**Estimating Time Variation of Market Power: Case of U.S. Soybean Exports**

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**Abstract**

As the development of methodology in new empirical industrial organization (NEIO), there have been increasing number of studies that estimate market power of sellers and/or buyers in various kinds of agricultural supply chains. Many of them, however, do not capture time variation of market power during the sample periods, even though they use long time series data. If the degree of market power actually changes along the time, such an estimation that uses only whole sample of the data may provide a misleading conclusion.

The main objective of this study is to establish a way of estimating time variation of market power and making a time series index of it. Such an index enables us to make a comparison with indices of market structure, such as market share, which has been one of the main research topics of traditional industrial organization studies. Empirical analysis is conducted using the case of the U.S. soybean exports.

The methodology employed in this study to estimate market power of the U.S. exporters is residual demand model, which enables us to derive the degree of market power and has widely been used in the context of international markets. To capture time variation of the market power, rolling window regression method is applied to the model, which is a methodology that repeats regressions using subsamples of total data by shifting the start

and end points with a fixed window. Using the parameter of residual demand elasticity in each rolling estimation, a time series index of market power is calculated.

The estimation results of rolling regressions of residual demand model using GMM-nonIV and the window size of 30 show that the U.S. had market power over importers to some extent until 1995, but had less and little power from the late 1990s to 2010. It also showed that the U.S. had almost no market power over China from 1996 to 2010. On the other hand, especially from the late 1990s, the U.S. had increasing market power over Mexico and Japan, although the extent was larger to Japan than to Mexico.

Using the estimated index of market power and published index of market shares, then the relation between market structure and performance was analyzed. The analysis indicates that the changes in market power of the U.S. soybean exporters to importers average correspond to the decrease of the U.S. market share in the world soybean exports and to the increase of importers concentration due to the increase of China's imports. It is also pointed out that indices of the U.S. market power over Mexico and Japan who depend soybean imports heavily on the U.S. may correspond to the changes in the market structure of the U.S. grain exporting industry.

## 1. Introduction

As the development of methodology in new empirical industrial organization (NEIO), there have been increasing number of studies that estimate market power of sellers and/or buyers in various kinds of agricultural supply chains[1]. Many of them, however, do not capture time variation of market power during the sample periods, even though they use long time series data. If the degree of market power actually changes along the time, such an estimation that uses only whole sample of the data may provide a misleading conclusion.

The main objective of this study is to establish a way of estimating time variation of market power and making a time series index of it. Such an index may enable us to make a comparison with indices of market structure, such as market share, which has been one of the main research topics of traditional industrial organization studies.

I chose the case of the U.S. soybean exports. Oilseeds are ones of commodities in which increasing number of researchers are interested, especially after the demand in emerging countries and that for biodiesel increased. Soybeans is the most produced and exported oilseed, and the U.S. exports is the largest, while a half of the traded soybeans is imported by China in these days. There are some previous studies that estimate market

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[1]  See, for example, a survey paper of Bresnahan (1989) and textbooks such as Kaiser and Suzuki (2006), Perloff et al. (2007), etc.

powers of exporters and/or importers. Pick and Park (1991) estimated market power of the U.S. in the agricultural exports and found that the U.S. had no market power in soybean exports over any major importers except for the Netherlands in 1978-1988 periods. Thraen et al. (1992) argued that the U.S. monetary growth may have important impacts on the competitive position of the U.S. in soybean exports through exchange rates, and pointed out that a weak dollar increases imports of soybeans significantly, which induces the increase in the equilibrium world price and increase in the exported quantity of exporters, and that, during periods of expansionary monetary policy in the U.S., there is little evidence of significant increases in the U.S. market share. Song et al. (2009) showed that import companies in China had more market power than did exporters in the U.S. from 1999 to 2005 using the two-country partial equilibrium model.

However, the time variation of the degree of market power is not the central interests in these studies. This point is one of the important motivation of Nakajima (2011), where asymmetric price transmission of soybeans from the U.S. domestic prices to its export prices were estimated, taking into consideration the time variation of the parameters. The study revealed that the price transmission was asymmetric in the way that the U.S. enjoyed excess profits over importers from 1967 to 1977, then symmetric or slightly

asymmetric in the way that the importers enjoyed excess profits until 1988. The asymmetry

transitioned back to the way that the U.S. enjoyed excess profits until the latter half of the

1990s and became the opposite way that the importers enjoyed excess profits again

afterwards. Although asymmetric price transmission is considered to have some causes

such as market power, the measure of the asymmetry is not directly connected with the

degree of market power.

The methodology employed in this study to estimate market power of the U.S.

exporters is residual demand model, which enables us to derive the degree of market power

and has widely been used in the context of international markets[2]. Residual demand

elasticity represents the degree of sellers' market power, taking into consideration the

demands that other competitors face in a selected importer's market.

To capture time variation of the market power, rolling window regression method

is applied to the residual demand model. Rolling window regression is a methodology that

repeats regressions using subsamples of total data by shifting the start and end points with a

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[2]  Baker and Bresnahan (1988) introduced the model and estimated the market powers of the three
largest U.S. beer companies. Goldberg and Knetter (1999) applied the model to the analysis of
international markets and conducted two empirical analyses using the case of German beer exports to
four importers and of the U.S. linerboard paper exports to six importers. Silvente (2005) analyzed the
case of the ceramic tile industry in Italy and Spain, and estimated pricing-to-market in the first step
and market powers of exporters in the second step. Reed and Saghaian (2004) estimated the market
powers of Australia, Canada, New Zealand, and the U.S. over Japan in exporting beef and Felt et al.
(2011) estimated the market power of the U.S., Canada, and Denmark over Japan in exporting pork.

fixed window. Using the parameter of residual demand elasticity in each rolling estimation, a time series index of market power is calculated.

This paper is organized as follows. In section 2, the residual demand model is reviewed, rolling window methodology is explained, and then a way of indexing degree of market power is proposed. In section 3, empirical analysis of these methods is conducted using the case of the U.S. soybean exports. Then the relation between the indices of market power and indices of market structure is discussed. Finally, concluding remarks and policy implications are drawn in section 4.

## 2. Model and Methodology

2.1. Residual Demand Model

The residual demand model shown here is based on Goldberg and Knetter (1999). Consider a target exporting country, $A$, who exports soybeans to a specific importing country, $M$, with $k$ ($\in [1,n]$) competing exporting countries. The (inverse) demand functions that $A$ and $k$ face are written respectively as:

$$p^A = D^A(Q^A, p^1, p^2, \cdots, p^n, Z) \tag{1}$$

$$p^k = D^k(Q^k, p^j, p^A, Z) \quad (j = 1, \cdots, n \wedge j \neq k) \tag{2}$$

where $p$ is export price, $Q$ is exported quantity, and $Z$ is demand shifter in country $M$.

