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SITUATIONS OF THEATERS AND MUSIC HALLS IN JAPAN AND CONSIDERATION OF EVALUATION METHODS USING PRODUCTION FUNCTIONS

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Abstract

The Cobb–Douglas production function of large theaters showed increasing returns to scale. The theaters researched are nationally well-known theaters conducting the best performing art activities in Japan. On the other hand, each region also has theaters intended for local people (local theaters). Researching and analyzing the differences between local theaters and these nationally famous theaters was an issue unexplored in the previous paper. To explore this issue, this research analyzed and evaluated local theaters qualified for financial support under the Theater Act, by using the same production function as the previous research, and compared them with large theaters. Unlike large theaters, local theaters are presumed to have a certain type of production function in terms of scale. The contribution of the number of employees (labor) is much higher than the number of seats (capital), compared to large theaters. The marginal rates of substitution of capital and labor are high in local theaters. In large theaters, the substitution rate is close to 1, but it is 8 or larger in local theaters. As a coefficient other than capital and labor, the stage performances index, which is the main purpose of theaters, is significant. The more active the stage performances, the higher the revenues both in large theaters and local theaters. As the overall audience size is declining, to achieve sustainable competitiveness, it can be pointed out that they must develop human resources capable of integrating and utilizing management resources unique to individual theaters regardless of the theater scale, and pass on their intellectual resources.

Keywords: Production functions, Management, Capital assets, Labor, High-ranked theaters and music halls, Medium-level theaters and music halls, Basic Law for Culture and Art

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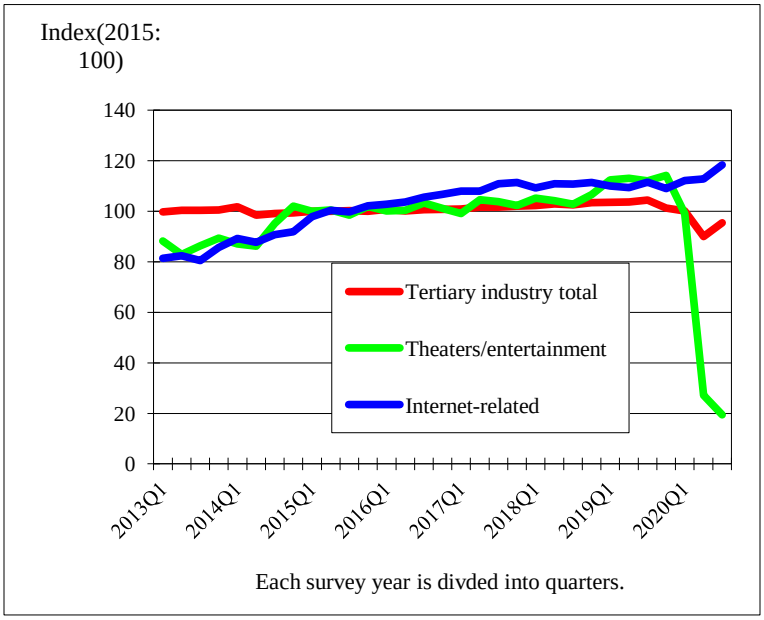
INTRODUCTION

Due to the Coronavirus crisis's impact in 2020, many theaters and music halls (hereinafter collectively referred to as "theaters") around the world were closed, and Japan was no exception. It impacted the tertiary industry activity index ("tertiary industry activity index survey," Ministry of Economy, Trade, and Industry (2020)) published by MITI, as shown in Figure 1 below, in which the index in 2015 is set as 100. As shown in the figure, in 2020, as a result of the official recommendation to refrain from going out and avoid dense human spaces, the activities of theaters and entertainment groups (drama and musical performance groups) have declined significantly compared to other service industries, while Internet-related and incidental businesses continue to expand.

Figure 1 Third (Service) Industry Activity Index



As of this paper's publication, the activities of theaters are significantly different from those in usual years due to the spread of Coronavirus infection. Therefore, this research limits its scope to their activities during three fiscal years from 2015 to 2017 (a fiscal year is from April 1 to March 31 of the following year). The author will report on the activity status of theaters and other facilities affected by the Coronavirus crisis in the future. In the meantime, this paper researches local theaters' activities during the same period as the period of the previous research for the top ranked theaters qualified for the subsidy program under the Act on Vitalization of Theaters, Music Halls, and Other Facilities.

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THEATER ACTIVITIES AND RESEARCH FRAMEWORK

Regarding the characteristics of theaters, readers are advised to refer to the previous paper, but the outline is as follows (Edagawa, 2020). According to the Social and Educational Survey conducted by the Ministry of Education, Culture, Sports, Science, and Technology in 2018, the number of theaters and music halls in Japan stood at 1,827 as of May 2018. 5.3% of them are for-profit corporations. Accordingly, most theaters are public/public interest corporations (including NPOs). Public culture halls serve as venues for local people's cultural activities. Privately-run culture halls exist only in big cities, and they are commercial theaters and music halls seeking profit. Most famous among such commercially operating halls are the Takarazuka Theater and the Shochiku Kabukiza Theatre, operated by Japan's two major entertainment companies. Given that most culture halls in Japan are publicly run, as mentioned above, this paper researches only non-profit theaters and music halls, the same as in the previous paper.

In Japan, theaters started as public halls (speech halls), so they are often set up for political purposes. Moreover, artist groups cannot afford to own a specific theater as a home base for their activities for financial reasons (Neki, Edagawa, Kakiuchi, & Sasai, 1997). In Western countries, it is common for artist groups to own their own theaters as their home base while also visiting and performing in other theaters. Therefore, for them, "a theater means an artist group and the building," not "a theater is a building (hardware)." People attach more importance to the activities of artist groups than to the buildings. On the other hand, in Japan, because the parties that have established the theaters and the artist groups are separate, the perception of "a theater is a building" is strong. It can be said that the prime function of a theater has not been nurtured in Japan because the local governments that manage the theaters only needed to focus on managing the building (Edagawa, 2015; Shimizu, 1999).

RESEARCH METHOD

To quantitatively grasp the activities of theaters, this research surveyed theaters in Japan, mainly focusing on their productivity, as in the previous research. Questionnaires were developed by the author. The survey was the first of its kind, as nothing like this had previously been conducted by Japanese think tanks or Japanese government agencies, including the Agency for Cultural Affairs.

Theaters surveyed

Theaters for this research were chosen from those whose performance quality has been rated highly. Unlike in the previous research, where nationally highly recognized theaters were selected, this research chose subjects from theaters highly recognized at local (prefecture or

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block comprising several prefectures) level (hereinafter “local theaters”). From a regional perspective, the survey collected as much quantitative data as possible regarding the theaters’ business, performance types, facility status, and financial condition. Seventy theaters were selected from among theaters receiving long-term subsidies from the Agency for Cultural Affairs, the Japan Arts Council, and the Japan Foundation for Regional Art-Activities. The previous research selected theaters from among the top large theaters in Japan receiving subsidies under the Act on Vitalization of Theaters, Music Halls, and Other Facilities. The theaters chosen for this research have also been receiving subsidies. However, they are local theaters, or venues for local people to appreciate stage, musical, and other art performances. They have different characteristics from large theaters, where performance arts are staged from a national perspective. Considering the regional distribution of theaters, 70 theaters were selected from large cities and local cities, referring to multiple performing art specialists’ comments.

This survey compares the theaters previously recognized as outstanding theaters with theaters conducting exemplary activities in rural areas. The survey was conducted from February 2020 to April 2020. To compare the data with the previous research that surveyed 20 theaters, this survey asked about activities, facilities, and the number of employees during three fiscal years from 2015 to 2017 (a fiscal year starts in April every calendar year and ends in March of the following calendar year). Therefore, this research concerns the respective states of theaters before the coronavirus pandemic. The selected theaters are shown in Table 1. In absolute numbers, densely populated areas, such as Greater Tokyo, have many theaters with outstanding functions. Over 70% of large theaters are located in the Tokyo, Hanshin, and Nagoya areas. On the other hand, even prefectures with one million or less population have six local theaters. Thus, the locations of local theaters are dispersed almost evenly nationwide.

