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Thai Sugar Market Power in Japan Market

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Abstract: *Purpose - This paper aims to measure the degree of market power for Thai sugar exporters in Japan market. Methodology – This paper adopted nonlinear GMM to estimate the demand and supply equations. Findings – Thai sugar is not competitive in Japan market. Originality/Value – This paper followed* Devadoss *et al. (2013) which proved that only demand and supply equation are enough to enable identification process of conjectural elasticity and inverse market demand elasticity which discussed by Appelbaum (1982)*

Keywords: Market Power, Sugar, Japan, nonlinear GMM.

Paper type: Research paper

1. Introduction

Japan is one of the world's top ten leading importer of sugar. The Japan government protected the domestic sugar production by a high rate of tariff and ad valorem tax. The protection was later alleviated by reducing custom rate of specific duty on raw sugar and ad valorem. According to the liberalization policy of imported sugar in 1963, the domestic price of sugar was oscillated. To protect consumers and producers, the government agency has bought and sold imported and domestically produced sugar to keep domestic wholesale prices in a range set by the government. As a result of government intervention, sugar prices paid to domestic producers are much higher than the import prices.

Australia, Cuba, South Africa, and Thailand have been the main partner countries for exporting sugar to Japan from 1986 to 1997. The market share in Japan of these four countries in 1986 and 1997 are 81% and 66%, respectively. Figure 1 shows that the market shares of South Africa and Cuba have been decreasing since 1986. In 1997, the market shares of Cuba and South Africa were 9% and 5.5%, respectively. While the market shares of Australia and Thailand were 25.7% and 25.8%, respectively, in the same year. After 2002, the market shares of Cube have been zero and that of South Africa have been less than 10%. In contrast to Australia and Thailand, their market shares have never been decreasing. These two countries are the competitor of sugar exporters to Japan market.

Sugar is one of the top ten agricultural industry exported product to Thailand and the study of market power of Thai sugar in Japan market is limited. This paper will study the issue and this would help Thai sugar

exporters evaluate how much they are able to mark-up their price in Japan market. When the market power is estimated, most previous studies used more than two simultaneous equations, as proposed by Appelbaum (1982) and Bresnahan (1982). Later, Devadoss *et al.* (2013) proved that only demand and supply equation are enough to enable identification process of conjectural elasticity and inverse market demand elasticity. The new contribution is that this study adopts the method proposed by Devadoss *et al.* (2013) to measure the degree of market power of Thai sugar in Japan market.

The next section discusses the literature reviews. The theoretical framework and empirical model are in section 3 and 4, respectively. Estimation results demonstrates in section 5. Section 6 concludes the study.

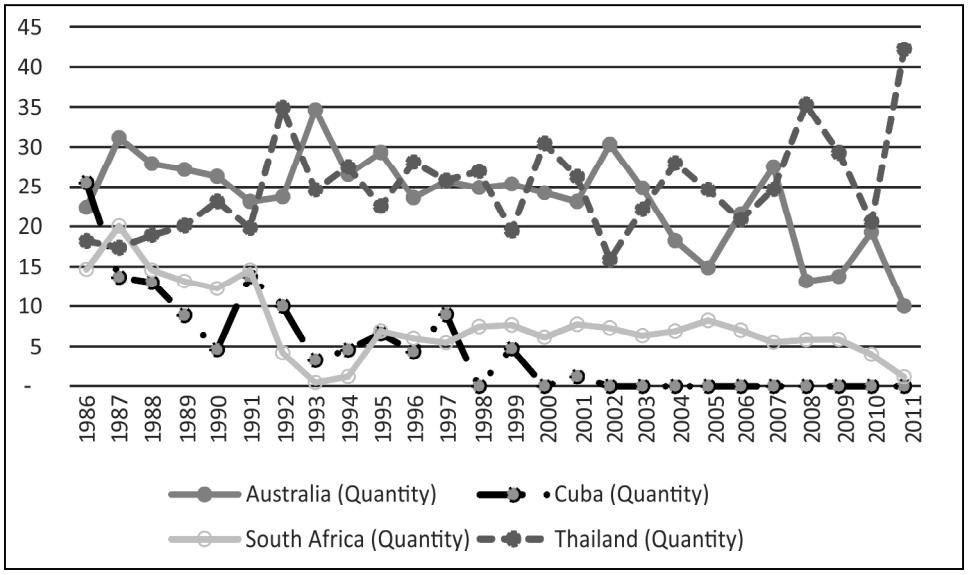

Figure 1: Australia, Cuba, South Africa, and Thailand Market Shares of Sugar in Japan