Each exporting firm $i$ in $A$ solves the following profit maximization problem:

$$\max_{q_i^A} \pi_i^A = p^A q_i^A - e C_i^A \tag{3}$$

where $e$ is the currency of $M$ per the currency of $A$ and $C_i^A$ is costs.

The first-order condition of profit maximization in the industry average in $A$ is:

$$p^A = e M C^A - Q^A D_1^A \theta \phi \tag{4}$$

where $MC^A$ is marginal cost, $D_1^A$ is partial derivative of $D^A$ with respect to $Q^A$, $\theta$ is industry average conjectural variation in $A$, and $\phi$ captures the competitive interaction between $A$ and $k$. Similarly, F.O.C. of profit maximization in $k$ are:

$$p^k = e^k MC^k - Q^k D_1^k \vartheta^k \quad (k = 1, \cdots, n) \tag{5}$$

where $D_1^k$ are partial derivatives of $D^k$ with respect to $Q^k$ and $\vartheta^k$ are conjectural variations in $k$.

Assuming $MC^k$ are functions of $Q^k$ and cost shifters ($W^k$), and using the demand functions and the first-order conditions for $k$, the partial-reduced form of $p^k$ are solved as:

$$p^k = p^{k*}(Q^A, W^N, Z, \vartheta^N), \quad k = 1, \cdots, n \tag{6}$$

where $W^N$ is the union of all firm-specific cost shifters and $\vartheta^N$ is the union of all the conduct parameters for $k$ ($W^A$ and $\theta$ are not included, respectively).

The residual demand curve facing $A$ is derived as:

$$p^A = D^{RA}(Q^A, W^N, Z, \vartheta^N) \tag{7}$$

That is, the residual demand of $A$ is represented using the three observable arguments: $Q^A$, $W^N$, and $Z$. The econometric model of this residual demand function can be written as:

$$\ln p_{Mt}^A = \gamma_M + \eta_M \ln Q_{Mt}^A + \alpha_M' \ln Z_{Mt} + \beta_M' \ln W_{Mt}^N + \epsilon_{Mt} \tag{8}$$

where $\epsilon_{Mt}$ is i.i.d. error term and the other Greek letters denote parameters.

The parameter $\eta_M$ represents degree of market power. If $\eta_M = 0$ then the residual demand curve is flat and the target country $A$ is unable to change the export prices

to the country $M$ by changing the quantity exported. This is consistent with the case of perfect competition. However, if $\eta_M < 0$ then the residual demand curve has downward slope and the exporter $A$ has market power over the country $M$. In general, steeper residual demand curves indicate more market power (Goldberg and Knetter, 1999).

Estimation of (8) may be conducted by both simultaneous and single equation models. In this study, two-stage least squares (2SLS), seemingly unrelated regressions (SUR), three-stage least squares (3SLS) are employed as simultaneous equation models, and 2SLS (instrumental variable, or IV, method), IV using general method of moments (mentioned as GMM-IV), and non-IV GMM (GMM-nonIV) as single equation models.

2.2. Rolling Window Methodology

Rolling window regression is a methodology that repeats regressions using subsamples of total data by shifting the start and end points with a fixed window. As explained in Zivot and Wang (2006), rolling analysis of a time series model is often used to assess the model's stability over time. If parameters are truly constant over the entire sample, then the estimates over the rolling windows should not be very different. However, if the parameters change at some points during the sample, then the rolling estimates should

capture this instability.

Here the rolling window methodology is applied to the residual demand model mentioned in the previous subsection, based on Nakajima et al. (2011). The rolling regression model of residual demand function (8) can be written as:

$$\ln p_{Mt(i)}^A = \gamma_{Mi} + \eta_{Mi} \ln Q_{Mt(i)}^A + \alpha_{Mi}' \ln Z_{Mt(i)} + \beta_{Mi}' \ln W_{Mt(i)}^N + \epsilon_{Mt(i)}, i = 1, \cdots n \quad (8')$$

where $i$ is the number of rolling regression, $t(i) \in [i, i + w - 1]$ represents time periods in $i$'s rolling regression, and $w$ the window size. If the total observation number is $N$ and the interval, or the increment of time period between the adjacent rolling regressions, is $d$, then the total number of rolling regression, $n$, is written as follows:

$$n = \left\lfloor \frac{N - w}{d} \right\rfloor + 1 \quad (9)$$

where $\lfloor \ \rfloor$ indicates floor function.

The parameters of rolling window regressions depend on the interval of each regression and window size. Smaller $d$ provides more detailed transition, hence $n$ is maximized when $d = 1$. It should be recommended that smaller intervals, such as one, be chosen by considering the functional processing ability of computers. As for window size, the smaller the window size, the more detailed the movement of the time-varying parameters; however, in this case, the variation in the movement is large (Su and Hwang,

2009). Conversely, a large window makes it difficult to determine possible structural changes in the subsample. The window size depends on the choices or the aims of the research. Swanson (1998) used 10-year (120-month) and 15-year (180-month) windows, while Su and Hwang (2009) compared the estimation results of 13, 25, 39, and 51 windows. In any case, some sensitivity tests or robustness check should be conducted during the empirical analysis.

2.3. Index of Market Power

Next, market power indices are defined using the results of rolling window estimation. First, using $\eta_{Mi}$ in (8'), define a type of market power indices as follows:

$$MP_i^1 = \eta_{Mi} \tag{10}$$

$$MP_i^2 = \begin{cases} \eta_{Mi} & \text{if significant} \\ 0 & \text{otherwise} \end{cases} \tag{11}$$

$MP_i^1$ is the elasticity of residual demand itself and $MP_i^2$ takes statistical significance into consideration. These indices can capture changes in the degree of market power of the exporter, but have no time index which is consistent with the one of the sample. Therefore, consider secondly another definition of market power indices as follows:

$$MP_t^k = \frac{1}{n_t} \sum_{i=\max(1,\,t-w+1)}^{\min(t,\,T-w+1)} MP_i^k, \quad n_t = \min(t,\ w,\ T-t+1), \quad k = 1, 2 \tag{12}$$

$MP_t^k$ are calculated by averaging $MP_i^k$ in each $t$.

