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Abstract

This paper focuses on the increase in slack costs due to municipality amalgamation, which is pushed forward in several countries to achieve economies of scale. Employing the stochastic frontier cost function to estimate the inefficiency of local public expenditure due to slack, this study investigated 479 Japanese municipalities that had amalgamated from 2000 to 2005. This work used the technical inefficiency variable "Number of municipalities that participated in an amalgamation" and a dummy variable for "The newly-established-municipality form of amalgamation." Results show that these variables have an impact on the cost inefficiency of local public expenditure. Average efficiency scores in the two estimations carried out were 1.145 and 1.100. The estimation results showed that municipality amalgamation produces integration costs (slack) in an administrative organization. The degree of slack depends on the form of amalgamation.

Keywords: Municipality amalgamation; Cost inefficiency; Slack cost; Stacastic frontier analysis; Japan

1. **Introduction**

Many countries have implemented municipality amalgamation or boundary reform to create larger local governments in order to achieve economies of scale and economies of scope. Local government studies in various countries have confirmed the existence of economies of scale or economies of scope based on population size. However, while municipality amalgamation or boundary reform raises population size, it introduces organizational changes in the local government that might increase administrative inefficiency. For example, an administration that served a distinct local government before will now have to work for an amalgamated municipality. The staff would need to adjust to different administrative systems and procedures. Moreover, it is possible that residents' oversight of local government behavior becomes difficult with the integration of multiple municipalities into a single amalgamated organization. Municipality amalgamation can possibly increase inefficiency by expanding organizational slack and raising watch costs.

Research on local government inefficiency commonly apply the stochastic frontier cost function to local government expenditure (e.g., Kumbhakar and Lovell, 2000, for a discussion of frontier analysis). Previous studies have focused on different local government structures. Deller and Rudnicki (1992); Couch, Shughart, and Williams (1993); Battese and Coelli (1995); Duncombe, Miner, and Ruggiero (1997); and Kan and Greene (2002) focused on the U.S. school district. Davis and Hayes (1993) focused on U.S. police. Grosskopf and Yaisawarng (1990) developed a multiproduct model of municipalities in California. Grossman et al. (1999) focused on large U.S. cities. Kalseth and Rattø (1995) estimated the Norwegian local per capita total budget. Loikkanen and Susiluo (2005) focused on Finnish municipalities' cost inefficiency of basic welfare service provision. Yamashita, Akai, and Sato (2002); Hayashi (2002); and Miyazaki (2006) estimated Japanese cities' total expenditure.

In this paper, I apply the stochastic frontier cost function to evaluate the cost inefficiency of Japanese municipalities after amalgamation. I use the amalgamation characteristics as technical inefficiency factors. The estimation results indicate that an increase in the number of municipalities that participated in an amalgamation and the newly-established-municipality form of amalgamation increased cost inefficiency. The results show that while amalgamation produces economies of scale based on population size it increases inefficiency by integrating administrative organizations and increasing watch costs.

This paper is organized as follows. Section 2 describes the methodology of estimation and the data used, Section 3 provides the empirical results, and Section 4 presents the conclusions of the study.

2. **Methodology and definition of valuables**

2.1 Stochastic frontier cost function

A stochastic frontier regression is typically formulated as follows:

$$C = f(\cdot) + u + v \qquad (1)$$

C is the local public expenditure, and $f(\cdot)$ is the cost function of local public expenditure generated from economic theory; v is a standard disturbance term, $E(v)=0$; u is a stochastically distributed technical inefficiency variable, which is truncated below zero according to the standard practice for cost functions.

First, I consider the production process of the local public good. The local government inputs the production input vector and produces the direct output (D-output, *g*), which, however, we cannot observe directly. Then, *g* is converted to the public services level *z*, which the residents finally consume (C-output). The vector **x** of municipality characteristics is assumed to influence the conversion process from D-output to C-output.

$$g = g(z, \mathbf{x}) \qquad (2)$$

Second, when (2) is substituted for $f(\cdot)$, the cost function is shown as follows.

$$C = c(g(z, \mathbf{x}), w) \qquad (3)$$

where *w* is the price of the production input.