Table 1 Population and number of surveyed theaters in the prefectures

Population (ten thousands of people)	Large theaters	Local theaters
≧1000	6	7
≧800	2	8
≧500	6	17
≧300	1	1
≧200	3	14
≧100	2	17
100>	0	6
Total	20	70

(Note) The analysis results of large theaters have already been published.

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FINDINGS

Staff and facilities of theaters

Events that can be held at a theater are significantly affected by the available facilities and staff. The availability of these resources determines the entire theater's ability to perform its function (Edagawa, 2913; Ei, 2000). Tables 2 and 3 show staff and facility sizes of surveyed theaters. The figures are simple averages of the numbers of employees and seats during the survey period (fiscal 2015 to 2017). While the numbers of seats and employees of theaters, which are inputs, change little over a short period, the number of projects, which is an output, may vary from year to year. In reality, however, because the annual operational budget does not increase or decrease significantly over a short period, the number of projects that can be implemented in a year does not change significantly.

Table 2 Number of employees by type in the surveyed theaters

Size		Artistic director	Project management staff	Stage management staff	Administrative staff	Others	Total
Large theaters	Average	1.40	23.40	8.95	14.90	8.55	57.20
	Surveyed theaters	20	20	20	20	20	20
	Standard deviation	1.08	12.54	6.44	14.84	12.35	29.26
Local theaters	Average	0.71	8.23	4.36	8.29	3.79	25.37
	Surveyed theaters	70	72	72	72	72	72
	Standard deviation	0.88	5.81	4.33	6.64	9.64	16.34
Total	Average	0.87	11.60	5.38	9.76	4.84	32.44
	Surveyed theaters	90	90	90	90	90	90
	Standard deviation	0.97	10.03	5.23	9.49	10.47	23.90

(Note)Artistic director: Ultimately responsible for the theater's performance projects, and proactively plans projects. Project management staff: Assists artistic directors in implementing and managing performance projects. Stage management staff: Respons

Accordingly, by simply averaging each index, statistical stabilization of measured values can be achieved (Kitamura, 2005; Matuura, Hayakawa, & Kato, 2007). As for human capital, based on the American economist Irving Fisher's concept of capital, this paper broadly defines capital as "a stock of rare resources that are required in the process of production and consumption," and assumes that artistic and technical knowledge, and business and management abilities are also fixed to theaters' human resources (Imai, Uzawa, Komiyama, Negishi, & Murakami, 1971; Ikegami, 2003; Throsby, 2001).

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Table 3 Distribution of the number of seats in the theaters surveyed

Number of seats	Large theaters		Local theaters		Total	
Less than 500 seats	2	10.0%	13	18.6%	15	16.3%
500 or more and less than 750	2	10.0%	7	10.0%	9	10.9%
750 or more and less than 1,000	1	5.0%	9	12.9%	10	10.9%
1,000 or more and less than 1,250	2	10.0%	8	11.4%	10	10.9%
1,250 or more and less than 1,500	3	15.0%	10	14.3%	13	14.1%
1,500 or more and less than 1,750	1	5.0%	4	5.7%	5	6.5%
1,750 or more and less than 2,000	5	25.0%	12	17.1%	17	18.5%
Over 2,000 seats	4	20.0%	7	10.0%	11	12.0%
Total	20	100.0%	70	100.0%	90	100.0%
Average	1469.4		1157.2		1225.0	

(Note) The theaters surveyed are the same as the notes in Table 1. The figures are the simple average from FY2015 to FY2017.

Of the human resources, the average number of artistic directors responsible for high-quality performance art is 1.40 for large theaters (in many cases, one director is assigned to each genre), 0.71 in local theaters, and 0.87 in a total of large and local theaters (Table 2). Both large and local theaters have a large standard deviation and a large coefficient of variation. The numbers of project management staff and stage management staff who help artistic directors are 23.40 and 8.95 in large theaters, and 8.23 and 4.36 in local theaters, respectively. As for the total number of employees, the gap between large theaters and local theaters exceeds 30. Also, in business management, large theaters have six more administrative staff members on average than local theaters. Large theaters are thus rich in human resources both in project implementation and business management.

Compared to the staff size of theaters on a national average (6.90 employees in 2018, “Social and Educational Survey”), the theaters chosen for the researches (large theaters and local theaters) are considerably rich in human resources regardless of their type. Some performance art projects at small-sized theaters with small halls are labor intensive, depending on whether the event is held there on a rental basis or held independently by the theaters. Therefore, generally speaking, the number of seats (scale) at theaters is not proportional to the number of employees. Because human resources are rich at the surveyed theaters, they can actively conduct performance art projects on their own initiative apart from renting venues to outside artist groups.

In addition to human resources, another resource for theaters is facilities, such as seating capacity and stage equipment of the hall. Table 3 shows the seating capacity of the halls. While technical aspects such as the acoustic system and stage mechanism of a facility

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are also important, this research compares the surveyed facilities using the number of seats as a benchmark.

Of all surveyed theaters, combining large theaters and local theaters, 36.7% have a hall with 1,500 or more seats. The rate is higher in large theaters, with 50% having a hall with 1,500 or more seats. According to the Social and Educational Survey, theaters nationwide have an average of 816.5 seats. Only 8.0% of large theaters have a hall with 1500 or more seats. A theater with a large hall can expand the audience by reducing the number of idle (vacant) seats as much as possible in an effort to use the hall's physical resources efficiently. In commercial companies, they need to combine various physical assets efficiently in the process of producing goods and services. Labor and capital are not always substitutable, which means that part of the capital is always idle. At theaters, the kinds of functions their halls have are the only physical resources that can contribute to expansion of the audience. These functions cannot be completely replaced by labor power. In this sense, the efficient use of halls (filling the hall to capacity) is especially important to increase the size of the audience. A hall can be fully seated by the theater manager's outstanding management ability to invite and deliver popular performance arts directed by excellent art directors (Edagawa, 2015; Ei, 2000). However, if the hall is not filled to capacity, an economic opportunity will be lost (Imai et al, 1971).

Size of audience (users)

Table 4 shows the average number of audience members (users) of the surveyed theaters measured for the three years in terms of annual total and per-project. The "project" mentioned in this paper represents a series of programs carried out for a certain purpose. Examples of such programs are a Shakespeare drama by a British theatrical troupe, a Mozart symphony concert by the Tokyo Symphony Orchestra, and a dance performance event by an overseas dance group, implemented to provide the audience with opportunities to appreciate high-quality artistic performances. The average annual number of audience members for projects hosted by large theaters and local theaters is 3.3 million, which has hardly changed over the three years. According to the Social and Educational Survey, the total number of audience members nationwide was 19.21 million in FY2017.

While the number of large theaters and local theaters surveyed for this paper account for only about 5% of all theaters in Japan, the projects hosted by them gathered about 17% of audience members. This indicates that audience members visit large theaters and local theaters to enjoy performing arts. On a national average, there were about 12,000 audience members per theater-hosted project per theater annually, which is about 16% of audience members attending large theaters and about 47% local theaters. The total number of audience members

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for all theaters nationwide increased by 6.0% from 2015 to 2017, partially because the number of theaters increased. The total number of audience members for large theaters and local theaters decreased by 1.7% in the same period.

Table 4 Number of audience per theater by type of business by theater size (3-year average).