**3. Empirical Analysis**

3.1. Data

The data used as $p_M^A$ are the U.S. soybean export unit prices to the importers; i.e., China, Mexico, and Japan, which were obtained from USDA's Global Agricultural Trade System (GATS). These price data were expressed in the importers' currency using the exchange rates between the U.S. and the importers (IMF-IFS) and were deflated using consumer price indices of each importers (100 in the year of 2005, IMF-IFS). $Q_M^A$ are exported soybean quantity from the U.S. to each importer, the source of which are USDA-GATS. Regarding $Z_M$, crude steel production of each importer was used as an index of economic growth, because GDP data of China prior to 1998 was not available. As the cost shifters, $W_M^N$, bilateral exchange rates between the competitors and the importers and the producer price index (PPI) were used. The competitors here are Brazil and Argentina. Because the data of their wage indices were not available, PPI were substituted for the indices, as previous studies such as Goldberg and Knetter (1999).

In the estimation of simultaneous equation models, quarterly data from the 4th quarter of 1995 to the 4th quarter of 2010 were used. Although the exchange rates of the competitors were available from 1993, exported quantity and prices to China from the 2nd

quarter of 1994 to the 3rd quarter of 1995 were not available due to no trade[3].

In the estimation of single equation models, an equation using the data of the U.S. total soybean exported quantity and the unit prices was estimated, which is denoted hereafter as "importers average" equation to represent the overall tendency of the U.S. market power in soybean exports[4]. Here the data from the 1st quarter of 1993 to the 4th quarter of 2010 were used to estimate the U.S. market power over Mexico, Japan, and importers average while the data from the 4th quarter of 1995 were used to estimate market power over China.

3.2. Total Sample Estimation Results

Using total sample, both the simultaneous equaion models and single equation models were estimated. Regarding the simultaneous equation models, Hausman test showed that OLS and SUR were prefereble than 2SLS and 3SLS, respectively, indicating

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[3]  The exported quantity of the 3rd quarter of 2001 and the 2nd quarter of 2004 to China were also zero, hence the quantity and price data of these quarters were interpolated by the method of "ipolate" command in Stata, using the data of the U.S. average soybean exported quantity and unit prices as the references. Because using long-time interpolated data in estimation may bring bias, the data from the 4th quarter of 1995 were used. It may be possible to use monthly data. However, there were more zero values on exported quantity to China. Therefore, monthly data were not used due to the same reason mentioned above.

[4]  As a demand shifter, $Z_M^A$, the indices of industrial production in developed countries were used (100 in the year of 2005, IMF-IFS). As the exchange rates, U.S. Dollar was used.

that $Q_M^A$ should be exogenous. And Breusch-Pagan test in the 3SLS model showed that there were correlations in errors of the equations, suggesting that SUR is more efficient than OLS. The estimation results using SUR is shown in Table 1.

In Table 1, the parameters of log of quantity for Mexico and Japan are shown to be significantly negative. This means that the residual demand elasticities for these countries are significantly lower than zero, which indicates that the U.S. had market power in exporting soybeans to Mexico and Japan. On the other hand, the parameter for China is not significantly different from zero, which suggests that the U.S. did not have market power over China.

Looking at the coefficient of cost shifters, all the parameters in the equation of Japan are significantly positive. This represents that if the competitors reduce the costs ($W_M^A$ decreases), then the U.S. must decrease the export price ($p_M^A$), implying that the competitors restrict the U.S. market power. In the case of soybean exports to Japan, the estimation results indicate that Brazil and Argentina are such competitors that constrain the exercise of market power by the U.S. Meanwhile, in the equations of Mexico and China, the coefficients of exchange rates with Brazil and Argentina and PPI of Argentina are positive and significant. This results suggest that mainly Argentina plays an role for restricting the

U.S. market power over Mexico and China.

Although the SUR model was found to be appropriate among simultaneous equation models, the Durbin-Watson d-statistics are much lower than 2, which implies the existence of serial correlation in the error terms. In addition, Matsuura and McKenzie (2001) points out that if there is misspecification in at least one equation in SUR model, the whole equation system may be biased. Therefore, single equation models using 2SLS (IV), GMM-IV, and GMM-nonIV were then conducted. According to the endogeneity tests using Hausman's (1978) regression-based test for 2SLS and Hayashi's (2000) C-statistic for GMM-IV, the null hypothesis of exogeneity was not rejected in all importers' and importers average equations. Furthermore, the GMM-nonIV model employed here used standard errors which are robust to heteroskedasticity and serial correlation and are suitable for small sample estimation. Below, the estimation results of GMM-nonIV are described.

Table 2 shows the results of GMM-nonIV estimation using the equations of China, Mexico, Japan, and importers average. The residual demand elasticity in the equations of Mexico, Japan, and importers average are significantly negative. Therefore, it suggests that the U.S. had market power over these countries and importers average in exporting soybeans. On the other hand, it implies that the U.S. could not exercise market power in the

case that it exports soybeans to China.

According to Table 2, significantly positive cost shifters are PPI of Argentina for Japan, bilateral exchange rates with Brazil and Argentina and PPI of Argentina for Mexico and China, and bilateral exchange rates with Argentina and PPI of Argentina for importers average. The results for Mexico and China is consistent with those of the SUR model; i.e., mainly Argentina constrains the U.S. market power over Mexico and China. However, the results for Japan is slightly different from those of the SUR model. According to GMM-nonIV model, not Brazil but Argentina restricts the exercise of market power by the U.S. over Japan. To the aggregated importers of the U.S. soybeans, market power may be weakened by Argentina.

3.3. Rolling Window Estimation Results

Next, estimations using rolling window methodology were conducted to see the changes in parameters in residual demand model. Here the results of GMM-nonIV model are shown because they were found in the previous subsection to be most robust among simultaneous and single equation models. Furthermore, rolling regressions with the window size of 30 (quarters) were focused and other regressions using different window size will be

explained later.

The indices of the U.S. market power, $MP_i^k$, over each country and importers average are calculated and shown in Figure 1. The dotted lines are $MP_i^1$ and the black circle on the lines are $MP_i^2$ where the residual demand elasticities are significantly negative at 10% level. Figure 1 (a) shows the $MP_i^1$ for importers average where the absolute values were large and significant when $i$ equals to 1 through 5, but then it decreased and became insignificant until $i$ reached around 20. $MP_i^1$ increased in absolute value and became significant when $i$ is from 25 to 31 but it decreased and became insignificant again with the exception when $i$ equals 39 and 40.