Then, I estimate the cost function, which I assume is of the Cobb-Douglas form; capital and labor are the production inputs. Thus, the price of the production input is the price of capital *r* divided by the price of labor *w*. The cost function is shown in a log-linear form as follows:

$$\ln C = \alpha_0 + \alpha_r \ln r + \alpha_w \ln w + \alpha_g \ln g \qquad (4)$$

I assume that the price of capital *r* is not different between municipalities (Brueckner, 1981). Thus, *r* is included at the constant term.

$$\ln C = \alpha_0 + \alpha_w \ln w + \alpha_g \ln g \qquad (5)$$

The D-output *g* is transformed to a log-linear form as follows:

$$\ln g = \beta_z \ln z + \sum_{j=1}^{n} \ln \beta_j \mathbf{x}_j \qquad (6)$$

Population size and area are the fundamental factors of municipality characteristics (vector **x**). I assume economies as well as diseconomies (congestion) of population size in the consumption process of public goods. I adopt the square of the population size. I also employ variables for the demographic structures of the municipality. Finally, substituting (6) into (5), I show the stochastic frontier cost function for each municipality as follows.

$$\ln C_i = \alpha_0 + \alpha_w \ln w_i + \beta_z \ln z_i + \beta_1 \ln pop_i + \beta_2 (\ln pop)_i^2 + \beta_3 \ln area_i + \sum_{j=4}^{n} \ln \beta_j \mathbf{x}_{i,j} + u_i + v_i \qquad (7)$$

2.2 C-output index and inefficiency factors

Recent estimates of the local public cost function use “Total score of public services,” prepared by Nihon Keizai Shinbunsya as the C-output *z* (Hayashi, 2002; Yamashita, Akai, and Sato; 2002). However, this index has a problem in that it is constructed only for cities. Use of this index results in a number of dropouts in the sample because the amalgamated municipalities include many towns and villages. Miyazaki (2006) established a new index that can be applied to towns and villages: “Total score of public services.” This paper uses Miyazaki’s method to construct index *z*. The calculation method is shown as follows.

C-output index is composed of five sub-indexes *Aged care*, *Child care*, *Education*, *Life infrastructure*, and *Safety*. These sub-indexes are weighted 30, 35, 25, 40, and 20, respectively, and include components that provide an index for each category of public service. The numerical values of weights of these sub-indexes are referred from the “Total score of public services.” All components are converted to their deviation values.

$$z = \left(30 \times \frac{1}{4}\sum_{s=1}^{4} y_s + 35 \times \frac{1}{2}\sum_{s=5}^{6} y_s + 25 \times \frac{1}{3}\sum_{s=7}^{9} y_s + 40 \times \frac{1}{2}\sum_{s=10}^{11} y_s + 20 \times y_{12} \right) \div 150 \quad (8)$$

where y_1 represents the number of doctors divided by the elderly population, y_2 the capacity in welfare facilities for the elderly divided by the elderly population, y_3 the capacity of healthcare facilities divided by the elderly population, y_4 the capacity of sanatorium-type medical care facilities divided by the elderly population, y_5 the enrollment in kindergartens and day nurseries divided by the 0- to 4-year-old population, y_6 the number of children on day nursery waiting-lists divided by the enrollment in day nurseries, y_7 the number of elementary school teachers divided by number of elementary school students, y_8 the number of junior high school teachers divided by number of junior high school students, y_9 the number of community centers divided by the population, y_{10} the total road length (km) divided by the area (km^2), y_{11} the number of people who disposed of general household garbage divided by the population, and y_{12} the number of fire occurrences divided by the population. All data are for FY2010.

This paper employed the technical inefficiency variable “Number of municipalities that participated in an amalgamation (nm_i)” and a dummy variable for “The newly-established-municipality form of amalgamation (d_new_i).” As regards the former, a greater number of participating municipalities would increase the management cost of reorganizing administrative responsibilities because the staff of a new municipality are drawn from other municipalities with different systems and procedures. In addition, more participating municipalities would increase watch costs. Generally, residents might not be familiar with other amalgamating municipalities, whereas they could easily identify with their own municipality before its amalgamation. Therefore, watch costs of residents are believed to rise as the number of participating municipalities increases. Thus, an increase in nm_i would lead to a higher slack cost. The choice of the amalgamation form might also affect slack costs after amalgamation. In Japan, municipality amalgamation can take one of two forms. The first is the "absorption form," in which a comparatively large municipality absorbs surrounding municipalities. In the other form, multiple municipalities amalgamate on an equal footing and establish a new municipality. In general, municipalities that adopt the absorption form might often employ the administrative procedures of the absorbed municipalities. On the other hand, municipalities that adopt the "newly established form" would face higher slack costs because the adjustment cost of reorganizing functional responsibilities among administration staff would be high.

3. **Data and estimation**

3.1 Data

The sample for this study consisted of 479 Japanese municipalities that were amalgamated from FY2000 to FY2005. The data relate to a cross section of these municipalities as of FY2010 since it is the latest data that can be used.

