the real data generating process game is a static oligopoly game. However, if the real data generating process is not from a static but from a dynamic game, then this approach can be seriously misleading. Corts (1999) argued that if the structure of a real game is a dynamic game such as a tacit collusion with repeated interaction, the estimate obtained by the NEIO approach cannot capture the real price cost margin. The main critique is that the demand shocks in a dynamic game induce

⁹ The NEIO approach provides a theoretical and empirical tool to estimate the degree of market power which cannot be provided by the previous paradigms such as Structure-Conduct-Performance (SCP) and Traditional Industry Organization (TIO) (Kaiser and Suzuki 2006).

firms to deviate from a collusion; therefore, their conjectural variations may vary over time. An econometric estimation for θ with an assumption of constant demand shocks cannot capture this aspect and leads to a bias. Several recent papers such as Clay and Troesken (2003) and Kim and Knittel (2004) support Corts's argument and point out that the NEIO approach is not appropriate to cover the real price cost margin.

Under which situations does the NEIO approach have a meaning? Kim and Knittel (2004) showed that in a dynamic game firms' first order condition is different from that of a static game, i.e., firms consider the incentive compatibility constraint associated with collusion in a dynamic game. Because of this incentive comparability, θ is varied with demand shocks in a dynamic game. Their arguments together with Corts (1999) indicate that the NEIO can be unbiased under some situations. If the firms are sufficiently patient (they have larger weights for future events) or demand shocks are completely persistent (they do not have much incentive to deviate from current collusion), then the CPM in the NEIO may accurately measure the real price cost margin. In the Korean raw milk market, each producer does not have any incentive compatibility constraint. Under the announced reference price for raw milk, each producer produces to maximize its profit. The behaviors of producers do not affect the reference price in the raw milk market because the reference price is fixed once it is announced by the government for several years. Hence, we do less concern about Corts's critique in this study. Based on the reasoning above, this study only cares about the first problem, i.e., estimate correct marginal cost.

5. Estimation

In this section, this study estimates a cost function, directly calculates marginal cost and the Lerner's Index. In addition, market power parameter is estimated using the NEIO technique with cost information. This study will compare the market power parameters estimated by these two methods.

5.1. Direct estimation of marginal cost and calculating the Lerner's index

We do not know the exact functional form of the cost function for making raw milk of domestic producers, so this paper uses a flexible trans-log cost function to approximate the real cost function. We can construct an arbitrary cost function in trans-log functional form as

$$(6) \ln(C) = f(\ln Q, \ln w),$$

where C is the total cost of producing raw milk, Q is the total raw-milk production, and w is a vector of input prices. This function can be generalized using Taylor's second order approximation into

$$(7) \ln(C) = \alpha_0 + \alpha_Q \ln Q + \sum_i \gamma_{Qi} \ln Q \ln w_i + \frac{1}{2} \gamma_{QQ} (\ln Q)^2 + \sum_i \alpha_i \ln w_i + \frac{1}{2} \sum_i \sum_j \gamma_{ij} \ln w_i \ln w_j.$$

From this equation, we can derive an input share equation as

$$(8) \frac{\partial \ln C}{\partial \ln w_i} = \alpha_i + \gamma_{Qi} \ln Q + \sum_j \gamma_{ij} \ln w_j.$$

Let's impose various theoretical restrictions to the system above. Homogeneity of degree one in input prices requires

$$\sum_i \alpha_i = 1, \sum_i \gamma_{Qi} = \sum_i \gamma_{ij} = \sum_j \gamma_{ij} = \sum_i \sum_j \gamma_{ij} = 0.$$

Using Young's theorem, symmetry requires

$$\gamma_{ij} = \gamma_{ji} \quad \forall ij.$$

Additionally, this study assumes that the production function is homogeneous of degree $k(>0)$ and its dual cost function can be written as

$$C(Q, w) = C(1, w)Q^{1/k}.$$

Under this assumption we can impose,

$$\gamma_{Qi} = 0 \quad \forall i, \quad \gamma_{QQ} = 0, \quad \alpha_Q = \frac{1}{k}.$$

With available data for cost, we can trace total cost using the input prices of

feed (F), labor (L), and materials (E).

