Development of a Quality Measure for the Child Care Service in Regional Level

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Abstract

This paper is to develop a quality measure to evaluate the quality level of child care service in the regional level. By utilizing the biannual intensive child care statistical reports, ten variables are integrated and summarized as a quality measure for child care service in regional level by employing Principal Component Analysis (PCA). Conclusively, it is possible to get a comprehensive measure and the measure obtained from data between 2003 and 2008 illustrates the difference in child care service quality among regions over years. With the measure developed by this research, each region can also get very good insight into what kinds of factors of child care service should be paid more attention to in order to improve the quality of its child care service. Moreover, the measure obtained in this paper is proven reliable and robust in that it reflects the quality of child care service in each region and gives us statistically uniform quality scores with a different data set.

1. Introduction

The enforcement of 2003 New Child Care Act and the Accreditation system for child care centers in 2005 has contributed to the improvement in the quality of child care service in Korea (Lee, 2002; Lee, 2004, Jung *et al.*, 2008). Through the above two systems, social interest in the child care service has been increased and central government and regional/local government has become to invest more budget. However, measure which is able to the quality of child care service has rarely been developed so far. While the Accreditation system for child care centers has developed a quality measure for child care center level (https://www.kcac21.or.kr/home_new/A04/A0401_03.jsp), that measure for macro levels such as region and city has hardly been available. So, it is necessary to develop a measure to examine the quality of child care centers with a whole approach. With the measure developed by this paper, it will be possible to evaluate the quality of child care service in regional level.

The measure for the quality of child care service in various subjects looks important in that it allows each subject to evaluate the current quality of child care service in itself and may

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get some insights into the direction of policies for child care service for local governments. Specially, in the case that numerous variables are involved in the determination of the quality of service such as the child care service, the development of a comprehensive measure will not be easy. The intensive statistical report on child care service includes over one hundred variables. This research focuses on the integration of these variables in order to develop a quality measure for the child care service in regional level. Regional level in this paper includes the metropolitan cities and provinces with their own local government.

As a relevant past work, it is possible to take on account of the research of Ryoo and Kim (2006) where tries to estimate technical efficiency at child care service in city level. They take the budget for child care centers and the number of civil servants as input factors and the number of child care centers, the area of child care service, and the number of children enrolled in child care centers as output factors in city level and estimate technical efficiency by employing Data Envelopment Analysis (DEA). The result shows the existence of substantial heterogeneity in efficiency across cities and the substantial opportunity to improve efficiency. Even though their research can generate a measure which integrates multiple variables and give cities good insight into the direction of improvement in child care service, it is limited in that it may not include numerous variables because of dimensionality problem (Fernandez-Cornejo, 1994) and cannot estimate the degree of impact of variables on the efficiency. As a similar research, Song (2008) also uses DEA to estimate technical efficiency at child care centers.

The approach of this paper is quite different from the above papers. This paper examines the degree of impact of variables taken on account of to consider the quality of child care service as well as includes numerous variables included in statistical report published by government in the development of a measure. Moreover, this research considers regional level. Thus, this paper will be regarded as the leading research which tries to develop a unique quality measure for child care service in regional level and confirm its reliability and robustness.

This paper consists of six sections. Next section deals with methodological approach to develop a measure, the third section discusses the data used in this paper, the fourth section includes the discussion about result, and conclusion and references are followed.

2. Approach

Generally speaking, since variables in multivariate data are mutually correlated, it is impossible to treat each variable independently of other variables. And if a multivariate data is treated wholly as one, it is very difficult or almost impossible for us to obtain some useful characteristics from the data set. Therefore, multivariate data often lies under the trials for reduction and summary minimizing loss of information which the data includes. A representa-

tive statistical methodology for this reduction and summary is Principal Component Analysis (PCA). In summary, when m variables are mutually correlated, PCA gives us k mutually independent virtual variables ($m \geq k$) through linear transformation of m variables. The most important point during PCA process is to minimize the loss of information and in order to evaluate it the explanation proportion of each principal component to total variation in data is used. The detail on PCA can be referred to Hair *et al.* (2006) and Kim (2006).