Size		Total number of projects	Total audience (people)	Number of hosted projects	Audiences of hosted projects (people)
Large theaters	Average	318.1	314114.1	73.1	76353.7
	Numbers of theaters	20.0	20.0	20.0	20.0
	Standard deviation	179.5	193367.9	54.9	86763.1
Local theaters	Average	399.5	189114.1	37.0	25268.7
	Numbers of theaters	70.0	70.0	70.0	70.0
	Standard deviation	654.8	139945.7	28.2	20330.1
Total	Average	381.4	216891.9	45.0	36620.9
	Numbers of theaters	90.0	90.0	90.0	90.0
	Standard deviation	584.2	161642.0	38.8	49243.7

(Note) "Hosted projects" are projects planned and implemented by the theater itself. "Total number of projects" is the number of projects that are not

Financial position of theaters

Revenues

Timely investment is necessary to use human and physical resources effectively (Uzawa, 1986). Such investment is usually allotted to expenses for running the business and facility improvement. This paper looks into flow expenses (balance) related to running the business, namely, expenses for projects, personnel expenses, and administrative expenses. Administrative expenses include facility maintenance costs (maintenance and upgrading costs for a decrease in their value (maintenance cost)). Table 5 shows the revenues of surveyed theaters.

Revenues obtained from performance projects, the prime function of large theaters and local theaters, did not change much in the three years from 2015 to 2017. The annual average per theater was 330 million yen for large theaters, 49 million yen for local theaters, and 111 million yen for large theaters and local theaters combined. On average over three years, large theaters earned 281 million yen more than local theaters, a 6.7-fold difference. During the three years, the total average revenues, including related and incidental businesses, were 1,265 million yen for large theaters and 360 million yen for local theaters. The average of the large theaters and local theaters combined was 561 million yen. Large theaters earned 905 million yen more than local theaters, a 3.51-fold difference. Looking at the breakdown of average revenues over the three years, project revenues accounted for a large proportion of total

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revenues in large theaters compared to local theaters (26.1% vs. 13.6%). Subsidy revenues were also 5.0 times higher at large theaters at 214 million yen than local theaters at 43 million yen.

Table 5 Revenues by theater type

year		Large theaters			Local theaters			Total		
		Project revenues	Subsidies	Total revenues	Project revenues	Subsidies	Total revenues	Project revenues	Subsidies	Total revenues
2015	Average	3.20	2.33	12.59	0.43	0.37	3.50	1.04	0.81	5.52
	Numbers of theaters	20.00	20.00	20.00	70.00	70.00	70.00	90.00	90.00	90.00
	Standard deviation	3.30	2.60	7.53	0.32	0.60	2.55	1.94	1.55	5.62
2016	Average	3.36	2.24	12.66	0.52	0.48	3.66	1.15	0.87	5.66
	Numbers of theaters	20.00	20.00	20.00	70.00	70.00	70.00	90.00	90.00	90.00
	Standard deviation	4.04	2.52	7.52	0.51	0.84	2.76	2.25	1.56	5.67
2017	Average	3.34	1.84	12.70	0.52	0.44	3.63	1.15	0.75	5.64
	Numbers of theaters	20.00	20.00	20.00	70.00	70.00	70.00	90.00	90.00	90.00
	Standard deviation	3.45	1.76	7.83	0.81	0.70	2.92	2.11	1.18	5.75
Three-year average	Average	3.30	2.14	12.65	0.49	0.43	3.60	1.11	0.81	5.61
	Numbers of theaters	20.00	20.00	20.00	70.00	70.00	70.00	90.00	90.00	90.00
	Standard deviation	3.55	2.30	7.50	0.58	0.72	2.66	2.10	1.44	5.66

(Note) Total revenues do not agree with the sum of project revenues and subsidies because they do not include related/incidental revenues from other businesses.

By comparing the revenues of large theaters and local theaters based on the percentage of each type of revenue to the total, we can see the characteristics of their business forms. There is a significant difference in the percentage of project revenues. This indicates that large theaters fulfill their prime function (stage performances) in terms of revenues, while local theaters tend to have insufficient stage performance revenues. In large theaters, revenues from performance projects performed in the hall, the prime function of theaters, are about 1/4 (26.1%) of total revenues, and subsidy revenues are 16.9%. Revenues from related/incidental activities, excluding revenues from performance projects and subsidies, account for more than half of their total revenues. In local theaters, the project revenue ratio is very low, at about 1/7 of total revenues. They need to rely on related and incidental businesses to cover the insufficient revenues from projects and subsidies.

The size of a hall is physically limited. Even if the hall is filled to capacity, project revenues are not large for performances staged for low unit prices (ticket prices). Accordingly, theaters need to increase related and incidental activities to increase their total revenues. The low project revenue percentage to the total indicates that local theaters can only charge low ticket prices due to local economic and social conditions and local audiences' tastes. This can be compared to commercial companies' efforts to expand total sales by increasing sales in related and incidental businesses to cover weak sales in their core business.

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Expenditures

Expenditures for performance projects, the prime function of large theaters and local theaters, did not change much in the three years from 2015 to 2017 for both large theaters and local theaters. The average expenditures per theater over the three years were 674 million yen for large theaters, 147 million yen for local theaters, and 245 million yen for large theaters and local theaters combined (Table 6). On average over the three years, large theaters spent 527 million yen more than local theaters, a 4.58-fold difference. Spending less on performance projects means allotting less money to performers and artist groups for their performance and stage-related expenses, possibly affecting the quality of the performances. Personnel expenses are an investment in human resources essential for theater management. During the surveyed three years, the average personnel expenses were 267 million yen for large theaters and 0.904 million yen for local theaters, a gap of 173 million yen. Total average expenditures were 1,271 million yen for large theaters and 411 million yen for local theaters. Large theaters spent 860 million yen more than local theaters, a 3.09-fold difference. Looking at the breakdown of average expenditures over the three years, project expenditures accounted for a large proportion of total expenditures in large theaters compared to local theaters (53.0% vs. 35.8%). Conversely, the percentage of personnel expenses was lower in large theaters than in local theaters (21.0% vs. 22.9%), although the difference was small. Considering the revenues mentioned in Section 2.2.4.1, when the project revenues per personnel expense (revenues per personnel expense unit) are compared, they amount to 1.24 for large theaters and 0.52 for local theaters. The ratio of personnel expenses to project revenues is therefore two times higher in large theaters. In other words, large theaters have better labor efficiency than local theaters.

Table 6 Expenditures by theater type (100 millions of yen)

year		Large theaters			Local theaters			Total		
		Project revenues	Subsidies	Total revenues	Project revenues	Subsidies	Total revenues	Project revenues	Subsidies	Total revenues
2015	Average	6.96	2.66	12.72	1.17	0.91	3.69	2.45	1.30	5.69
	Numbers of theaters	20.00	20.00	20.00	70.00	70.00	70.00	90.00	90.00	90.00
	Standard deviation	4.62	1.38	7.57	1.06	0.66	2.77	3.36	1.13	5.69
2016	Average	6.71	2.57	12.68	1.35	0.94	3.83	2.54	1.30	5.80
	Numbers of theaters	20.00	20.00	20.00	70.00	70.00	70.00	90.00	90.00	90.00
	Standard deviation	5.05	1.45	7.51	1.49	0.66	2.98	3.49	1.12	5.71
2017	Average	6.56	2.79	12.72	1.15	0.95	3.85	2.35	1.36	5.82
	Numbers of theaters	20.00	20.00	20.00	70.00	70.00	70.00	90.00	90.00	90.00
	Standard deviation	4.84	1.64	7.48	1.08	0.69	2.99	3.32	1.24	5.71
Three-year average	Average	6.74	2.67	12.71	1.47	0.94	4.11	2.45	1.32	5.77
	Numbers of theaters	20.00	20.00	20.00	70.00	70.00	70.00	270.00	270.00	270.00
	Standard deviation	4.76	1.47	7.39	2.09	0.66	3.47	3.38	1.16	5.68

(Note) Total expenditures do not agree with the sum of project expenditures and personnel expenses because they do not include administrative expenses and other expenditures

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Looking at the average project balance over the three years, project revenues were 330 million yen, and project expenditures were 674 million yen in large theaters. The balance after deducting expenditures from revenues was negative 344 million yen. Revenues from performances staged in the hall, which is the prime purpose of a theater, cover only about half of the project expenditures (Tables 5 and 6).