Figure 1 (b), (c), and (d) represent $MP_i^1$ and $MP_i^2$ for Japan, Mexico, and China, respectively. The index for Japan was close to zero when $i$ equals from 1 to around 18 but it increased in absolute value and became significant where $i$ is larger than 20 and remained at the same level until the end of the rolling regression ($i$ equals to 43). The index for Mexico was also close to zero when $i$ is from 1 to 8, but it increased in absolute value and became mostly significant when $i$ is from 9 to 40. However, the level of the value is lower than that of Japan in absolute value. On the other hand, the index for China was significantly negative when $i$ is from 1 to 3, but then it became close to zero and

insignificant until the end of the rolling regression.

Using the transformation equation (12), $MP_t^1$ and $MP_t^2$ are calculated using $MP_i^1$ and $MP_i^2$, respectively. Figure 2 (a) shows $MP_t^1$ for each importer and importers average. $MP_t^1$ for importers average was negative throughout the period (1993-2010), but its absolute value decreased from 1996 and stayed at lower level compared to the one in 1993-1995. For China, $MP_t^1$ was slightly different from zero and negative until the end of 20th century, but it was almost zero after 2000. On the other hand, $MP_t^1$ for Mexico was close to zero until 1995, but then its absolute value increased and remained at almost same level from 2000 to 2010. And $MP_t^1$ for Japan was also near zero until 1997, but it increased in absolute value from 1998 and kept increasing until 2009.

$MP_t^2$ for each importer and importers average are shown in Figure 2 (b). Because the index takes statistical significance into consideration, the absolute values are lower than those of $MP_t^1$. For importers average and China, the values were close to zero in most sample period, while the ones for Mexico and Japan were different from zero especially from the end of 1990s to the end of 2000s.

$MP_t^1$ using the window size of 20 and 40 are shown in Figure 3 (a) and (b) respectively. $MP_t^1$ with window 20 seem to capture more detailed movements than those

with the original window size of 30. However, the number of observation in each rolling

regression is so small that the estimation may lose efficiency. Meanwhile, sample size of

$MP_t^1$ with window 40 seems enough although it is difficult to capture more detailed

changes in parameters than those with smaller window sizes. Nevertheless, the tendency of

the movements of $MP_t^1$ and the level of $MP_t^1$ using different window size are similar to

each other.

Furthermore, the rolling regression of SUR model provides the similar movements

of the indices of market power $(MP_t^1)$ as shown in Figure 4. These comparisons indicate

that the degrees of and the changes in the U.S. market power over the selected importers

and importers average are essentially robust to any window sizes and model selection

including single/simultaneous equation models.

3.4. Relation to Market Structure

Using data on market shares and the calculated time series of market power,

market structure and market performance become comparable. The U.S. market share in the

world soybean exports, soybean importers' Herfindahl-Hirschman Index (HHI), and a

market power index, $MP_t^1$, for importers average are shown in Figure 5. The movements of

these indices indicate that the U.S. share has decreased, especially from the late 1990s, and the U.S. market power also decreased (in absolute value) from the similar period. The correlation coefficient of these indices was -0.232, hence the decrease in the U.S. market power may correspond with the decrease in the U.S. market share, although the coefficient was not statistically significant. Meanwhile, the HHI of importers increased in 2003 and 2008, mainly due to the increase of China's soybean imports, and the U.S. market power decreased further in 2007. The correlation coefficient was 0.472 and statistically significant at 10% level, hence there should be such a relationship that as the HHI of importers increases, the U.S. market power decreases.

For Mexico and Japan, the shares of the U.S. in soybean imports in these countries are relatively high and stable: 96% in Mexico[5] and 77% in Japan[6]. The U.S. market power over these countries may mainly depend on the concentration of the U.S., not on its competitors. According to Isoda (2001), the U.S. grain exporting industry was highly concentrated and became more concentrated from the 1980s to the late 1990s. In these periods, some grain majors such as ADM, ConAgra, CHS, etc. obtained larger shares, and

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[5] Weighted average from 1990 to 2009. The data source is UN Comtrade.
[6] Weighted average from 1988 to 2009. The data source is Trade Statistics of Japan, Ministry of Finance, Japan.

the largest company, Cargill, mergered the grain division of the second largest company, Continental Grain, in 1997. The concentration ratio of top five companies in the share of storage capacities of export elevators was 52-55% in the 1970s, 53.4% in 1992, and it changed to 64.8% in 1997 and 69.2% in 2007 (Isoda, 2001). Thus, the industry became more concentrated especially in the late 1990s. Meanwhile, the U.S. market powers over Mexico and Japan were zero in the early 1990s but they increased in the late 1990s. Therefore, there should be some relation between the U.S. market power over these countries and the market structure in the U.S. exporters, although it is not easy to show that statistically due to the limitation of data on the market structure.

The share of the U.S. in China's soybean imports has been relatively low and unstable compared to those for Mexico and Japan; it was averaged to around 44% in 1992 through 2009. Hence, the U.S. market power over China should depend not only on the U.S. concentration but also those of its competitors, which may be represented by the U.S. share in the world soybean exports as a proxy. As shown in the previous subsection, the U.S. had no market power over China in 1996-2010. Because the U.S. share had already been low since the late 1990s, the market share and the market performance should be corresponded.

## 4. Conclusion

This paper estimated the degree of the U.S. market power in soybean exports and its changes using the residual demand model and its rolling window regression. The empirical results indicated that the U.S. had market power over importers average in the early 1990s but it lost market power from the late 1990s. The U.S. had also no market power over China from the latter of 1990s. On the other hand, the U.S. could not exercise market power over Mexico and Japan in the early 1990s, but it had the power from the late 1990s. Using the estimated indices of market power and the indices of market shares available from official statistics and previous studies, it was confirmed that there is relation between the market structure and market performance to a degree.

Because the indices of market power actually changed throughout the given sample periods, there should be a risk by drawing conclusions according to the estimation results using the whole sample in a time series analysis. Another implication of this study is that making the time series indices of market power enalbes us to compare them with the indices of market structure, which had been one of the main topics in the traditional industrial organization researches but was not easy to be implemented using the case of a single industry.

According to the empirical results that the U.S. had market power over Mexico and Japan, possibly because these importers depend soybean imports mainly on the U.S. and the U.S. exporters' concentration increased, one recommendation for these importers is that they should import more soybeans from the competitors of the U.S. such as Brazil and Argentina. However, in the case of Japan, it is not easy to shift the origin due to the preference for the U.S. soybeans, or the high switching costs: the Japanese consumers prefer relatively high and homogeneous quality, and Japan also depend corn imorts on the U.S. and needs to import corn and soybeans at the same time to reduce the deadweight loss in a vessel. If the soybeans from south America has lower quality or more heterogeneity in quality, it should be another recommendation that the importers invest on research and development activities for soybean (or even corn) quality improvement and/or on the infrastracture that enables more efficient and traceable grain distribution in the south American countries, which should induce less product differentiation and more competition among soybean exporters.