The most statistical packages such as SPSS, SAS, and STATA etc. include the module for PCA and this research uses the STATA package for running PCA. Before doing PCA, it is necessary to examine the mutual relationship among variables. If they are found to be mutually correlated, the result from PCA can be expressed mathematically as in equation (1).

$$\begin{aligned} C_1 = c_1' X &= c_{11}X_1 + c_{12}X_2 + \cdots + c_{1m}X_m \\ &\cdots \\ C_k = c_k' X &= c_{k}X_1 + c_{k2}X_2 + \cdots + c_{km}X_m \end{aligned} \tag{1}$$

where $X = (X_1, \cdots, X_m)$ is raw data matrix with m variables and n observations, C_k is the vector of k^{th} principal component scores expressed by a linear combination of each vector in X, and c_k is the vector of coefficients for vectors in X for linear combination. Moreover, how much of total variation each principal component explains can be estimated by the eigen value of each principal component and eigen vector for each eigen value estimates the impact of each variable on each principal component, which equals to c_k (Kim, 2006). After identifying principal components, correlation analysis between the identified principal components and variables is performed in order to examine the degree of impact of each variable on each principal component. Through this analysis, it is possible to analyze the significance of each variable in each principal component.

Finally, principal component scores for each principal component are calculated for observations (each region in each half year). They are reviewed to examine whether they have the same trend as that of the currently known quality of child care service in each regional in each half year. They are also subject to Wilcoxon signed rank test in order to compare the principal component scores calculated with separated data for each year. The first analysis is to examine the reliability of the quality measure developed by this research and the second analysis is to examine the robustness of it.

3. Data and Empirical Issues

The data for this research 'Intensive child care statistical report' are gotten from home-

page of the Ministry of Health, Welfare and Family Affairs from 2003 till 2008. Since the intensive child care statistical report is published biannually on June 30 and December 31 of each year, total twelve data sets are available between 2003 and 2008. However, since the reports in some years are not available or have different variable specification, just 6 reports are selected for this research (12/2003, 12/2004, 12/2006, 12/2007, 06/2008, and 12/2008). Putting six reports into a data set will not reduce the generality of this research because enough observations are obtained and randomness is still kept. Each report includes sixty observations (Kangwon, Kyunggi, Kyungnam, Kyungbook, Kwangju, Daegu, Daejon, Busan, Seoul, Ulsan, Incheon, Jeonanm, Jeonbook, Cheju, Choongnam, and Choongbook) and several dozens of variables. This research classifies and integrates variables into ten representative variables shown in Table 1 before going on PCA.

As noted, ten representative variables are utilized to develop a quality measure. The variables are regarded as included in five factors such as the number of child care centers, the number of children enrolled to centers, the capacity for child care service, the size of manpower, and the number of children supported by government for tuition. The number of child care centers consists of two variables of the number of national or public centers (pub_num) and the number of private centers (pri_num), the number of children enrolled to centers currently also consists of two variables of the number of children enrolled to national or public centers (pub_cur) and the number of children enrolled to private centers (pri_cur), the capacity of child care service consists of the capacity of national or public centers (pub_cap) and the capacity of private centers (pri_cap), the size of manpower consists of the number of teachers (teacher) and the number of other employees including doc-

Table 1. Summary of data for sample

Variables	N	Min	Max	Mean	Standard Deviation
pub_num	96	11	637	100.67	148.00
pri_num	96	351	9326	1740.81	1874.31
pub_cur	96	530	49136	7197.20	11657.02
pri_cur	96	1478	242630	54581.72	49259.90
pub_cap	96	671	52964	7961.31	12457.24
pri_cap	96	1659	313521	68095.67	61948.59
Teacher	96	1046	32695	6437.62	6698.01
Employee	96	231	4420	1156.65	883.39
sup_inf	96	442	64463	11955.55	12069.23
sup_chi	96	765	56051	13374.88	11193.52

tors, nurses, drivers, and cooks etc. (employee), and the number of children supported by government for tuition consists of the number of children supported whose age is less than three (sup_inf) and the number of children supported whose age is greater than three (sup_chi). Table 1 illustrates the summary of ten varaibles.