The project balance in local theaters was 0.908 million yen, smaller than that of large theaters. However, since the amount of project revenues was small, only 1/3 of project expenditures were covered by project revenues. Comparing the balance of total revenues and expenditures, comprising performance projects and related and incidental activities, there is little difference between large theaters and local theaters. In many large theaters and local theaters, the establisher and the manager are different. The local government that built the theater often outsources its management to a non-profit organization. The local government, the establisher, pays high management service fees to the managing organization (Edagawa, 2013; Shimizu, 1999). A theater's operating deficit is covered by these management service fee revenues, hall rental fees collected from artistic groups, and revenues from other related/incidental activities. Related/incidental activities include administration (facility/equipment management) excluding labor, cafe/restaurant, parking lot, and outreach performances (traveling performances not using the theater hall). In particular, local theaters in less populated areas where a large audience cannot be expected rely heavily on management service fees received from the local government, the establisher of the theater, from the viewpoint of securing opportunities for local people to appreciate art. It can be said that these theaters are operated at public expense.

These analyses indicate a tendency, in terms of spending, that performance projects, which are the prime purpose of the theater, are the principal activities of large theaters. In contrast, performance projects that do not spend much are implemented in local theaters.

Relationship between resources and outputs in theaters

For the following method of analyzing the relationship between theater resources and output with the production function, please refer to the previously published paper (Edagawa, 2020). This paper expanded the range of surveyed theaters and analyzed the differences in production functions depending on the theaters' characteristics, such as their scale and location. Simply put, this analysis method regards the theater as a corporate entity, revenues as an output, and physical capital/assets (the number of seats and human capital) as inputs (production elements). Operating expenses used for the normal activities of the theater is working capital.

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Operating expenses are classified into personnel expenses, administrative expenses, and performance project costs. As for the measuring unit of capital and assets invested in humans, the quality of labor is evaluated by per-capita wage (average labor cost) in accordance with the theories of Keynes, Uzawa, and others, the same as in the previous paper (edagawa, 2020). Based on this approach, the adjusted number of theater employees (hereinafter, “the number of employees”) was calculated by dividing the surveyed theater’s total personnel expenses by its average per-capita wage. The calculation considered wage differences between prefectures based on the Basic Statistical Survey on the Wage Structure for the respective years published by the Ministry of Health, Labour and Welfare. In the following, this paper simply uses the number of employees as an input, and the theater project revenues and total revenues as outputs, from 2015 to 2017.

Figure 2 shows the correlation between the adjusted number of employees for each year above and the corresponding annual project revenues. The correlation coefficient is 0.339 for large theaters and 0.472 for local theaters. Similarly, Figure 3 shows the relationship between the adjusted number of employees and total revenues. The correlation coefficient is 0.589 for large theaters and 0.778 for local theaters, higher than the correlation coefficients with project revenues.

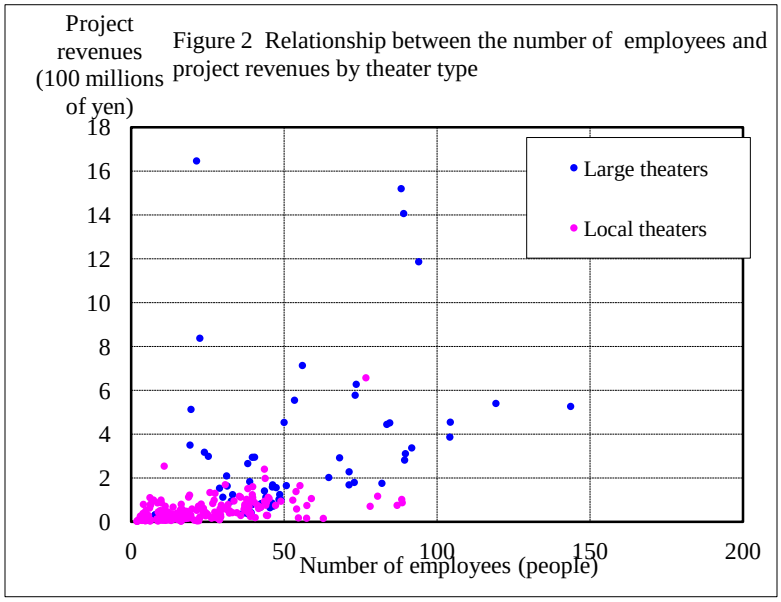

Figure 2 Relationship between the number of employees and project revenues by theater type

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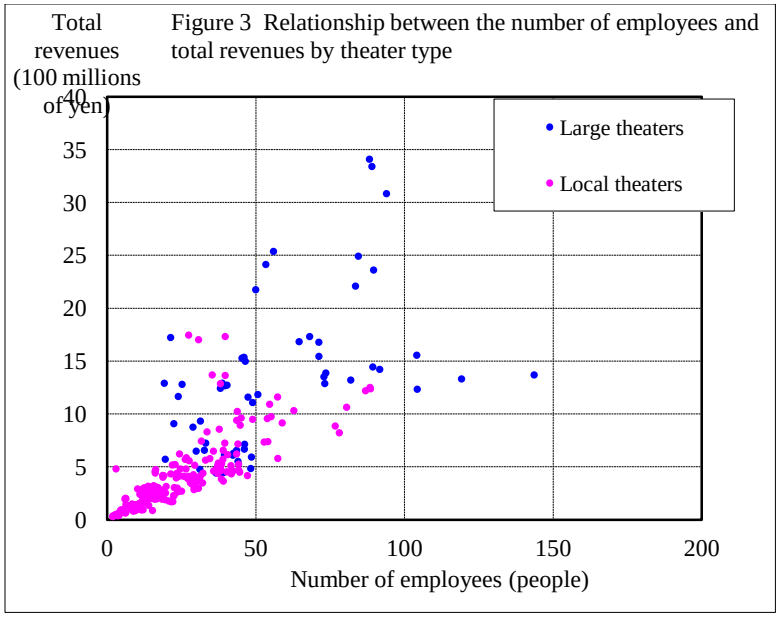

Figure 3 Relationship between the number of employees and total revenues by theater type

Figure 4 shows the relationship between the number of seats (the number of seats at the time of opening because it is not open every day) and project revenues for each year. Fig.4 shows that project revenues of large theaters with around 1,500 to 2,000 seats are distributed fairly widely from around 100 million to around 1,600 million yen. From the perspective of project revenues, it shows that large theaters with around 500 to 2,500 seats are widely distributed within the project revenue range from about 400 million yen to 600 million yen.

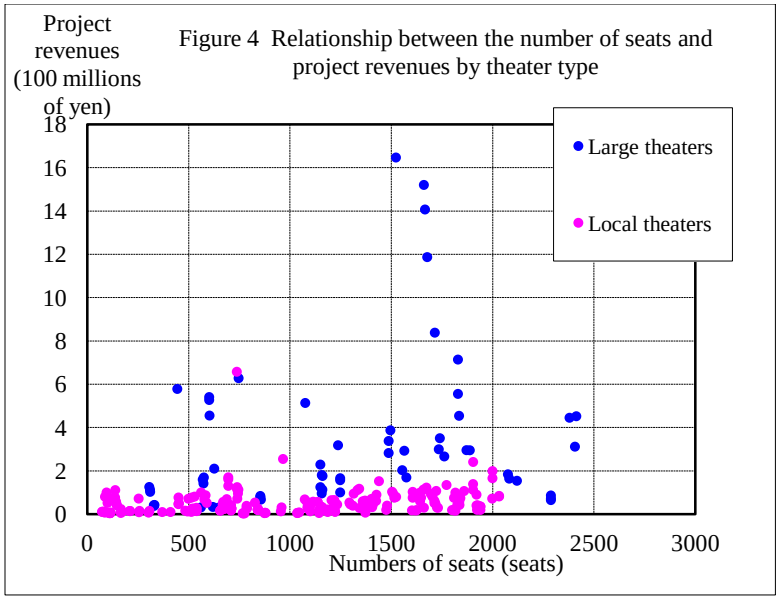

Figure 4 Relationship between the number of seats and project revenues by theater type

