Price-Cost Margins for Export and Domestic Markets: A Case for the Japan's Iron and Steel Industry

Atsuko Matsuoka
Research Assistant Professor, ICSEAD

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Abstract

This paper estimates and compares the price-cost margin (that is, markup ratio minus one) for both domestic markets and export markets in Japan's iron and steel industry from 1986 to 1998, with system estimation of profit maximization conditions under the production technology of translog cost function.

First, this paper found that both domestic and export markets in Japan's iron and steel industry were imperfectly competitive, setting prices 11.6 percent in excess of corresponding marginal costs, so that the degrees of market power were the same in both domestic and export markets. Second, this paper also found that the cost elasticity of the products sold at export markets was smaller than at domestic markets, implying that the production cost at the margin for export markets was lower than for domestic markets. Thus export activity generates a diversification benefit for Japan's iron and steel industry through the differences in cost structure for domestic and export products.

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1. Introduction

The iron and steel industry is generally characterized as one in which average cost is decreasing because of large fixed cost. In such an industry, a product market is imperfectly competitive, with a few firms possessing market power. In the case when such an industry faces a single product market, the profit maximization under imperfect competition leads these producers to set price in excess of their marginal cost. Nishumura, Ohkusa, and Ariga (1999) and Shirai (2000) reported evidence that the product market of Japan's iron and steel industry was imperfectly competitive, based on estimation results of markup ratio (the ratio of price over marginal cost)[1].

However Matsuoka (2002) found that a simple index of price-cost margin in Japan's iron and steel industry (measured as profit rate per variable cost) was not so high compared with other industries in Japan (see Figure 1).[2] This price-cost margin increased sharply during the economic boom in the late 1980 to the early 1990. However, the price-cost margin has been declining during the Heisei recession in the 1990s (Figure 2). During this period, price index for steel products declined more sharply than the corresponding index for all other commodities. Matsuoka (2002) suggested that this recent downward trend of price-cost margins in Japan's iron and steel industry might be related with the price decline of steel products, possibly due to the increased competition among major steel makers.[3]

In the above-mentioned market structure, Japan's iron and steel industry is assumed to face a single product market, without distinguishing between domestic and export markets. Even though the share of iron and steel industry was declining in the total manufacturing exports in Japan (along with the corresponding GDP share), it is still important to examine the market structure in this industry by distinguishing between domestic and export markets. This is not only because Japan has been consistently ranked among the world's top three steel producers for almost three decades, but also because the recent downward trend in the above-mentioned index of price-cost margin (profit rate per variable cost) in Japan's iron and steel industry might be related to a fall of domestic steel prices rather than a fall of export prices (Matsuoka, 2002).

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[1] See Appendix Table 1.

[2] Simple index of price-cost margin measures as profit rate per variable cost is defined as $\frac{VA - WB}{MC + WB}$, where *VA*, *WB*, and *MC* indicate value added, compensation, and material cost.

[3] The share of value added for the five major steel makers in Japan (Nippon Steel, NKK, Kawasaki Steel, Sumitomo Metal Industries, and Kobe Steel) declined from 54 percent in 1986 to 35 percent in 1999, while shares of sales or variable cost were stable during the period. This may imply the decreasing market power for the five major steel makers, which may be one of the causes of the price declines of steel products (Matsuoka 2002).

Another reason to distinguish the two markets is that export markets are usually expected to be more competitive than domestic markets. The primary reason for this is a larger number of firms whose products are close substitutes, so that the degree of market power could be weaker in export markets than in domestic markets, or at least the same between the two markets. Facing several markets (domestic and export markets in our case), producers with market power can maximize their total profit by setting location-differentiated prices in accordance with the structure of each market. In addition, the price-cost margin (markup ratio minus one) is expected to be higher at domestic markets than at export markets, or at least the same at the both markets. Bernstein and Mohnen (1991) found that price-cost margins were higher at Canada's domestic markets than at export markets in non-electrical machinery industry and chemical industry, while they were the same in electrical products industry. Bughin (1996) also found that in cases of chemical industry and electric and electronic products industry in Belgium, the price-cost margins were higher at domestic markets than at export markets[4].

In addition, the distinction between domestic and export markets might be indirectly related to the recent controversy about dumping by Japan's steel exporters. If Japan's iron and steel industry does dumping in export markets, then the price-cost margin in domestic markets might be higher than in export markets, though it does not always happen.[5] With export prices set lower than at the level of maximized profits, the incurred loss of total profit could be mitigated by higher price-cost margin in domestic markets. This means that profits at the margin (i.e., the marginal profit increase by the additional output) is transferred from domestic to export markets. However, due to the previously-mentioned decline in steel prices and increased competition among Japan's major steel makers, such a profit transfer might be small or negligible.

Another aspect in analyzing domestic and export markets is a possible difference in the cost structure between products sold at these two markets because of transportation costs, insurances, commissions, risk premiums for exchange rates and so on. Those additional costs are usually added to the cost of exports. However, the cost elasticity of joint production with respect to the marginal increase of products for export markets is not necessary higher than for domestic markets, especially when those

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[4]See Appendix Table 1.

[5]It should be noticed a comparison of price-cost margins in both markets does not give any evidences that Japan's steel exporters do or do not conduct dumping. Because the assessment of dumping is supposed to be applied to each commodity, not industry levels. Furthermore, price should be compared with average cost, not marginal cost.

two products share some common technologies, equipments, and other assets, allowing producers to exhibit scope of economy, or to have diversification benefits. In other words, the marginal cost of joint production with respect to the one product declines as the other product increases. In this respect, a transfer of profit at the margin from the one product to another occurs due to different cost structure for two products. This was demonstrated by Bernstein and Mohnen (1991) and Bughin (1996), who found that cost elasticity of exports was lower compared with domestic products, and resulted in diversification benefits to export markets.

