Scale Economies and Optimal Size in the Japanese Broadcasting Market

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Abstract

The purpose of this paper is to calculate the optimal size for broadcasters as well as scale economies in the Japanese terrestrial broadcasting market. From the estimation of total cost function, scale economies are evaluated in the broadcasting market. It is found that many broadcasters have been operating at a less than optimal size. Therefore, the merger of local stations can be justified as an effective way of improving their management, when industry structure is evaluated from an economic standpoint.

1. Introduction

The Japanese broadcasting market experienced steady expansion until the 1990s. Entry into the terrestrial broadcasting market has been regulated due to the scarcity of available radio frequencies, and no terrestrial broadcaster in Japan has yet gone bankrupt. However, there is a growing concern regarding the management of terrestrial broadcasters, which reflects the following changes in circumstances.

First, digital broadcasting started in Japan's three major metropolitan areas in December 2003. Digitalization of broadcasting offers several advantages including the realization of multi-channel broadcasting and better picture quality. However, terrestrial broadcasters have to replace their analog facilities with new, digital broadcasting facilities, and the investment required for digitalization imposes a considerable financial burden on small-scale broadcasters[1].

Second, the decrease in advertising expenditure paid by advertisers and the growth of competition in the media industry affect the management of terrestrial broadcasters. Advertising sales are the primary source of revenue for commercial broadcasters. As Kurokawa (2000) found, there is a positive relationship between economic activity, represented by gross domestic product (GDP) and advertising expenditure[2]. Since the Japanese economy has experienced difficult times over the last decade, advertising expenditure has remained static. In addition, while terrestrial television broadcasting is the most familiar medium in Ja-

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pan, broadcasting via communications satellite (CS) and CATV have been developing since the 1990s. Although the share of online advertising in the total advertising market is quite small at present, it has grown at a rapid rate and there has been fierce competition in the media industry.

The Ministry of Internal Affairs and Communications (MIC) has restricted the service area of broadcasters in order to maintain the localization of broadcasting. However, assuming that the above factors could adversely affect the operations of broadcasters, the Ministry began considering revision of the media ownership rule in 2003[3] and decided to allow mergers between small-scale broadcasters facing financial difficulties[4].

When discussing the industry structure, it is essential to consider the cost structure. Recognizing the changes in the circumstances of the broadcasting market mentioned above, the purpose of this paper is to calculate the optimal size for a broadcaster as well as scale economies and elasticity of substitution.

For empirical analysis on terrestrial broadcasting, Ueda, Takahashi and Mitomo (2004) calculated the scale economies by region. However, cost studies by researchers other than Ueda et al. are rare. Several reasons for not conducting empirical cost studies on terrestrial broadcasting have been pointed out. First, since the terrestrial broadcasting market has experienced steady expansion, little attention has been paid to the analysis of management. Second, viewers are not charged for terrestrial broadcasting services. In other words, a market as defined in economics does not exist between the viewers and the broadcasters. Free service means that the researchers are more inclined to study the cultural aspects of broadcasting rather than economic aspects. Third, since broadcasters are not obliged to publish detailed financial statements, the data available on terrestrial broadcasters in Japan is limited. This makes it difficult to conduct econometric studies on terrestrial broadcasting.

The rest of the paper is organized as follows : Sections 2 and 3 provide the model and the data. Empirical results are presented in Section 4. Finally, Section 5 offers some conclusions.

2. Model

To begin with, the total cost function takes the form, $TC = f(W_i, Y)$, where TC is the total cost, W is the input price vector, Y is the output. Input factors are labor, capital and materials. Since one of the purposes of this paper is to estimate the substitution of input factors, a translog cost function is specified to avoid prior restrictions on the characteristics of production technology. Symmetry and linear homogeneity of input prices are assumed. Equation (2) is the cost share equation given by Shephard's Lemma.

