A Bottom Up Approach to Forecast Total Market for Telecommunication Services

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Abstract

In forecasting future market size for telecommunication services, it is customary to analyze individually the diffusion processes of the services that make up the whole market and aggregate them. Recently, however, many existing telecommunication services have diversified and new services have arisen in an effort to satisfy customer needs. Thus, an aggregated forecast should consider the various relationships among telecommunication services, such as competitiveness and complementariness in view of the customer's desires for telecommunication. In this paper, a framework for classifying telecommunication services is proposed and independent, competitive and complementary relationships are defined according to customer needs, customer premise equipment, cost and network. Forecasting models based on such relationships are applied to telecommunication services in Korea.

Keywords : classification, competitive relationship, complementary relationship

1. Introduction

Telecommunication services have changed greatly since the invention of the telegram and the telephone. While the telephone satisfies the telecommunication needs of most customers, technological advancement and diversified communication needs have brought about many new services such as data communication and multimedia services.

When the telephone was the major service and a service provider monopolized a market, the telecommunication services market was usually analyzed without considering any relationships among the services. Today's market, however, includes varied telecommunication services, many of those service providers compete with one another. Thus, an analysis of the telecommunication services market should consider the relationships among the service providers. An analysis of the service market and a development of a forecast of its size that accounts for these relationships requires an understanding of the user's service needs and a classification of the telecommunication services according to those needs.

Section 2 of this paper introduces a classification of the services based on customer needs for information and telecommunication. Definitions of mutually independent, complementary and competitive relationships among the telecommunication services are also proposed. We discuss the demand forecast models that accounts for these relationships in section 3. Section 4 presents application results for the models proposed by Peterson and Mahajan[5]. Section 5 presents concluding remarks.

2. Classification and relationships of telecommunication services

In this section, we present a customer-oriented hierarchical classification of telecommunication services. A definition of the relationships among them is also provided based on this classification.

2.1. Classification of telecommunication services

A user wishes to select the best service to satisfy various needs for telecommunication using a particular information medium; the user may be constrained by time, cost, customer premise equipment (CPE), etc. CPE includes items such as fax, modem, and telephone. From this viewpoint, we define five aspects of telecommunication service use: user, purpose of use, means of use, core service, and base service. The user can be classified as an individual, government, etc. and the purpose of use as conversation, inspection, etc. The means of use are classified as character, digital data, etc. The core service represents the type of service that is generally used, e.g., telephone, facsimile. The base service is a subscriber-oriented basic service to which the user pays a subscription charge. The scheme of our classification is shown in figure 1. We index the user, the purpose of use, the means of use, the core service and the base service as I_1, I_2, I_3, I_4 and I_5, respectively. A service type B_Ω represents a service defined by index set $\Omega=\{I_1=i_1, I_2=i_2, I_3=i_3, I_4=i_4, I_5=i_5\}$.

2.2. Definition of relationships among telecommunication services

In this paper, we define three kinds of relationships among services: mutually independent, complementary, competitive. Mutually independent services are those having no relation to one another from the perspective of