2. Literature Reviews

Ever since Bresnahan (1982) proposed an idea to estimate the degree of market power using the rotation of output demand function and a supply relation with linear marginal cost. There have been number of research studied in market power measurement. The following are the examples of papers based on this approach.

Deodhar and Sheldon (1997) estimated the degree of imperfect competition in the world market for soymeal exports. A demand function and the industry first – order profit –maximization condition, from which an estimate of the degree of market power are retrieved. They found that the world market for soymeal exports is perfectly competitive. Arnade *et al.* (1998) tested the existence of oligopoly power in both domestic and export markets exercised

by four industries in US. The marginal cost was derived using Generalized Leontief cost function. The price mark-up equation for both domestic and export market were derived. Then the market power is determined by the optimality condition for both domestic and export market. They found that in some cases, industries exhibit oligopoly behavior in either or both market.

Hyde and Perloff (1998) estimated the market power in the Australian retail beef, lamb, and pork markets simultaneously. The marginal cost is assumed constant return to scale and is linear in wholesale price and wages. Then the market power is determined by the optimality condition. The results indicated that there is no market power in these market. Gunning and Sickles (2013) examined collusion and market power in physician private practices. The cost function was adopted to derive the physician labor supply function. The residual demand function for the services provided by a physician was discussed. Then the market power measurement was derived by the equilibrium condition such that the physician achieve the maximized profit. The results indicated that the behavior of physicians in medical subspecialties and surgical subspecialties is consistent with a non-cooperative Nash equilibrium. Silvente (2005) measured the extent of competition in the export markets of ceramic tiles by Italian and Spanish. The pricing-to-market equation and the residual demand elasticity equation were combined to measure the market power. The results revealed that Italian mark-ups are less sensitive to Spanish competition, while the historical leadership of Italian exporters has a depressive effect on Spanish mark-ups in many destinations.

Several papers extended the idea of Bresnahan (1982) by using the dynamic model instead of static as in the previous papers. For example, Bask *et al.* (2011) examined if the Nordic power market, Nord Pool, has been competitive or if electricity suppliers have had market power. The linear demand function for electricity with interaction term between price and exogenous is used. The supply function is created by the linear marginal cost function. The result indicated that the market power has been a small, but statistically significant, degree of market power during almost the whole period. Sckokai *et al.* (2013) also adopted the dynamic model to evaluate the role of market power by retailers of two most famous Italian quality cheeses. Market power is analyzed in the context of a dynamic imperfect competition model of the supply chain, in which retailers are allowed to exert market power both downstream and upstream. The results indicated that there exist evidence of downstream market power by retailers (toward final consumers) for both cheeses, but no evidence of upstream market power (toward processors/ ripeners).

There are papers used a dominant firm and competitive fringe model to measure the market power. Buschena and Perloff (1991) studied the market power in the Coconut oil export market. This paper used three-equation system: world demand, competitive fringe supply, and the Philippine export equation. The results showed that prior to the 1970s the Philippine coconut oil export

market was competitive but that legal and institutional changes in the early 1970s, which centralized control of the Philippines to exercise some of its potential dominant firm market power. Yang (2002) measured the extent of Alcoa's (dominant firm) market power in the post-war US aluminium industry. An indirect procedure that combines estimation of the fringe supply elasticity, market demand elasticity, and market share data generates the estimate of Alcoa's residual demand elasticity which infers the firm's market power. The results found that Alcoa's market power declines with fringe's expansion.