This study focused on the soybean exports, but soybean exporters may face the competition with exporters of other vegetable oils and oilseeds such as palm oil and rapeseed (canola). Taking into consideration the substitutability of these vegetable oils and

oilseeds should be important and beneficial, hence should be conducted in the future. The assumption of perfect competition in the individual importing countries may be relaxed and possibility of bilateral oligopoly should also be considered in the future work. Furthermore, a food system approach that include several stages of supply chains should have more implications especially for grain importers like Japan, because it is possible to show which industries have more impacts (or how much impact) on the end users in the importing countries.

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**Tables**

## Table 1 Estimation Results of Residual Demand Model with SUR

| $\ln p_M$ | Japan | Mexico | China |
|---|---|---|---|
| $\ln Q_M$ | -0.120 *** | -0.057 ** | -0.002 |
| | (0.033) | (0.029) | (0.008) |
| $\ln CSP_M$ | -0.305 *** | -0.442 *** | -0.198 |
| | (0.097) | (0.084) | (0.121) |
| $TREND$ | -0.023 *** | -0.039 *** | -0.020 *** |
| | (0.005) | (0.006) | (0.005) |
| $\ln(M/BRL)$ | 0.418 ** | 0.496 *** | 0.394 ** |
| | (0.164) | (0.187) | (0.172) |
| $\ln(M/ARS)$ | 0.294 * | 0.668 *** | 0.371 ** |
| | (0.177) | (0.186) | (0.174) |
| $\ln PPI_{BRA}$ | 0.814 *** | 0.382 | 0.390 |
| | (0.297) | (0.342) | (0.304) |
| $\ln PPI_{ARG}$ | 0.801 *** | 1.616 *** | 1.086 *** |
| | (0.303) | (0.329) | (0.296) |
| $cons.$ | 6.276 *** | 3.643 *** | 3.335 *** |
| | (1.209) | (1.180) | (1.124) |
| DW d-statistics | 0.566 | 0.566 | 0.527 |
| Breusch-Pagan test of independence | | 120.254 *** | [0.000] |
| Hausman Test | | 0.36 | [0.999] |

Notes:

1. Values in ( ) and [ ] represent standard errors and p-values, respectively.

2. The null hypothesis of Hausman test is that SUR is preferable to 3SLS.

3. Breusch-Pagan test tests the null hypothesis that there is no correlation between errors in each equation in SUR model.

4. ***, **, and * represent significance at 1%, 5%, and 10% level, respectively.

**Table 2 Estimation Results of Residual Demand Model with GMM-nonIV**

| $\ln p_M$ | Japan | Mexico | China | Importers average |
|---|---|---|---|---|
| $\ln Q_M$ | -0.101 * | -0.056 * | -0.004 | -0.031 ** |
| | (0.053) | (0.033) | (0.010) | (0.012) |
| $\ln CSP_M$ | -0.201 *** | -0.550 *** | -0.580 | -0.570 |
| | (0.070) | (0.117) | (0.359) | (0.382) |
| $TREND$ | -0.008 * | -0.034 *** | -0.011 | -0.005 |
| | (0.005) | (0.003) | (0.010) | (0.003) |
| $\ln(M/BRL)$ | 0.082 | 0.391 *** | 0.552 ** | 0.164 |
| | (0.245) | (0.136) | (0.235) | (0.184) |
| $\ln(M/ARS)$ | 0.573 | 0.600 *** | 0.223 ** | 0.540 ** |
| | (0.413) | (0.161) | (0.111) | (0.253) |
| $\ln PPI_{BRA}$ | 0.112 | 0.140 | 0.551 | 0.117 |
| | (0.256) | (0.127) | (0.365) | (0.173) |
| $\ln PPI_{ARG}$ | 1.146 ** | 1.615 *** | 1.014 *** | 1.100 *** |
| | (0.542) | (0.253) | (0.277) | (0.314) |
| $cons.$ | 6.060 ** | 5.620 *** | 6.774 ** | 4.113 ** |
| | (2.850) | (1.166) | (2.559) | (1.675) |
| $R^2$ | 0.696 | 0.821 | 0.720 | 0.789 |

Notes:

1. Values in ( ) and [ ] represent standard errors and p-values, respectively.

2. Standard errors are heteroskedasticity and autocorrelation consistent, and suitable for small sample estimations.

3. ***, **, and * represent significance at 1%, 5%, and 10% level, respectively.

**Figures**

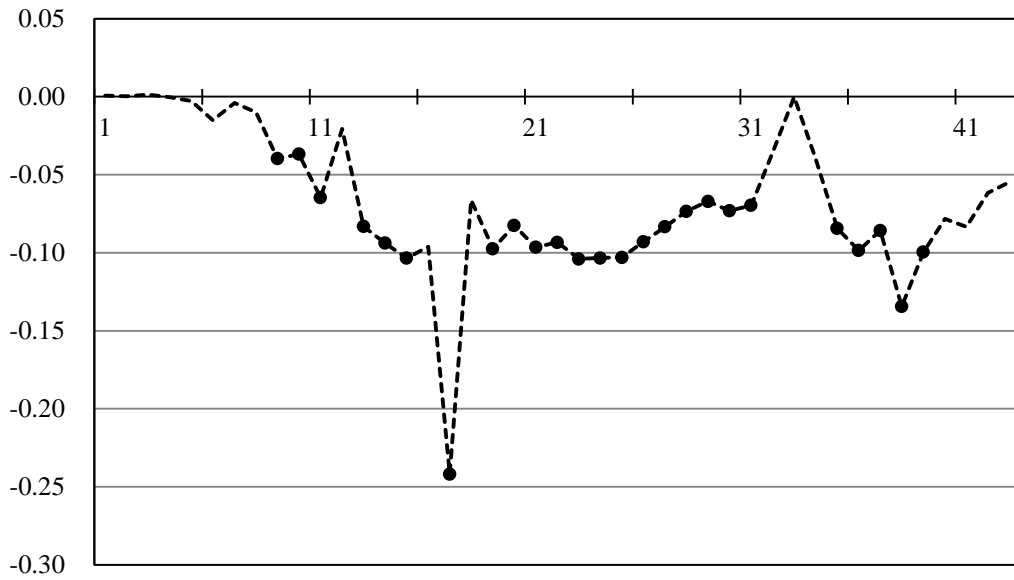(a) Importers Average
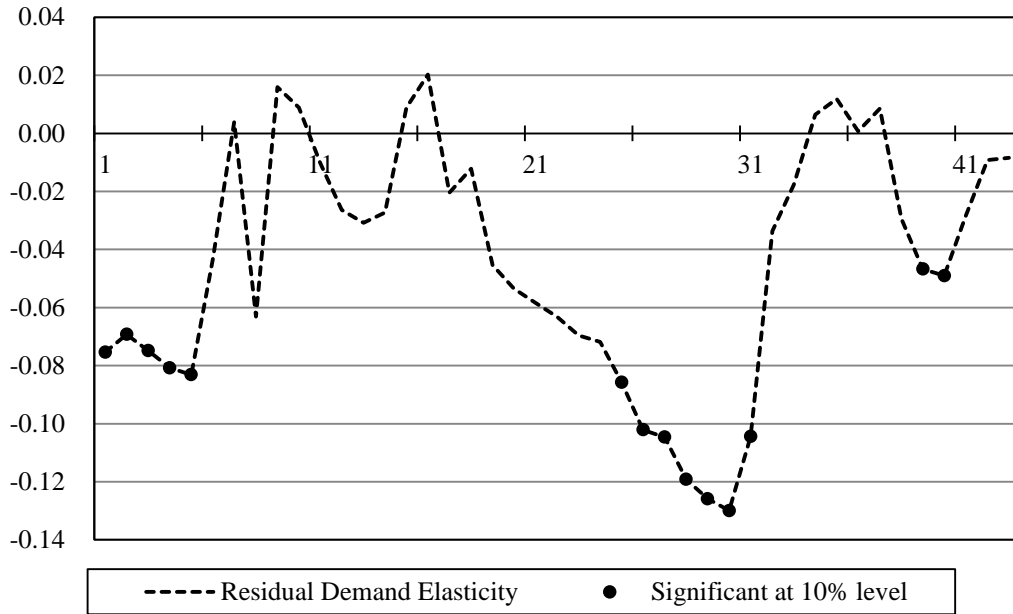