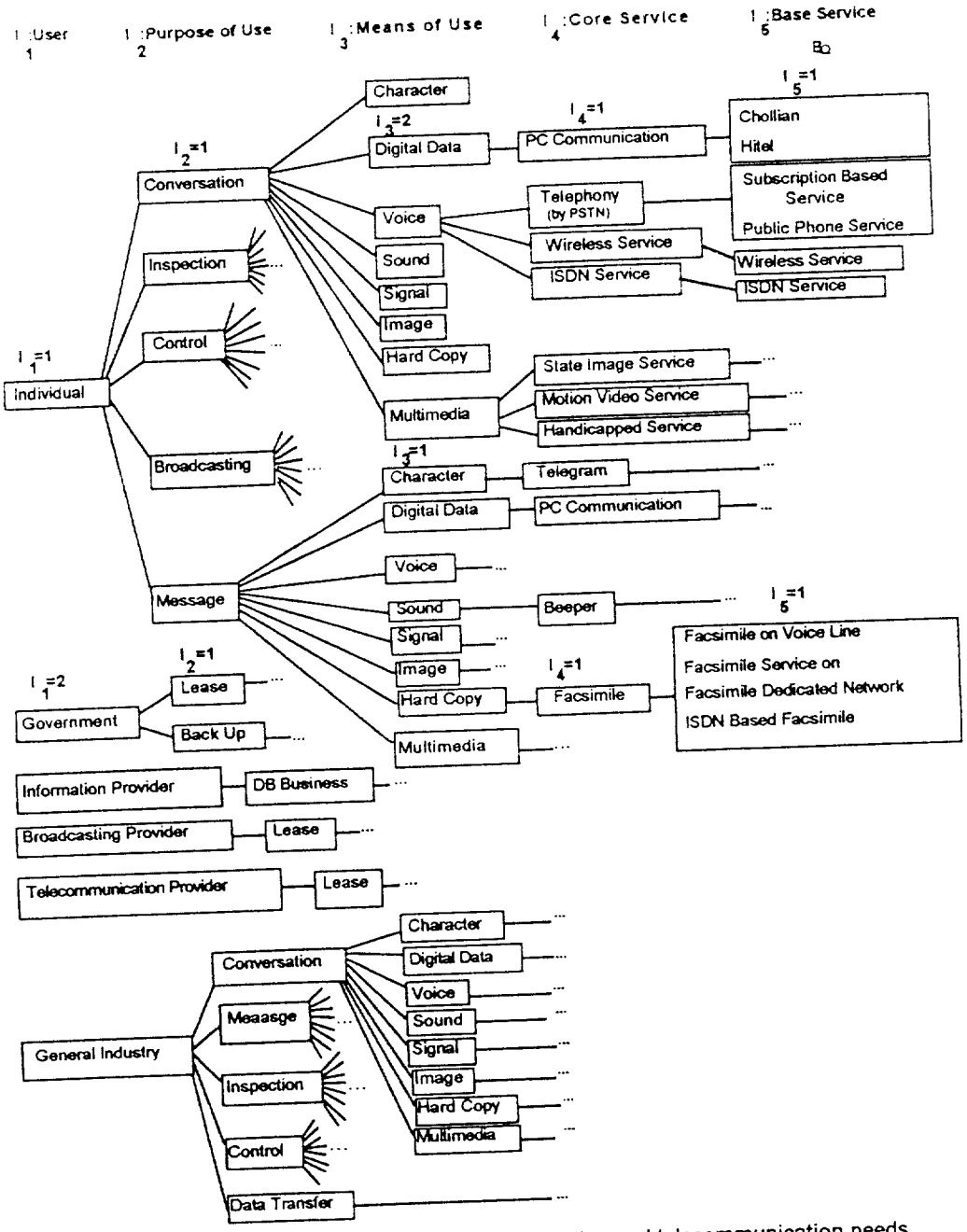

Fig.1 Service classification based on information and telecommunication needs

the user. It is sufficient to analyze the demands for such services independently of one another.

Complementary services are those required simultaneously to satisfy identical or similar information and telecommunication needs. As shown in Table 1, complementary services may be classified as either narrow-scope or wide-scope. We denote T_Ω as CPE and N_Ω as a network for a service B_Ω. $S_{\Omega\Omega'}$ is defined as the additional cost incurred and $E_{\Omega\Omega'}$ as a dummy variable representing any network interconnectivity required when adding a new service B_Ω to a given service $B_{\Omega'}$. $E_{\Omega\Omega'}$ is defined as one if interconnection is necessary and zero otherwise. Then, narrow-scoped complementary services represent those that may be provided without additional cost ($S_{\Omega\Omega'}=0$) using the existing CPE ($T_\Omega=T_{\Omega'}$) and networks ($N_\Omega=N_{\Omega'}$). Wide-scoped complementary services, on the other hand, represent those types of services requiring additional CPE ($T_\Omega\neq T_{\Omega'}$), an additional cost ($S_{\Omega\Omega'}>0$), or interconnectivity with other networks ($E_{\Omega\Omega'}=1$).

Competitive services are individual services, the only one among which is required to satisfy a particular information and telecommunication need. As shown in Table 1, Competitive services can also be classified as either narrow-scope or wide-scope. The relationship between base services (i_5) is defined to be narrow-scoped competitive if they have the same user(i_1), purpose of use (i_2), means of use (i_3), and a core service (i_4). In Table 1, the notation $\bigcup_{i_5}$, given i_1, i_2, i_3, i_4 denotes the set of all base services in a narrow-scope relationship. Similarly,

Table 1 Definition and example of complementary and competitive relationships among telecommunication services

