

## International Comparison on Operational Efficiency of Terrestrial TV Operators: Based on Bootstrapped DEA and Tobit Regression

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**Abstract.** The terrestrial TV service operator has begun to represent the increasing share of content production in media industry. Even though few differences can be found in different countries, CPND (Contents-Platform-Network-Devices) is the most important value chain in every country. Despite the importance of CPND, there are relatively few studies about effectiveness of terrestrial TV operation. In this research, DEA method is used to measure effectiveness of major Terrestrial TV service operator using such variables as capital, employee, and asset. This research also attempts to provide the better accurate results by removing bias of the estimates through bootstrap DEA proposed by Simar and Wilson [1]. It analyzes the cause of efficiency by Tobit regression after setting the dependent variable as a proposed efficiency score. Moreover, the current research helps to find the causes of efficiency in various aspects by analyzing the differences in efficiency between countries, private/public service operators, and sizes through Wilcoxon Test.

**Keywords** Bootstrap, Data Envelopment Analysis, Efficiency, Terrestrial TV, Tobit Regression.

### 1 Introduction

Terrestrial TV is considered as traditional media market and important business that produces new content. However, professional company of global media such as ZenithOptimedia also faced declining gradually because of the size of the advertising market is shrinking and economic crisis all over the world causes the reduction of advertising. Moreover, not only these factors causes the decrease of advertising market but also transition of advertisement through Internet and smart media affecting the decrease in advertising market of terrestrial operators.

Meanwhile, huge media companies of United States can enter the market domestically in a variety of ways in the economic open environment such as TPP and FTA. Therefore, media companies in developing countries (including South Korea) have a great mission of securing competitiveness. However, terrestrial operators in South Korea tend to deprive rent from another entrepreneur's platform which has the bargaining power and relatively high government support rather than to ensure global

competitiveness. This phenomenon can be found in the other major countries where commercial broadcasting stations are not fully developed. Therefore, this study attempts to examine the factor that considers ensuring the competitiveness of Terrestrial TV operators prior to face open environment.

The competitiveness can be represented as a variable of efficiency, and this study will use Bootstrapped DEA to measure variable of efficiency. Furthermore, the study attempts to find the causes of efficiency using Tobit Regression.

## 2 Empirical Application

### 2.1 Data

For this study, subjects were selected based on the classification in the Television Business International Yearbook 2012 by Informa Telecoms & Media [2]. A total of twenty operators in ten countries, Australia, Canada, France, Japan, South Korea, New Zealand, Sweden, Taiwan, U.K., U.S.A. were examined. The analysis was based on corporate accounting data and the data used extracted from company annual reports and Thompson Reuters accounting data.

For input variables, 'Total Assets' and 'Operation Expenses' were selected as capital input elements and 'Employees' as a labor input element. For output variables, the 'Total Revenue' was used. The data on each variable is as illustrated in Table 1.

Table 1. Summary of the Input and Output Variables (Total Asset, Operation Expense, Revenue: thousand USD, Employee: FTE)

Fiscal Year		Inputs			Output
		Total Assets(000)	Operation Expense(000)	Employees	Revenue(000)
2012	Minimum	47,878	53,136	300	52,209
	Median	1,739,879	1,156,206	1,995	1,363,163
	Mean	6,052,674	2,602,438	5,691	3,486,622
	Maximum	54,462,000	21,031,000	40,000	23,812,000
	SDc	12,805,556	4,708,609	9,413	5,736,245
	B/A	1,138	396	133	456

For the purposes of this study, data based on relevant national currency were changed to real variables as of 2010 by using the subject country's producer price index. In addition, figures have been translated to PPP price by using Purchasing Power Parity (PPP) to enable international comparison. Through this process, firm-level data was used as an overall sample upon which the efficiency indexes of each operator. The operators with the maximum value of Total Assets, Operation Expense, Employees, Revenue is NBCuniversal of the United States and company with a minimum value was TV ontario. Meanwhile, the 2012 capital productivity of each

company (Capital Productivity, Total Revenue / Total Assets and Labor Productivity (Labor Productivity, Total Revenue / Employees) are shown in table 2.

