

The Impacts of the Introduction of New Public Management on Japanese Public Museums

Miyuki Taniguchi

Department of Economics, Keio University, Japan

E-mail: t-miyuki@keio.jp

Abstract

This paper focuses on estimating the efficiency of Japanese prefectural museums and its determinants. Using econometric methods, the aim of this paper is to determine how the small government policy has changed the management of Japanese prefectural museums since 2006. In order to reconstruct the budget positions of local governments, the *Koizumi* government advocated a policy of “small” government and cuts in the costs of public cultural facilities. One example was the introduction of the Designated Manager System (DMS) into public facilities in 2006, which was an example of the New Public Management and enabled private managers to manage public facilities. The main contribution of this paper is to examine the impact of the introduction of New Public Management into public museums, using statistical data. A stochastic production frontier is used to confirm if there has been any improvement in the economic efficiencies of museums since 2006 and whether or not this is due to the DMS itself. Microdata for the period from 1998 to 2014 obtained from the “Prefectural Art Museum Survey” (*Todoufukeritsu Bijutsukan Chosahyou*) which was conducted by the Council of Deputy Director Generals and others of Prefectural Art Museums (*Todoufukeritsu Bijutsukan Fukukanchotou-jimusekininsya-kaigi*) is used in the analysis. The estimation results show that designated managers could reduce inefficiencies when they engage in planning the exhibitions in the prefectural museums. Museums where their designated managers are selected through a competitive process also show a more efficient performance.

Key Words: efficiency, production function, museums, new public management

JEL classification numbers: H76, D24, H72

1 Introduction

In order to reconstruct the budget positions of local governments, the Koizumi government advocated a policy of “small” government and cuts in the costs of public cultural facilities. In order to try to reduce or eliminate inefficiencies in the management of public facilities, some local governments introduced the New Public Management (NPM). The NPM is a system to apply private management methods to the public sector and is based on the idea that the introduction of private sector management methods can improve efficiencies in the public sector. One example of a NPM introduced into public facilities in Japan was the Designated Manager System (DMS), which was enacted in 2006 and enabled private managers to manage public facilities. Regardless of whether or not the DMS was introduced, many public facilities introduced some form of the NPM.

This paper focuses on prefectural museums, and aims to determine how the small government policy has changed the efficiency of Japanese prefectural museums since 2006, using econometric methods. Generally speaking, a prefectural museum is a museum which has been established by a prefectural government. For the purpose of this paper, museums that have been established by prefectural governments and that are members of the Council of Deputy Director Generals and others of Prefectural Art Museums (*Todoufukeritsu Fukukanchoutou Sekininsyakaigi*) are defined to be Japanese prefectural museums. According to this definition, the total number of the Japanese prefectural museums in 2015 is 65. In all 47 prefectures except Tokyo, the fiscal deficits of prefectural governments have been increasing and prefectural cultural facilities have been a heavy burden on public finances. Some museums introduced NPM by introducing the DMS in order improve the prefectural budget situation. Other museums introduced NPM without introducing the DMS. Therefore, this paper measures the impact of the DMS on the productive efficiencies of museums.

Assuming that holding exhibitions is the main activity of a museum, the existing literature estimates either production frontier functions or cost frontier functions to measure the productive efficiencies of museums. In most of existing studies, the “output” of museums is defined to be the total number of visitors to exhibitions. Using data from a postal survey of the members or associate members of the South West Museums Council in 1998, Bishop and Brand (2003) measure the technical efficiency of 110 British museums by estimating a Cobb-Douglas production function, using the stochastic frontier approach (SFA). Their results indicate that public funding and voluntary activity decrease technical efficiencies. Basso and Funari

(2003) analyses the performance of museums, using classical data envelop analysis (DEA) and free disposal hull data envelop analysis (FDH DEA). Basso and Funari (2004) measures technical efficiencies of 15 public Italian museums in 1998, using DEA. Basso and Funari (2004) proposes to consider both quantitative and qualitative factors when the efficiencies of museums are measured. Haruna, Kuwahara, and Shiozu (2011) measure the inefficiencies of Japanese prefectural museums from 1998 to 2006 using network DEA, and considering the local characteristics where museums are located, for example, the monetary supports, the number of volunteers, and the prefectural population. However, they did not analyze the factors causing these inefficiencies. Suhara (2011) measures the technical efficiency of the Japanese prefectural museums from 1998 to 2008 using SFA. Suhara (2011) estimates a Cobb-Douglas production function using data from micro data of the “Prefectural Art Museums Survey” conducted by the Council of Deputy Director Generals and others of Prefectural Art Museums. Suhara’s results indicate that prefectural educational events and the introduction of the DMS did not affect technical efficiency of museums. Only the distance from the central city in the prefecture to the museum improves technical efficiency. To examine the moral hazard that public museums do not made effort to avoid deficit in Japan when they can cover deficits with any public financial supports, Kuwahara and Siozu (2013) estimate a Cobb-Douglas cost frontier function for the Japanese prefectural museums over the period from 1998 to 2007 using SFA. However, their estimated cost function is not based on economic theory because the inefficient factors are treated as input factors in the estimated cost function. The estimation results also do not satisfy the standard assumption of a cost function that all coefficients of input variables should be positive. Kuwahara and Siozu (2013) conclude that exhibitions financed mainly by prefectural governments are not cost inefficient compared with co-hosted exhibitions financed by private companies because the co-hosts have less incentive to minimize costs in Japan.