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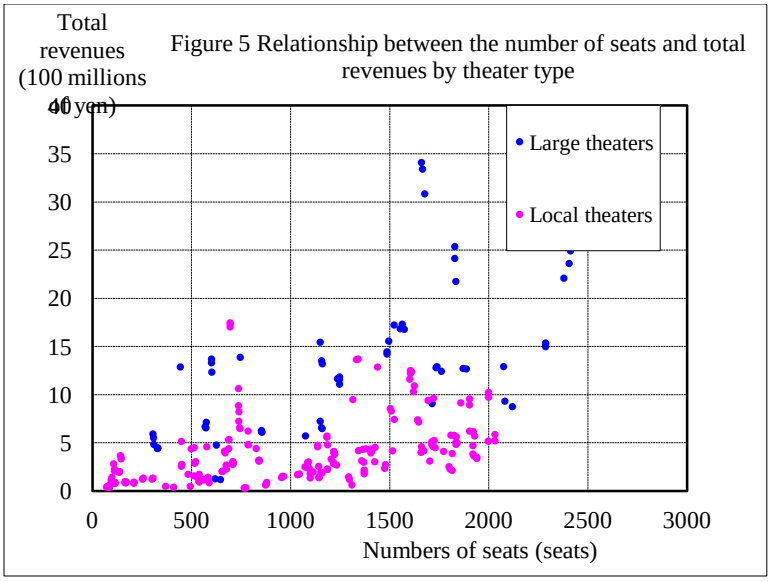

Figure 5 Relationship between the number of seats and total revenues by theater type

On the other hand, local theaters' project revenues are distributed in the range below 200 million yen regardless of the number of seats, with a few exceptions. The correlation coefficient between the number of seats and project revenues is 0.245 for large theaters and 0.207 for local theaters. Figure 5 shows the relationship between the number of seats and total revenues. As in Fig. 3, the total revenues of large theaters with 1,500 to 2,000 seats are widely distributed in the range from about 1,000 million yen to about 3,500 million yen. In local theaters, because the distribution of total revenues is broader than that of project revenues, local theaters are distributed in a broader range. The correlation coefficient is 0.637 for large theaters and 0.445 for local theaters.

Production function of theaters

Many projects supported by the government's cultural administration policy take a long time to produce measurable results after their startup. Therefore, cultural projects are said to be unfit for quantitative evaluation. It is technically difficult to grasp their outcome or output quantitatively (this issue was already pointed out in the Research and Study on Cultural Expenditures in the United States and Five Major European Countries, conducted by the Agency for Cultural Affairs in 1993) (Throsby, 2001). However, at the beginning of the 21st century, the administrative system for national and public cultural facilities changed, and they were reorganized into incorporated administrative agencies, local incorporated administrative agencies, or entities whose management and operation are entrusted to private businesses. After the system's revision, the granting of subsidies from the national and local governments is determined mostly

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based on their output: revenues and the number of users. Under these circumstances, managers at each cultural facility are struggling to increase revenues and audiences.

Each cultural facility must compete with other cultural facilities now. In the 21st century, theaters and other cultural facilities have started to adopt marketing approaches that commercial companies use to win customers. Meanwhile, sector-by-sector production functions and cost functions have been studied from an economic viewpoint to decide inputs and the corresponding optimal output (Enya, 2000; Hori and Yoshida, 1996; Konishi & Nishiyam, 2009; Matuura, Hayakawa, & Kato, 2007; Miyagawa, Takizawa, & Gak, 2006; Omori & Nakajima,1999). However, as pointed out in the previous paper, the production function of cultural facilities has not been sufficiently studied. Using the same method as in the previous paper, this paper estimates the production functions of large theaters and local theaters and conducts a comparative analysis.

The operation of theaters includes planning and implementing art performances by artist groups, business management, and administration. Halls in theaters have been upgraded technologically. Many multi-purpose halls now can be used for stage performances thanks to the advancement of computer technology. Thus, the hall function is less likely to significantly impact the artists' performance (artist groups) (Shimizu, 1999). A hall can be operated by utilizing IT technology even in the absence of specialized staff. Accordingly, theater staff and theater facilities can be substitutable production factors to a certain extent. The Cobb–Douglas production function was initially used only for the manufacturing industry. Later, however, its application to other sectors, including the service industry, increased (Enya, 2000; Hori et al. ,1996; Miyagawa et al. ,2006).

The Cobb–Douglas production function, first used in the manufacturing industry, is now applied to a wide range of fields, including the service industry, and regarded as a useful analysis technique. Based on the study above, this paper uses the Cobb–Douglas production function, which has substitutability between human capital/assets and physical capital/assets, as the production function for theaters. In the retail sector, floor area is used as a physical capital/asset factor. In the banking sector, financial assets are used. In the case of theaters, the number of seats used throughout the year (hereinafter, "the number of seats") is used. Capital should be measured in terms of service provided, not stock. Accordingly, this analysis uses the number of seats adjusted by the number of seats used throughout the year. The adjusted number of employees (hereinafter, the "number of employees"), explained earlier, is used as labor capital.

Data collected from the survey are panel data of the same theaters over the three years from fiscal 2015 to fiscal 2017 (each year starting in April and ending in March of the following

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year). However, the period covered by the survey is three years, too short for treating the data as time series data. According to Kitamura and Matsubara in cases where there is almost no change in the explained variable/explanatory variable over time, it is difficult to estimate the coincidence of fixed effects (Kitamura, 2005; Matsubara, 2014). Accordingly, it is better to treat them as so-called “between data” (between-class deviation) with an emphasis on variable stability (Kitamura, 2005). This treatment is based on the idea that single-year cross-section data may bias the estimates because the revenues of individual theaters are affected by specific time effects. However, the effect at a particular time point can be mitigated by collecting data for three years in the time series direction for each theater and taking the time average. On the assumption that there are differences in productivity between theaters, emphasis is placed on finding differences between theaters rather than changes in the time series direction. It can be assumed that the operating status of theaters is affected by the social and eographical conditions of their areas. Specifically, the project revenues and total revenues of theaters are often affected by their locations and the local employment conditions of theater staff. In densely populated urban areas, for example, transportation infrastructure is well established, making it easier for people to go to theaters. The situation is totally different in scarcely populated areas.

Figure 6 shows the correlation between the number of seats and the number of employees of each theater as explanatory variables of the production function. As shown in this figure, these explanatory variables are independent of each other.

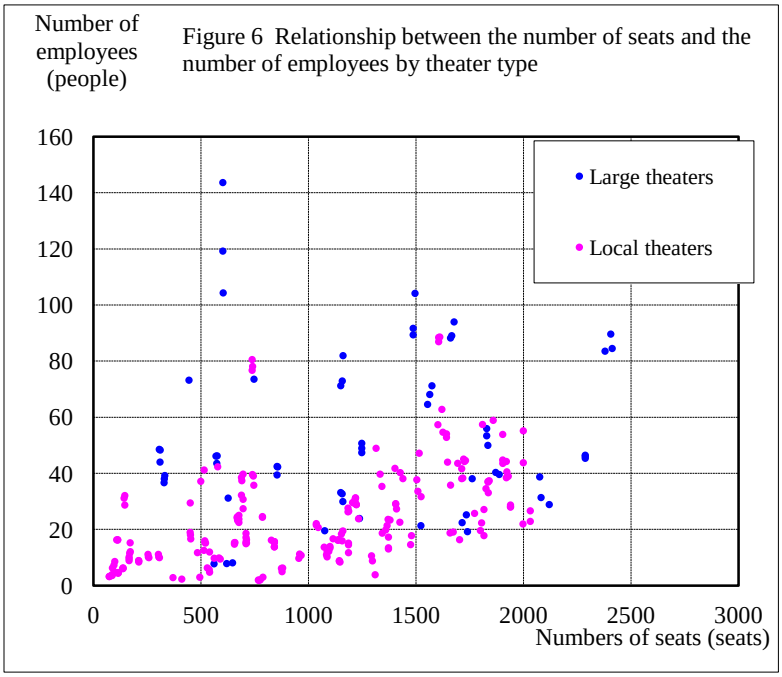

Figure 6 Relationship between the number of seats and the number of employees by theater type

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Looking at the multicollinearity between the explanatory variables, it is VIF = 1.02 in large theaters and VIF = 1.56 in local theaters. As it is said that there is no multicollinearity if VIF <10, this assumption is reasonable (Iwata, 1983). Since there is no multicollinearity between the number of seats and the number of employees, this paper considers them as explanatory variables independent of each other and has adopted these two variables as explanatory variables. It is generally believed that the larger the theater's size, the larger the number of its employees. However, these data show that the number of employees at a theater is not affected by its size. In other words, the number of employees at a theater hardly affects its operation.

