Incremental Cost Estimation Model for Interconnection Charge in Korea

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Abstract

The Top-Down approach is using management and financial data as a starting point. This approach has a number of strength. First, the approach is based on cost-volume relationship. Second, it can be integrated with Accounting Seperation and Costing System. Third, it does not require a great deal of information. So, Top-Down approach is efficient to develop the model in Korea.

We develop appropriate incremental cost model in Korean case. Estimated model is empirically tested. The test is executed by regression analysis using KT samples. Dependent variables are the cost of KT in 1997. Independent variables are the Calls, Installed Lines and Used Lines. There are two kinds of models. One is simple regression model and the other is cost driver model.

Two test results are as follows. First, the Lines as independent variables are more useful rather than the Calls. Second, estimated LRIC figures in urban area are larger than those in rural area.

1. Introduction

Competition in telecommunication industries can take the form of infrastructure and service based competition. Efficient competition will be achieved if firms are allowed to interconnect with networks, or to allow the provision of competitive services. Interconnection conditions and charges are very important to the development of competitive telecommunications market. If interconnection charge is set too high, competitors would be unable to achieve realistic retail margins. If they are low, there would be little network competition because operators would find it cheaper simply to but services from network-owned operator rather than build their own networks.

The rational interconnection network charge system is contributed to raising international competitiveness by optimal allocation of national resources and to introducing of competition in telecommunication market. The Korean government has announced the interconnection standards three times. But interconnection charge decision principles are still controversial.

This study has two main objectives. The one is development of appropriate model in Korean case in terms of LRIC(Long Run Incremental Cost). The other is empirical test on Korean case model.

We examine economic model and the traditional rule of determining access charge based on the cost. Especially, we examine LRIC model in the US and the UK, because fully distributed cost approach is being criticized for its arbitrary allocations of common and joint cost.

There are two basic approaches to the empirical estimation of forward-looking incremental costs-bottom-up model and top-down model. Each model has its strength and weakness.

The bottom-up model typically involves the construction of an economic-engineering model that identifies the technology components required to build and operate a particular incremental supply capability. One advantage of this model is that it can embody information about the costs of deploying technology when and where appropriate to do so.

In general, output is supplied using mix of current and older technology. Newer technology is phased in over time, as older technology is retired. However, This process can take many years, because telecommunications plant is relatively long-lived. A bottom-up model should reflect this mix of new and old technology. By doing so, it can estimate that actual costs that are likely to be incurred in various levels of output. A realistic bottom-up model requires a great deal of information. In addition to substantial data, many assumptions are needed regarding cost relationships. Such assumptions are inevitably subject to debate and criticism. There is always a danger that such intricate models will yield cost estimates that diverge substantially from reality.

Top-down model is a good antidote for this potential problem. Top-down model draws forward-looking inferences on the basis of experience in building and operating the networks that actually exist in the real world. The Top-Down approach is using management and financial data as a starting point. This approach has a number of strength. First, the approach is based on cost-volume relationship. Second, it can be integrated with Accounting Seperation and Costing System. Third, it does not require a great deal of information.

Informations of facility, technology, network construction did not collect in Korea. Relatively, Accounting information was found easily. But, the Accounting seperation standards of telecommunication industry was regulated from 1995. Moreover, they changed three times. They also did not reliable and comparable.

2. Purposes and Methodology

Our study provides applicable incremental cost estimation model in Korea. The lack of engineering information did not apply to bottom-up model. We used regression analysis by Korea Telecom’s accounting data in 1997 for estimationg incremental cost. Estimated cost is a figure of Korea Telecom. But, The Model used estimating is a general top-down model. This Study also distinguishes between high and low cost area.