$$\ln TC = \alpha_0 + \alpha_Y \ln Y + \sum_{i=1}^{n} \alpha_i \ln W_j + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \beta_{ij} \ln W_i \ln W_j + \sum_{i=1}^{n} \beta_{iY} \ln W_i \ln Y + \frac{1}{2}\beta_{YY} \ln Y^2$$

$$\sum_{i=1}^{n} \alpha_i = 1,\ \beta_{ij} = \beta_{ji},\ \sum_{i=1}^{n} \beta_{ij} = 0,\ \sum_{i=1}^{n} \beta_{iY} = 0 \qquad (1)$$

$$S_i = \alpha_i + \sum_{j=1}^{n} \beta_{ij} \ln W_j + \beta_{iY} \ln Y \qquad (2)$$

Scale economies (Scale) are defined as unity minus the elasticity of total cost with respect to output. If Scale>0, the broadcaster enjoys scale economies. If Scale<0, the broadcaster has diseconomies of scale.

$$Scale = 1 - \left(\frac{\partial \ln TC}{\partial \ln Y} \right) \qquad (3)$$

Since the estimated function is a single output cost function, the optimal size of a broad-

caster refers to an organization size with the minimum average cost[5]. The average cost function is obtained from equation (1) and the output at the minimum average cost is given by equation (4).

$$\frac{\partial AC}{\partial Y} = \frac{\partial (TC/Y)}{\partial Y} = 0 \tag{4}$$

Since exp (TC) $\neq 0$ and $Y \neq 0$, equation (5) is obtained as follows :

$$\alpha_Y + \sum_{i=1}^{n} \beta_{iY} \ln W_i + \beta_{YY} \ln Y = 1 \tag{5}$$

The Allen partial elasticity of substitution (δ) and price elasticity of factor demand (ε) are given by equations (6) and (7). If $\delta_{ij} > 0$, factor i is a substitute for factor j. If $\delta_{ij} < 0$, factor i is a complement to factor j. Since the cost share is always positive, δ_{ij} and ε_{ij} take the same sign.

$$\delta_{ij} = \frac{(\beta_{ij} + S_i S_j)}{S_i S_j}, \; i \neq j$$
$$\delta_{ii} = (\beta_{ii} + S_i S_i - S_i)/S_i S_i \tag{6}$$

$$\varepsilon_{ij} = \delta_{ij} S_j \tag{7}$$

3. Data

The subjects of this study are twenty local stations that submitted financial statements to the Ministry of Finance during the fiscal year 1997-2002[6]. In addition to the twenty local stations, the financial data on so-called networks, a few large-scale broadcasters are also available. However, since the revenue structure of network is different from that of local stations[7], the networks are excluded from the estimation.

These broadcasters provide both television and radio services. Seventeen broadcasters have provided services within a single prefecture, according to the license issued by the MIC[8]. Three broadcasters have operated across several prefectures (the Kansai and Tokai areas) in consideration of the economic connections between these areas.

The inputs are L = labor, K = capital and M = program as materials. The data on both inputs and output are obtained from financial statements submitted to the Ministry of Finance.

L represents the number of employees at the end of a fiscal year. K is a fixed asset, excluding assets in construction and land. Capital stock is constructed using the perpetual inventory method. $K_t = (1 - \delta)\ K_{t-1} + I_t$, where δ is the depreciation rate of capital and is calculated as the ratio of depreciation expenses to book-valued fixed assets at the beginning of the period. Investment is calculated by adding the depreciation expenses and changes in assets between the beginning and end of the fiscal year. It is deflated using the price index of investment goods taken from the Monthly Report on the Price Indexes, issued by the Bank of Japan. Program (M) as input quantity, is calculated as the program cost divided by the program price (P_M). Since most program cost of a local station is made up of the expenditure for packaged programs, the price index of recorded materials is adopted as the program price.

The price of labor (P_L) is calculated as compensation of the employees divided by the number of employees. According to Christensen and Jorgenson (1969), the price of capital service (P_K) is calculated by $p\ (r + \delta) / (1 - \tau)$. The price index of capital goods is p, and r is the long-term prime lending rates from *the Bank of Japan's Monthly Report*. δ is the depreciation rate for capital stock as mentioned above. τ is the corporate tax rate, and is computed as the corporate tax divided by income taken from the financial statements.