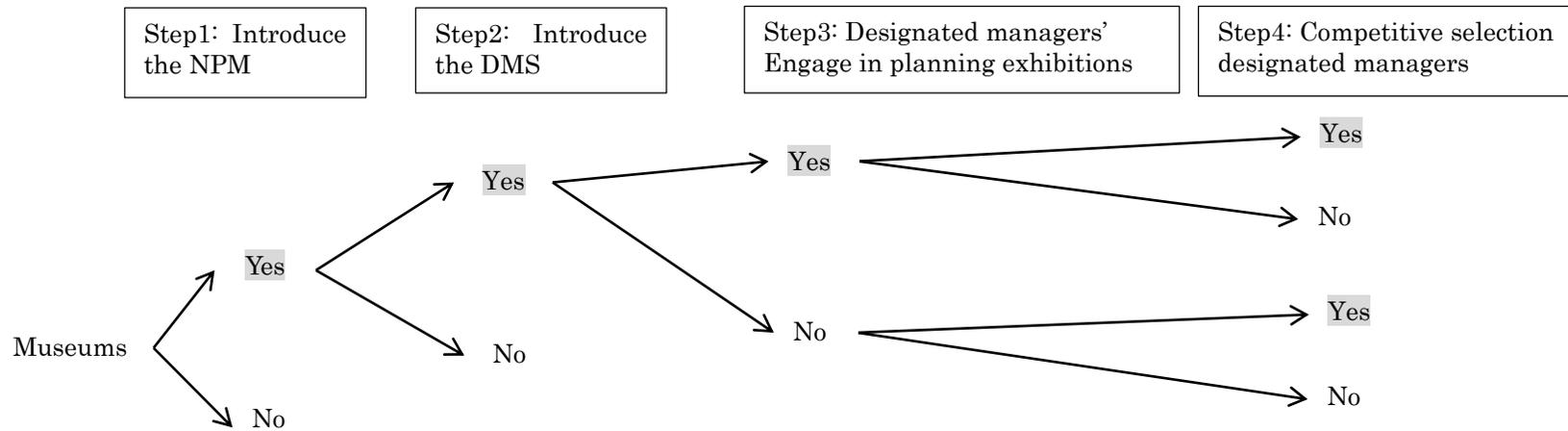
The main contribution of this paper is consider the impact of the introduction of the New Public Management into Japanese public museums around 2006 based on statistical data. The econometric analysis is conducted in two steps. First, a translog production frontier function, which relaxes some of the assumptions of the Cobb-Douglas production frontier functions estimated in Suhara (2011), is estimated to measure the inefficiency of production. Second, the factors influencing museum inefficiency are analyzed, and the impacts of both the NPM and the DMS are examined using the estimated inefficiencies.

2 The Management of Japanese Prefectural Museums

The New Public Management (NPM) was introduced into Japanese public museums around the time the Designated Manager System (DMS) was enacted in September, 2006 and as a result the management of the Japanese public museums has diversified. Before August 2006, prefectural museums were either managed by prefectural governments or by the external organizations of the prefectural governments. Private managers had not been allowed to manage the prefectural museums. After September 2006, private managers have been allowed to manage prefectural museums. In some museums, the managers changed to private managers. In the other museums, the managers did not change, so that either the prefectural government continued to manage the prefectural museums or an external organization of the prefectural government continued to manage the prefectural museums as the designated manager.

Each prefectural government decides on the managers of the prefectural museums located in each prefecture. To organize the decision making process relating to the management of prefectural museums, this paper assumes that the prefectural governments decides how to manage each museum in four steps. Figure 1 shows the decision making process relating to the management of the prefectural museums after 2006. In the first step, the prefectural government decides whether or not introduce the NPM into prefectural museums. In the second step, the prefectural government decides whether or not to introduce the DMS into the prefectural museums. In the third step, the prefectural government decides whether or not the designated managers will engage in planning exhibitions in the prefectural museums. Finally, the prefectural government decides how to select the designated managers. The prefectural government choose between a competitive system and direct designations. In econometric analysis in this paper, these four impacts on product

Figure 1: Decision making process relating to the management of Japanese prefectural museums