This paper employs two type of cost C_i. One is the total local public expenditure of the municipalities that amalgamated. The other is the total personnel expense of the municipalities that amalgamated. It seems that slack costs of amalgamation would mainly apply to operating expenses. The explanatory valuable z_i is calculated according to the procedure described in Section 2.2. The labor cost of public services w_i is obtained as the average labor cost, calculated by dividing the total public labor cost of the municipality by the number of public employees. Population (pop_i) and area ($area_i$) data of the municipality are from the National Census. The variable of demographic characteristics $ru15_i$ is the ratio of the 15-and-under population to total population, $ro65_i$ is the ratio of the 65-and-older population to total population, and rpd_i is the ratio of daytime to nighttime population. These data are also from the National Census.

This paper employed the technical inefficiency variable Number of municipalities that participated in an amalgamation (nm_i) and a dummy variable for the newly-established-municipality form of amalgamation (d_new_i), as described in Section 2.2. These data were obtained from the Digital Archive of Amalgamation of the Ministry of Internal Affairs and Communications.

The data used for the estimation are described as follows with their source and the descriptive statistics.

[Table 1 here]

3.2 Estimation results

This paper employs two types of estimation. The first is the ordinary least squares (OLS) regression excluding inefficiency variables. OLS regression is the base model for comparison with stochastic frontier estimation results. The second is the stochastic frontier estimation incorporating inefficiency variables. The OLS test for heteroskedasticity is implemented with Heteroscedasticity-Consistent Standard Errors (HCSEs). The stochastic frontier estimation uses the maximum likelihood (ML) method with the half-normal distribution as the distribution of inefficiency term. As described above, this paper chooses two types of public expenditure. One is the total local public expenditure of the municipalities that amalgamated. The other is the total personnel expense. Estimation results are shown in Table 2.

First, I examine the estimation results of the total local public expenditure. On a comparison of the OLS regression with the stochastic frontier estimation result, the parameters of $\ln w$ and $\ln pop$ are both insignificant for the OLS result. On the other hand, the parameters of the stochastic frontier estimation are all significant and appropriate in economic theory. The parameter of $\ln z$ is significantly positive. Local government expenditure increases as public service output increases. Compared to the OLS regression result, the influence of $\ln z$ is excessively evaluated in the OLS regression. The parameter of $\ln w$ is significantly positive at the 10% level. The low significance level of this parameter can probably be explained by the fact that the average labor cost for public employees was used as an index. The average labor cost for public employees depends on the number of staff and the age distribution of the municipality. The parameter of $\ln pop$ is significantly negative and that of $\ln(pop)^2$ is significantly positive. These results show that the relationship between total public expenditure and population size describes a U-shaped curve for the municipalities after amalgamation. Thus, these municipalities have both economies and diseconomies (congestion) of population size for total public expenditures. The other geographic and demographic characteristics are significantly positive. These variables work as cost-pushing factors.

[Table 2 here]

The inefficiency variables nm and d_new are significantly positive. The number of municipalities that participated in an amalgamation and the newly-established-municipality form has positive effects on the inefficiency of the total local public expenditure. Therefore, municipality amalgamation causes integration costs (slack) for an administrative organization. Moreover, the scale of slack depends on the form of amalgamation.

Second, I examine the estimation results for total personnel expenses. With $ru15$ excluded, both results are significant and appropriate in economic theory. The parameter of $ru15$ is not significant in OLS regression, and is significantly negative in stochastic frontier estimation. Total personnel expenses include the labor cost of the local public elementary school and junior high school. As for management expenses and labor cost of these schools, scale economies work easily. An increase in the student population would have a negative effect on the total personnel expenses of the municipality. Thus, the estimation results of the stochastic frontier are considered appropriate.

The parameter of $\ln pop$ is significantly positive and has a strong negative effect on total personnel expenses. Municipality amalgamation promotes economies of population scale for personnel expenses through staff reorganization and deployment. However, as for total personnel expenses, the inefficiency variables nm and d_new are significantly positive. Although the effect of economies of population scale is high with amalgamation, the inefficiency associated with the amalgamation form was an obstacle for cost minimization in the municipalities after amalgamation.

The coefficients of nm and d_new are stronger for the estimation of total personnel expenses compared to total public expenditure. This means the administration slack inefficiency due to amalgamation has a strong influence on personnel expenses, which are related to the number of staff and staff deployment.