The approaches for interconnection charges determination describe cost based approach in accounting, usage based approach and regulatory approach in economics. Cost based approaches are fully distributed method, activity based method, incremental cost method. Usage based method are Ramsey pricing, OFTEL method and Efficient Component Pricing Rule. Regulatory approaches are Rate of return regulation and price-cap regulation. Thse approaches was tested each country. Recently, Each country prepares to incremental cost model. Because its has incentive effect of efficient cost spending and merits of easily applicable. In Korea, researches of top-down and bottom-up was progressed. The model appropriated in Korea did not determine yet. We provides a figure of incremental cost and empirical test firstly.

3. Sample Selection

The sample consists of telephone area offices of Korea Telecom. Korea Telecom is organized headquarter, operating division, research center and area offices. Area offices take the responsibility of providing service and managing employee, facility. Korea Telecom has 10 area offices. <Table 1> is shows that a number of offices and subscription members of 10 areas. Others are information , construction, computer, and telegraph center.

Table 1 Information of Area offices and subscription members

Area	Offices	Sub-offices	Others	Subscription Members
Seoul	33	15	6	5,353,806
Pusan	42	26	5	3,269,637
Kyunggi	46	33	3	4,195,884
Junnam	27	13	3	1,370,421
Taegu	32	23	3	2,173,425
Chungnam	28	7	2	1,300,237
Junbuk	15	9	3	776,399
Kangwon	18	11	2	648,155
Chungbuk	13	2	1	589,621
Jeju	5	11	-	215,469
Total	259	150	28	19,893,054

We classified three size area-large, medium, small. This classification basis is subscription members. Seoul, Pusan and Kyunggi are large sample area, Junnam, Taegu, chungnam are medium sample. The others are small sample.

The sample is composed of offices with the required data was available. Seoul area represented large samples, Junnam and kanwon area represented medium and small. Seoul area selected all 33 offices, Junnam area selected 22 offices from 27 offices. Kangwon area selected 17 offices from 18 offices. These samples distinguished between high and low cost area. High cost area is that subscribers are widely distributed. Low cost area is densely distributed. Seoul area is assumed high cost area, Junnam and Kangwon area is assumed a low cost area. The ratio of sample is 27.8% of total offices, 37.1% in total subscribers.

The cost and other data of each office was collected Accounting separation data from Korea Telecom in 1997. Cost data consists of functional cost data-switching, transmission, cable and wire, etc. The other data is call-traffics, lines(cable and wire). Cost data is investment and expense.

3. Definition of variables

3.1 dependent variables

<Table 2> provides dependent variables. Dependent variables are same to accounting separation.

Table 2 dependent variables

Dependent variables	Function
Switching investment	Local, international exchange investment
Transmission investment	Local, international transmission investment
Cable and wire investment	Copper and fiber cable, local and international cable investment
Other investment	Other service facility investment
Support investment	Power and support facility investment
Switching maintenance expense	Switching facility maintenance expense
Transmission maintenance expense	Transmission facility maintenance expense
Cable and wire maintenance expense	Cable and wire facility maintenance expense
Other maintenance expense	Other service facility maintenance expense
Support maintenance expense	Power and support facility maintenance expense
General administration expense	General mgt. Finance and billing, marketing and sales expense

Investment is computed as follows.

Investment = Facility Book Value x Annual Factor

Annual Factor = ROR + (Depreciation of historical cost / Total Average Capital)

In this study, We assumed that annual factor was 12.5%.

3.2. independent variables

Investment depends on both calls and lines. Lines are distinguished used lined from installed line. We analyses used line and installed line. Calls are assumed erlangs. Our approach is to develop four cases of independent variables.

① Case 1 : independent variable is call traffic
② Case 2 : independent variable is Installed-Line
③ Case 3 : independent variable is Used-Line
④ Case 4 : independent variables are Installed-Line and Used-Line

Case 4 is used both installed line and used line. Independent variable of Investment is used installed line, because Facility investment is related to usable line including a surplus. But expenses are related to used lines practically.