As explained above, since annual average data was used for data analysis for each theater, between estimation is used. The following Cobb–Douglas production function was estimated using project revenues and total revenues as non-explanatory variables and the number of seats and the number of employees as explanatory variables.

$\ln(Y)=\alpha \ln(\text{number of seats}) +\beta\ln(\text{adjusted number of employees})+\gamma$,

where Y: project revenues or total revenues (unit: 100 million yen), α: capital share, β: labor share, and γ: all production factors.

Table 7 shows the coefficients of the explanatory variables of the production function of total revenues and project revenues by theater type. For reference, the sums of the capital share and the labor share are also shown.

Table 7 Production functions for each theater group

Explanatory variables and others	otal revenues			Project revenues		
	Large theaters	Local theaters	Total	Large theaters	Local theaters	Total
α (Numbers of seats)	0.665 6.58	0.101 1.66	0.168 2.85	0.580 1.88	0.023 0.19	0.041 0.31
β (Adjusted number of employees)	0.759 7.51	0.872 12.82	0.921 16.45	0.695 2.26	0.671 4.93	0.095 7.30
β/α	1.141	8.634	5.482	1.198	29.174	2.317
(Reference) α + β	1.424	0.973	1.089	1.275	0.694	0.136
γ	-5.323 6.96	-2.181 6.65	-2.704 8.05	-5.979 2.59	-3.235 4.83	-3.961 5.22
Numbers of theaters	20	70	90	20	70	90
Adjusted R2	0.872	0.820	0.851	0.372	0.367	0.476

(Note) The values under the variable is the t value of each variable

In the above table, the residual of each equation was tested by the Kolmogorov–Smirnov test. Since the normal distribution was confirmed in the test, the estimation formula is appropriate. In the case where project revenues are the objective variable, the production function is statistically unreliable in view of the t-value of the coefficient. This may be because theaters in

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Japan conduct many outreach activities by going outside the theaters, apart from projects that use only their stage and halls. As shown in Table 5, project revenues account for a small portion of theaters' total revenues. Theater staff often engage in activities outside the theater in addition to stage activities (projects). If project revenues are used as the objective variable, it cannot be explained by the number of employees or the number of seats in the stage (hall).

In the case where the total revenues formula is used as the objective variable, the total of the sums of the capital share and the labor share is about 1 in local theaters, constant returns to the production technology. On the other hand, it is 1.424 in large theaters, increasing returns. This indicates that large theaters with more seats and more employees have an advantage in terms of revenues. In the case of increasing returns, perfect competition between theaters does not work. The larger the theater is, the more advantageous it becomes. Large theaters would get bigger and small theaters would be driven out. Eventually, one large theater might monopolize, or a few theaters might dominate the market. However, unlike the manufacturing industry, which produces physical products and has a broad market, a theater is a community-based organization, and the audience is made up of mostly local people. Therefore, although the form of competition is different from that of the manufacturing industry, it is extremely disadvantageous financially for small theaters located near a large theater if they conduct the same types of activities as those of the large theater (such as performances of the same genre). They need to conduct, as necessary, unique activities or niche business activities which do not compete with those of the large theater.

Looking at the total revenues formula, in local theaters, the coefficient of the number of seats (capital share), which is one of the explanatory variables, is much lower than the coefficient of the number of employees (labor share). There is high elasticity in the substitution between production factors. The sum of capital share and labor share is approximately 1, which is a linear homogeneous production function. The marginal productivity of capital and labor depends only on the capital-labor ratio and is constant in terms of scale. As the input (labor) increases, the marginal rate of substitution between capital and labor decreases. Furthermore, looking at the elasticity of the substitution rate between capital share and labor share, the elasticity of substitution between production factors is not as high in large theaters as in regional theaters. In local theaters, labor share is abnormally large compared to capital share, and the number of employees contributes significantly to total revenues. In local areas that have fewer advantages than metropolitan areas, such as dense population and convenient transportation, it can be said that the function of the theater largely depends on the staff.

Under the project revenue formula, the degree of the freedom-adjusted coefficient of determination is very low, explaining only about 40% of the total both in large theaters and local

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theaters. Moreover, the coefficient related to capital among explanatory variables is statistically insignificant. In theaters, besides the hall business (mainly performances), related/incidental businesses are also important. The Theater Act stipulates that theaters' functions include collaboration with local universities, engaging in art management, providing local people with an art learning experience, and visiting performances (outreach), and that these functions have the same level of importance as giving opportunities to local people to enjoy art performances. Therefore, larger theaters and major theaters in local areas have more activities (revenues) related to businesses that are not hall performances, resulting in more total revenues combined with project revenues. The staff in these theaters are often engaged in these related/incidental activities, not only performance projects. Therefore, in the following analysis, total revenues are used as the objective variable (output) of the production function, based on theaters' actual states and statistical judgments on the production function estimates.

Comparison between estimates and actuals of the production function of theaters

The estimated total revenues at theaters, calculated using the two-production-factor "between" model formula, are compared with their actual total revenues. Figure 7 shows the actual and estimated values of total revenues of large theaters and local theaters. The square of the freedom-adjusted correlation coefficient is 0.852 overall. This is an intermediate value between the explanatory variables of the large theater logarithmic model formula and the local theater logarithmic model formula, but it is almost the same as that of the estimation formula for all theaters.

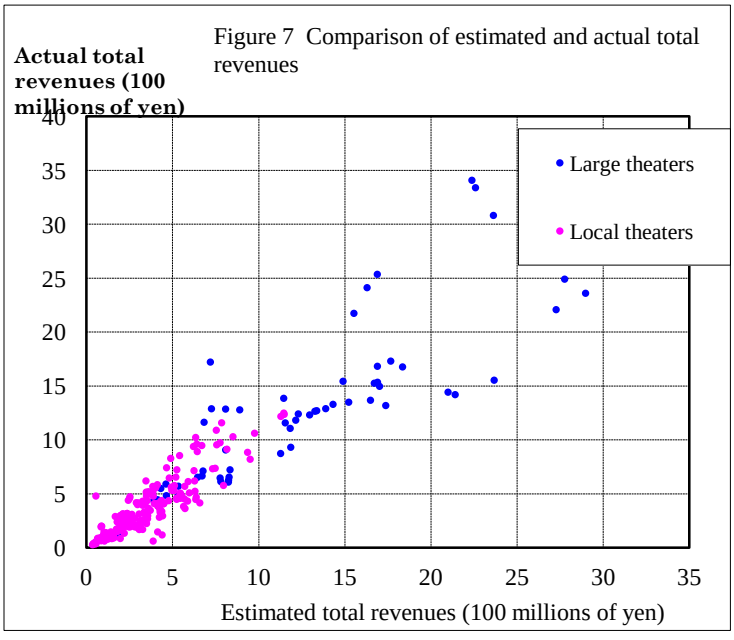

Figure 7 Comparison of estimated and actual total revenues

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Looking at Fig. 7, there are many cases where the actual revenue deviates considerably from the estimated value. In particular, theaters with actual revenue of 2,000 million yen or more are distributed above or under the 45-degree line. This indicates that revenues differ significantly in large-scale theaters, even if they have the same number of seats and employees. On the other hand, values of local theaters are distributed near the 45-degree line. Since they are shown in Fig. 7 on the same scale as for large theaters, a more scaled-down distribution is shown in Figure 8. Looking at Fig. 8, you can observe that the difference between the actual revenues and the estimated revenues of local theaters is smaller than those of large theaters and are distributed near the 45-degree line.