**Table 2.** Labor Productivity and Capital Productivity

Country	Operators	Labor Productivity	Capital Productivity
AUSTRALIA	ABC	171,619	0.94
	Ten	479,106	0.52
CANADA	CBC	74,116	1.31
	TV ontario	174,031	1.09
FRANCE	TF1	2,171,035	0.72
	M6	876,336	0.95
JAPAN	fuji TV	958,390	0.62
	TBS	2,416,279	0.62
	NHK	462,939	2.29
KOREA	SBS	953,884	0.92
	KBS	372,290	1.09
	EBS	502,838	1.49
	MBC	444,552	0.41
NEW ZEALAND	TVNZ	277,842	1.56
SWEDEN	MTG	655,375	1.14
TAIWAN	TTV	2,553,530	0.34
UK	ITV	684,479	0.78
USA	CBS	673,149	0.53
	NBCUniversal	595,300	0.44
	PBS	1,011,330	1.22
Average		825,421	0.949

Capital productivity can be defined as total revenue is divided by total asset, and labor productivity is total revenue is divided by employees. Average capital productivity of 20 operators is shown as 0.949, average Labor Productivity has become 825,421 dollars. The companies with the highest capital productivity is NHK of Japan, the operator with lowest capital productivity is the NBCUniversal of USA. On the other hand, companies with the highest labor productivity are appeared to TTV of Taiwan, and the lowest operator is appeared to CBC of Canada. NBCUniversal is operating the cable and broadcasting business, and therefore the capital of the capital productivity is low because of the large scale, Tawian Employee of the TTV is operating with a very small number of employees. Therefore, it generates relatively high revenue. In the case of Korea, labor productivity is shown to be low with the exception of SBS's labor productivity and regarding capital productivity, MBC is significantly lower than the average.

## 2.2 Result of DEA

As a result of average value of the efficiency is the optimal ratio Frontier CRS (CCR) – 0.841, VRS (BCC)- 0.902 [3][4][5][6]. Terrestrial TV operators in Japan showed high efficiency. Also, the average of the economies of scale was relatively high at 0.936 except in the case of South Korea, SBS showed lower efficiency. This phenomenon can be caused by large number of human resource than appropriate number of human resource and inefficiencies of advertisement orders. In the case of

the United States NBCuniversal, they do have low economies of scale however, this is caused from they do have an appropriate level of asset. Moreover, the phenomena can be caused from low capital productivity as well. For instance, for M6 and MTG, efficiency is appeared to be high, and this may be presumed from relaxation of restrictions on advertising and ownership. By effective policies in transition to digital conversion, advertising market is able to maintain the integrity. Looking at the results of the Bootstrapped DEA where Bias is adjusted, it was found that the efficiency of about average 12% or more decreased. This indicates that the DEA general estimates excessive efficiency. Most of the companies that have appeared to adjusted bias as Table 3.

### 2.3 Result of Tobit Regression

To confirm factor that cause differences of efficiency between TV providers, a regression about main factors is performed. However efficiency value is between 0 and 1, and efficiency value of most efficient terrestrial TV providers can't exceed 1, therefore, general regression analysis can't be used and censored distribution is appeared. In this research, also, efficiency value is between 0 and 1. In case that this dependent variable has value in constant range, and many units have value near frontier border, estimated coefficient can have convenience by estimating by regular OLS. This problem can be solved by using Tobit regression. For this variable that influence efficiency is determined.

**Table 3.** Result of Original and Bootstrapped Efficiency Score

Operators	Original DEA			Bootstrapped DEA					
	CRS	VRS	SE	BC.CRS	Confidence Interval		BC.VRS	Confidence Interval	
					Lower Bound	Upper Bound		Lower Bound	Upper Bound
1 ABC	0.682	0.689	0.99	0.632	0.587	0.679	0.639	0.593	0.685
2 CBC	0.571	0.6	0.952	0.486	0.436	0.568	0.538	0.475	0.597
3 TV ontario	0.717	1	0.717	0.66	0.613	0.711	0.788	0.698	0.994
4 TFI	1	1	1	0.805	0.735	0.99	0.849	0.762	0.994
5 fuji TV	1	1	1	0.76	0.734	0.991	0.8	0.704	0.993
6 TBS	1	1	1	0.798	0.735	0.99	0.828	0.749	0.993
7 NHK	1	1	1	0.755	0.726	0.99	0.792	0.702	0.992
8 SBS	0.991	1	0.991	0.911	0.855	0.983	0.92	0.867	0.994
9 KBS	0.798	0.798	0.999	0.72	0.674	0.792	0.722	0.665	0.794
10 EBS	0.909	1	0.909	0.792	0.728	0.901	0.871	0.804	0.994
11 MBC	0.541	0.551	0.982	0.485	0.446	0.536	0.5	0.458	0.548
12 TVNZ	0.846	0.902	0.938	0.75	0.686	0.838	0.812	0.736	0.897
13 TTV	1	1	1	0.717	0.681	0.989	0.79	0.696	0.995
14 ITV	0.821	0.859	0.955	0.76	0.719	0.814	0.773	0.723	0.853
15 CBS	0.747	1	0.747	0.675	0.622	0.741	0.818	0.742	0.994
16 NBC	0.595	1	0.595	0.549	0.513	0.59	0.781	0.7	0.994
17 PBS	1	1	1	0.801	0.78	0.992	0.802	0.734	0.994
18 Ten	0.62	0.652	0.952	0.562	0.523	0.614	0.605	0.563	0.648
19 M6	1	1	1	0.925	0.873	0.99	0.918	0.872	0.994
20 MTG	1	1	1	0.876	0.84	0.991	0.881	0.836	0.993
Average	0.841	0.902	0.936	0.721	0.675	0.834	0.771	0.703	0.896