Relationship			Definition	Example
Complementary Services	Narrow-Scope		$\{B_\Omega \mid T_\Omega=T_{\Omega'}, N_\Omega=N_{\Omega'}, S_{\Omega\Omega'}=0, E_{\Omega\Omega'}=0, {}^\forall\Omega\}$	Telephone and Local telephone call or Long-distance call
	Wide-Scope	Additional CPE	$\{B_\Omega \mid T_\Omega\neq T_{\Omega'}, N_\Omega=N_{\Omega'}, S_{\Omega\Omega'}=0, E_{\Omega\Omega'}=0, {}^\forall\Omega\}$	Telephone and Facsimile
		Additional Cost	$\{B_\Omega \mid T_\Omega=T_{\Omega'}, N_\Omega=N_{\Omega'}, S_{\Omega\Omega'}>0, E_{\Omega\Omega'}=0, {}^\forall\Omega\}$	Telephone and Three-man call
		Additional CPE & Additional Cost	$\{B_\Omega \mid T_\Omega\neq T_{\Omega'}, N_\Omega=N_{\Omega'}, S_{\Omega\Omega'}>0, E_{\Omega\Omega'}=0, {}^\forall\Omega\}$	Telephone and PC communication
		Network Interconnectivity	$\{B_\Omega \mid T_\Omega=T_{\Omega'}, N_\Omega\neq N_{\Omega'}, S_{\Omega\Omega'}=0, E_{\Omega\Omega'}=1, {}^\forall\Omega\}$	Telephone and ISDN service
Competitive Services	Narrow-Scope		$\bigcup_{i_5} B_\Omega$, given i_1, i_2, i_3, i_4	Facsimile on voice line and Facsimile service on facsimile dedicated networks and ISDN based facsimile service
	Wide-Scope		$\bigcup\bigcup_{i_4\ i_5} B_\Omega$, given i_1, i_2, i_3 $\bigcup\bigcup\bigcup_{i_3\ i_4\ i_5} B_\Omega$, given i_1, i_2	Telephone and Wireless service and ISDN service

means of use (i_3) are said to be in a wide-scoped competitive relationship when they share the same user (i_1) and purpose (i_2). Finally, core services are in a wide-scoped competitive relationship when they share the same user (i_1), purpose of use (i_2), and means of use (i_3). For example, for those who already use telephony ($B_{\{1,1,3,1,1\}}$, where {1,1,3,1,1} implies individual customer, conversational purpose, voice media, telephony, subscription based service) facsimile service ($B_{\{1,5,7,1,1\}}$) is a CPE-added complementary service ($T_{\{1,5,7,1,1\}}\neq T_{\{1,1,3,1,1\}}$). PC communication service ($B_{\{1,1,2,1,1\}}$) is a CPE- and cost-added complementary service ($T_{\{1,1,2,1,1\}}\neq T_{\{1,1,3,1,1\}}$ and $S_{\{1,1,2,1,1\}\{1,1,3,1,1\}}>0$) for those customers; ISDN service ($B_{\{1,1,3,3,1\}}$) is a complementary service requiring network interconnectivity ($E_{\{1,1,3,3,1\}\{1,1,3,1,1\}}=1$, which implies that network interconnectivity between PSTN and ISDN is required).

Facsimile on voice line ($B_{\{1,5,7,1,1\}}$), facsimile service on facsimile dedicated networks ($B_{\{1,5,7,1,2\}}$) and ISDN based facsimile services ($B_{\{1,5,7,1,3\}}$) are narrow-scoped competitive services ($\bigcup_{i_5} B_{\{1,5,7,1,i5\}}$, given $I_1=1$, $I_2=5$, $I_3=7$, $I_4=1$) for those who require facismile services. The following services are in wide-scoped competitive relationships for voice communication ($\bigcup\bigcup\bigcup_{i_3\ i_4\ i_5} B_{\{1,1,i3,i4,i5\}}$, given $I_1=1$, $I_2=1$) : character ($I_3=1$), digital data ($I_3=2$), voice ($I_3=3$), etc. Telephony ($I_4=1$), wireless phone ($I_4=2$), ISDN service ($I_4=3$) are wide-scoped competitive services when a user requires voice communication ($\bigcup\bigcup_{i_4\ i_5} B_{\{1,1,3,i4,i5\}}$, given $I_1=1$, $I_2=1$, $I_3=3$).

3. Forecasting models considering the relationships among services

The diffusion model of Bass [1] has been widely applied to various products to explain the diffusion process of a new product or service (refer to Mahajan et al. [3]). When the sales during period t are defined as S_t, the cumulative sales until time t-1 as Y_{t-1}, and a saturation level as N, the Bass model can be represented as follows:

$$S_t = \left(p + q\frac{Y_{t-1}}{N}\right)(N - Y_{t-1}). \quad (1)$$

Although many attempts have been made to construct new product growth models, these attempts have focused on single-product models. New telecommunication services do not, however, exist in isolation. Thus, it is necessary to account for relationships among them when analyzing the market for these services.

Peterson and Mahajan [5] proposed a few extensions of the Bass model to explain competitive and complementary relationships among new products as follow :

$$S_t^1 = \left(p_1 + q_1\frac{Y_{t-1}^1}{N_1} + r_1\frac{Y_{t-1}^2}{N_2}\right)\left(N_1 - Y_{t-1}^1\right);$$
$$S_t^2 = \left(p_2 + q_2\frac{Y_{t-1}^2}{N_2} + r_2\frac{Y_{t-1}^1}{N_2}\right)\left(N_2 - Y_{t-1}^2\right), \quad (2)$$

where two products have complementary relationships if $r_1 > 0$, $r_2 > 0$, and competitive relationships if $r_1 < 0$, $r_2 < 0$. The parameters r_1, r_2 reflect the complementary or the competitive impact for each case.