The average technical efficiency scores of total public expenditure and total personnel expenses are 1.145 and 1.100, respectively. This means that, on average, 14.5% of the total public expenditure and 10% of the total personnel expenses are wasted. That is to say, municipalities can potentially reduce these costs by 14.5% and 10%, respectively, after amalgamation, maintaining the same level of public services. However, municipality amalgamation, if not followed by administrative reorganization and efficiency improvement, would create sustained administration slack, leading in turn to higher local public expenditure.

4. **Conclusion**

This paper examined the cost inefficiency of municipalities after amalgamation, using stochastic frontier cost estimation. Several countries push forward municipality amalgamation to achieve economies of scale. However, while municipality amalgamation raises population scales, it might increase slack costs. Municipality amalgamation can potentially create inefficiency by increasing organizational slack and residents' watch costs. This paper employed two variables to represent the form of amalgamation and the inefficiency of local public expenditure. The main findings of this study are as follows.

Using OLS to estimate the local public cost function of municipalities after amalgamation might lead to miss-specified results because of the exclusion of inefficiency terms resulting from the amalgamation. With the elimination of inefficiency terms, the other variables might be either underestimated or overestimated.

Second, the inefficiency terms are all significantly positive for all estimations. From this result, this paper concludes that the number of municipalities that participated in an amalgamation and the newly-established-municipality form generates inefficiency from higher administrative slack and greater residents' watch costs. Thus, this paper shows that amalgamation might lead to cost inefficiency due to administrative slack even as it creates economies of population scale. This slack might be called "administrative adjustment costs after amalgamation."

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Table 1. Data descriptions and descriptive statistics

Valuable	Description	Mean	S.D.	Min	Max	Source
C	Total public expenditures (1million JPY)	35,615	55,432	2,644	777,000	A
	Total personnel expense (1million JPY)	5,994	8,980	475	120,613	A
z	Total score of public services	50	2.768	42.423	70.048	B, C
w	Average labor cost for public employees (1,000JPY)	9,394	884	6,920	12,850	A
pop	Population (1,000 people)	81	127	1.371	1,382	D
area	Area (km^2)	356	302	14	2,177	D
ru15	Ratio of 15 or younger	0.125	0.017	0.047	0.178	D
ro65	Ratio of 65 or older	0.295	0,064	0.136	0.545	D
rpd	Ratio of daytime population	0.991	0.085	0.761	1.283	D
nm	Number of municipalities that participated in an amalgamation	3.455	1.786	2	14	E
d_new	Dummy variable for the newly-established-municipality form of amalgamation	0.802	0.399	0	1	E

Sources: A: Ministry of Internal Affairs and Communications; B: Statistic Bureau, Ministry of Internal Affairs and Communications; C: Statistic Bureau, Ministry of Health, Labour and Welfare; D: Statistic Bureau (National Survey); E: Ministry of Internal Affairs and Communications (Digital Archive of Amalgamation).

Table 2. Estimation results.

	Total public expenditure						Total personnel expense					
	OLS			Frontier			OLS			Frontier		
	coef.		t	coef.		z	coef.		t	coef.		z
ln*z*	0.537	***	3.03	0.394	***	3.21	0.510	***	3.67	0.378	***	2.77
ln*w*	0.066		0.78	0.132	*	1.87	0.192	**	2.30	0.223	***	3.09
ln*pop*	-0.164		-1.16	-0.245	**	-2.56	-0.864	***	-9.96	-1.057	***	-11.04
$\ln(pop)^2$	0.044	***	6.98	0.048	***	11.27	0.032	***	8.32	0.041	***	9.40
ln*area*	0.112	***	8.27	0.108	***	11.44	0.106	***	9,49	0.098	***	9.68
ru15	3.780	***	4.42	3.272	***	4.46	-0.851		-0.93	-1.512	**	-1.96
ro65	1.874	***	6.79	1.567	***	6.28	1.003	***	3.58	0.627	**	2.37
rpd	0.653	***	6.99	0.582	***	7.34	0.428	***	4.26	0.396	***	4.61
constant	8.584	***	5.97	9.084	***	9.12	5.001	***	4.28	6.498	***	6.08
Inefficiency												
nm	-			0.206	***	3.25	-			0.354	***	2.54
d_new	-			0.885	**	2.49	-			1.020	*	1.75
constant	-			-5.127	***	-8.94	-			-6.507	***	-4.50
Adj R^2	0.971						0.768					
Log likelihood				292.784						264.651		
Technical efficiency												
Average				1.145						1.100		
Min				1.022						1.027		
Max				1.886						1.518		
Sample	479			479			479			479		

Note: The asterisks ***, **, and * indicate statistical significance at the 0.01, 0.05, and 0.1 levels, respectively.