Note: BC. Bias-Corrected

**Table 4.** Summary of Tobit Regression Variables

Operator		t1	t2	t3	t4
		(Public 1, Commercial 0)	Channel Number	Labor Productivity	Capital Productivity
1	ABC	1	4	254,182	0.9424
2	CBC	1	3	91,825	1.3075
3	TV ontario	1	1	215,613	1.0905
4	TFI	0	1	1,677,337	0.7244
5	fuji TV	0	1	100,328,714	0.6226
6	TBS	0	1	252,947,445	0.6242
7	NHK	1	4	48,462,603	2.2891
8	SBS	0	1	808,829,207	0.9179
9	KBS	1	2	315,676,440	1.091
10	EBS	1	1	426,372,990	1.4939
11	MBC	1	1	376,950,211	0.4086
12	TVNZ	1	3	402,357	1.5609
13	TTV	0	4	3,697,902	0.3412
14	ITV	0	4	472,055	0.7832
15	CBS	0	1	673,149	0.5323
16	NBC	0	1	595,300	0.4372
17	PBS	1	1	1,011,330	1.2234
18	Ten	0	3	709,598	0.5167
19	M6	0	2	677,055	0.9503
20	MTG	0	3	655,375	1.1408
Max		1	4	808,829,207	2.2891
Min		1	1	91,825	0.4086
Mean		0.45	2.1	117,035,034	0.949905
Sd		0.510418	1.25	215237298.9	0.4372

The following formula can be established to find the cause of efficiency.

**Table 5.** Result of Tobit Regression and OLS Score

Variables	BC.CRS		BC.VRS	
	OLS	Tobit	OLS	Tobit
Intercept	-1.55(-3.737)**	-2.53(-1.652) ***	-0.263(-0.509)	-1.510(-1.366)
t1	-0.06(-1.01)	-0.049(-0.746)	-0.148(-2.010) .	-0.281(-1.911) .
t2	-0.001(-0.092)	0.011(0.616)	-0.042(-2.115) .	-0.105(-2.403) *
t3	0.164(5.571)***	0.231(5.963) ***	0.082(2.253)*	0.184(2.342) *
t4	0.257(4.921) ***	0.375(5.287) ***	0.237(3.641)**	0.506(3.02) **
F	17.09***		7.417***	
R2	0.772		0.574	
Log(Scale)		-2.52(-11.802) ***		-1.95(-6.813) ***
Wald-Statistic		69.58		17.31
Log-Likelihood		9.544		0.548

Note: F value, R<sup>2</sup> => OLS/Sigma, Log-Likelihood => Tobit, Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Table 5 shows the value of the results of estimated OLS and Tobit models. Bias is adjusted in CRS model, the OLS Labor productivity (t3) and Capital Productivity (t4) showed that statistically significant, and t3 and t4 are also statistically significant in Tobit model. These findings confirm the results of the above-mentioned. In VRS facilities has been adjusted, show that the t1, t2, t3, t4, both have significant impact

under the OLS model [6], and in particular, commercial terrestrial TV operators show high efficiency. As number of channel is less and efficiency starts to increase, this can be explained as focused structure influences efficiency. Under the Tobit model, variables except t1 showed that significant, and as capital productivity high, showed effective efficiency.

### 3 Conclusion

This study attempts to measure the efficiency of the major terrestrial broadcasters in the world and analyzes the position of the terrestrial operators in Korea. Based on the data of 2012, it is estimated using the Bootstrap DEA and original DEA efficiency of terrestrial broadcasters more than 10 countries to explore the cause of the decrease in efficiency [1]. This study demonstrates that efficiency of TV operator is significantly affected by its size. The Korean terrestrial operators, except for private-owned SBS, pay more attention to increase operational and technological efficiency. In the case of the MBC, many labors' strike caused decreasing in advertising profit to broadcaster. This study shows relatively low efficiency in Public terrestrial TV operators from an economic point of view, which caused from sacrificing the production efficiency in order to meet public interest. In order to analyze efficiency, uniform data was needed. Therefore, analyzing uniformity of the variables in different country should be considered carefully. Moreover, more in-depth knowledge of broadcasters in the broadcasting environment was needed and also need to find more definite efficiency through more reliable time-series analysis for further study.

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