All of them above together make a set of structural equations for estimation. Equation (7) under theoretical restrictions becomes

$$\begin{aligned}
 \ln C = & \alpha_0 + \alpha_Q \ln Q + \alpha_F \ln w_F + \alpha_L \ln w_L + (1 - \alpha_F - \alpha_L) \ln w_E \\
 (9) \quad & + \gamma_{FF} \left(\frac{1}{2}\right) (\ln w_F)^2 + \gamma_{LL} \left(\frac{1}{2}\right) (\ln w_L)^2 + (0 + \gamma_{FF} + 2\gamma_{FL} + \gamma_{LL}) \left(\frac{1}{2}\right) (\ln w_E)^2, \\
 & + \gamma_{FL} \ln w_F \ln w_L + (0 - \gamma_{FF} - \gamma_{FL}) \ln w_F \ln w_E + (0 - \gamma_{FL} - \gamma_{LL}) \ln w_L \ln w_E \\
 & + \phi^* D98
 \end{aligned}$$

where $D98$ is a dummy variable (0 for the years before 1998 and 1 for the years after 1998) to reflect the technology improvement after a foreign currency shock happened in late 1997. The cost share equations for feed and labor can be driven by equation (8) under theoretical restrictions as

$$(10) \quad s_F = \alpha_F + \gamma_{FF} \ln w_F + \gamma_{FL} \ln w_L + (0 - \gamma_{FF} - \gamma_{FL}) \ln w_E$$

and

$$(11) \quad s_L = \alpha_L + \gamma_{FL} \ln w_F + \gamma_{LL} \ln w_L + (0 - \gamma_{FL} - \gamma_{LL}) \ln w_E.$$

For empirical purpose, we drop the share equation for material.¹⁰ Equations (9) ~ (11) become a seemingly unrelated regression (SUR) model.

Table 1 shows the data used in this paper. Table 2 shows the estimation results.¹¹ To calculate the Lerner's Index, we need the estimate for marginal

cost. It is obtained as $\frac{\partial \ln C}{\partial \ln Q} = \frac{\partial C}{\partial Q} \frac{Q}{C} = \alpha_Q$; hence, the estimate for marginal cost is $mc = \frac{\partial C}{\partial Q} = \alpha_Q \frac{C}{Q}$, where α_Q and C are the estimates from equation (9).¹²

¹⁰ To avoid a singularity problem, the sum of shares should be equaled to one. Hence, we can drop one equation.

¹¹ This study does the LR test for homogeneity restriction and cannot reject the null hypothesis under 5 percent significance level. Also, this study checks the regularity conditions for cost function that are monotonicity and concavity. All conditions are satisfied, so the estimated cost function can be used as a cost function.

¹² This paper does the Wald test for constant returns to scale (the null hypothesis is $H_0: \alpha_Q = 1$) and cannot reject it under 5 percent significance level. Hence, constant returns to scale is adopted in this paper.

TABLE 1. Data description (1983-2005)

| | Cost | | | | Input prices | | |
|-----------------|--------|--------|-----------|------------|--------------|-------|-----------|
| | Feed | Labor | Materials | Total cost | Feed | Labor | Materials |
| Average | 20,454 | 9,892 | 16,219 | 46,565 | 99 | 66 | 86 |
| Standard errors | 4,656 | 3,390 | 1,892 | 6,957 | 15 | 36 | 19 |
| Maximum | 28,864 | 15,575 | 19,356 | 58,599 | 135 | 123 | 139 |
| Minimum | 14,979 | 6,490 | 12,483 | 34,256 | 80 | 19 | 66 |

Source: Cost data are from the Livestock Production Cost (the ministry of agriculture and forestry in Korea) and input prices are from Korea Statistical Information System.