Table 1 Sample Summary Statistics

	Input						Output Y (Million Yen)
	P_L	P_M	P_K	L	M	K	
Average	13.81	1.029	0.374	257.3	4433.7	5110.1	14428.5
Standard error	3.58	0.006	0.178	162.3	7033.1	4361.5	17261.9
Maximum	21.7	1.03	0.97	734	30706	17824	70522
Minimum	6.48	1.01	0.12	131	836	758	4434

Table 2 Correlation Coefficients

	P_L	P_K	P_M	L	K	M	Y
P_L	1.0000						
P_K	0.1648	1.0000					
P_M	0.0067	−0.1916	1.0000				
L	0.6362	0.1657	−0.0762	1.0000			
K	0.6366	−0.0192	0.0291	0.7624	1.0000		
M	0.6550	0.1236	−0.0141	0.9631	0.7620	1.0000	
Y	0.6665	0.1293	−0.0298	0.9812	0.7792	0.9916	1.0000

The output quantity is calculated as the sum of television and radio revenues divided by the price of broadcasting advertising service. This price index is adopted because the revenue source of commercial terrestrial broadcasters is advertising expenditure. The price indexes of recorded materials (P_M), capital goods (p) and broadcasting advertising service as output price are taken from the *Bank of Japan's Monthly Report on Price Indexes*.

Table 1 presents some summary statistics on the variables. The maximum output is fifteen times larger than the minimum output, and the differences in the scale of broadcasters can be clearly seen from this data. The expenditures for programs by small-scale broadcasters are relatively small, and the standard error of program cost is large. It is found that local broadcasters depend on the networks for programs through network affiliate contracts[9]. Table 2 indicates the correlation coefficients of variables.

4. Empirical Results

The cost function in equation (1) is jointly estimated with the cost share equation using the maximum likelihood method. The results of the estimation are shown in Table 3. The estimated cost function satisfies monotonicity in output over the entire sample and concavity in input prices at the sample means. The model that includes time trend variables has also been estimated. However, since the coefficients of time trend are not significant, the model is not adopted. This suggests that analog technologies are saturated and large-scale technological progress cannot be expected during the estimation period.

The scale economies calculated at the sample means by equation (3) is 0.09115. Since the standard error is 0.0109, the existence of scale economies is shown at the one percent significance level. The values of three large-scale broadcasters are in the range of −0.217~−0.123, and diseconomies of scale exist. Other broadcasters have scale economies.

Table 3 Parameter Coefficients of Cost Functions

α_0	−0.04419 (0.0147)*
α_Y	0.90885 (0.0121)*
α_K	0.20204 (0.0067)*
α_M	0.39570 (0.0048)*
β_{LK}	−0.06324 (0.0103)*
β_{KM}	−0.04994 (0.0096)*
β_{ML}	−0.13641 (0.0154)*
β_{YK}	−0.01742 (0.0077)**
β_{YM}	0.13971 (0.0063)*
β_{YY}	0.07329 (0.0256)*
Adjusted R-squared	
Cost Function	0.98648
Share equation of labor	0.66810
Share equation of capital	0.33490
Log likelihood	512.719
Number of samples	120

Heteroscedasticity consistent standard errors are in parentheses.
*1 percent significance level
** 5percent significance level

Table 4 Allen Partial Elasticity of Substitution

δ_{LM}	δ_{KL}	δ_{MK}
0.02239	0.00905	0.01532
(0.0123)***	(0.0054)***	(0.0052)*

Standard errors are in parentheses.
*1 percent significance level
***10 percent significance level

Table 5 Own-Price Elasticity of Factor Demand

ε_{LL}	ε_{MM}	ε_{KK}
−0.01641	−0.02088	−0.00970
(0.00625)*	(0.00056)*	(0.00121)*

Standard errors are in parentheses.
*1 percent significance level

From equation (5), the output that attains the minimum average cost is obtained to be 25, 573 million Yen. The average output of the samples is 14, 428 million Yen, and in 18 of 120 samples (three broadcasters), the output is more than 25,573 million Yen. Therefore, it is confirmed that most broadcasters have been operating at less than optimal size[10].

The values reported in Tables 4, 5 and 6 are calculated at the sample means of these variables. Table 4 presents the Allen partial elasticity of substitution obtained from equation (6). Labor is a substitute for program as well as capital, and capital is a substitute for program. Tables 5 and 6 present estimates of own-price and cross-price elasticity of input demands respectively. Consistent with expectations, own-price elasticity is negative across the entire sample, and all input demands are inelastic. On the other hand, the price of labor has increased on average during the estimation period. Since ε_{ML} is a positive value, it suggests that the increase in the price of labor has caused an increase in purchase of programs, instead of producing programs in-house[11]. This finding does not appear to support the localism that the Ministry had expected.