4. Results and Discussion

As noted, as preliminary study of PCA, it is necessary to examine whether variables in data are mutually correlated and variance of them are quite different in size or not in order to confirm the possibility of using PCA and find the appropriate matrix for PCA between co-

Table 2. Covariance between variables

	pub_num	pri_num	pub_cur	pri_cur	pub_cap
pub_num	21904.90	214344.93	1715953.09	5516814.00	1836634.66
pri_num	214344.93	3513020.85	15920351.52	89959452.17	17070310.80
pub_cur	1715953.09	15920351.52	135886103.78	410945056.87	145130540.06
pri_cur	5516814.00	89959452.17	410945056.87	2426537938.60	440688027.91
pub_cap	1836634.66	17070310.80	145130540.06	440688027.91	155182799.42
pri_cap	6871463.89	113167008.94	510527371.45	3048452804.01	547783297.27
teacher	4274.61	-571706.20	-539317.87	-9976351.16	717455.17
employee	104728.14	1406894.38	8118444.51	37126948.48	8642285.54
sup_inf	1108027.60	17738950.16	77887362.18	446866029.77	85788073.99
sup_chi	1078866.77	17405724.22	76639068.10	455508007.40	84089333.24

	pri_cap	Teacher	employee	sup_inf	sup_chi
pub_num	6871463.89	4274.61	104728.14	1108027.60	1078866.77
pri_num	113167008.94	-571706.20	1406894.38	17738950.16	17405724.22
pub_cur	510527371.45	-539317.87	8118444.51	77887362.18	76639068.10
pri_cur	3048452804.01	-9976351.16	37126948.48	446866029.77	455508007.40
pub_cap	547783297.27	717455.17	8642285.54	85788073.99	84089333.24
pri_cap	3837627308.18	-9765946.56	46036937.41	572469829.51	578548774.35
teacher	-9765946.56	44863372.41	-526493.33	8818326.11	8133959.87
employee	46036937.41	-526493.33	780378.65	5343935.30	5963587.78
sup_inf	572469829.51	8818326.11	5343935.30	145666253.93	130397261.00
sup_chi	578548774.35	8133959.87	5963587.78	130397261.00	125294904.93

variance matrix and correlation matrix (Hare *et al.*, 2006). In order to do so, covariance of variables should be estimated. Table 2 shows us it. Looking at the absolute value of covariance, since minimum is 4,274.61 and maximum is 3837627308.18, the difference is huge, which implies that the heterogeneity in covariance between variance is substantial. In this case, PCA should be run based on correlation matrix rather than covariance matrix because correlation matrix is obtained by standardizing the raw data with respect to their mean and variance in order to avoid some problems which can happen when covariance matrix is used (Kim, 2006).

Table 3 illustrates the correlation coefficients between ten variables. As noted, the correlation among variables is quite great except the number of teachers. The reason why the number of teachers is not correlated to other variables may be explained by the fact that the number of children cared by one teacher in child care center is regulated to be different according to the age of children by government. For example, only three children should be cared by a teacher in the class for 0-year0old children and twenty children can be cared by

Table 3. Correlation between variables

	pub_num	pri_num	pub_cur	pri_cur	pub_cap	pri_cap	teacher	Employee	sup_inf
pri_num	0.7727								
p-value	0.0000								
pub_cur	0.9946	0.7287							
p-value	0.0000	0.0000							
pri_cur	0.7567	0.9743	0.7157						
p-value	0.0000	0.0000	0.0000						
pub_cap	0.9962	0.7311	0.9994	0.7182					
p-value	0.0000	0.0000	0.0000	0.0000					
pri_cap	0.7495	0.9746	0.7070	0.9990	0.7098				
p-value	0.0000	0.0000	0.0000	0.0000	0.0000				
teacher	0.0043	-0.0455	-0.0069	-0.0302	0.0086	-0.0235			
p-value	0.9667	0.6595	0.9467	0.7699	0.9337	0.8199			
employee	0.8010	0.8497	0.7884	0.8532	0.7853	0.8412	-0.0890		
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3886		
sup_inf	0.6203	0.7842	0.5536	0.7516	0.5706	0.7657	0.1091	0.5012	
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2901	0.0000	
sup_chi	0.6512	0.8296	0.5873	0.8261	0.6030	0.8343	0.1085	0.6031	0.9652
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2927	0.0000	0.0000

a teacher in the class for 4-year-old children (Kang *et al.*, 2006). This fact means that the more teachers do always not reflect the more capacity of child care service and the more children's enrollment. Anyway, the result that the number of teachers is not correlated to other variables allows for the prediction that the number of teachers will not affect the principal component scores much. Except the number of teachers, since all other variables are quite correlated to each other it is possible to expect that they generate a very good comprehensive principal component (Kim, 2006).

Table 4 illustrates the eigen values and the proportion of explanation for total variation in data for principal components resulted from PCA. Since the number of principal components whose eigen value is greater than 1 is two and about 84% of total variation in data is explained, it is possible to keep two principal components as significant. In conclusion, it can be said that ten variables are summarized into two principal components, which implies that each observation (for example, Daegu in December 2003) is evaluated and ranked by the 1st principal component score and then if ties exist, it will be evaluated by the 2nd principal component score (Hare *et al.*, 2006).