Figure 1 shows the pattern of raw-milk price received by producers, estimated marginal cost, and the calculated Lerner's Index. We can see the gradual increase of the raw-milk price and estimated marginal cost before 1998. However, after 1998, estimated marginal cost dropped and has rebounded

TABLE 2. Estimation results for trans-log cost function and share equations

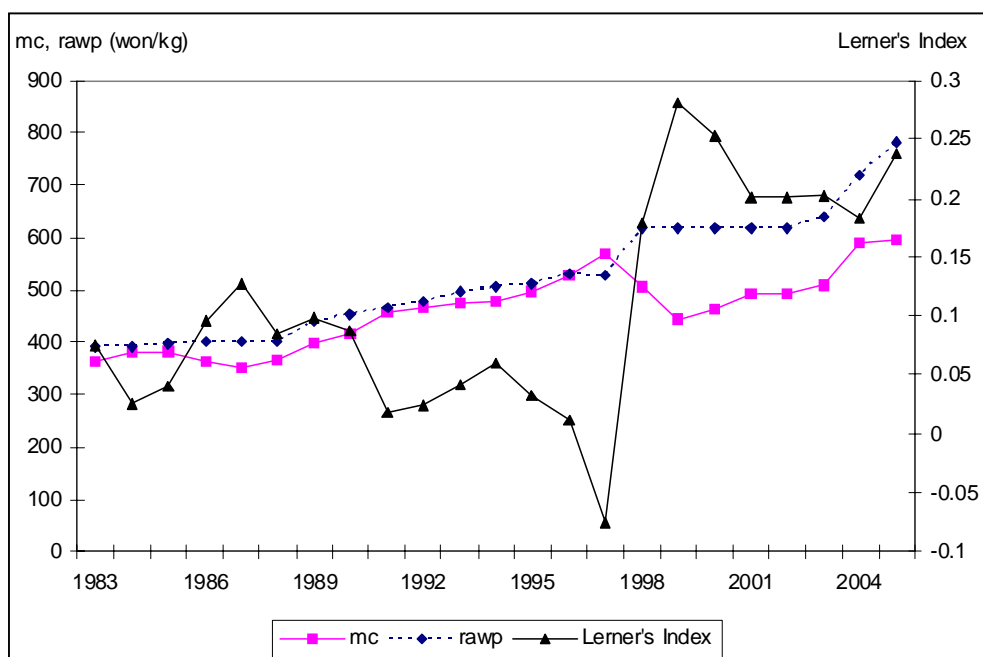
| Parameters | Restricted model (a) | | Unrestricted model (b) | | Restricted model (c) | |
|----------------|----------------------|------------|------------------------|------------|----------------------|------------|
| | Coef. | Std. error | Coef. | Std. error | Coef. | Std. error |
| α_0 | 1.9635 | 2.3927 | -44.1306 | 34.0658 | 1.9636 | 0.5393*** |
| α_Q | 0.9890 | 0.1603 | 7.2990 | 4.8184 | 0.9890 | 0.0375*** |
| α_F | 0.4618 | 0.0493*** | 4.8431 | 4.0131 | 0.4618 | 0.0184*** |
| α_L | 0.2017 | 0.0339*** | -1.7584 | 2.5801 | 0.2017 | 0.0160*** |
| γ_{FF} | -0.0377 | 0.0958*** | -0.1770 | 0.1461 | -0.0377 | 0.0435 |
| γ_{FL} | 0.0335 | 0.1003 | 0.2113 | 0.1065 | 0.0335 | 0.0196* |
| γ_{LL} | -0.0027 | 0.1052 | -0.0791 | 0.0811** | -0.0027 | 0.0185 |
| ϕ | -0.2641 | 0.1746 | -0.3280 | 0.0640 | -0.2641 | 0.0191*** |
| γ_{QQ} | | | -0.4316 | 0.3406*** | | |
| γ_{QL} | | | -0.2982 | 0.2728 | | |
| γ_{QF} | | | 0.1323 | 0.1751 | | |
| Log likelihood | -332.257 | | -331.251 | | | |