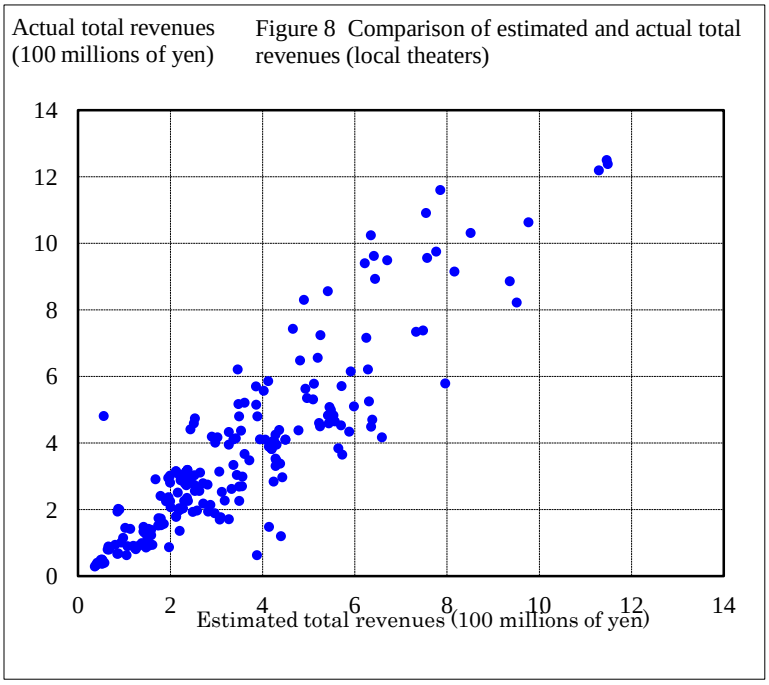

Figure 8 Comparison of estimated and actual total revenues (local theaters)

The analyses above indicate that revenues of large theaters with large numbers of seats and employees differ even if the number of seats (capital) and the number of employees (labor) are the same due to other factors. On the other hand, local theaters' revenues are almost the same if the size of capital and labor are the same. However, since capital and labor cannot explain all revenues, Table 8 shows the number of theaters by dissociation coefficient rank in order to identify those other factors.

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Table 8 Correlation between socio-economic status indices and discrepancy coefficients in

	Items	Large theaters	Significance level	Local theaters	Significance level
Characte-ristics of theaters	Purpose of theater hall	-0.249		0.031	
	Expenditures for stage projects	0.394	**	0.324	**
	Continuity of the same project	0.282	*	0.129	
	Number of stage/project staff	0.313	*	0.085	
	Subsidiaries from national/local governments and others	0.076		0.070	
Geographi-cal socioeconomic status	Population of the prefecture	0.064		0.089	
	Area of the prefecture	0.259	*	-0.074	
	Population density of the prefecture	0.044		0.115	
	Prefectural total income	0.090		0.131	
	Prefectural average income	0.091		0.174	
	Number of higher education graduates (educational background)	0.010		0.097	
	Number of theaters in the prefecture	0.094		-0.009	
	Number of theater audience in the prefecture	0.142		0.007	
	Number of theater projects in the prefecture	0.153		-0.006	

(Notes) 1. * Significant at 5% level (both sides), **: Significant at 1% level
2. All prefectures are simply called a "prefecture."

Factors behind the discrepancy between estimates and actuals of theaters' production functions

The discrepancy between estimates and actuals in the production function using two production factors indicates that factors other than the number of employees and the number of seats affect the theater's total revenues. The magnitude of the disparity varies depending on the geographical and socioeconomic conditions of the areas, in addition to the characteristics of theaters and the content of their projects. Once established, theaters are significantly affected by the social and economic conditions of the local communities. If there are similar theaters in the vicinity, the competition for audiences will intensify. As pointed out in the previous paper (Baumol & Bowen, 1968; Edagawa, 2020; Suo & Wakamatsu, 2003), in the case of theaters focusing on projects that are greatly influenced by the cultural capital of the audience, such as operas, classical concerts, and ballet, theaters located in areas populated with more highly educated and high-income people have the advantage in attracting audiences.

Based on the viewpoints above, this paper analyzes the relationship between the economic and social conditions of theaters' location (prefectures) and the dissociation

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coefficients, adopting the method used in the previous paper. Since the previous paper used a fixed-effect model to analyze the characteristics unique to theaters, the characteristics of individual theaters were emphasized more. However, this research estimates the production function of theaters as a whole. Accordingly, this paper analyzes the discrepancy factors between the large theater group and the local theater group. Table 8 shows theaters' unique characteristics and economic and social conditions for theaters as indices, and the correlation between each index and the discrepancy coefficient. If there are two or more theaters of a similar type in the same area, it can be assumed that audience numbers will be affected by the competition among them. Accordingly, indices representing local conditions, such as the number of theaters in the same prefecture and the number of visitors to theaters in the same prefecture, and indices representing the characteristics of individual theaters, such as the structure of the theater hall and the mode of the theater's business, are adopted. To briefly explain the table, the "continuity of the same project" index is a quantitative variable. As mentioned earlier, a "project" refers to a series of programs implemented for the same purpose. "Continuity of the same project" refers to the running years during which a project has continued to be implemented. For each theater, it is the simple average of running years of all projects. For "continuity" to be recognized, a project need not continue for 12 consecutive months. If the continuity and the discrepancy coefficient show a positive correlation coefficient, the discrepancy coefficient is large (the actual value of the production function is larger than the estimated value).

Looking at Table 8, there is a correlation between some theater-specific indices and the discrepancy coefficient. However, there is almost no correlation with the socioeconomic status indices in the theaters' locations, which are environmental factors for theaters. This tendency is observed both for large theaters and local theaters. It can be said that the discrepancy coefficient has little correlation with the income level or educational background of the residents. In terms of correlation with discrepancy indices, the largest amount of spending is on stage projects in both large theaters and local theaters. Given the analysis above, it can be concluded that at both Japan's top 20 theaters and local theaters surveyed, revenues are determined by their inherent characteristics and that the social and economic conditions in the theaters' respective areas do not correlate with their revenues. This means that regardless of where they are located, theaters can expect audiences and revenues if they conduct unique art activities that reflect their inherent characteristics. According to the production functions, about 87% of total revenues can be explained by the number of seats and the number of employees in large theaters and about 82% in local theaters. As shown in Table 8, other contributions to total revenues are theaters' unique management techniques. Based on these analyses, the research estimated production functions of local theaters again.

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Table 9 shows the production function by adding the conventional coefficient of the production function and the “project expenditures” variable for large theaters and local theaters. There was no problem with VIF and the normal distribution of residuals between independent variables. Figure 9 shows the distribution of the estimates and actuals of total revenues using that production function. In this figure, estimates and actuals match much better for both large theaters and local theaters than before the variable was added. This indicates that project expenditures contribute significantly to the total revenues of theaters. By adding project expenditures, the total contribution rate of capital and labor decreases for large theaters. However, the marginal rate of substitution of capital and labor hardly changed. In local theaters, the reliability of the contribution rate of capital is not statistically solid. The marginal rate of substitution of capital and labor drops slightly from 8.63 to 7.19. When the production function is added with the variable, large theaters show increasing returns to scale. In a local theater, when the [project expenditures coefficient] is added to α and β, it becomes about 1.04, showing constant returns to scale, and a linear homogeneous production function is estimated. The project expenditures have a positive effect on income, indicating that the theaters’ prime business using the stage greatly contributes to their revenues. Comparing the coefficients, the contribution rate is not much different between large theaters and local theaters, but it is slightly larger in large theaters. This is because large theaters have better stage equipment than local theaters. Projects using better stage equipment contribute more to the revenues of large theaters than local theaters.