(b) Japan
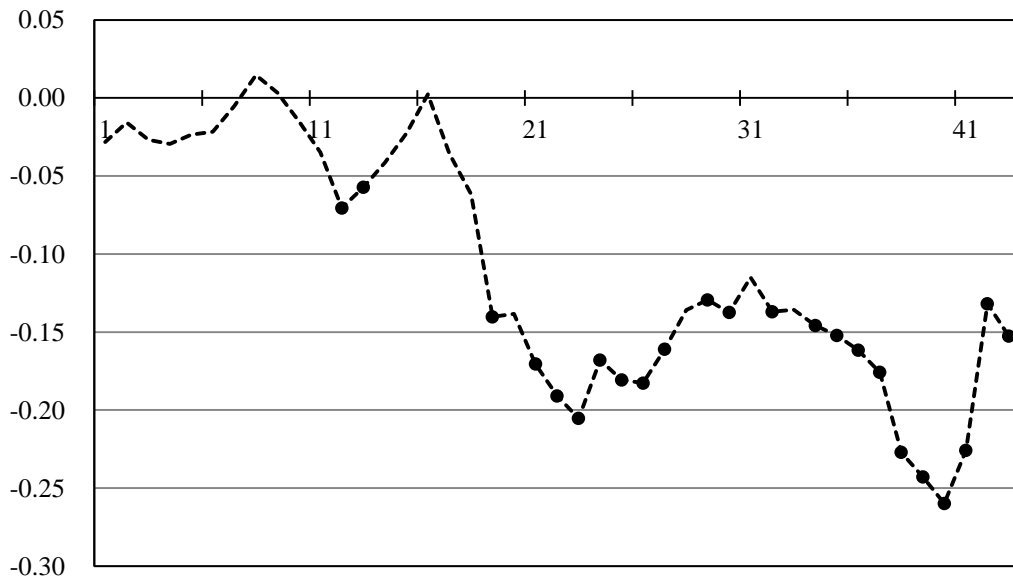


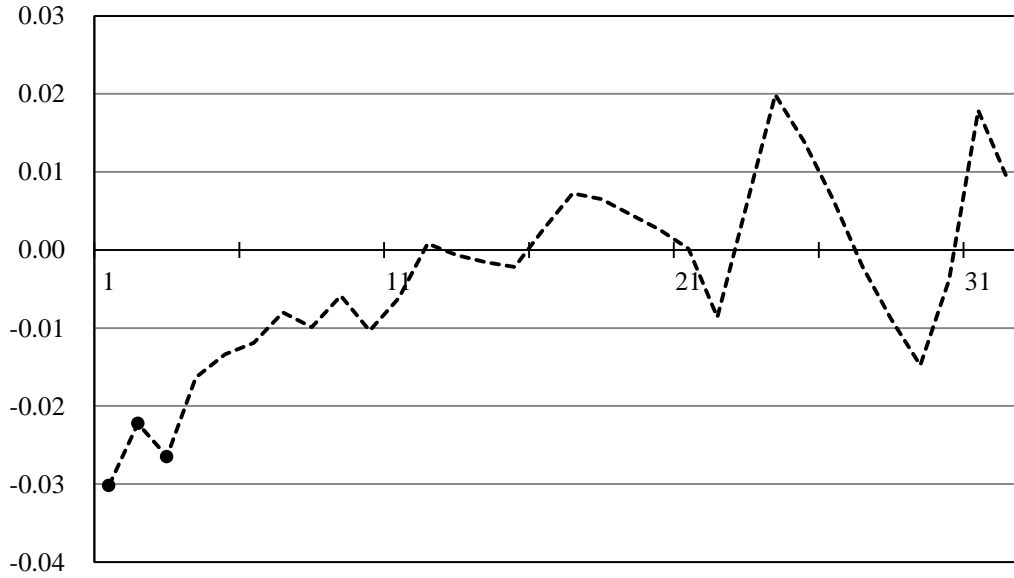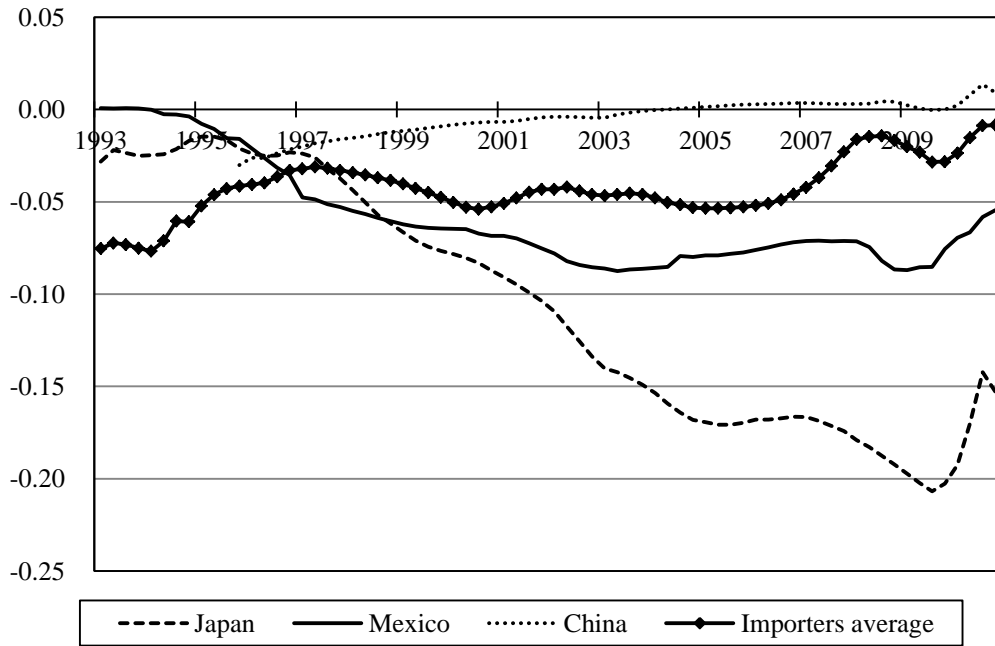**Figure 1 Changes in $MP_i^1$ and $MP_i^2$**