In this paper, we examine the existence of imperfect competition in both domestic and export markets in Japan's iron and steel industry from 1986 to 1998, and then compare the degree of market power in these markets by estimating price-cost margins. Our secondary purpose is to examine the existence of profit transfers between these markets, and if so, whether they can be attributed to differences in either market structure or cost structure, and whether these transfers originate from domestic or export markets.

To examine these issues, we estimate price-cost margins for both markets with system estimation of profit maximization conditions under the production technology of translog cost function, similarly to Nadiri and Nandi (1999). It should be noted that this methodology allows to consider both market and cost structure, which is different from the comparison of price elasticities in several markets (with focus only on market structure) in the pricing to markets studies. Our major conclusion is that both domestic and export markets exhibited imperfect competition, but the degree of market power was the same in these two markets. Furthermore, cost elasticity of exports was lower compared with domestic products, implying the existence of diversification benefits to export markets.

This paper is divided into 5 sections. Section 2 introduces the theoretical model to estimate the price-cost margins for domestic and export markets, and section 3 discusses data sources. Section 4 explains the empirical specification of estimated model, and then reports major estimation results. Concluding remarks are given in section 5.

2. The model

Bernstein and Mohnen (1991) and Bughin (1996) estimated markup ratios (price-cost margins plus one) for both domestic and export markets by system estimation of profit maximization conditions with production technology given by translog cost function. Bernstein and Mohnen (1991) assumed the oligopolistic market structure and decomposed markup ratios for domestic and export markets into two parts: the demand elasticity and the conjectural variation element.[6] On the other hand, the model of Bughin (1996) examined monopolistic markets under short-run equilibrium conditions, and included capacity constraints to the production for export markets. Finally, the model of Nadiri and Nandi (1999) did not make distinction between domestic products and exports, and monopolistic markets were assumed.[7] In this paper, we mainly follow the model of Nadiri and Nandi (1999), and apply it to the case of multi-products, sold at domestic and export markets.

Production technology and factor markets

Japan's iron and steel industry is assumed to be a representative producer, which requires two kinds of variable inputs (labor and material inputs) and produces two kinds of products, sold at domestic and export markets. The variable cost function is given by

$$VC = C^V(Y_D, Y_F; W, P_M, K, T),$$

where VC is variable cost, Y_D and Y_F are output quantities sold at domestic and export markets, respectively. W is labor wage and P_M is the price of material input, K is capital stock, assumed to be quasi-fixed input, and T denotes technology, represented by time. The variable cost function is translog as follows:

$$\begin{aligned}\ln\frac{VC}{P_M} &= \alpha_0 + \sum_i \beta_i \cdot \ln Y_i + \beta_V \cdot \ln\omega + \beta_K \cdot \ln K + \beta_T \cdot T \\ &+ \sum_i \gamma_{iV} \cdot (\ln Y_i)\cdot(\ln\omega) + \sum_i \gamma_{iK} \cdot (\ln Y_i)\cdot(\ln K) + \gamma_{VK} \cdot (\ln\omega)\cdot(\ln K) \\ &+ \sum_i \gamma_{iT} \cdot (\ln Y_i)\cdot T + \gamma_{VT} \cdot (\ln\omega)\cdot T + \gamma_{KT} \cdot (\ln K)\cdot T \\ &+ \tfrac{1}{2}\{\sum_i\sum_j \gamma_{ij} \cdot (\ln Y_i)\cdot(\ln Y_j) + \gamma_{VV} \cdot (\ln\omega)^2 + \gamma_{KK} \cdot (\ln K)^2 + \gamma_{TT} \cdot T^2\},\end{aligned}$$

$$\gamma_{ij} = \gamma_{ji},\ i,j = D,F \qquad (1)$$

where $\omega \equiv W/P_M$.

Under the assumption of competitive factor markets, each input demand is obtained from the variable cost function by using the Shepard's Lemma. Thus, the

[6] They called it the degree of oligopoly power.

[7] However, their model was the multi-product case in telecommunication industry, where the two kinds of products were local (call) services and toll services.

labor cost share function is calculated by

$$S_L \equiv \frac{W \cdot L}{VC} = \frac{\partial \ln C^V}{\partial \ln W}$$

$$= \beta_V + \gamma_{VV} \cdot \ln \omega + \sum_i \gamma_{iV} \cdot (\ln Y_i) + \gamma_{VK} \ln K + \gamma_{VT} \cdot T , \qquad (2)$$

where S_L denotes labor cost share. The material cost share is one minus S_L.

Following Bernstein and Mohnen (1991) and Nadiri and Nandi (1999), the producer chooses the quantity of capital as a quasi fixed factor in long-term equilibrium, with rental rate of capital equal to the marginal reduction of variable cost with respect to the marginal increase of capital. Formally, this condition of the capital demand can be written by

$$S_K \equiv \frac{W_K \cdot K}{VC} = -\frac{\partial \ln C^V}{\partial \ln K}$$

$$= -\{\beta_K + \gamma_{KK} \cdot \ln K + \sum_i \gamma_{iK} \cdot (\ln Y_i) + \gamma_{VK} \ln \omega + \gamma_{KT} \cdot T\} , \qquad (3)$$

where S_K denotes the ratio of capital cost to the variable cost.