3 Model

3.1 A translog stochastic production function

The number of inputs and the number of outputs of the Japanese prefectural museums are defined following Suhara (2011), that is, there are assumed to be three inputs and one output in the production of exhibitions. The three inputs are assumed to be: the premises to exhibit art works (K_1); the expenses for advertisements and leasing art works (K_2); and labor (L_1). Output (Y) is defined as the total number of visitors to exhibitions. While Suhara (2011) assumes a Cobb-Douglas production function for museums, this study assumes a translog production function, which requires weaker assumption than a Cobb-Douglas production function. The inputs and outputs are assumed to be related by the following translog production function:

$$\begin{aligned} \ln Y_{it} = & \alpha + \beta_1 \ln K_{1it} + \beta_2 \ln K_{2it} + \beta_3 \ln L_{1it} \\ & + \beta_4 \frac{1}{2} (\ln K_{1it})^2 + \beta_5 \frac{1}{2} (\ln K_{2it})^2 + \beta_6 \frac{1}{2} (\ln L_{1it})^2 \\ & + \beta_7 \ln K_{1it} \ln K_{2it} + \beta_8 \ln K_{1it} \ln L_{1it} + \beta_9 \ln K_{2it} \ln L_{1it} + v_{it}, \end{aligned} \quad (1)$$

$$\ln Y_{it} = f(\cdot) - u_{it} + v_{it}, \quad (2)$$

where Y_{it} is the total number of visitors to exhibitions at the i -th museum in year t , K_{1it} is the premises to exhibit art works at the i -th museum in year t , K_{2it} is the expenses for advertisements and leasing art works at the i -th museum in year t , L_{1it} is the number of employees employed by the i -th museum in year t , $\alpha, \beta_1, \dots, \beta_9$ are coefficients to be estimated, u_{it} is the inefficiency term for the i -th museum in year t , and v_{it} is a standard disturbance.

3.2 Stochastic Frontier Models

Equation (1) with $u_{it}=0$ for all i and t gives rise to a simple pooling model. In addition to this simple pooling model, six kinds of stochastic frontier models are estimated in this study to allow for the possible existence of stochastic inefficiencies. These six models are: the pooling stochastic frontier (pooling SF) model; the time invariant stochastic frontier (TI-SF) model (the random-effects stochastic frontier model); the time varying decay stochastic frontier (TVD-SF) model; the fixed-effects stochastic frontier (FE-SF) model; the true fixed-effects stochastic frontier (true FE-SF) model; and the true random-effects stochastic frontier (true RE-SF) model. The specification of these models are as follows:

Pooling Stochastic Frontier (Pooling-SF) Model

$$\ln Y_{it} = f(\cdot) - u_{it} + v_{it}, \quad u_{it} \sim N^+(\mu, \sigma_\mu^2), \quad v_{it} \sim N(0, \sigma_v^2), \quad (3)$$

Time Invariant Stochastic Frontier (TI-SF) Model

$$\ln Y_{it} = f(\cdot) - u_i + v_{it}, \quad u_i \sim N^+(\mu, \sigma_\mu^2), \quad v_{it} \sim N(0, \sigma_v^2), \quad (4)$$

Time Varying Decay Stochastic Frontier (TVD-SF) Model

$$\ln Y_{it} = f(\cdot) - u_{it} + v_{it}, \quad u_{it} = \exp\{-\eta(t - T_i)\}u_i, \quad u_i \sim N^+(\mu, \sigma_\mu^2), \quad v_{it} \sim N(0, \sigma_v^2), \quad (5)$$

Fixed-Effects Stochastic Frontier (FE-SF) Model

$$\ln Y_{it} = f(\cdot) + \zeta_i - u_i + v_{it}, \quad u_i \sim HN(0, \sigma_\mu^2), \quad v_{it} \sim N(0, \sigma_v^2), \quad (6)$$

True Fixed-Effects Stochastic Frontier (True FE-SF) Model

$$\ln Y_{it} = f(\cdot) - u_{it} + v_{it}, \quad u_{it} \sim |N(0, \sigma_{\mu it}^2)|, \quad \sigma_{\mu it}^2 = \sigma_\mu^2 \times \exp(\alpha_i + \delta' z_{it}), \quad v_{it} \sim N(0, \sigma_v^2), \quad (7)$$

True Random-Effects Stochastic Frontier (True RE-SF) Model

$$\ln Y_{it} = f(\cdot) + w_i - u_i + v_{it}, \quad w_i \sim N(0, \sigma_w^2), \quad u_i \sim N(0, \sigma_u^2), \quad v_{it} \sim N(0, \sigma_v^2), \quad (8)$$

where u_i , and u_{it} are measures of technical inefficiency, v_{it} is standard disturbance, ζ_i is an individual museum fixed effect, T_i is the number of observations on the i -th museum in the panel data set, and N and HN denote a normal distribution and a half normal distribution, respectively. The difference between models (3), (4), (5), (6), (7) and (8) lies in the specification of the inefficiency term. Models (3), (4), and (7) take no account of the panel nature of the data, while model (6) does. It should be noted that models (3) and (4) are non-nested models, while equation (4) can be obtained as a special case of equation (5) by imposing the restriction $\eta = 0$, and as a special case of equation (6) by imposing the restriction $\zeta_i = 0$ for all i . The pooling model can be obtained as a special case of equations (3) and (4) by imposing the restriction $\sigma_\mu^2 = 0$.

