Telecommunications and National Economy

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A. Introduction

Considering the importance of telecommunication in an economy, it is necessary to investigate how telecommunication services are related with economic activities. In the existing macro-economic studies on telecommunications, the simple regression method has been used to explore the extent that telecommunication equipments (the number of telephones or subscribers) contribute to economic activities (GNP or GDP). The close relationship between the level of GNP and telephone subscribers found in the studies leads to the conclusion that telecommunications are an important factor in national economic activities (Saunders et al, 1983; Hardy, 1980; Bebee and Gilling, 1976; Jipp, 1963). As we will see later in this study, however, their claim suffers from misinterpretation of correlation coefficients and/or misspecified regression estimation of the GNP equation. An alternative method to avoid such problems are suggested in this study.

Regarding the regression analysis between GNP and telecommunication equipments, the question whether any causal relationship between the two variables could be drawn has been raised and debated hotly in the relevant literature. Namely, the estimated simple correlation coefficient between the two variables cannot tell clearly whether any causal effect works from telecommunications to GNP or the reverse. In this study the relationship between GNP and telecommunications is estimated in two way; production side and demand side. This separate estimation of the GNP production function and the telecommunications demand function will clarify the ambiguous point of the macro-analysis.

No one will disagree with the assertion that telecommunications compose one of the main social and economic infrastructures of a country and thus their impacts on the national economy is fundamental and far reaching. Therefore, the macro-approach which captures the relationship between the

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level of economic activities and telecommunication services should be used for overall understandings of the role played by telecommunications in a national economy. And then the input-output analysis can be used as a complementary tool by giving quantitative effects of the telecommunication industry on other industries.

In the following section how telecommunications have contributed to GNP production in Korea is analyzed by using regression. In the regression analysis, labor, capital and telephone services are used as explanatory variables for the GNP. This equation is distinguishable from those in the current literature on telecommunications. Demand aspect of telecommunications which has been neglected in the existing literature is introduced in section III. A brief summary and the implications of this study is presented in the final section.

B. Telecommunications and GNP

In this section the relationship between per capita GNP and telecommunications is estimated to see how telecommunications affect national economic activities. Compared with existing studies, this paper uses telephone services rather than telephone equipments or the number of telephone subscribers in the regression analysis.

First, the relationship between telephone subscribers and GNP is examined using the conventional way. 〈Fig. 1〉 shows the telephone subscribers-GNP relation during the period of 1961~1984 of Korea. Generally, a positive

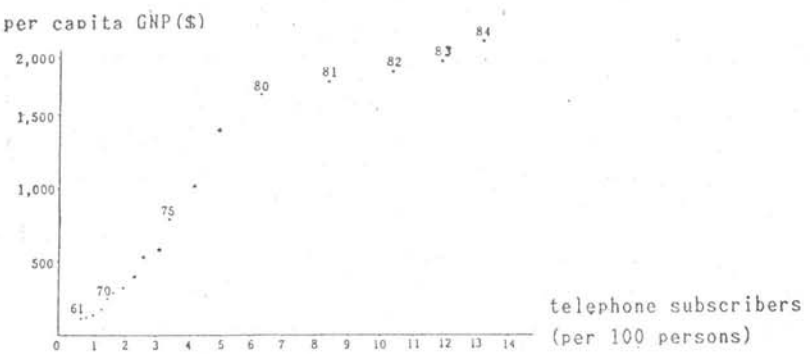

Fig 1. The Number of Telephone Subscribers and GNP in Korea
Sources: Korea Telecommunications Authorities, Annual Reports,
The Bank of Korea, The National Income Account.

relationship between telephone subscribers and GNP can be inferred from the Figure as in other studies on telecommunications. Specifically, the number of telephone subscribers and GNP move in the same direction in Korea as in other countries. However, Korea experienced faster growth of GNP than telephone subscribers until late 70s, which resulted in a relatively steeper slope. And then the slope has become relatively flatter entering the 80s.