Market structure and profit maximization conditions

We assume that the two kinds of products are sold monopolistically at each market. A representative producer sells each of these products, equalizing their marginal revenue to marginal cost. In domestic markets, the producer faces the following inverse demand function:

$$P_D = \phi_D \cdot (Y_D)^{-\theta_D} ,$$

while in export markets the inverse demand function in domestic currency base (that is, in the yen base) is given by

$$P_F = \phi_F \cdot (Y_F)^{-\theta_F} \cdot \left(\frac{1}{ER}\right)^{-\delta} ,$$

where *ER* denotes exchange rate in the foreign currency base, and δ is the adjustment parameter of the export price to changes in exchange rate. In both demand functions, P_i denotes the price of products, sold at each market in domestic currency base. Price elasticity of demand is given by $1/\theta_i$, while the impact of other factors on prices is ϕ_i (*i*=*D*,*N*). The profit maximizations conditions for each product can be written as

$$S_i \equiv \frac{R_i}{VC} = \frac{\partial \ln C^V}{\partial \ln Y_i}$$

$$=\left(\frac{1}{1-\theta_i}\right)\cdot\{\beta_i+\sum_j\gamma_{ij}\cdot(\ln Y_j)+\gamma_{iV}\ln\omega+\gamma_{iK}\ln K+\gamma_{iT}\cdot T\},$$

$i,j=D,F,\ i\neq j$. (4D) and (4F)

In equations (4D) and (4F), S_i denotes revenue cost ratio, where R_i denotes revenue from the ith market. R_i, in turn, equals to price P_i multiplied by output quantity Y_i ($i=D,N$).[8] The price-cost margin PCM_i for each market is defined by

$$PCM_i=\frac{1}{1-\theta_i}-1,\qquad i=D,N$$

where markup ratio denotes $\frac{1}{1-\theta_i}$. When the price-cost margin exceeds zero (in other words, markup ratio exceeds one), the market is imperfectly competitive. On the other hand, the market is perfectly competitive when the price-cost margin equals zero (or markup ratio equals one). The revenue R_i from the ith market can be written as follows:

$$\ln R_D=\alpha_D+(1-\theta_D)\cdot\ln Y_D, \tag{5}$$

$$\ln R_F=\alpha_F+(1-\theta_F)\cdot\ln Y_F+\delta\cdot\ln(ER), \tag{6}$$

where $\alpha_i=\ln\phi_i$ ($i=D,N$).[9]

Partial equilibrium

Long-term partial equilibrium conditions are characterized by seven equations (1), (2), (3), (4D) for domestic products and (4F) for exports, (5), and (6).[10] Endogenous variables include variable cost VC, two output quantities Y_D and Y_F, revenues from the two markets R_D and R_F, labor cost share S_L and capital cost share S_K.

3. The data

The model mentioned of section 2 is estimated from 1986Q2 to 1998Q4, resulting in 52 observations, while the total number of observations in the system estimation is 354. This analysis is mainly based on Japan's *Input-Output Tables*

[8] As far as variable cost is in the yen base, revenue (R_i) also must be measured in the yen base. If so, exchange rate does not appear in export markets of equation (4F).

[9] Nadiri and Nandi (1999) included inverse demand functions, instead of including (5) and (6).

[10] This paper assumes the long-term equilibrium model. However, it requires the specification test for the long-term or short-term equilibrium model, as shown in Bernstein and Mohnen (1991) and Nadiri and Nandi (1999).

published by Ministry of Economy, Trade and Industry (METI, several issues). An important advantage of using this data source is availability of consistent data for total output values and export values. However, this source provides only annual data, making it too short to analyze the performance of the iron and steel industry since mid-1980s. To solve the problem, some of quarterly data (namely, domestic output revenue $R_D = P_D \cdot Y_D$, export revenue $R_F = P_F \cdot Y_F$, and material cost $P_M \cdot M$) are constructed from the original annual data.

To construct quarterly data, we used annual data for total output revenue, export revenue, and material cost from Ministry of Economy, Trade and Industry (METI, several issues). Their quarterly data are obtained by using the procedure, explained in Appendix A. Then, following Bernstein and Mohen (1991) and Bughin (1996), the domestic output revenue $R_D = P_D \cdot Y_D$ is obtained by total output revenue minus export revenue. Additional information about data sources is given in Appendix B.[11]

The domestic output quantity Y_D is calculated in the 1990 yen base, obtained from domestic output revenue R_D divided by domestic wholesale price index in steel industry P_D from *Economic and Financial Data on CD-ROM* (Bank of Japan, several issues, a). Similarly, export quantity Y_F in the 1990 yen base is calculated from export revenue R_F, divided by export price index in steel industry P_F from the same source. Similarly, the quantity of material input in 1990 base year is obtained from material cost $P_M \cdot M$, divided by input price index of steel industry P_M, taken from Input-Output Price indices, available in Bank of Japan (several issues, a).

Labor input quantities and corresponding earnings are obtained from *Year Book of Labour Statistics* (Ministry of labour, several issues). Hourly wage W is calculated from monthly cash earnings per person divided by monthly hours worked per person. Labor input quantity L is calculated as the quarterly hours worked per person times the number of workers. Labor cost is calculated by multiplying W and L.

The capital stock K is taken from *Gross Capital Stock of Private Enterprises* (Economic Planning Agency, 2000, b). Rental price of capital (W_K) on the quarterly basis is calculated by

$$W_K = \left((r+\delta)/4 - \dot{P}_K \big/ P_K \right) \cdot \frac{P_K}{1-\tau},$$

where r, δ, P_K, and τ denote interest rate (per annum), depreciation rate (per annum), price of capital goods, and corporate tax rate, respectively. Capital cost is calculated

[11] All of the quarterly data are seasonally adjusted with The Census X11 methods. And all of the value data and the price data for the iron and steel industry are real bases, by dividing nominal data with overall wholesale price index for all commodities in Bank of Japan (several issues, a).

by multiplying W_K and K. The sources of other quarterly data are shown in Appendix B. In appendix table 2 we provide the descriptive statistics of the above-mentioned data.