3.3 Examination of the impacts management changes on the productive efficiencies in museums

Following the discussion of Figure 1, four hypotheses are examined. The first hypothesis is that the political trend which introduced the New Public Management (NPM) into Japanese prefectural museums around 2006 contributed to improving the productive efficiencies of exhibitions rather than the introduction of the Designated

Manager System (DMS). The second hypothesis is that the introduction of the DMS into Japanese prefectural museums contributed to improving the productive efficiencies of exhibitions. The third hypothesis is that exhibitions which the designated managers are involved in planning are more efficient in increase the visitors than exhibitions. The fourth hypothesis is that designated managers which are selected through a competitive process contributed to improve the productive efficiencies of exhibitions. These four hypotheses correspond to the four decision-making steps of the prefectural governments in Table 1. In order to test these hypotheses, we postulate the following model to explain the variations in technical inefficiency as measured by u_{it} determine the impact of these various;

$$u_{it} = a + b_1NPM_t + b_2DMS_{it} + b_3TRE_{DMS_{it}} + b_4DMS_EXH_{it} + b_5TRE_{DMS_EXH_{it}} + b_6DMS_COM_{it} + b_7TRE_{DMS_COM_{it}} + \sum_{s=8}^n b_s J_{sit} + e_{it}. \quad (9)$$

where u_{it} is the efficiency term for the i -th museums in year t which is obtained from the results of estimating a stochastic frontier production function, NPM_t is a 0-1 dummy variables taking the value 1 in 2006 – 2014 and 0 for 1998-2005, DMS_{it} is a 0-1 dummy variables taking the value 1 if the i -th museum is managed by a designated manager in year t and 0 otherwise, $TRE_{DMS_{it}}$ is a 0-1 dummy variables taking the value 1 if the i -th museum has been managed by the designated manager sometime during the sample period and zero otherwise, $DMS_{EXH_{it}}$ is a 0-1 dummy variable taking the value 1 if the designated manager of the i -th museum is involved in the planning of exhibitions in year t , $TRE_{DMS_{EXH_{it}}}$ is a 0-1 dummy variables taking the value 1 if the designated managers of the i -th museum has engaged in planning exhibitions sometime during the sample period, $DMS_{COM_{it}}$ is a 0-1 dummy variable taking the value 1 if the i -th museums is managed by a designated manager selected through a competitive process in year t and 0 otherwise, $TRE_{DMS_{COM_{it}}}$ is a 0-1 dummy variable which takes the value 1 if the i -th museums has been managed by a designated manager selected through a competitive process during the sample period, J_{sit} denotes other factors that influence the technical efficiency of the i -th museums in year t , a , b_1 , ..., b_7 , and b_s are coefficients to be estimated, e_{it} is a standard disturbance. $TRE_{DMS_{it}}$, $TRE_{DMS_{EXH_{it}}}$, and $TRE_{DMS_{COM_{it}}}$ is used to control each group effects of which management changes. Equation (9) is estimated by ordinary least squares (OLS), Since a larger positive value of u_{it} indicate greater inefficiency, if the introduction of NPM, the introduction of the DMS, allowing the designated manager to be involved in the planning of exhibitions or the use of a competitive process to choose the designated manager leads to greater efficiency, then the

coefficients b_1 , b_2 , b_4 and b_6 should have negative signs.

4 Data

Data on inputs and output used in estimation of the production functions of exhibitions are taken from the “Prefectural Art Museum Survey” (*Todoufukeritsus Bijutsukan Chosahyou*) from 1998 to 2014. This survey is conducted by the Council of Deputy Director Generals and others of Prefectural Art Museums (*Todoufukeritsus Bijutsukan Fukukanhotou-jimusekininsya-kaigi*). Data on whether or the designated manager engaged in planning an exhibition and whether or not the designated manager were selected through a competitive process were obtained by conducting a telephone survey of all prefectural museums. Data on the population of the prefecture where the museum is located were taken from the “Population Estimates” (*Jinkou-suikei*) which are based on the national census conducted by Statistics Bureau in the Ministry of Internal Affairs and Communications (*Soumushou, Toukei-kyoku*).

The “Prefectural Art Museum Survey” includes microdata on all the prefectural museums in Japan, and this analysis uses all the available microdata available as of December 2015. The prefectural museums in Tokyo, Kyoto¹, Osaka are excluded from this analysis because the data needed to estimate the production function cannot be available. For the same reason, some observations on other museums are also excluded from our analysis. As a result, we have an unbalanced panel data set of 55 museums from 1998 to 2014 is used² which gives a total sample size of 731. Table 1 provides information on the number of museums by their management type, while Table 2 provides descriptive statistics for all the relevant variables. The variables LNY, LNK1, LNK2, and LNL1 in Table 2 refer to the natural logs of Y_{it} , K_{1it} , K_{2it} , L_{1it} , respectively.