Puller (2007) analyzed the pricing behavior of electricity generating firms in the restructured California market from its inception in April 1998 until its collapse in late 2000. The hourly residual demand functions of the five strategic firms and the fringe supply were adopted. Then the Lerner index was derived. The results showed that the five large nonutility generators raised prices slightly above unilateral market-power levels in 2000, but fell far short of colluding on the joint monopoly price. Hansen and Lindholt (2008) tested if the behavior of OPEC as a whole or different sub-groups of the cartel is consistent with the characteristics of dominant producers on the world crude oil market. This paper distinguish between the producer price and the consumer price of oil. The world demand for oil, the fringe oil supply from the nondominant producers is used. Then the equilibrium condition for demand for dominant producer is proposed. The results indicated that the producers outside OPEC can be described as competitive producers, the OPEC members do not fit the behavior of price-taking producers.

The method developed by Appenbaum (1979, 1982) has also been widely adopted. For example, Mello and Brandao (1999) adopted the method to estimate the market power of the Portuguese milk industry. They used linear demand equation, factor demand system, and equilibrium condition to derive the market power. The results corroborated the presence of an imperfectly competitive market structure and the exploitation of market power by domestic firms.

Other approaches can be used to measure the degree of market power. Rude *et al.* (2011) derived the degree of market power using profit function. They tested the hypothesis that Canadian beef packers use oligopsony power to pay lower prices for cattle than those which would prevail in a competitive market. A profit function was used to derive output supply and input demand equations. Then the equilibrium condition was derived. The results showed that no evidence is found that beef packers behaved in an anticompetitive manner on a national basis when procuring cattle during the period examined. Jumah (2004) examined the existence of market power in the respective pork and poultry meat market in Austria. The relationship of retail price, farm price, and marketing margin were derived, then the market power was derived. The results showed the existence of market power in pork retail pricing. Poultry retail price was found to be competitive.

Alleman *et al.* (2003) examined market power in US international telephone market. The negative inverse of residual demand elasticity is used to estimate the degree of market power held by the dominant carrier. The inverse supply equation for the competitive fringe in bilateral market is proposed. US outgoing market demand is proposed. The market demand elasticity with respect to collection rate and the fringe's own price supply elasticity are used to estimate Market power. The results confirmed that AT&T did not hold substantial market power in collection rate pricing from 1991 to 1995. Digal (2011) analyzed market power in food industry of the Philippine retail. This paper combined several approaches, called as multistage framework, to estimate the maker power. Time series models, particularly cointegration and price asymmetry, are estimated in the first stage. The second stage is the explicitly test for market power in the output and input market. The bargaining model is estimated in the third stage, particularly in industries where both retailers and manufacturers appear to exercise market power. Market power exists in industries where price transmission is asymmetric.

Efthyvoulou and Yildirim (2014) assessedd the market power in Central and Eastern European banking market and explore how the global financial crisis has affected market power. The market power was measured by the Lerner index, where the price of bank output was proxied by the ratio of total revenue (interest and non-interest income) to total assets and marginal cost is derived from a translog cost function. The results showed that there is some convergence in country-level market power during the pre-crisis period.

3. Theoretical Framework and Model

According to the literature reviews in the previous section, two papers that have been the prototype to estimate the market power are Appelbaum (1982) and Bresnahan (1982). The first paper assumed the constant marginal cost, while the second paper assumed linear marginal cost. In this paper, we followed Appelbaum (1982), since the factor markets; such as sugar cane, labor, are competitive in sugar production of Thailand. The idea of this paper is summarized as follows.

Given p is the price of output industry supply $y = \Sigma_{j=1}^{S} y^j$ and y^j is the output of the jth firm in a non-competitive industry producing a homogenous output. The cost function of the jth firm is $C^j = C^j(y^j, w)$ where w is the vector of input prices. Appelbaum (1982) used the optimality condition of profit maximization to derive the degree of market power of the jth firm as followed.

$$p(1\ \theta^j\varepsilon) = MC^j \tag{1}$$

where θ^j is the conjectural elasticity of total industry output with respect to the output of the jth firm (defined by $\frac{\partial y}{\partial y^j}\frac{y^j}{y}$) and ε is the inverse market

demand elasticity (defined by $-\frac{\partial p}{\partial y}\frac{y}{p}$). Under perfect competition $\theta^j = 0$ and under pure monopoly $\theta^j = 1$ ($y = y^j$). From equation (1), the degree of market power $\left(\frac{p - MC^j}{p}\right)$ is measured by $\theta^j\varepsilon$, which is between 0 and 1.