- Note: 1. ***, **, and * are significant under 1%, 5%, and 10% of significance level.
2. Annual data from 1983 to 2005 from the Livestock Production Cost (the ministry of agriculture and forestry in Korea) are used for estimation.
3. Columns (a) and (b) are estimated by Full Information Maximum Likelihood (FIML) and column (c) is estimated by iterative Seemingly Unrelated Regression (SUR). For the analysis, the results in column (c) are used.

gradually again. During the foreign currency crisis of late 1997, the dairy industry also faced a similar managerial problem like many other industries. Some inefficient domestic raw-milk producers went out of business due to managerial problems, and the average marginal cost of producing raw milk in an industry level fell from 1998.

With price and marginal cost, we can directly calculate the Lerner's Index (see figure 1 for the changes of the Lerner's Index). The Lerner's Index shows these facts. For the whole period from 1983 to 2005, the Lerner's Index is estimated as 0.11. For the period from 1983 to 1997, it is 0.05; but for the period 1998~2005, it is 0.22, which is quite larger than the value for the previous period.

FIGURE 1. Pattern of raw-milk price, estimated marginal cost, and Lerner's Index



Note: 'mc' is a directly estimated marginal cost, 'rawp' is the raw-milk price received by domestic producers, and 'Lerner's Index' is calculated by these two values.

5.2. NEIO approach

Following the NEIO approach, a supply relation for raw milk can be specified as

$$(12) \quad P = -P'\theta Q + mc(W, Q) + \varepsilon_s,$$

where P is the raw-milk price received by domestic producers, Q is the amount of raw milk produced by domestic producers, P' is the slope of inverse demand curve, θ is a conjectural elasticity, mc is the marginal cost which is a function of input prices (W) and output level (Q), and ε_s is an independently and identically distributed disturbance term. We do not know the structure of the marginal cost, so this study incorporates the estimated marginal cost from the previous section into equation (12).

To obtain θ in equation (12), we need an information for the slope of demand curve. To obtain the slope of demand curve, I impose two different functional forms for estimating demand equation; that is log linear and linear in models 1 and 2 below. For a log linear demand equation, we can set

$$\ln(Q) = \beta_0 + \beta_1 * \ln(P / GDEF) + \beta_2 * \ln(GDP / GDEF) + \varepsilon_d,$$

where Q is the amount of raw milk sold to dairy processors, P is the raw-milk price paid by processors to producers, GDP is a gross domestic product, $GDEF$ is a GDP deflator, and ε_d is an independently and identically distributed disturbance term. β_1 is a price elasticity of demand and β_2 is an income elasticity of demand. For linear demand equation, we can take out log from each variable.

(Model 1)

$$P = \mu_0 * mc + \mu_1 * Q + \varepsilon_s, \quad (\mu_1 = -P'\theta)$$

$$\ln(Q) = \beta_0 + \beta_1 * \ln(P / GDEF) + \beta_2 * \ln(GDP / GDEF) + \varepsilon_d.$$

(Model 2)

$$P = \mu_0 * mc + \mu_1 * Q + \varepsilon_s, \quad (\mu_1 = -P'\theta)$$

$$Q = \beta_0 + \beta_1 * (P / GDEF) + \beta_2 * (GDP / GDEF) + \varepsilon_d.$$

Under an assumption that the estimated marginal cost is very close to real marginal cost, two different models inform us how much the different specification

of a demand equation affects the estimates of market power parameter (θ). The error terms of two equations in both models 1 and 2 may be correlated, so we have to estimate it using SUR. Furthermore, Q in supply relation equation is correlated with error term, so it causes an endogenous problem. However, P in a demand equation is pre-determined by the political power of domestic producers; so there is no endogeneity problem in the demand equation. This study estimates these two models by using the iterative three stage least squares (3SLS) method.