¹ One prefectural museum in Kyoto, the Kyoto Prefectural Museum of Kyoto Culture (*Kyoto-fu Kyoto-bunka-hakubutsukan*), is excluded from our analysis even though data is available from the “Prefectural Art Museum Survey.” The reason for excluding this museum is that despite its name the museum was established and has been managed by a private organization.

² In 2006, there were a total of 65 Japanese prefectural museums.

Table 1: The number of prefectural museums by management type

	The number of museums (percentage)
Museums managed by designated managers	16 (29%)
Museums managed by designated managers which engage in planning exhibitions	6 (11%)
Museums managed by designated managers which were selected through a competitive process	8 (15%)
All museums	55 (100%)

Table 2: Descriptive Statistics

Variable	Definition	Mean	Std.Dev.	Minimum	Maximum
LNY	log (total number of paying visitors)	10.713	0.894	6.887	13.285
LNK1	log (premises of the museum)	9.792	1.120	7.574	12.899
LNK2	log (expenses to hold exhibitions)	10.893	0.741	7.386	13.361
LNL1	log {(full-time employees)+(part-time employees) \times 0.5}	2.811	0.436	1.253	3.980

[1] The sample size is 731.

[2] Following Suhara (2011), the total number of part-time employees is converted into an equivalent number of full-time employees.

[3] Since the labor costs to employ the temporary staff cannot be derived from the total costs for holding exhibitions, the total number of temporary staff is not included in the labor input, LNL1.

Table 2: Descriptive Statistics (Cont.)

Variable	Definition	Mean	Std.Dev.	Min.	Max.
NPM_t	A 0-1 dummy variable taking the value 1 in 2006 – 2014, and 0 in 1998-2005.	0.554	0.497	0	1
DMS_{it}	A 0-1 dummy variable which takes the value 1 if the i -th museum is managed by a designated manager in year t , and 0 otherwise.	0.142	0.350	0	1
TRE_DMS_i	A 0-1 dummy variables which takes the value 1 if the i -th museum was managed by a designated manager for some time during the sample period, and 0 otherwise.	0.272	0.445	0	1
DMS_EXH_{it}	A 0-1 dummy variable which takes the value 1 if the designated manager of the i -th museum engages in planning exhibitions in year t , and 0 otherwise.	0.059	0.235	0	1
$TRE_DMS_EXH_i$	A 0-1 dummy variable which takes the value 1 if the designated manager of the i -th museum has engaged in planning exhibitions some time during the sample period, and 0 otherwise.	0.088	0.283	0	1
DMS_COM_{it}	A 0-1 dummy variable which takes the value 1 if the i -th museum is managed by a designated manager selected through a competitive process in year t , and 0 otherwise.	0.075	0.264	0	1
$TRE_DMS_COM_i$	A 0-1 dummy variable which takes the value 1 if the i -th museum has been managed by a designated manager selected through a competitive process some time during the sample period, and 0 otherwise.	0.148	0.355	0	1
$VOLUNTEER_{it}$	A 0-1 dummy variable which takes the value 1 if volunteer activities exist in the i -th museum in year t , and 0 otherwise.	0.718	0.450	0	1
$EDUCATION_{it}$	Expenses to hold educational events.	7764.806	23299.470	0.000	420223.000
$POPULATION_{it}$	The population in year t in the prefecture where the i -th museum is located.	2724.237	2035.076	574.000	8792.000
$OPEN_{it}$	The number of days the i -th museum is open in year t .	288.992	37.878	24.000	359.000
L_FULL_{it}	The total number of full-time employees.	14.494	6.006	3.000	50.000
L_PART_{it}	The total number of part-time employees.	7.398	7.347	0.000	55.000
L_TEM_{it}	The total number of temporary employees.	2.254	4.467	0.000	38.000

5 Results and Discussions

5.1 Estimated results of a production function

LIMDEP 10 (Greene (2005)) is used to obtain all the estimates presented in Tables 3, 4, 5, and 6. Table 3 presents results of estimating the production frontier function. It should be noted that estimates of the true fixed-effects stochastic frontier model could not be obtained. In choosing between the non-frontier model (Models (3-1)) and the frontier models (Models (3-2), (3-3), (3-4), (3-5), and (3-6)), all the frontier models except Model (3-4) are supported because estimates of λ and σ (or σ_u) are positive and significant. The time varying decay model (Model (3-4)) is not supported because the estimates of σ and η are not significant. As a result, the pooling stochastic frontier model, the time invariant stochastic frontier models, and the true random-effects models are the candidate models for the production function. In choosing the most appropriate model among the candidates, true random effects model (Models (6)) is chosen because it has the largest log likelihood value and the smallest *Akaike* Information Criteria (AIC) value. Thus, estimates of the true random effects model are used to compute the estimates of inefficiencies that are used to examine the four hypotheses discussed in Section 3.3.