Similar to Appelbaum (1982), this study use the generalized Leontief function form to represent for the cost function of Thailand sugar's imported by Japan as follow,

$$C^j(y^j, w_{1,} w_2) = b_1 w_1 + b_2 w_2 + (b_{12} w_1^{1/2} w_2^{1/2} + b_{11} w_1 + b_{22} w_2) y^j$$

where y^j is the Thailand's sugar imported by Japan (Tonnes), w_1 is real price of Thai sugar cane (Baht/Ton), w_2 is energy price index (2005 = 100). Hence, the marginal cost of Thailand's sugar imported by Japan can be represented by

$$MC^j(w_1, w_2) = b_{12} w_1^{1/2} w_2^{1/2} + b_{11} w_1 + b_{22} w_2 \quad (2)$$

The linear inverted demand function is represented by

$$p_j = \gamma_0 + \gamma_1 y^j + \delta_1 z_1 + \delta_2 z_2 + \delta_1 z_3 + u \quad (3)$$

where p_j is the real price of Thailand's sugar imported by Japan (1000 Yen/ Ton), z_1 is the real price of Australia sugar imported by Japan (1000 Yen/ Ton), z_2 is the Japan's population (thousands of people), and z_3 is Japan's real GDP (Trillion Yen).

Substitute the marginal cost function (2) and the inverse market demand elasticity equation (3) into equation (1), we obtain the supply relation

$$p_j = + b_{12} w_1^{1/2} w_2^{1/2} + b_{11} w_1 + b_{22} w_2 \, \theta^j \gamma_1 y^j \quad (4)$$

Devadoss *et al.* (2013) proved that the conjectural elasticity θ^j is identifiable using the simultaneous equation (3) and (4). This implies that the factor demand equations is not necessary to be estimated when we measure the market power. Hence, this paper use equation (3) and (4) to estimate the market power of Thailand's sugar imported by Japan.

Annually data from 1987 to 2011 are used in this study, which is the longest available data. The quantities and values of Thailand sugar imported by Japan are obtained from FAO's website, the price of Thailand and Australia's sugar imported by Japan estimated by the values divided by quantities. The population and GDP of Japan are from World Bank. Price of Thai sugar can and the energy price index are obtained from Office of Agricultural Economics of Thailand and Bureau of Trade and Economic Indices of Thailand, respectively. The consumer price indices of Japan, Thailand, and Australia, which are used to estimate the real value, are from World Bank.

4. Results

The demand and supply equations of (3) and (4) are estimated by the nonlinear generalized method of moment, the convergence achieved after 334 weight matrices and 335 total coefficients iterations. According to, Table 1, the *J*-statistics is 0.228, this implies that the exogenous variables in the model are valid at 0.05 significance level. All parameters in both demand and supply equations are significant at least 0.10 significance level.

When we consider the estimates of demand equation, the coefficient estimate of y^j is negative (-0.0000655), which corresponds to the demand theory. The coefficient estimate of z_1 is positive (0.548), which confirms that the Australia's sugar is substitutable to Thai sugar. This paper found that the coefficient estimate of z_2 (real GDP of Japan) is negative (-0.051), this implies that Thai sugar is the inferior product to Japan. The coefficient estimate of z_3 (Japan's population) is positive, which corresponds to the demand theory.