3.3 descriptive statistics

Samples divided high cost area and low cost area by subscribers. Also they divided urban and rural by Korea Telecom classification. High cost area is not same rural area. Junnam & Kangwon samples contain cities. Urban area samples consist of 53 offices, all offices in Seoul area and 20 offices in Junnam & Kangwon area. <Table 3> and <Table 4> show descriptive statistics of samples.

Table 3 Average and Ratio of investment. (krw 1,000)

dependent variable	Seoul	Junnam & Kangwon	Urban	Rural	Total
Switching	1,500,917	404,203	1,183,275	138,859	908,488
	0.212	0.107	0.186	0.060	0.171
Transmission	1,415,370	421,150	1,140,572	137,651	876,834
	0.200	0.111	0.179	0.060	0.165
Cable & Wire	2,688,417	1,943,077	2,567,346	1,462,979	2,284,691
	0.380	0.511	0.403	0.642	0.431
Others	102,331	44,196	90,685	15,436	70,841
	0.014	0.012	0.014	0.007	0.013
Power	91,902	44,165	80,507	23,214	66,044
	0.013	0.012	0.013	0.010	0.012
Support	1,267,413	501,809	1,303,313	501,809	1,092,549
	0.179	0.248	0.205	0.220	0.206

<Table 3> shows that investment of Junnam & Kangwon area is higher than it of Seoul area, Urban area investment is higher than rural area. These results do not mean that incremental cost of Seoul area is higher than that of Junnam & Kangwon area. The focus of these results is that Cable and Wire investment of urban area is 2 times as large as Switching or transmission investment. Especially, Cable & Wire investment of rural area is 10 times.

<Table 4> shows average of expenses.

Table 4 Average and Ratio of Expenses (KRW 1,000)

Dependent variable	Seoul	Junnam & Kangwon	Urban	Rural	Total
Switching	5,253,784	1,957,036	4,439,066	759,408	3,468,045
	0.188	0.145	0.180	0.101	0.172
Transmission	6,137,382	2,085,913	5,071,291	795,042	3,942,837
	0.219	0.155	0.206	0.106	0.196
Cable & Wire	12,141,724	6,952,516	11,000,329	4,674,081	9,330,903
	0.434	0.516	0.447	0.621	0.464
Others	610,917	295,880	553,834	123,493	440,272
	0.022	0.022	0.022	0.016	0.022
Power	1,142,663	552,007	1,032,003	238,948	822,724
	0.041	0.041	0.042	0.032	0.041
Support	756,310	530,475	763,504	272,686	633,983
	0.027	0.039	0.031	0.036	0.032
General Mgt	1,922,385	1,104,214	1,770,601	666,380	1,479,209
	0.069	0.082	0.072	0.088	0.074

<Table 5> shows mean value of independent variables.

Table 5 Means of Independent Variables

Independent variable	Seoul	Junnam &Kangwon	Urban	Rural	Total
Calls	138,662	19,487	96,447	11,799	74,109
Installed line	191,882	58,813	153,653	25,378	119,803
Used line	168,353	50,496	133,912	22,508	102,498

4. Description of Estimation Model

We estimated 2 models - simple regression model and cost driver model - for incremental cost. Each model is estimated 4 cases and total samples is divided high/low cost area by cost levels. We compared results between models, cases and samples.

We assumed Networks consist of switching and transmission. They cause support investment and each maintenance expense. Additionally, they cause general management expense. Call is assumed cost driver.