4. Estimation results

After augmenting the system of simultaneous equations in section 2 with error terms, the system was estimated by non-linear three stage least squares (3SLS).[12] Instrumental variables were exogenous variables and the first-order lagged values of exogenous and endogenous variables. Furthermore, the first-order autocorrelation was corrected in equations (1), (2), (4D), (4F), (5), and (6), and the fourth-order autocorrelation was additionally corrected in equation (2).

Our empirical estimation proceeded in two stages. In the first stage, we assumed that price-cost margins were not the same in domestic and export markets, so that the system of equations was estimated without the restriction $\theta_D = \theta_F = \theta$. As shown in appendix Tables 3 and 4, the estimation of this unrestricted model produced θ_D equal to 0.093, and the estimate was highly significant. This indicated that price-cost margin for domestic markets equaled to 0.103. On the other hand, the estimate for θ_F was 0.169, with corresponding price-cost margin for export markets equal to 0.204. However, the latter parameter estimate turned out statistically insignificant, implying that the hypothesis of competitive export markets for Japan's iron and steel industry could not be rejected.

Furthermore, the null hypothesis that price-cost margins for domestic and export markets are the same ($\theta_D = \theta_F = \theta$) was not rejected by the Wald test.[13] In other words, the estimation results with the unrestricted model show that domestic markets exhibit imperfect competition, while the null hypothesis of competitive export markets was not rejected. However, the results did not exhibit significant differences between price-cost margins in the two markets.

To identify the source of this result, we proceeded to the second stage, and estimated the restricted model with the restriction $\theta_D = \theta_F = \theta$. Estimation results are shown in Table 2. In addition, we imposed in equation (1) parametric constraints to reflect the theoretical conditions for a cost function, such as parametric symmetry and

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[12]Prior to estimation, variables in the all equations of this system were normalized by their sample means, as discussed in Green (2000).

[13]The χ^2 statistic for the hull hypothesis was 0.383, with critical value $\chi^2_{0.05,1}$=3.84 (see appendix table 4).

homogeneity of degree one with respect to input prices[14]. As shown in Table 2, the estimate of β_V turned out positive and significant, assuring monotonicity. Besides, the estimate of γ_{VV} was also positive and significant, implying that the concavity holds in the case of two variable inputs[15].

Using these results, the joint price-cost margin for domestic and export markets is calculated in Table 3. The estimate of θ was 0.104, significant at 1 percent level, indicating that the price-cost margin for both markets was 0.116.[16] This implies that the Japan's iron and steel industry sells the products at the equilibrium under the given production technology and market structure so that its price is 11.6 percent higher than its marginal cost in both domestic and export markets. To test the null hypothesis of the restricted model against unrestricted model (estimated in the first stage), the likelihood ratio (LR) statistic turned out 0.241 (see Table 2), less than the critical value of 3.84. Since the null hypothesis of the restricted model was not rejected, we accepted the restricted model with $\theta_D = \theta_F = \theta$, with price-cost margin of 0.116, which was the same in both domestic and export markets.

From these estimation results, we calculated cost elasticities with respect to capital, and to both domestic products and exports. These cost elasticities are evaluated at sample means of the restricted model, and are shown in Table 4. The cost elasticity of capital was -0.282, meaning that 1 percent increase in capital reduced the variable cost of Japan's iron and steel industry by 0.282 percent during the estimation period. On the other hand, the cost elasticities of domestic products and exports were 1.050 and 0.089, respectively.[17] This means that the production cost at the margin for exports is the one tenth lower than for domestic products. This result is similar to findings by Bernstein and Mohnen (1991) and Bughin (1996), who concluded that "it pays to diversity to export market", and the Japan's iron and steel industry appears to follow this strategy. This result is also supported by the estimate for γ_{DF}, which turned out negative and significant (see Table 2). The negative estimate of γ_{DF} means that the cost elasticity of the one product declines with the marginal increase of

[14]See Jorgenson (1986) for the required restrictions of the cost function.

[15]These conditions were also satisfied with the unrestricted model as shown in Appendix Table 3.

[16]Nishimura, Ohkusa, and Ariga (1999) estimated markup ratio in Japan's manufacturing industries, though they use different models with firms' panel data from 1971 to 1994. Their estimated markup ratio for the total output market in the iron and steel industry was 1.204 (meaning price-cost margin was 0.204). Shirai (2000) followed the model in Nishimura, Ohkusa, and Ariga (1999), however estimated with industry data, and it was 1.347 (meaning price-cost margin was 0.347) in the iron and steel industry during 1980-1984. Appendix Table 1 also shows the comparison of the results in other industries of foreign countries by the former literature.

[17]This gap of cost elasticities between the domestic products and the exports was relatively large compared with the former literature. See Appendix Table 2.

the other product.[18] In the case of multi-product, the degree of return to scale is defined by

$$\textit{Degree of return to scale} = \frac{1 - \dfrac{\partial \ln C^V}{\partial \ln K}}{\sum_{i=D,F} \dfrac{\partial \ln C^V}{\partial \ln Y_i}} .$$

As shown in Table 4, the degree of return to scale was 1.125, meaning there were increasing returns to scale for the Japan's iron and steel industry during 1986 to 1998.[19]

5. Conclusion

By estimating price-cost margins in Japan's iron and steel industry in 1986-1998, this paper examined the existence of imperfect competition in both domestic and exports markets, and then compared the corresponding degrees of market power. In addition, we examined the existence and sources of profit transfer between domestic and exports markets.