(c) Mexico



(d) China



**Figure 1 Changes in $MP_i^1$ and $MP_i^2$**

Note: For China, $i = 1$ is a regression using the sample from 4th quarter of 1995 to 1st quarter of 2003. For other importers and importers average, the rolling regression starts with the sample from 1st quarter of 1993 to 2nd quarter of 2000.
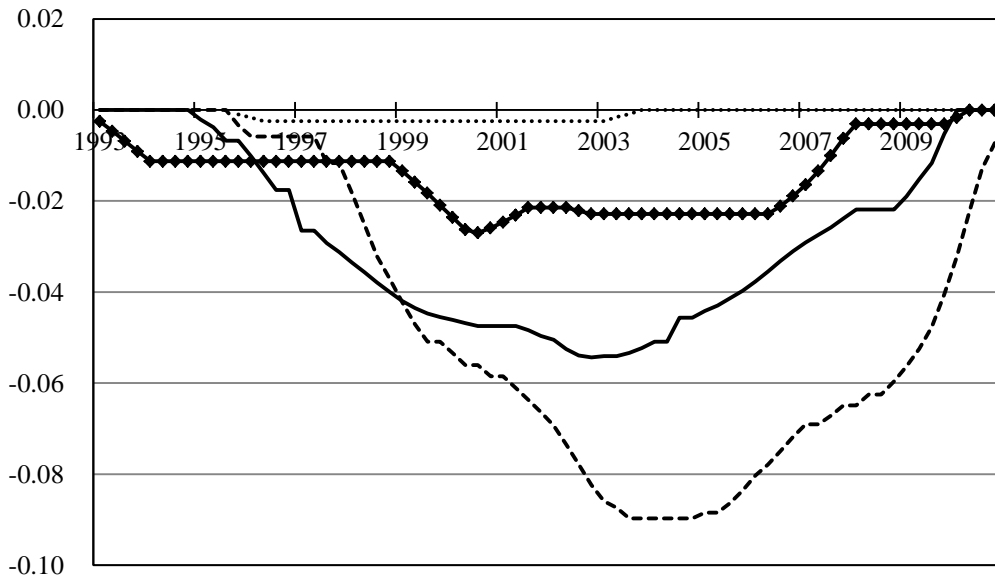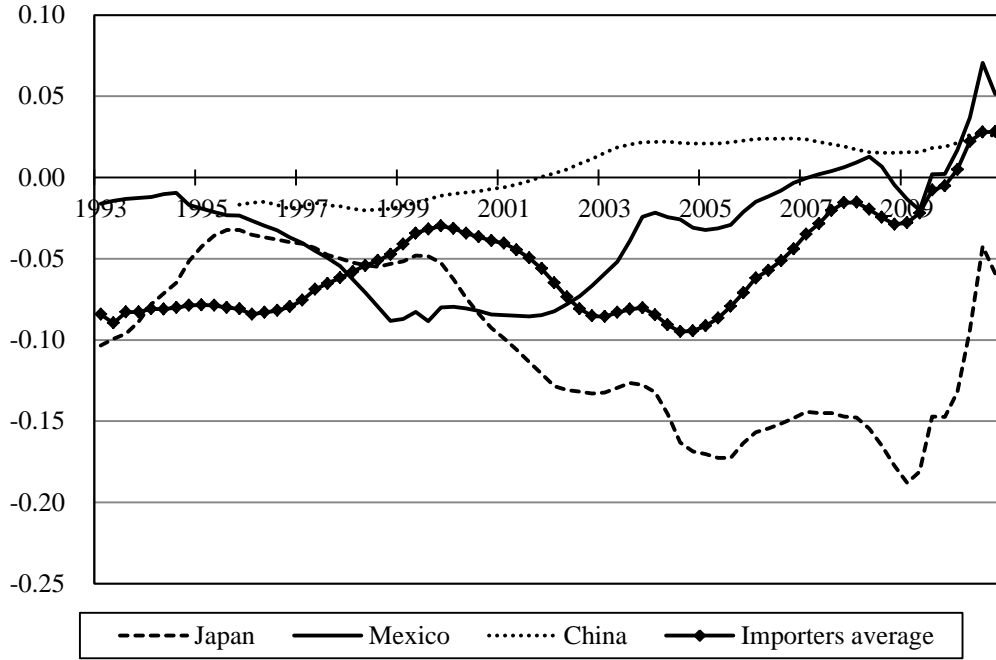
(a) $MP_t^1$



(b) $MP_t^2$



**Figure 2 Changes in $MP_t^1$ and $MP_t^2$**

Note: The indices are calculated using the window size of 30.