Table 3: Production function estimates

	Stochastic Frontier (SF) model					
	Pooling (3-1)	Pooling-SF (3-2)	TI-SF (3-3)	TVD-SF (3-4)	FE-SF (3-5)	true RE-SF (3-6)
LNK1	-0.122 (0.538)	-0.084 (0.531)	-0.832 (1.045)	-0.764 (1.099)	-1.345*** (0.254)	-0.395 (0.323)
LNK2	0.251 (0.617)	0.257 (0.614)	-1.359** (0.554)	-1.357** (0.570)	-2.025*** (0.234)	-1.395*** (0.383)
LNL1	0.361 (1.052)	0.412 (1.047)	2.101 (1.391)	2.107 (1.519)	2.671*** (0.602)	1.891*** (0.657)
LNK1_2	0.023 (0.037)	0.019 (0.037)	0.099 (0.090)	0.096 (0.093)	0.109*** (0.020)	0.074*** (0.026)
LNK2_2	0.071 (0.066)	0.071 (0.066)	0.225*** (0.067)	0.223*** (0.0689)	0.260*** (0.037)	0.212*** (0.045)
LNL1_2	0.449* (0.254)	0.512** (0.255)	-0.327 (0.218)	-0.305 (0.223)	-0.152 (0.166)	-0.299** (0.141)
LNK1K2	-0.004 (0.045)	-0.002 (0.045)	-0.023 (0.034)	-0.023 (0.035)	0.024 (0.022)	-0.022 (0.025)
LNK1L1	-0.057 (0.082)	-0.065 (0.081)	0.045 (0.130)	0.033 (0.149)	0.006 (0.045)	-0.020 (0.053)
LNK2L1	-0.083 (0.114)	-0.094 (0.113)	-0.126 (0.094)	-0.121 (0.095)	-0.186** (0.073)	-0.063 (0.0719)
Constant	5.593 (3.9569)	5.742 (3.926)	17.075** (6.878)	16.770** (7.188)		
Constant means for random parameters						14.499*** (2.493)
Constant Scale parameters for dists. of random parameters						0.652*** (0.020)
σ_u		0.521	1.345	1.360	1.762	0.335
σ_v		0.626	0.457	0.457	0.502	0.409
$\sigma = \sqrt{\sigma_v^2/\sigma_u^2}$		0.815*** (0.001)	1.345*** (0.221)	0.463 (2.930)	1.832*** (0.048)	0.528*** (0.0139)
$\lambda = \sigma_u/\sigma_v$		0.833*** (0.096)	2.942*** (0.831)	2.975*** (0.050)	3.506*** (0.158)	0.819*** (0.101)
η				-0.002 (0.002)		
Log likelihood	-777.500	-776.546	-557.784	-557.588	-797.624	-549.694
AIC	-0.683	1577.100	1139.600	1141.200	1725.200	1125.400

[1] For each explanatory variable and λ , the first line reports the estimated coefficient, and the second line reports the estimated standard error.

[2] *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.

5.2 First derivatives of the production function

The first derivatives of the production function are as follows:

$$\frac{\partial \ln Y_{it}}{\partial \ln K_{1it}} = \beta_1 + \beta_4 \ln K_{1it} + \beta_7 \ln K_{2it} + \beta_8 \ln L_{1it} > 0, \quad (10)$$

$$\frac{\partial \ln Y_{it}}{\partial \ln K_{2it}} = \beta_2 + \beta_5 \ln K_{2it} + \beta_7 \ln K_{1it} + \beta_9 \ln L_{1it} > 0, \quad (11)$$

$$\frac{\partial \ln Y_{it}}{\partial \ln L_{1it}} = \beta_3 + \beta_6 \ln L_{1it} + \beta_8 \ln K_{1it} + \beta_9 \ln L_{1it} > 0, \quad (12)$$

Table 4 provides descriptive statistics for estimates of these first derivatives of the production function computed using estimates obtained from the true random-effects models (Model (3-6)). Since each of the averages of first derivatives are positive, it can be said that Model (3-6) satisfies this condition on average.

Table 4: Checking the first derivatives

Variable	Mean	Std.Dev.	Minimum	Maximum
$\frac{\partial \ln Y_{it}}{\partial \ln K_{2it}}$	0.041	0.080	-0.074	0.281
$\frac{\partial \ln Y_{it}}{\partial \ln K_{1it}}$	0.526	0.146	-0.200	0.990
$\frac{\partial \ln Y_{it}}{\partial \ln L_{1it}}$	0.162	0.164	-0.269	0.831

- [1] Estimates of the first derivatives are computed using estimates of the true random-effects model.