Table 9 Production functions for each theater group

Explanatory variables and others	Two variables		Variable added	
	Large theaters	Local theaters	Large theaters	Local theaters
α	0.665	0.101	0.477	0.101
(Numbers of seats)	6.58	1.66	4.15	1.87
β	0.759	0.872	0.560	0.726
(Adjusted number of employees)	7.51	12.82	4.75	10.52
β/α	1.141	8.634	1.174	7.188
(Reference) α + β	1.424	0.973	1.037	0.827
Coefficient	—	—	0.256	0.215
(Project expenditures)			2.53	4.39
γ	-5.323	-2.181	-3.628	-1.712
	6.96	6.65	3.84	3.86
Numbers of theaters	20	70	20	70
Adjusted R2	0.872	0.820	0.908	0.861

(Note) The values under the variable is the t value of each variable

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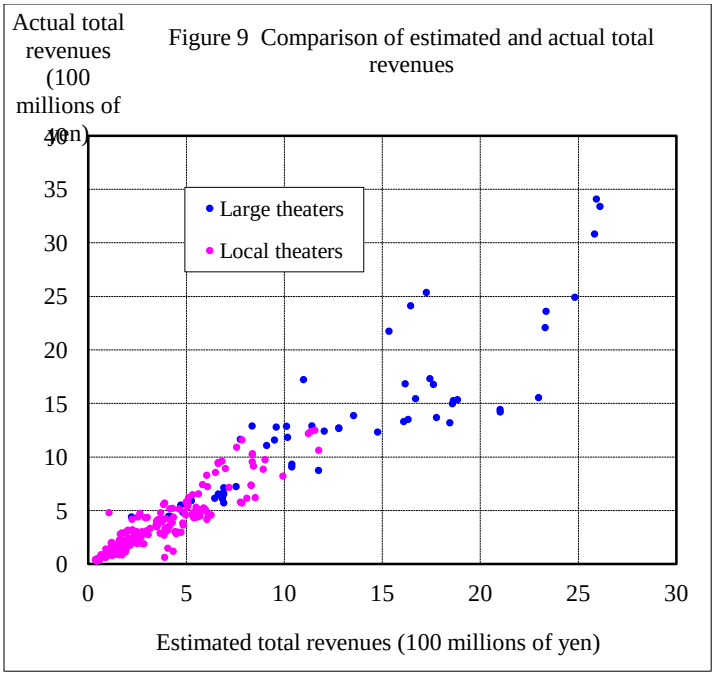

Figure 9 Comparison of estimated and actual total revenues

HOW THEATERS SHOULD BE OPERATED AND THEIR FUTURE DIRECTION

Large theaters have the production function of increasing returns to scale, indicating that they will monopolize the market in their location. By adding a variable, it can be estimated that activities utilizing theaters' unique characteristics, such as a stage, are a factor in their monopolization. Large theaters with excellent stage equipment can invite famous, high-quality artists (groups) that can attract audiences at high ticket prices. They can also capture audiences with the particular genres of performances they can provide, an operational advantage over local theaters. Large theaters possess human resources and their know-how, capable of utilizing excellent stage equipment and inviting artists (artist groups). The national and local governments and non-profit organizations in Japan determine operating expense subsidies for theaters on a competitive basis. Accordingly, large theaters have an advantage over local theaters in obtaining subsidies. This advantage can be observed from the fact that the ratio of subsidies to revenues is about 5% higher for large theaters than for local theaters. Therefore, local theaters have no choice but to rely on revenues from related/incidental activities in addition to subsidies. Apart from the theater's prime function of delivering performance arts, revenues must be earned from related/incidental activities such as restaurant/parking lot, goods sales, outreach projects that do not use stages, and hall rental.

Outputs and outcomes produced by cultural facilities are difficult to evaluate. The national or local government that has established a theater and/or provides subsidies evaluates the theater by the number of visitors and its revenues to determine subsidies for operational

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expenses and the implementation of performance art activities. The production function of large theaters is increasing returns to scale. Large theaters possess rich human resources and their know-how, which are theaters' unique resources, compared to local theaters. The larger theaters become, the more disadvantageous local theaters become in terms of theater outputs. In other words, large theaters have rents arising from possessing scarce and valuable resources, such as excellent stage equipment, talented human resources, a good location, and a large budget. Barney's VRIO framework (1997) conceptualizes resource value, rareness, imitability, and organization (Peteraf, 1993; Barney, Wright, & Ketchen, 2001). To integrate such rents and form sustainable competitive significance, a competent approach is necessary to integrate and manage resources (Teece, Pisano, & Shuen, 1997). Among theater management resources, they are "invisible assets," including invisible technology, skills, and management know-how, and "tacit knowledge" that is difficult to formulate (texting).

In the general manufacturing industry, to utilize a new technology effectively, you need to combine it with the existing technology and know-how and continuously review the organization and manufacturing method (Penrose, 1959). The productivity of a theater's resources can only be evaluated by the relationship between the discovered resources and services. Therefore, productivity can be evaluated only when available services are discovered and embodied. The discovery and embodiment of services need knowledge and conviction. The productivity obtained from there also relies on the ability of people (human resources) to discover and embody services. Specifically, the theater business, which has many intangible assets, such as theater performance methods and skills to negotiate with performers, and the accumulation and improvement of traditional know-how, significantly depends on the theater operator's ability and management policy. In particular, it must take a long time to accumulate intangible assets that lead to productivity. A theater can continue performance projects for a long time because it has accumulated intangible assets necessary for implementing the projects, an advantage in competition with other theaters.

The Guidelines for Activities to Revitalize Theaters and Music Halls issued by the Ministry of Education, Culture, Sports, Science and Technology in 2013 pointed out that enhancement of soft and human resources (projects and staffing) is urgently needed. Securing human resources is a necessary measure for theaters to present high-quality art performances. This paper shows the contribution of human resources to the revenues of theaters by using the production function. These findings can only be applied to excellent theaters surveyed in this research receiving governmental support under the Theater Act, although there is variance in their size. The situations in many other theaters, which total about 2,000, are unknown. However, if these findings could be applied to theaters nationwide, many high-quality

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employees would be needed for their operation, which is not realistic. In that sense, the guidelines of the Ministry of Education, Culture, Sports, Science and Technology are too ideal.

WAY FORWARD

This research examined the productivity of 20 excellent large theaters and 70 local theaters in Japan. The research also analyzed the productivity of a limited number of theaters, using the Cobb–Douglas production function. Future research needs to examine the universality of these results. In economics, general production functions—those to be generally applied to all kinds of production industries—have been proposed. However, a comprehensive discussion has not yet been held on production functions and the productivity of theaters. Moreover, in focusing on the sharing of knowledge, or "invisible assets," among theater staff, such as know-how to integrate and operate various theater resources having a competitive advantage, that is, generation of a context, further discussion is necessary regarding the shift from "tacit knowledge" to "explicit knowledge."

To solve these problems, it is necessary to increase the number of theaters surveyed to confirm the applicability of the Cobb–Douglas production function and the effective range of these research results. It is also necessary to conduct case studies to explore the "sharing of invisible knowledge" for theater management. Specifically, it is necessary to conduct aggregative research, including 1) theaters of different sizes in Japan with about 2,000 seats, and 2) expanding the research scope to similar theaters in Western countries. In the current Coronavirus crisis, in looking at the responses of theaters to the infection, preventive measures taken by individual theaters vary and are adjusted according to the situation of each theater. Even if the same measures are taken by different theaters, the consequences may be different. Therefore, it is necessary to conduct a case study of the intellectual resources utilized by individual theaters for the operation.

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