Table 5 shows the eigen vectors for the 1st and 2nd principal components shown in Table 4. Each eigen vector corresponding to each principal component is equivalent to the vector of coefficients for variables as explained in equation (1). In other words, 1st and 2nd principal component scores for observations are calculated by the following equation (2).

$$C_1 = c_1' Z = 0.33941 Z_1 + 0.35416 Z_2 + \cdots + 0.31767 Z_{10} \quad (2)$$
$$C_2 = c_2' Z = -0.23253 Z_1 + 0.07335 Z_2 + \cdots + 0.38332 Z_{10}$$

Table 4. Eigen values of each principal component

	Eigen value	Difference	Proportion of explanation	Cumulative explanation
Principal Component 1	7.21688	6.06433	0.72169	0.72169
Principal Component 2	1.15255	0.17676	0.11526	0.83694
Principal Component 3	0.97579	0.48774	0.09758	0.93452
Principal Component 4	0.48806	0.37976	0.04881	0.98333
Principal Component 5	0.10830	0.06695	0.01083	0.99416
Principal Component 6	0.04135	0.02706	0.00413	0.99829
Principal Component 7	0.01429	0.01223	0.00143	0.99972
Principal Component 8	0.00206	0.00151	0.00021	0.99993
Principal Component 9	0.00055	0.00038	0.00005	0.99998
Principal Component 10	0.00017	-	0.00017	1.00000

where Z is the matrix of values standardizing the values of matrix X.

Among the coefficients for the 1st principal component, the coefficient for the number of teachers (0.00082) is quite less than those for other variables (over 0.30000). The parenthesized values in Table 5 indicate the rank of each coefficient based on the degree of impact of each variable on the component. This result comes from the fact that the number of teachers is not correlated to other variables, which implies that the variable 'the number of teachers' does not affect the 1st principal components as much as other variables and it is useless for each region to increase the number of teachers for the improvement in the 1st principal component score (quality of child care service). In contrast, increasing the number of teachers can improve the 2nd principal component score by 0.63318, which means that if all other variables are equivalent, a region should increase the number of teachers in order to get the better quality of child care service.

In conclusion, it is possible to regard the 1st principal component as a general comprehensive measure for the quality of child care service in regional level because nine variables except the number of teachers have the very similar impact on the component and, as noted in Table 4, it can explain about 73% of total variation by itself. The 2nd principal component may be useful as an auxiliary measure of the 1st principal component.

Table 6 illustrates the principal component scores for each region in each half year. The greatest 1st principal component score is 8.90117 which belongs to Kyunggi in December 2008 and the lowest 1st principal component score is -2.23079 which belongs to Ulsan in December 2003. This result illustrates the fact that the quality of child care service in Ulsan in December 2003 is worst relatively to other regions in all half years and that in Kyunggi

Table 5. Eigen vectors for 1st and 2nd principal component

	1st principal component	2nd principal component
pub_num	0.33941(4)	-0.23253
pri_num	0.35416(1)	0.07335
pub_cur	0.32717(6)	-0.29176
pri_cur	0.35206(2)	0.08010
pub_cap	0.32888(5)	-0.27109
pri_cap	0.35137(3)	0.09946
teacher	0.00082	0.63318
employee	0.32597(7)	-0.21866
sup_inf	0.29931(9)	0.41227
sup_chi	0.31767(8)	0.38332