With respect of analyzing the market structure, we found that (1) Japan's iron and steel industry experienced imperfect competition in both domestic and export markets, (2) the price-cost margins were 11.6 percent in both markets, and (3) these price-cost margins were of the same magnitude. These findings imply that Japan's iron and steel industry sets its prices so as to exceed its marginal cost by 11.6 percent, and that the degree of market power is the same in domestic and export markets. Compared with other previous analysis for Japan's iron and steel industry, as well as other industries in foreign countries (as summarized in appendix table 1), our estimate for the degree of market power in Japan's iron and steel industry turned out rather low. However, it should be noted that in recent years, the profit rate per variable cost in Japan's iron and steel industry was lower compared with other industries and was even declining in the 1990. Moreover, the value added share of major steel makers was also declining recently. For this reason, our estimate of low degree of market power for this industry appears to be reasonable. Furthermore, the results shows that price-cost margin in export markets is the same as in domestic markets, suggesting that Japanese steel makers do not reduce their profit rate in export markets by dumping of steel products.

With respect to the existence and sources of profit transfer, we found that (4)

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[18]See Bernstein and Mohnen (1991).

[19]Those results in the unrestricted model are shown in Appendix Table 5.

the cost elasticity of exports was smaller compared with domestic products, meaning that the production cost at the margin for exports was lower than for domestic products. Since price-cost margins were the same in domestic and export markets, profit transfer was not originated from the market structure, but from different cost structure in domestic products and exports. Besides, the direction of profit transfer was from exports to domestic products. Though the export of steel industry has been losing its position in Japan's economy, steel exports are still important in Japan’s iron and steel industry due to diversification benefits through the different cost structures between domestic products and exports.

Several tasks are left for future analysis. First, price-cost margins should be estimated also for other industries in Japan, and comparison across industries is an interesting topic. Second, the analysis with more detailed industry classification is justified, because the iron and steel industry in Japan's 2-digit industrial classification includes the second- or the third-processing industries such as cans or nails. The latter industries may be more competitive, or may have higher price elasticities, translating into smaller price-cost margins in domestic products compared with exports. Such industries may also have decreasing return to scale, which may increase the gap of cost elasticities between domestic products and exports. The last problem might be an outcome of voluntary restrain agreement (VRA), in effect until 1992, where the export quantity was restricted to be lower than under the free trade, increasing, in turn, the export price level. Therefore, the comparison of price-cost margins in export markets before and after VRA appears to be an interesting topic, but the lack of quarterly data remains a serious problem.

Appendix A
Construction of quarterly data

Let X_t and P_t^X be the quantity and price of X in year t, so that $TR_t^X = P_t^X \cdot X_t$ is the value of X. Then $TR_{t,s}^X$ in the sth quarter of the year t can be calculated as

$$TR_{t,s}^X = TR_t^X \cdot S_{t,s}^X, \tag{A1}$$

where the sth quarter's value share of X in its annual value ($S_{t,s}^X$) equals

$$S_{t,s}^X = \frac{TR_{t,s}^X}{\sum_{s=1}^{4} TR_{t,s}^X}. \tag{A2}$$

The quarterly data of export revenues is calculated by equations (A1) and (A2) using the annual export revenues from METI (several issues, a) times the quarterly value share of X in its annual value $S_{t,s}^X$ from The Japan Tariff Association (several issues).

Following the approach of Bernstein and Mohen (1991) and Bughin (1996), the domestic output revenue is obtained as the total output revenue minus export revenue. The quarterly data of total output revenue is calculated by equation (A1), while the quarterly share in the annual data $S_{t,s}^X$ is calculated by:

$$S_{t,s}^X = \frac{\widetilde{P}_{t,s}^X \cdot \widetilde{X}_{t,s}}{\sum_{s=1}^{4} \widetilde{P}_{t,s}^X \cdot \widetilde{X}_{t,s}^X}, \tag{A3}$$

where tilda denotes price and quantity indices. The quarterly data of domestic output revenue is obtained from the quarterly data of total output revenue minus the quarterly data of export revenue. The quarterly data of material input cost is also obtained from equations (A1) and (A3), similarly to the case of the total output revenue. Data sources for annual and quarterly data are written in the table below.

The sources of annual and quarterly data for Japan's iron and steel industry

X	TR_t^X	$S_{t,s}^X$	$\widetilde{P}_{t,s}^X$	$\widetilde{X}_{t,s}$
	Annual	Quarterly	Quarterly	Quarterly
Total Output Revenue (R_D+R_F)	"Domestic Production" in METI (several issues)	Calculation	"Output Price Index" of Input-Output Price in Bank of Japan (several issues, a)	"Indices of Industrial Production" in MITI (1998)
Export Revenue (R_F)	"Exports" in METI (several issues)	Japan Tariff Association (several issues)	---------	---------
Domestic Output Revenue (R_D)	(Total output revenue) – (Export revenue)	---------	---------	---------
Material Cost ($P_M \times M$)	"Total of Intermediate Sectors" in METI (several issues)	Calculation	"Input Price Index" of Input-Output Price in Bank of Japan (several issues, a)	"Indices of Raw Materials Consumption" in MITI (1998)

Appendix B

The list of the data and their sources

Variables	Symbols	Sources
Domestic output revenue	$R_D = P_D \times Y_D$	See Appendix A
Domestic output quantity (Base year =1990)	$Y_D = \frac{R_D}{P_D}$	Calculation
	P_D : Domestic output price (Domestic Wholesale Price Index in Steel Industry)	Bank of Japan (several issues, a)
Export revenue	$R_F = P_F \times Y_F$	See Appendix A
Export quantity (Base year =1990)	$Y_F = \frac{R_F}{P_F}$	Calculation
	P_F : Export price (Export Price Index in Steel Industry)	Bank of Japan (several issues, a)
Labor cost	$W \times L$	Calculated from W and L
Hourly wage	W=(Monthly cash earnings per person) ÷ (Monthly hours worked per person)	Ministry of Labour (several issues)
	L: Labor input quantity (hours worked × number of workers)	Ministry of Labour (several issues)
Material cost	$P_M \times M$	See Appendix A
Material price	P_M : Material price (Input price index in Input-Output price)	Bank of Japan (several issues, a)
	M: Material input quantity	(Implicit)
Variable cost	$VC = W \times L + P_M \times M$	Calculation