5.3 Estimated inefficiencies

The technical efficiencies are calculated as $\exp(-u_{it})$, using the estimates of the inefficiency terms of Model (3-6) (the true RE-SF model). Technical Efficiency (TE) is calculated as follows, using the estimated inefficiency term:

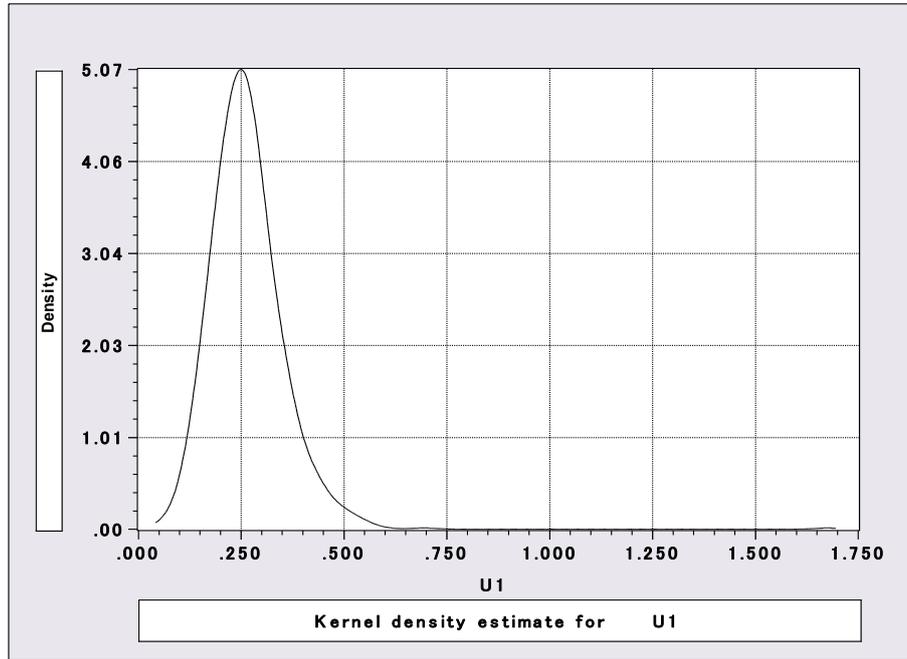
$$TE_{it} = \exp(u_{it}), \quad (12)$$

where TE_{it} is the estimated technical efficiency of the i -th museum in year t , and u_{it} is the inefficiency term of the i -th museum in year t which is obtained from estimates of production function. These technical efficiencies range from 0 to 1, with larger values of technical efficiency indicating a firm is more efficient. Table 5 presents the descriptive statistics for estimates of u_{it} and TE_{it} obtained from Model (3-6). The most efficient museum takes the value 0.938, while the least efficient museum takes the value 0.169, and the average of TE is 0.770. This suggests the existence of many museums whose management efficiencies are far worse than the sample average. Figure 2 estimates the distribution of the estimated inefficiencies $u_{it}E(u_{it}|v_{it} - u_{it})\sigma_u$.

Table 5: Estimated Results of Technical Efficiencies: Descriptive Statistic

Variable	Mean	Std.Dev.	Minimum	Maximum
u_{it}	0.265	0.094	0.064	1.675
TE_{it}	0.770	0.062	0.187	0.938

Figure 2: Estimated Inefficiencies



5.4 Results of examination of hypotheses

In order to examine four hypotheses presented in Section 3.3, equation (9) is estimated by ordinary least squares and the results are reported in Table 6. First, we examine whether or not the political trend which introduced the New Public Management (NPM) into Japanese prefectural museums around 2006 contributed to improving the productive efficiencies of exhibitions. Since the estimated coefficients of NPM_t are positive and significant in both equations, it is found that the introduction of the NPM around 2006 did not contribute to improving the productive efficiencies of Japanese prefectural museums. Rather, since 2006, it appears that the productive efficiencies of museums have decreased. Second, we examine whether or not the introduction of the DMS into the Japanese prefectural museums contributed to improving the productive efficiencies of exhibitions. Since the estimated coefficients of DMS_{it} are positive but insignificant, it is found that the DMS itself does not contribute to improving productive efficiencies. This result is consistent with Suhara (2011). One possible reason for is that some designated managers have not engaged in planning exhibitions. In this case, the prefectural governments have engaged in planning exhibitions and the designated manager have only engaged in the maintenance of the museum buildings. Third, we examine whether or not the designated managers which engage in planning exhibitions have contributed to improving productive efficiencies.

The estimated coefficients of DMS_EXH_{it} are negative and significant which suggests that the presence of designated managers which engages in planning exhibitions decreases inefficiencies significantly. Lastly, we examine whether or not designated managers which are selected through a competitive process contribute to improving productive efficiencies. The estimated coefficients of DMS_COM_{it} are negative and significant which suggests that the designated managers selected by competitive processes decrease inefficiencies significantly. Therefore, the results of examining the four hypotheses show that the productive efficiencies of museums have improved when designated managers are engaged in planning exhibitions and when the designated managers are selected through a competitive process.