Table 3 reports estimation results. The estimated parameters in both models are highly significant and the sign of all variables are correct. The estimated price elasticity of demand for log-linear demand equation is less elastic than that of linear demand. As argued above, the calculated political oligopoly power (θ) is smaller in a less elastic demand equation; i.e., 0.073 is smaller than 0.083, but the two values are only slightly different.¹³

The Wald statistic for the null hypothesis that $\theta = 0$ for both models are smaller than the critical value $\chi_{0.95}^2(1) = 3.84$. Therefore, we cannot reject the null hypothesis and the directly estimated marginal cost fits well in the supply relation. The Wald statistic for the null hypothesis that domestic producers have no political oligopoly power ($H_0: \theta = 0$) is 2.994 for model 1 and 7.722 for model 2. These statistics are significant under 10 percent ($\chi_{0.90}^2(1) = 2.71$) and 5 percent ($\chi_{0.95}^2(1) = 3.84$) of significance level respectively.

The calculated political market power parameters above are averages for the whole period. In the meanwhile, we know that there was a great change in the political circumstance surrounding the domestic producers in 1999. The KDC was inaugurated in January 1999. Therefore, this paper estimates the model 3 below to see whether the inauguration of the KDC affects the political oligopoly power of the domestic producers.

(Model 3)

$$P - mc = \mu_1 * Q + \mu_2 * D99 * Q + \varepsilon_s,$$

$$\ln(Q) = \beta_0 + \beta_1 * \ln(P / GDEF) + \beta_2 * \ln(GDP / GDEF) + \varepsilon_d,$$

¹³ Political oligopoly power θ is calculated by $\frac{\mu_1}{-\mu_2}$.

where $D99$ is a dummy variable that is zeros for the period 1983~1998 and ones for the period 1999~2005. $D99$ is included because the KDC was launched in 1999. The estimation result in table 3 shows that all variables are highly significant. The estimated political oligopoly power for the period 1983~1998 is 0.044 and 0.131 for 1999~2005. The Wald statistics for the null hypothesis that

TABLE 3. Estimation results of political market power using directly estimated marginal cost

| | Model 1 | | Model 2 | | Model 3 | |
|----------------------------------|----------|-------------|----------|-------------|----------|-------------|
| | Coef. | Std. error | Coef. | Std. error | Coef. | Std. error |
| μ_0 | 9.89E-01 | 3.51E-02*** | 0.992079 | 0.035026*** | | |
| μ_1 | 4.48E-05 | 1.25E-05*** | 4.36E-05 | 1.24E-05*** | 2.43E-05 | 6.19E-06*** |
| μ_2 | | | | | 3.52E-05 | 8.98E-06*** |
| β_0 | 12.21072 | 4.221833*** | 2649317 | 390362.7*** | 14.36896 | 4.09045*** |
| β_1 | -0.64924 | 0.327483* | -1896.41 | 372.548*** | -0.87525 | 0.314508*** |
| β_2 | 0.422671 | 0.142213*** | 0.126244 | 0.031005*** | 0.377922 | 0.13886*** |
| η | 0.649 | | 0.753 | | 0.875 | |
| θ | 0.073 | | 0.083 | | | |
| θ_{83-98} | | | | | 0.044 | |
| θ_{99-05} | | | | | 0.131 | |
| $Wald(H_0 : \mu_0 = 1)$ | 0.101 | | 0.051 | | | |
| $Wald(H_0 : \theta = 0)$ | 2.994 | | 7.722 | | | |
| $Wald(H_0 : \theta_{83-98} = 0)$ | | | | | 4.601 | |
| $Wald(H_0 : \theta_{99-05} = 0)$ | | | | | 7.601 | |