EX : Switching Investment
TR : transmission investment
SU : support investment
MA1 : switching maintenance
MA2 : transmission maintenance
MG : genenral maintenance
X : call traffics

Total cost is as follows.

$$TC = EX + TR + SU + MA1 + MA2 + MG$$

4.1. Simple Regression Model

Total cost of simple regression model is estimated only one variable.

$$TC = \alpha + \beta \cdot X$$

β : incremental unit cost

We analyses investment and expenses.

$$EX + TR + SU = \alpha\_1 + \beta\_1 \cdot X$$

$$MA1 + MA2 + MG = \alpha\_2 + \beta\_2 \cdot X$$

$$\text{incremental unit cost : } \beta\_1 + \beta\_2 = \beta$$

4.2 Cost Driver Model

Incremental cost of Cost driver model is estimated by causation of cost occurrence.

$$EX = \alpha\_1 + \beta\_1 \cdot X$$
$$TR = \alpha\_2 + \beta\_2 \cdot X$$
$$SU = \alpha\_3 + \delta \cdot (EX + TR)$$
$$MA1 = \alpha\_4 + \gamma\_1 \cdot EX$$
$$MA2 = \alpha\_5 + \gamma\_2 \cdot TR$$
$$MG = \alpha\_6 + \mu \ (EX + TR + SU + MA1 + MA2)$$

Incremental unit cost : $(1 + \mu)(\beta\_1 + \beta\_2 + \delta \cdot \beta\_1 + \delta \cdot \beta\_2 + \gamma\_1 \cdot \beta\_1 + \gamma\_2 \cdot \beta\_2)$

Support investment is an indirect consequence of direct investment. Calls and Lines cause investment in switching , transmission and cable & wire. These, in turn, generate the need for support investment. Maintenance expenses are also indirect cost of investment. That is, switching and transmission cause investment, which requires maintenance. The effect is doubly-indirect for maintenance of support investment.

Incremental cost estimating process is as follows,

Step 1 : Regression analysis of each function

Step 2 : Regression analysis of support investment

Step 3 : Regression analysis of maintenance expenses

Step 4 : calculation of incremental cost

5. Results

5.1 Simple regression model

Simple regression model is estimated total cost of providing telecommunication services from one independent variable – call, installed line, or used line. The results for simple regression model are provided in <Table 6>.

Table 6 Summary of incremental cost by simple regression model

independent variable		Total	Seoul	Junnam & Kangwon	Urban	Rural
Case 1	Inv	32,144	35,039	90,127	27,076	23,352
	Exp	135,665	140,983	342,188	114,519	57,684

	Total	167,810	176,021	432,315	141,595	81,035
Case 2	Inv	28,197	23,774	45,283	26,023	61,281
	Exp	122,413	106,002	185,899	115,628	167,355
	Total	150,610	129,776	231,182	141,651	228,636
Case 3	Inv	31,144	24,636	53,625	28,037	70,306
	Exp	136,670	113,253	221,973	126,873	194,141
	Total	167,815	137,889	275,599	154,910	264,446
Case 4	Inv	18,197	13,774	45,283	26,023	61,281
	Exp	136,670	113,253	221,973	126,873	194,141
	Total	154,867	127,027	267,256	152,896	255,422

5.2 Cost driver Model

The variables of Cost driver model are as follows.

SWINV : switching investment
TRINV : transmission investment
CWINV : cable and wire investment
ETINV : Other facility investment
SUINV : Power and support investment
SWEXP : switching maintenance expenses
TREXP : transmission maintenance expenses
CWEXP : cable and wire maintenance
ETEXP : Other facility maintenance
MGEXP : general management expenses
CALL : call traffic
INVSSUM : Sum of SWINV, TRINV, CWINV, ETINV
MGT : total cost minus MGEXP
TLINE : installed line
ULINE : used line

The Results for total sample are provided <Table 7>, <Table 8>. <Table 7> provides regression analysis results for investment. <Table 8> provides regression analysis results for expense that independent variable is call.