(a) Window Size: 20



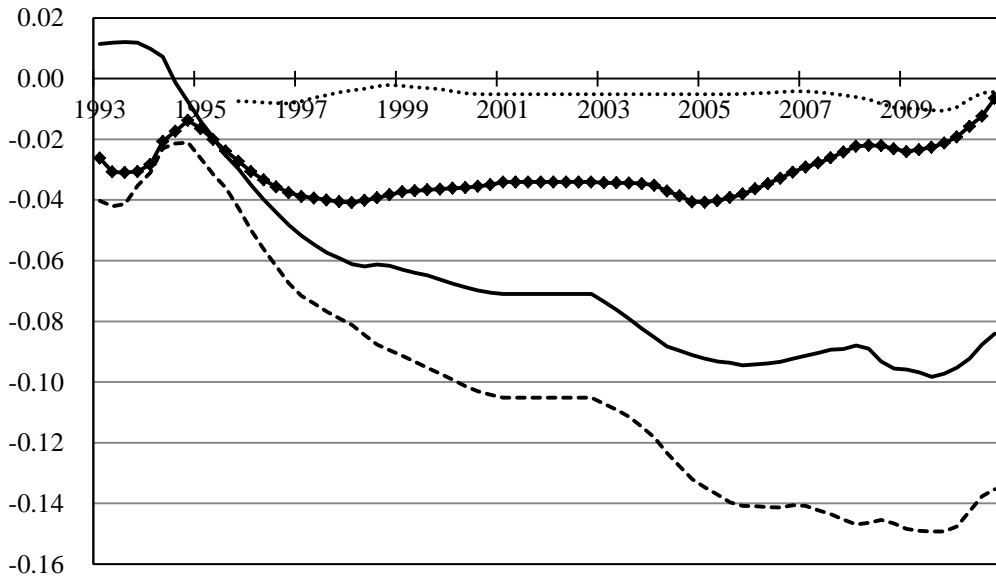| | |
|---|---|
| - - - - Japan | ——— Mexico |
| ·········· China | ——◆—— Importers average |

(b) Window Size: 40



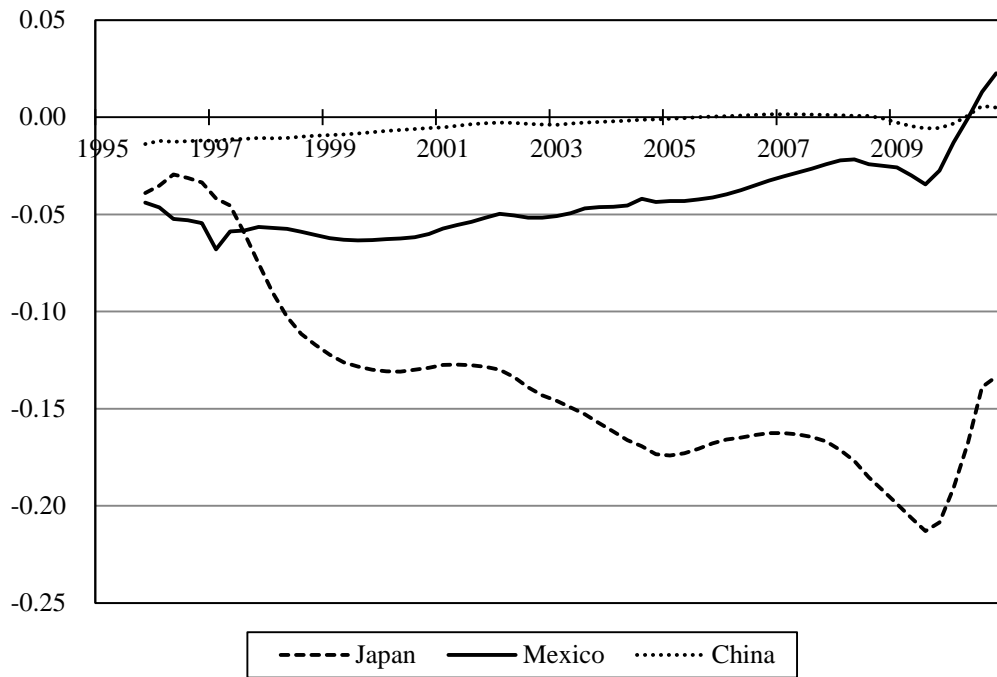**Figure 3 Changes in $MP_t^1$ Using the Other Window Size**

**Figure 4 Changes in $MP_t^1$ Based on the SUR Model**

Note: The indices are calculated using the window size of 30.
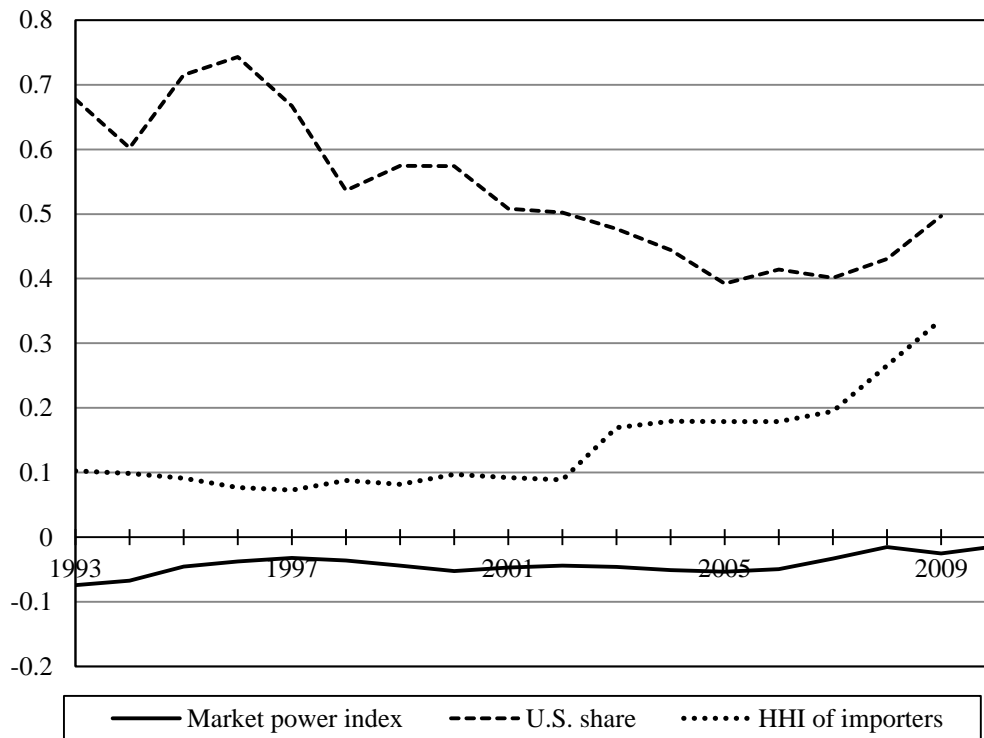
**Figure 5 Indices of Market Structure and Performance**

Sources: The U.S. share in the world soybean exports was calculated from the data of FAOSTAT, HHI of importers from the data of USDA-GATS, and the market power index is $MP_t^1$ for importers average using the window size of 30.