- Note: 1. ***, **, and * are significant under 1%, 5%, and 10% of significance level.
2. η is the price elasticity of demand. η for model 2 is calculated at the mean of price and quantity.
3. θ is the conjectural elasticity that is the index for political oligopoly power of domestic producers. It is calculated by the formula $\frac{\mu_1}{-P} = \mu_1 * (-\beta_1) * \frac{\bar{Q}}{\bar{P}}$, where \bar{Q} and \bar{P} are the sample mean for the period 1983~2005.
4. θ_{83-98} is calculated by $\frac{\mu_1}{-P} = \mu_1 * (-\beta_1) * \frac{\bar{Q}}{\bar{P}}$, where \bar{Q} and \bar{P} are the sample mean for the period 1983~1998.
5. θ_{99-05} is calculated by $\frac{\mu_1 + \mu_2}{-P} = (\mu_1 + \mu_2) * (-\beta_1) * \frac{\bar{Q}}{\bar{P}}$, where \bar{Q} and \bar{P} are the sample mean for the period 1983~2005.

political market power is zero for the periods 1983~1998 ($H_0: \theta_{83-98} = 0$) and 1999~2005 ($H_0: \theta_{99-05} = 0$) are 4.601 and 7.601, which are greater than the critical value ($\chi_{0.95}^2(1) = 3.84$). From this result, we can check whether and how domestic producers exert political oligopoly power when the government sets the raw milk price. Furthermore, their political power has increased more after the inauguration of KDC in 1999.

6. Interpretation

Two estimation results (direct cost estimation and the NEIO approach) show that we can see a certain degree of political oligopoly power of domestic producers in the raw-milk market. In other words, domestic raw-milk producers exert political power toward the government when the government sets the reference price for raw milk.

Answers for the two questions in section 2 can be interpreted using estimation results. First, estimation results show that the government effectively protects the domestic raw milk producers from domestic dairy processors by announcing the reference price for raw milk. Although the values for political oligopoly power from all three models are not great, test statistics show that they are different from zero, which means there exists a certain degree of political power of domestic raw-milk producers when the government sets the reference price for raw milk. Even though the test statistic for model 1 is slightly small, this is because model 1 does not separate the periods before and after the inauguration of the KDC. All results from model 1, 2, and 3 support that the government effectively protects domestic producers from the potential oligopsony power of domestic dairy processors. From the result of model 3, the degree of the political power of the producers before 1999 is around 0.04, which is not a big number but significantly different from 0. Hence, the domestic producers are supposed to exert slight market power before the inauguration of KDC.

Second, the inauguration of KDC shifts up the political oligopoly power of the domestic producers. The result of model 3 shows that the political power of the producers jumped from 0.04 to 0.13 after the inauguration of KDC in 1999. The hypothesis test for this result is also very convincing. Given

the slope of demand curve, the political oligopoly power of the domestic producers is determined by the raw milk price and marginal cost of the producers. Figure 1 shows that the gap between the raw milk price and marginal cost becomes larger in 1998 and stays almost constant after 1998. In late 1997, the Korean economy was under the foreign currency crisis, during which many inefficient domestic raw-milk producers went out of business; and the average marginal cost of making raw milk decreased in 1998. Although the average marginal cost dropped, the survived domestic raw-milk producers could enjoy their raised political power especially after the inauguration of KDC in 1999.

The establishment of KDC is evaluated as a failure considering its role of stabilizing the domestic demand and supply of raw milk (Song et al. 2005). But in the viewpoint of domestic raw-milk producers, the raw-milk price supported by the KDC is a good economic incentive for producers. If the degree of the political oligopoly power is not as great as estimated, the political influence of the producers' group cannot be a serious problem.¹⁴ The problem is that the raw-milk price has to reflect the market situation.¹⁵

7. Conclusion

This paper derives the supply relation of domestic raw-milk producers from the policy preference function of a social planner. From the first order condition of this problem, this paper obtains the supply relation of domestic raw milk in which the degree of political oligopoly power is a function of political weight of the social planner. A solution for this problem is found with a two stage game. With econometric tools, we can recover the political oligopoly power parameter.

To estimate the political oligopoly parameter, this paper directly estimates the cost function and calculates the marginal cost and the Lerner's Index

¹⁴ Many countries including Korea have spent a lot of money to support domestic farmers.