Table 7 Results for investment regression

	Intercept	Coefficient	Independent variable	R^2
SUINV	-42,593,560	0.98	INVSSUM	0.997
	-4.933***	177.346***		
SWEXP	642,628,969	3.11	SWINV	0.897
	4.095***	24.905***		
TREXP	543,911,649	3.87	TRINV	0.929
	3.066***	30.518***		
CWEXP	493,321,533	3.86	CWINV	0.807
	0.833	17.277***		
ETEXP	242,019,981	2.80	ETINV	0.480
	6.316***	8.161***		
MGEXP	557,439,457	0.04	MGT	0.558
	4.795***	9.528***		

* $p < 0.1$ t-test for significance of regression coefficient

** $p < 0.05$ t-test for significance of regression coefficient

*** $p < 0.01$ t-test for significance of regression coefficient

Table 8 Results for expense regression

전체	Intercept	coefficient	independent variable	R^2
SWINV	217,064,472	9,330	CALL	0.647
	2.523**	11.443***		
TRINV	251,248,861	8,441	CALL	0.331
	1.695*	6.008***		
CWINV	1,513,360,880	10,408	CALL	0.336
	8.379***	6.081***		
ETINV	36,419,304	464	CALL	0.151
	2.743**	3.692***		

Incremental cost is estimated by regression coefficient.

$$
\begin{aligned}
\textit{Incremental cost} = &\ (1 + \textit{MGT coefficient}) \times \\
&(1 + \textit{INVSSUM coefficient} + \textit{SWINV coefficient}) \times \textit{CALL(SWINV) coefficient} \\
&+ (1 + \textit{INVSSUM coefficient} + \textit{TRINV coefficient}) \times \textit{CALL(TRINV) coefficient} \\
&+ (1 + \textit{INVSSUM coefficient} + \textit{CWINV coefficient}) \times \textit{CALL(CWINV) coefficient} \\
&+ (1 + \textit{INVSSUM coefficient} + \textit{ETINV coefficient}) \times \textit{CALL(ETINV) coefficient}
\end{aligned}
$$

As above equation, incremental cost is computed as follows.

$$
\begin{aligned}
\textit{Incremental cost} = &\ (1 + 0.04) \times \\
&(1 + 0.98 + 3.11) \times 9{,}330 + (1 + 0.98 + 3.87) \times 8{,}441 \\
&+ (1 + 0.98 + 3.86) \times 10{,}408 + (1 + 0.98 + 2.80) \times 464 = 165{,}915.5
\end{aligned}
$$

The results for each independent variables and the comparison between two models provide <Tables 9>.

Table 9 Comparison of incremental cost estimation results

Model	independent variable	Total	Seoul	Junnam & kangwon	Urban	Rural
Simple Regression Model	CALL	167,810	176,021	432,315	114,519	81,035
	TLINE	150,610	129,776	213,182	141,651	228,636
	ULINE	167,815	137,889	275,599	154,910	264,446
	Mixed	154,867	127,027	267,256	152,896	255,422

Cost Driver Model	CALL	165,915	174,485	442,821	144,386	83,023
	TLINE	144,450	84,646	217,990	139,272	203,390
	ULINE	160,472	138,762	258,926	151,454	233,659
	Mixed	153,276	140,606	239,752	147,575	225,583

<Table 9> shows that incremental costs of simple regression model are lower than its of cost driver model without regard to area except in the case of call. Seoul area as low cost area is lower than Junnam & Kangwon area. Generally, Rural area is high cost area. But in the case of call, incremental costs of rural area are lower than urban case. It cannot justify call as independent variable for the recognition of the high/low cost area. These results show that the line as independent variable for estimating incremental cost is appropriate than call. The results of mixed line are similar to installed line and used line.

6. Conclusion

We have demonstrated how econometric tools can be used to estimate costs on the basis of “real-world” network operations. One important advantage of our model is its ability to track indirect cost effects. This is an important property given the desirability of minimizing the amount of cost allocation via arbitrary accounting convention. The top-down approach draws forward-looking inferences on the basis of experience in building and operating the networks that actually exist in the real world. The econometric top-down model we describe and estimate reflects operating experience in a diversity of operating environments and optimization decisions taken by real decision makers spending real money in a real-world business setting.

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