(Continued)

The list of the data and their sources (continued)

Variables	Symbols	Sources
Capital stock	K	Economic Planning Agency (2000,b)
Rental price of capital	$W_K = \left((r+\delta)/4 - \dot{P}_K \big/ P_K\right) \cdot \frac{P_K}{1-\tau}$	Calculation
	r : Interest rate (Average Contracted Interest Rates on Loans and Discounts, All Banks)	Bank of Japan (several issues, b)
	δ : Depreciation rate	Calculated from the data in Economic Planning Agency (2000,b)
	P_K : Price of capital goods (Deflators of the fixed capital formation of the plant and equipment in private sector)	Economic Planning Agency (2000,a)
	τ : Corporate tax rate	Ministry of Finance (1999)
Real effective exchange rate	ER	IMF (2002)

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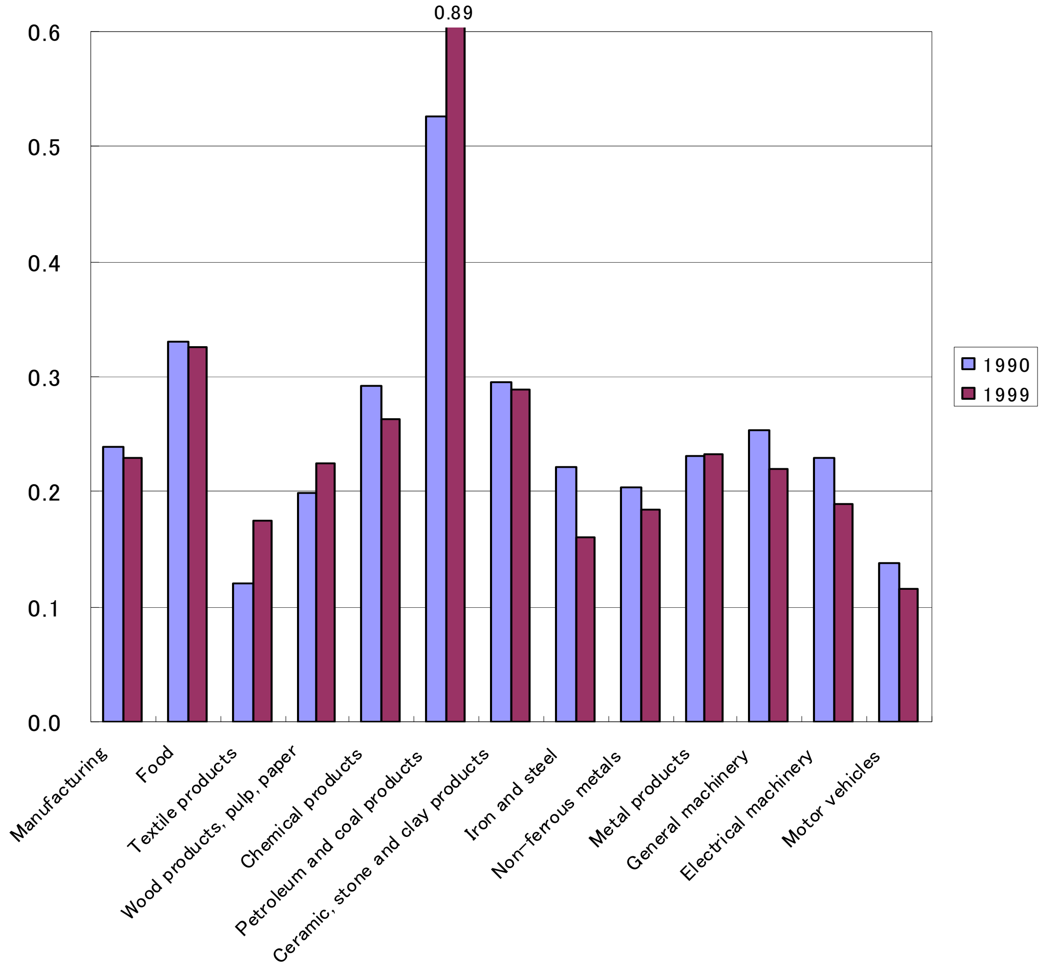
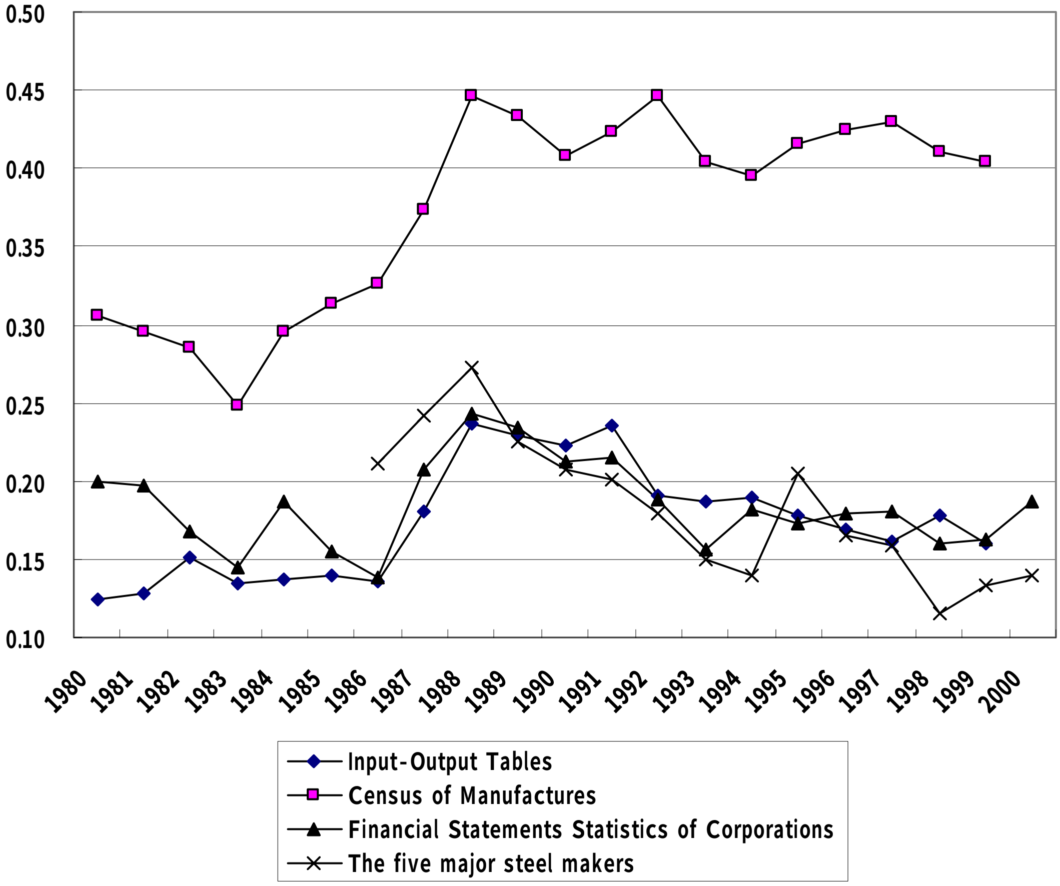
Figure 1: Price-cost margins of Japan's major industries in 1990 and 1999