5. Conclusion

Since the value of scale economies is significantly positive, it is evident that broadcasters enjoy scale economies. Therefore, the merger of broadcasters can be seen as an effective way of

Table 6 Cross-Price Elasticity of Factor Demand

ε_{LM}	ε_{LK}	ε_{ML}	ε_{MK}	ε_{KL}	ε_{KM}
0.00886	0.00183	0.00901	0.00309	0.00364	0.00606
(0.00487)***	(0.0011)***	(0.00496)***	(0.00106)*	(0.00216)***	(0.00204)*

Standard errors are in parentheses. *1 percent significance level
***10 percent significance level

improving management from an economic point of view. However, in examining the industry structure of broadcasting, some problems need to be considered. Although a merger of broadcasters in the same service area may contribute to improving their efficiencies, it will lead to a decrease in the number of channels that the audience can watch.

On the other hand, judging from the estimation result, relaxing the limitations on service areas may also contribute to improving efficiency. As long as the number of broadcasters is fixed, an expansion of service area will bring about an increase in the number of channels that the audience can enjoy however, it will reduce localism. Similarly, the merger between two neighboring broadcasters will also reduce localism, although efficiency is expected to improve. In other words, the results of this estimation imply that policymakers have placed priority on localism and media diversity, rather than economic efficiency in the broadcasting market. Though this study concentrates on economic efficiency, it is necessary to discuss whether local stations should continue to bear the responsibility of localism from a broad perspective.

Finally, the problems regarding data need to be considered. While NHK, as a public broadcaster, is obliged to submit financial statements to the MIC, according to the Broadcasting Law, commercial broadcasters are not obliged to submit their statements to this Ministry. According to the Securities and Exchange Law, the data on commercial broadcasters that are not required to submit their financial statements to the Ministry of Finance is not public information to which the public is entitled to have access. Accordingly, the data on broadcasting is limited and the subjects of this study are a part of broadcasters. It would be highly desirable to be able to re-estimate the cost function using the data on all broadcasters and confirm the result of the present estimation.

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Notes

1. In the U.K., digital broadcasting started in 1998. However, one digital broadcaster, ITV Digital went bankrupt in May 2002.
2. The value of the coefficient of correlation is reported to be 0.98. See Kurokawa (2000).
3. See the final report of the study group on broadcasting policy in the MIC, and the press statement given by the chairman of the Radio Administrative Council, dated May 14, 2003.
4. See the press release from the MIC, dated March 17, 2004. However, no mergers have yet occurred.
5. With regard to the relationship between cost function and industry structure, see Baumol et al. (1982).
6. Firms that meet certain requirements such as the size of capital and the number of stockholders are obliged to submit their financial statements to the Ministry of Finance, according to the Securities and Exchange Law. However, since some broadcasters are small-scale firms, they are not obliged to submit these statements.
7. For a detailed account of the revenue structure, see Sugaya (1997).
8. For the outline of Japanese broadcasting policy and its history, see Sugaya (1997) and Sunagawa (2001).

9. Networks enter into affiliation contracts with local stations and provide their affiliates with programs and commercial messages at no charge.
10. The data on revenues of broadcasters that have not submitted their financial statements to the Ministry of Finance are available in the Japan Commercial Broadcasting Yearbook. According to the Yearbook 1997–2002, the output of every local station that is not included in this study, is less than 25, 573 million Yen. However, since cost data such as compensation and program cost is not included in the Yearbook, this empirical study does not refer to the Yearbook.
11. In principle, a terrestrial broadcaster represents a vertical integration of hardware (facilities for the transmission of programs) and software (program). However, it is pointed out that even large-scale broadcasters often purchase programs from production companies to reduce costs. With regard to small-scale local stations, the ratio of locally–produced programs to total transmitted programs is almost 10 percent on average, according to the investigation by the National Association of Commercial Broadcasters in Japan.

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我が国の放送市場における規模の経済性と最適規模

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