Table 6. Principal component scores for regions

		2003년 12월	2004년 12월	2006년 12월	2007년 12월	2008년 6월	2008년 12월
Kangwon	**C1**	-1.55432	-1.48637	-1.13121	-1.04047	-0.96890	-0.91559
	C2	0.13039	0.47070	1.01397	1.38227	1.53417	1.46352
Kyunggi	**C1**	3.92214	4.84161	7.23500	7.85588	8.52082	8.90117
	C2	-1.54782	-1.05650	1.39291	2.18194	2.58564	2.54551
Kyungnam	**C1**	-0.45944	-0.38480	0.42827	0.69951	0.90161	0.11880
	C2	-0.93553	-0.59701	0.20703	0.61238	0.79901	0.54098
Kyungbook	**C1**	-0.98623	-0.71976	-0.18149	0.19650	-0.00726	-0.64074
	C2	-0.82126	-0.62976	-0.02521	0.18502	0.62887	0.43791
Kwangju	**C1**	-1.55618	-1.44316	-0.93765	-0.94187	-1.16324	-1.04461
	C2	-0.64480	-0.46992	-0.12372	0.20681	0.27380	0.26601
Daegu	**C1**	-1.52353	-1.29632	-0.64899	-0.57632	-0.56783	-0.45238
	C2	-0.70796	-0.51978	0.12126	0.41101	0.59860	0.59288
Daejon	**C1**	-2.10109	-2.04487	-1.66354	-1.46755	-1.36597	-1.31394
	C2	-0.84685	-0.71560	-0.36233	-0.08305	-0.02751	-0.03363
Busan	**C1**	-0.44899	-0.05142	0.14207	0.21749	0.23977	0.35070
	C2	0.15695	0.89979	1.68747	2.48090	2.75297	2.71048
Seoul	**C1**	4.66285	5.28542	6.98745	7.16578	7.38347	7.46877
	C2	-3.45440	-3.38036	-2.23704	-1.54011	-1.49985	-1.52560
Ulsan	**C1**	-2.23079	-2.15031	-1.96170	-1.93582	-1.92125	-2.18619
	C2	-0.82787	-0.66159	-0.46431	-0.37624	-0.30796	-0.35206
Incheon	**C1**	-1.46202	-1.28607	-0.88082	0.20436	-0.42664	-0.34613
	C2	-0.96081	-0.77730	-0.07050	1.15030	0.30266	0.27440
Jeonnam	**C1**	-1.26502	-1.13386	-0.60578	-0.78915	-0.57358	-0.98980
	C2	-0.54372	-0.44502	0.02476	0.17583	0.31605	0.18223
Jeonbook	**C1**	-0.97773	-0.90382	-0.34965	-0.55356	-0.39220	-0.94991
	C2	-0.60171	-0.53884	0.01282	0.34011	0.41918	0.26380
Cheju	**C1**	-2.19598	-2.10176	-1.90153	-1.82656	-1.79556	-1.97626
	C2	-0.66308	-0.53619	-0.38439	-0.11182	-0.08437	-0.11145
Choongnam	**C1**	-1.44835	-1.33489	-0.90142	-0.77065	-0.63298	-0.57073
	C2	-0.55363	-0.41744	0.12877	0.41959	0.49717	0.53655
Choongbook	**C1**	-1.51228	-1.36131	-1.05424	-1.01545	-1.00253	-0.96916
	C2	-0.85746	-0.76876	-0.50833	-0.24337	-0.17913	-0.18241

in December 2008 is best. The main trend of the 1st principal component score is the increase in half year though there are some exceptions such as decreases in Kyungnam and Kyungbook ets. between June 2008 and December 2008. This increasing trend reflects that each regional government has tried to increase the capacity of child care service and support to children in order to improve the quality of its child care service. The decreasing cases in some regions between June 2008 and December 2008 can be explained by temporary reduction of budget caused by worldwide depression though it cannot be supported by real data because of no availability of it. As predicted, capitol regions such as Seoul and Kyunggi get high 1st principal component score and regions far from capitol area get low score. This result is reasonable in that relatively more investment has been put to capitol regions than other regions and, in fact, local governments of capitol regions have more capability to invest in child care service.

Table 7 illustrates the correlation coefficients between two sorts of principal components scores and ten original variables. Except the number of teachers, all variables are highly positively correlated to the 1st principal component score, which implies that, as noted, it is a very good comprehensive measure for the quality of child care service in regional level. Also, it is possible to confirm that the 2nd principal component score is correlated to the number of teachers.

Finally, it is necessary to compare the 1st principal component score estimated by PCA so far with the 1st principal component score estimated with respect to separated data for each half year in order to examine the robustness of the quality measure developed by this research. Since the result in Table 8 shows that two 1st principal component scores are equivalent

Table 7. Correlation between principal component scores and 10 variables

	Principal component 1		Principal component 2	
	Correlation	**p-value**	**Correlation**	**p-value**
pub_num	0.9118	0.0000	-0.2496	0.0142
pri_num	0.9514	0.0000	0.0787	0.4457
pub_cur	0.8789	0.0000	-0.3132	0.0019
pri_cur	0.9458	0.0000	0.0860	0.4048
pub_cap	0.8835	0.0000	-0.2910	0.0040
pri_cap	0.9439	0.0000	0.1068	0.3005
teacher	0.0022	0.9830	0.6798	0.0000
employee	0.8757	0.0000	-0.2348	0.0213
sup_inf	0.8041	0.0000	0.4426	0.0000
sup_chi	0.8534	0.0000	0.4115	0.0000

Table 8. Comparison result of the 1st principal component score estimated with respect to pooled data with that estimated with respect to separated data in each half year

Wicoxon Signed rank test	
1st principal component score by pooling data vs. that by separate data	
Z	-1.88928
p-value	0.05885

statistically, it is possible to conclude that the quality measure developed by this research is a robust measure of child care service quality in regional level.