For the estimates of supply equation, we found that w_1 (price of sugar cane) and w_2 (energy price index) have positive effect to p_j, which corresponds to supply theory. The coefficient of the interaction term of these two input prices is significant at 0.10 level, which implies that the effect of sugar cane price (or energy price) to p_j depends on the energy price (or sugar cane price). The estimate of conjectural elasticity $(\hat{\theta}^j)$ is 0.372, which is significant at 0.01 level. This implies that Thai sugar in Japan market is not competitive market. The estimate market power of Thai sugar in Japan market is the multiplication of estimate conjectural elasticity $(\hat{\theta}^j)$ and estimate the inverse market demand elasticity $(\hat{\varepsilon}^j)$, which is calculated by $-\hat{\gamma}\frac{y}{p}$.

Table 2 shows the estimates of and Thai sugar market power $(\hat{\theta}^j\hat{\varepsilon})$ in Japan from 1987 to 2011. The average of the estimates the inverse market demand elasticity is 1.57. This means that if the imported quantity of Thai sugar by Japan decrease 1%, the imported price of Japan would decrease 1.57% in average. The average inverse market demand elasticity of Thai sugar is very high. The lowest and highest values of the inverse elasticity are 0.80 and 3.22 in 1990 and 2000, respectively. The values inverse elasticities are greater than 1 for 21 years and less than 1 only 4 years. This implies that Thai sugar exporters are able to control their price in some degree for Japan market.

This pattern is consistent to the estimates of market power degree, the highest and lowest values are in 1990 and 2000, which are 0.30 and 1.20, respectively. The average degree of market power is 0.58. This implies that sugar market in Japan is not competitive market for Thai sugar exporters. The degree of market power is greater than 0.5 for 14 years.

Table 1: Parameter Estimates of Demand and Supply Equations

Parameters	*Demand Equation*	*Supply Equation*
γ_0	565.04	
	$(2.74)^{***}$	
γ_1	-0.0000655	
	$(-3.58)^{***}$	
δ_1	0.548	
	$(3.15)^{***}$	
δ_2	-0.0051	
	$(-2.71)^{***}$	
δ_3	0.283	
	$(3.64)^{***}$	
b_{12}		-0.693
		$(-1.84)^{*}$
b_{11}		0.170
		$(2.81)^{***}$
b_{22}		1.113
		$(2.21)^{**}$
θ^j		0.372
		$(3.38)^{***}$
J – statistics = 0.228^{***}		

Note: *t*-value is in the parenthesis, ***, **, and * represent for 1%, 5%, and 10% significance level.

Table 2: Estimate of the Inverse Market Demand Elasticity and Thai sugar Market Power in Japan

Year	$\hat{\varepsilon} = -\hat{\gamma}\frac{y}{p}$	Market Power $(\hat{\theta}^j\hat{\varepsilon})$	Year	$\hat{\varepsilon} = -\hat{\gamma}\frac{y}{p}$	Market Power $(\hat{\theta}^j\hat{\varepsilon})$
1987	1.06	0.39	**2000**	3.22	1.20
1988	1.03	0.38	**2001**	1.83	0.68
1989	0.92	0.34	**2002**	1.32	0.49
1990	0.80	0.30	**2003**	1.68	0.63
1991	1.20	0.45	**2004**	2.78	1.03
1992	2.20	0.82	**2005**	1.66	0.62
1993	1.71	0.64	**2006**	0.94	0.35
1994	1.66	0.62	**2007**	1.18	0.44
1995	1.22	0.45	**2008**	2.00	0.74
1996	1.74	0.65	**2009**	1.37	0.51
1997	1.43	0.53	**2010**	0.84	0.31
1998	1.26	0.47	**2011**	1.69	0.63
1999	2.46	0.92	**Mean**	1.57	0.58

5. Conclusion

This study aims to measure the degree of market power of Thai sugar in Japan market. The data adopted are from 1987 to 2011. We use the nonlinear GMM

to estimate the demand and supply equation of Thai sugar in Japan market. This study found that all parameter estimates consistent to the demand and supply theory. It can infer that Australia's sugar is competitive to Thai sugar, and Thai sugar is inferior products to Japan market. The effect of sugar cane price (or energy price) to the price of Thai sugar imported by Japan depends on the energy price (or sugar cane price). This study found that Thai sugar exporters to Japan have some degree of market power, they have some ability to control Thai sugar price imported by Japan.

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