4. Applications

This section presents results of applications of the forecasting models proposed by Peterson and Mahajan[5] to services in Korea.

4.1. Application services

Facsimile service is a CPE-added complementary service for the user of telephone in table 1. These services are applied as an example of a complementary relationship. Telephone and wireless service are analyzed as the wide-scoped competitive services.

Table 2. Application results for Peterson and Mahajan models

			Parameter Estimates	Root MSE
Complementary Services : Telephone and Facsimile service in Korea	Peterson and Mahajan	Telephone	$S_t^{tel} = (0.186_{(0.0001)} \frac{Y_{t-1}^{tel}}{N_{tel}})(N_{tel} - Y_{t-1}^{tel})$	213,070
		Facsimile	$S_t^{fax} = (-0.021_{(0.0001)} + 0.264_{(0.0001)} \frac{Y_{t-1}^{fax}}{N_{fax}} + 0.137_{(0.0001)} \frac{Y_{t-1}^{tel}}{N_{tel}})(N_{fax} - Y$	16,144
	Bass	Telephone	$S_t^{tel} = (0.186_{(0.0001)} \frac{Y_{t-1}^{tel}}{N_{tel}})(N_{tel} - Y_{t-1}^{tel})$	213,070
		Facsimile	$S_t^{fax} = (0.008_{(0.0022)} + 0.433_{(0.0001)} \frac{Y_{t-1}^{fax}}{N_{fax}})(N_{fax} - Y_{t-1}^{fax})$	23,520
Competitive Services : Telephone and Wireless service in Korea	Peterson and Mahajan	Telephone	$S_t^{tel} = (0.214_{(0.0001)} \frac{Y_{t-1}^{tel}}{N_{tel}} - 0.974_{(0.0002)} \frac{Y_{t-1}^{wire}}{N_{wire}})(N_{tel} - Y_{t-1}^{tel})$	172,346
		Wireless	$S_t^{wire} = (0.004_{(0.0730)} + 1.118_{(0.0001)} \frac{Y_{t-1}^{wire}}{N_{wire}} - 0.018_{(0.0230)} \frac{Y_{t-1}^{tel}}{N_{tel}})(N_{wire} - Y_t^$	30,399
	Bass	Telephone	$S_t^{tel} = (0.186_{(0.0001)} \frac{Y_{t-1}^{tel}}{N_{tel}})(N_{tel} - Y_{t-1}^{tel})$	213,070
		Wireless	$S_t^{wire} = (0.982_{(0.0001)} \frac{Y_{t-1}^{wire}}{N_{wire}})(N_{wire} - Y_{t-1}^{wire})$	30,250

* N_{tel}=30,000,000, N_{wire}=8,000,000 and N_{fax}=2,000,000 are given.
* the value in the parenthesis denotes the p-value.

4.2. Results

The first part of Table 2 shows the results of the application of the complementary model of Peterson and Mahajan[5] to annual subscriptions to telephone lines from 1960 and those for fax from 1982 to 1994. The Root MSE for this application is lower than that for the Bass Model. The estimate of r_2 reflects a significant complementary impact. The market potential of telephone was assumed based on the number of households and persons employed in Korea and that of facsimile was also infered from many related reports and opinions of experts because of the difficulty of estimation. The second part of table 2 shows the result of the application of the competitive model of Peterson and Mahajan[5]. The data analyzed are the number of subscribers to telephone lines from 1960 and wireless phone from 1984 to 1994. The Root MSE of wireless service for the model of Peterson and Mahajan[5] is a little higher than that of Bass[1]. This is due to the sensitiveness to the number of parameters in the models. For both services, the competitive model performs a little better than two individual diffusion models by Bass[1]. Their competitive relationship turns out significant as shown from the estimates of r_1 and r_2. The size of potential market for wireless phone was estimated based on the survey data.

5. Conclusion

In this paper, telecommunication services are classified according to customer' needs and mutually independent, competitive, and complementary relationships are defined. Then, the model of Peterson and Mahajan[5] are applied as the forecasting models reflecting such relationships. In this paper, we do not provide a complete example of its application to forecasting total market demand because of a lack of data. The results, however, may be used for forecasting the total market for telecommunication services. We call this a bottom-up approach because it starts with customer needs and leads to a forecast of total market. In a top-down approach, on the other hand, the total market demand is forecasted and the proportion of a particular network or service market may be estimated by predicting each diffusion rate.

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