5. Conclusion

This research deals with a topic how to evaluate and compare the quality of child care service in regional level. Because numerous variables are involved in the provision process of child care service in regional level it is not easy to evaluate and compare the quality. For this reason, it is necessary to develop a comprehensive measure which can integrate and summarize the variables. This research takes Principal Component Analysis (PCA) to develop the measure. The process of PCA consists of calculation of covariance and correlation between original variables to examine whether significant relationship between variables or not as the preliminary step of PCA, running PCA to determine the significant principal components, the impact of each variable on each principal component, and the explanation power of each principal component to total variation in data, and calculation of principal component scores to evaluate and to compare the quality of child care service in regional level.

The result from the calculation of covariance and correlation illustrates the existence of statistically significant correlation among variables included in biannual incentive child care statistics report except the number of teachers. This result supports the fact that all variables except the number of teachers can be integrated to form a comprehensive measure and it is possible for us to develop it to evaluate the quality of child care service in regional level. The result from running PCA shows that two principal components can be identified and they can explain over 80% of total variation. However, the second component is far less explainable than the first component and looks developed for the variable 'the number of teachers' which is omitted from the first component. If only the variable 'the number of teachers' is not so important for the quality of child care service but the 'constitution' of teachers is important because of the government regulation to the number of children cared by a teacher, it is possible to omit the variable 'the number of teachers' from the variable list and also to use only the first principal component as the quality measure for child care

service in regional level. This can be confirmed by the result that the coefficient of the variable 'the number of teachers' in the linear combination equation for the first principal component is far less than that of other variables. Eventually, if the quality measure (the first principal component) developed by this research is practically utilized to evaluate the quality of child care service in each region the increase of the number of teachers is useless and other variables should be increased following the rank of impact on the quality measure.

The reliability and robustness of the quality measure (the first principal component) developed by this research can be supported by two more analyses: the analysis of principal component scores for each region in each half year and the comparison of principal component scores estimated by pooled data with those estimated by separated data for each half year. The result from two analyses illustrates that the quality measure developed by this research is reliable and robust in that the measure follows the current trend of the quality level of regions which has been known to us so far and the measure estimated with respect to pooled data looks equivalent to that estimated with respect to separated data.

In conclusion, regions are able to evaluate the quality of their child care service through the quality measure developed by this research and should adjust the level of variables in an order following the size of impact on the quality measure and unit cost to adjust each variable.

References

1. Fernandez-Cornejo, J.(1994), "Nonradial technical efficiency and chemical input use in agriculture," Agricultural and Resource Economics Review, pp. 11-21.
2. Hare, J., Black, B., Babin, B., Anderson, R., and Tatham, R.(2005), "Multivariate Data Analysis," Prentice Hall, 6thed., Boston.
3. Jung, C., Kim, U., and Min, H.(2008), "Research on the Effect of the Accreditation Systems for Child Care Centers," Child Education, Vol. 17, No. 1, pp. 269-279.
4. Kang, M., Yoon, A., Lee, K., and Jung, J.(2006), "Operation of kindergartens and child care centers," Hakjisa, Seoul.
5. Kim, H.(2006), "Fundamentals of multivariate Analysis," Kyungmonnsa, Seoul.
6. Lee, O.(2002), "Accreditation system for child care centers and quality of child care service," Social Science Review, Vol. 8, pp. 213-229.
7. Lee, O.(2004), "Modification of child care Act and roles of researchers on child," Conference Proceeding of Korean Child , pp. 95-117.
8. Ryoo, Y. and Kim, K.(2006), "Evaluation of Nurture Institutions using Data Envelopment Analysis," The Korean Local Administration Review, Vol.20, pp. 225-254.
9. Song, S.(2008), "Efficiency at Child Care Center for Infants: An Evaluation with Data Envelopment Analysis," Asian Journal on Quality, Vol. 8, No. 2, pp. 13-31.