Source: Matsuoka (2002).

Note: Price-cost margin (PCM) is calculated as $PCM = (VA - WB) / (MC + WB)$, where VA, WB, and MC denote value added, compensation, and material cost.

Figure 2: Price-cost margins of Japan's iron and steel industry with several databases



Source: Matsuoka (2002)

Table 1: The result of estimation (The restricted model)

The restriction: $\theta = \theta_D = \theta_F$

H_0: The restricted model is correct.

Sample period: 1986Q2-1998Q4

	Coef.	S.E.
α_0	8.193	0.124 ***
β_D	1.328	0.083 ***
β_F	0.101	0.017 ***
β_V	0.145	0.025 ***
β_K	-0.704	0.318 **
β_T	0.007	0.004 *
γ_{DF}	-0.097	0.009 ***
γ_{DV}	-0.072	0.003 ***
γ_{FV}	-0.006	0.002 ***
γ_{DK}	0.355	0.122 ***
γ_{FK}	0.029	0.035
γ_{VK}	0.083	0.057
γ_{DT}	-0.004	0.001 ***
γ_{FT}	0.000	0.000
γ_{VT}	-0.001	0.000 ***
γ_{KT}	0.006	0.005
γ_{DD}	-0.144	0.038 ***
γ_{FF}	0.077	0.007 ***
γ_{VV}	0.080	0.003 ***
γ_{KK}	-0.968	0.669
γ_{TT}	0.000	0.000 *
$\theta = \theta_D = \theta_F$	0.104	0.034 ***
α_D	0.858	0.291 ***
α_F	0.509	0.209 **
δ	-0.017	0.025
Number of observations	52	
Total number of observations in the system	354	
Log of residual covariance determinants	-29.248	
LR test for H_0	0.241 (P-value:0.64) *Chi* (0.05, 1)=3.84 ***H_0* : Not rejected**	

Source: Author's calculation.

Notes: Non-linear 3SLS is used for estimation.

Estimated parameters of AR(1) were 0.78*** in Eq.(1), 0.71*** in Eq.(2), 0.90*** in Eq.(4D), 0.80*** in Eq.(4F), 0.93*** in Eq.(5), 0.80*** in Eq.(6), and it was 0.24*** for AR(4) in Eq.(2)

***=significant at the 1 percent level, ** =significant at the 5 percent level, and *=significant at the 10 percent level.

Table 2: Price-cost margin of domestic markets and export markets in Japan's iron and steel industry (The restricted model)
The restriction: $\theta = \theta_D = \theta_F$

	Price-cost margin
	Both of domestic markets and export markets
Parameter: θ	0.104***
Price-cost margin : $\frac{1}{1-\theta} - 1$	0.116

Source: Table 1 and author's calculations.
Note: ***=significant at the 1 percent level, ** =significant at the 5 percent level, and *=significant at the 10 percent level.

Table 3: Cost elasticities of variables and the degree of return to scale in Japan's iron and steel industry (The restricted model)
The restriction: $\theta = \theta_D = \theta_F$

Cost elasticity	
Capital (K)	-0.282
Domestic products (Y_D)	1.050
Exports (Y_F)	0.089
Degree of return to scale	1.125

Source: Table 1 and author's calculations.
Note: Cost elasticities of those variables and the degree of return to scale are evaluated at the logarithm of the sample mean of variables.