¹⁵ There are a lot of marketing channels from the producers to final consumers. Hence, we have to extend this study to elicit some information for a raw-milk pricing policy that reflects the domestic market situations.

directly. In addition, this paper uses the NEIO approach with cost information to check the availability of the NEIO approach. From direct estimation, this study gets 0.05 for the period 1983~1997 and 0.22 for the period 1998~2005 for the Lerner's Index (no adjustment for demand elasticity). With the NEIO approach with cost information, this study obtained political oligopoly power parameters (adjusted by demand elasticity) of 0.044 and 0.131 for the periods 1983~1998 and 1999~2005, respectively. Both results support our two statements: the producers exert their political power against the government by making the government raise the reference price above their marginal cost and the producers enhance their political power after the change of domestic political situation (the inauguration of the KDC in 1999).

The more fundamental problem argued by Corts (1999) and Kim and Knittel (2004) is that the estimate obtained by the NEIO approach may be biased and so this approach is not good to capture the real price cost margin. However, this problem is not serious in this study. If the reference price for raw milk is set by the government, this price remains constant for the time being. As a result, each producer has no incentive and option to break this announced price.

Still, there are several caveats to interpret the results of this study. Although this paper uses a generalized trans-log cost function, there still remains an approximation problem for the estimation of marginal cost. The estimated value of political oligopoly power is obtained in an industry level. Hence, some inefficient raw-milk producers may not have benefits from this average political power.

Song et al.(2005) criticize the current raw milk pricing policy in Korea, in which the raw-milk price received by domestic farmers does not correspond to the market situation especially when there is an over-production of raw milk. Economically, the estimation of marginal cost developed in this study can be meaningful to suggest the relevant level of raw-milk price considering the cost side. However, there still exists a problem for considering the demand side, which will be a good research topic for further study.

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Appendix

The profit of a representative domestic processor is

$$(A.1) \quad \pi_p = \left[\{P_{fl}^r(Q_{fl}^r)\} q_{fl} - \{P_{fl}^f + c_{fl}\} q_{fl} - F_{fl} \right] + \left[\{P_{pro}^r(Q_{pro}^r)\} q_{pro} - \{P_{pro}^f + c_{pro}\} q_{pro} - F_{pro} \right], \quad p = 1, 2, \dots, N$$

where q_{fl} (or q_{pro}) is the sales of fluid-milk product (or processed-milk product) of a domestic processor p to the domestic consumers, P_{fl}^f (or P_{pro}^f) is the unit cost of marketing and processing for fluid milk (or for processed milk) of the processor, P_{fl}^r is the unit cost for the processor to buy one unit of raw milk from domestic producers to make fluid-milk products, P_{pro}^r is the unit cost for the processor to buy one unit of raw milk from domestic producers to make processed-milk products, and F_{fl} (or F_{pro}) is a fixed cost for producing fluid milk (or processed milk) of the processor.

First of all, let's try to get a solution of the second stage in the fluid milk market. We obtain the optimality condition by differentiating the equation (A.1) with respect to Q_{fl} in the fluid-milk market and summing up these equations across all processors. The derived optimal condition for fluid milk is

$$(A.2) \quad P_{fl}^r(Q_{fl}) = \left(-\frac{\partial P_{fl}^r}{\partial Q_{fl}} Q_{fl} \xi_{fl} \right) + P_{fl}^f + c_{fl},$$

where ξ_{fl} is $\frac{\partial Q_{fl}}{\partial q_{fl}} \frac{q_{fl}}{Q_{fl}}$. By the same logic, we can obtain the optimal condition for processed milk by differentiating the equation (A.1) with respect to q_{pro} as

$$(A.3) \quad P_{pro}^r(Q_{pro}) = \left(-\frac{\partial P_{pro}^r}{\partial Q_{pro}} Q_{pro} \xi_{pro} \right) + P_{pro}^f + c_{pro},$$

where ξ_{pro} is $\frac{\partial Q_{pro}}{\partial q_{pro}} \frac{q_{pro}}{Q_{pro}}$.