In addition to these four hypotheses, some other factors which could possibly improve productive efficiencies are examined. The estimated coefficients of $VOLUNTEER_{it}$ are positive and significant which suggests the presence of volunteer activities which is expected to work as a kind of supervision that prevent employees from being lazy did not contribute to improved efficiency, but rather led to greater inefficiencies. The estimated coefficients of $POPULATION_{it}$ are positive and significant, so that a larger population did not increase the productive efficiencies of exhibitions. The estimated coefficients of $EDUCATION_{it}$ are almost zero and their significance differs across the two equations. It might be expected that educational events in museums possibly have the effect of increasing the participation in exhibitions, but this effect cannot be observed. The estimated coefficients of $OPEN_{it}$ are positive and significant which suggests that opening a museum for more days does not necessarily increase the participation in exhibitions and reduce inefficiencies.

Table 6: Estimates of equation (9)

	OLS
NPM _t	0.018** (0.009)
DMS _{it}	0.049 (0.032)
TRE_DMS _i	0.009 (0.023)
DMS_EXH _{it}	-0.074* (0.040)
TRE_DMS_EXH _i	0.002 (0.032)
DMS_COM _{it}	-0.119*** (0.036)
TRE_DMS_COM _i	0.031 (0.026)
VOLUNTEER _{it}	0.028*** (0.009)
EDUCATION _{it}	0.000** (0.000)
POPULATION _{it}	0.001*** (0.000)
OPEN _{it}	0.000*** (0.000)
L_FULL _{it}	
L_PART _{it}	
L_TEM _{it}	
R ²	-0.166
log likelihood	635.782

[1] *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.

[2] Both equations are estimated by ordinary least squares (OLS).

5 Concluding Remarks

In order to improve the management of public museums, the Designated Manager System (DMS) was enacted in 2006, which was a kind of the New Public Management (NPM) and enabled private managers to manage public museums. Whether the Designated Manager System is introduced or not, many Japanese prefectural museums introduced the NPM around 2006. The aim of this paper is to determine how the limited government policy has improved the management of the Japanese prefectural museums since 2006, using econometric methods. In this study, exhibitions are forced as the main activities of the Japanese prefectural museums. In a production of exhibitions, output is defined as the participation in exhibitions of residents.

Four hypotheses are examined; they are; (A) the political trend which introduced the NPM into the Japanese prefectural museums around 2006 contributed to improve the productive efficiencies of exhibitions rather than the introduction of the Designated Manager System (DMS); (B) the introduction of the DMS into the Japanese prefectural museums contributed to improve the productive efficiencies of exhibitions; (C) the designated managers contributed to improve the productive efficiencies of exhibitions only when they engage in planning exhibitions; and (D) the designated managers which selected through the competitive public offering contributed to improve the productive efficiencies of exhibitions. The estimation results support hypothesis (C) and (D). As a result, it can be said that the productive efficiencies of museums have improved when the designated managers engaged in planning exhibitions. Especially, the designated managers selected through the competitive public offering showed more efficient performances.

Reference

- [1] Bishop, P., and Brand, S. (2003). “The efficiency of museums: a stochastic frontier production function approach,” *Applied Economics*, 35(17), 1853-1858.
- [2] Basso, A., and Funari, S. (2003). “Measuring the performance of museums: classical and FDH DEA models,” *rendiconti del comitato per gli studi economici quantitative*, 1-16.
- [3] Basso, A., and Funari, S. (2004). “A Quantitative Approach to Evaluate the Relative Efficiency of Museums,” *Journal of Cultural Economics*, 28, 195–216.
- [4] Fujinami, K., Kakiuchi, E., and Tone, K. (2010). “The study on effective use of public museums based on DEA: Human resource development in decentralized governance,” GRIPS Policy Research Center, Discussion Paper 10-16. (in Japanese with English abstract)
(<http://r-center.grips.ac.jp/gallery/docs/10-16.pdf>)
- [5] Greene, W., 2005. Fixed and Random Effects in Stochastic Frontier Models, *Journal of Productivity Analysis*, 23, p.7.
- [6] Haruna, R., and Kuwahara, M. (2010). “Management efficiency analysis in public museums from medium and long term viewpoints,” *the Proceeding of the 26th Fuzzy Syetem Symposium in Hiroshima*, 2010. (in Japanese with English abstract)
(https://www.jstage.jst.go.jp/article/fss/26/0/26_0_143/_pdf)
- [7] Haruna, R., Kuwahara, M., and Shiotsu, Y. (2011). “Evaluation of Middle and Long Term Management Efficiency of Public Museums by Network DEA”, *Biomedical Soft Computing and Human Sciences*, 17(1), 11-17.
(http://www.bmfsa.org/jpn/index.php?action=pages_view_main&page_id=36)
- [8] Kuwahara, M., and Siozu, Y. (2013) “Moral hazards within public museum management system in Japan,” *Aichi University Journal of Economics*, (193), 25-42.
(https://aichiu.repo.nii.ac.jp/?action=pages_view_main&active_action=repository_view_main_item_detail&item_id=3081&item_no=1&page_id=13&block_id=17)
- [9] Suhara, M. (2011). “The efficiecnies of prefectural art museums; an empirical analysis using stochastic frontier model,” *Green New Deal and Fiscal Policy*, 191-208. (in Japanese)