Appendix Table 1: Comparison of the results in the previous literature

	Data	Period	Country	Industry	Price-cost margin			Cost elasticity				Degree of return to scale
					Domestic products	Exports	Total output	Capital	Domestic products	Exports	Total output	
This analysis	Industry data	1985-1998	Japan	Iron and Steel	0.116 [1)]	0.116 [1)]	-	-0.282	1.050	0.089	-	1.125
Bernstein and Mohnen(1991)	Industry data	1962-1983	Canada	Non-electrical machinery	0.887	0.639	-	-0.148 [2)]	0.755 [2)]	0.525 [2)]	-	0.974 [2)]
				Electrical products	0.471 [1)]	0.471 [1)]	-	-0.217 [2)]	0.726 [2)]	0.194 [2)]	-	1.323 [2)]
				Chemical products	0.205	0 [3)]	-	-1.181 [2)]	1.682 [2)]	0.317 [2)]	-	1.097 [2)]
Bughin(1996)	Firm data	1981-1987	Belgium	Chemicals	0.340	0.060	-	-0.540	0.880	0.520	-	1.100
				Electric and Electronic products	0.420	0.270	-	-0.220	0.720	0.250	-	1.150
Morrison(1992)	Industry data	1960-1981	The U.S.	Manufacturing	-	-	0.205 [4)]	-	-	-	0.854 [4)]	1.271 [4)]
			Japan	Manufacturing	-	-	0.481 [4)]	-	-	-	0.678 [4)]	1.372 [4)]
Aiginger, Brandner, and Wuger (1995)	Industry data	1963-1990	Austria	Glass	-	-	0.410	-	-	-	-	-
				Non-electric machinery	-	-	0.230	-	-	-	-	-
Nishimura et.al.(1999)	Firm data	1971-1994	Japan	Iron and Steel	-	-	0.204	-	-	-	-	-
Shirai(2000)	Industry data	1980-1984	Japan	Iron and Steel	-	-	0.347	-	-	-	-	-

Note 1: The markup ratios were same from the test result.
Note 2: The data are at 1983.
Note 3: The market was competitive from the test result.
Note 4: The data are at 1981.

Appendix Table 2: Descriptive Statistics (1986Q1-1998Q4)

		Mean	Std. Dev.
R_D	Bil.of Yen	5,253	578
Y_D	Bil.of Yen (1990 Base year)	5,359	483
P_D	(1990=1)	0.98	0.03
R_F	Bil.of Yen	450	42
Y_F	Bil.of Yen (1990 Base year)	511	44
P_F	(1990=1)	0.89	0.10
W	Yen	2,779	340
$W*L$	Bil.of Yen	396	34
P_M	(1990=1)	0.98	0.02
P_M*M	Bil.of Yen	4,111	404
VC	Bil.of Yen	4,507	424
S_L	(share)	0.09	0.01
K	Bil.of Yen	35,189	3,741
W_K*K	Bil.of Yen	1,254	359
ER	(1990=1)	1.18	0.14

Appendix Table 3: The result of estimation (The unrestricted model)

Sample period: 1986Q2-1998Q4

	Coef.	S.E.
α_0	8.192	0.130 ***
β_D	1.333	0.085 ***
β_F	0.095	0.020 ***
β_V	0.132	0.028 ***
β_K	-0.711	0.320 **
β_T	0.007	0.004 *
γ_{DF}	-0.091	0.015 ***
γ_{DV}	-0.072	0.004 ***
γ_{FV}	-0.005	0.002 ***
γ_{DK}	0.362	0.122 ***
γ_{FK}	0.029	0.033
γ_{VK}	0.048	0.049
γ_{DT}	-0.004	0.001 ***
γ_{FT}	0.000	0.000
γ_{VT}	-0.001	0.000 **
γ_{KT}	0.006	0.005
γ_{DD}	-0.146	0.039 ***
γ_{FF}	0.067	0.019 ***
γ_{VV}	0.080	0.003 ***
γ_{KK}	-0.956	0.670
γ_{TT}	0.000	0.000
θ_D	0.093	0.035 ***
θ_F	0.169	0.118
α_D	0.768	0.304 **
α_F	0.919	0.736
δ	-0.017	0.025
Number of observations	52	
Total number of observations in the system	354	
Log of residual covariance determinants	-29.253	

Source: Author's calculation.

Note: Non-linear 3SLS is used for estimation.

Estimated parameters of AR(1) were 0.79*** in Eq.(1), 0.73*** in Eq.(2), 0.90*** in Eq.(4D), 0.79*** in Eq.(4F), 0.92*** in Eq.(5), 0.80*** in Eq.(6), and it was 0.24*** for AR(4) in Eq.(2).

***=significant at the 1 percent level, ** =significant at the 5 percent level, and *=significant at the 10 percent level.

Appendix Table 4: Price-cost margins of domestic markets and export markets in Japan's iron and steel industry (The unrestricted model)

	Price-cost margin	
	Domestic markets (i =D)	**Export markets (i =F)**
Parameter: θ_i	0.093***	0.169
Price-cost margin: $\frac{1}{1-\theta_i}-1$	0.103	0.204
Wald test for H_0 **:** $\theta_D = \theta_F$	0.383 (P-value:0.54) H_0 : Not rejected	

Source: Appendix Table 3 and author's calculations.

Note: ***=significant at the 1 percent level, ** =significant at the 5 percent level, and *=significant at the 10 percent level.

Appendix Table 5: Cost elasticities of variables and the degree of return to scale in Japan's iron and steel industry (The unrestricted model)

Cost elasticity	
Capital (K)	-0.282
Domestic products (Y_D)	1.056
Exports (Y_F)	0.083
Degree of return to scale	1.125

Source: Appendix Table 3 and author's calculations.

Note: Cost elasticities of those variables and the degree of return to scale are evaluated at the logarithm of the sample mean of variables.