1. Traditional method

The GNP-telephone subscribers relation is estimated by the least squares method. A slope dummy variable is used in the estimation to test wether there was any significant change in the telecommunications-GNP relation that appeared in the late 70s. The result, equation (1) shows significant and positive coefficient of telephone subscribers, which is consistent with the existing literatures' assertion that there is a positive relationship between the GNP and telecommunication equipments.

(1) $\log Y = 4.9 + 1.37 \log T - 0.24 \log DT$

$\qquad\qquad (18.3) \qquad\qquad (-3.6)$

$\qquad\qquad R = 0.98 \qquad DW = 0.69$

where Y=per capita GNP,

T=the number of tephone subscribers per 100 persons,

DT=slope dummy (1 for 1964~1978 and T for 1979~1884)

and figures in parentheses are t-values.

One interesting result of equation (1) is that estimated coefficient of the slope dummy variable is negative and statistically significant. This indicates that the relatronship between telecommunications and GNP became weaker since the late 70s in the Korean economy. Specifically, until the late 70s, the GNP had grown at a faster rate than the number of telephone subscribers. However, since the late 70s the latter has increased faster than the former. Therefe, someone may assert that telephone services has contributed to GNP or economic activities a lot until the late 70s but the contribution has fallen in recent years.

However, equation (1) cannot give a full explanation for the changes in the slope. The main reasons are as follows. First, equation (1), $Y=f(T)$ shows well the movement of GNP and the number of telephone subscribers and the estimated positive coefficient of the number of telephone subscribers tells us that GNP increases as telephone subscribers increases. But nothing

more than that. In other words, how the increase in telephone subscribers affects the GNP can not be derived from the equation.

And there is no theoretical basis for specifying the GNP and telephone subscribers relation as in equation (1). If that specification implies a production function, then other important variables such as labor and capital are omitted. Therefore, it is hard to avoid misspecification error when the equation is estimated.

Finaly, equation (1) can be considered as a demand function for telephone services. The reasen is that equation (1) becomes a demand relationship of telephone and income when horizontal and vertical axes are switched with each other in Fig 1. And thus, equation (1) is nothing more than the inverse relation of the demand for telephone services. Thus the conventional identification problem arises when Fig 1 is fitted in the form of equation (1).

2. Alternative mehtod

To avoid those problems faced by the traditional method, telephone services instead of subscribers are used as an independent variable. And other variables such as labor and capital are also included in the GNP equation. Namely, $Y=g(TS, L, K)$ where TS represents telephone services and L and K are labor and capital respectively. This specification is a GNP production function. Regressing the same data using the new specification results in equation (2).

$$\log Y=-6.83+0.096 \log TS+1.69 \log L+0.074 \log K \quad (2)$$
$$(3.31) \qquad (9.23) \qquad (2.04)$$
$$R=0.99 \qquad DW=1.22$$

where Y=per capita GNP,
TS=telephone services revenue of KTA,
L=the number of total employees,
K=the gross domestic capital formation,
and figures in parentheses are t-values.

The positive and significant estimated coefficient of telephone services indicates that telephone services is one of the main production inputs along with other factors such as labor and capital. In this specific specification, we can assert that telecommunications affect GNP as other production factors do.

The slope dummy variable of telephone services is added to equation (2) in order to test whether there is any structural change in the late 70s as shown by equation (1). The estimated result is equation (3).

(3) $\log Y = -6.7 + 0.077 \log TS + 0.003 \log DTS + 1.68 \log L + 0.91 \log K$
(1.92) (0.73) (8.98) (2.08)
$R = 0.99$ $DW = 1.12$

where DTS=slope dummy for telephone services (1 for 1964~78, TS for 1979~84) and t-statistics are in parentheses.

In the estimated equation (3), the slope dummy variable of the telephone services turns out to be insignificant (t-value is 0.73). Consequently, a structural change in the telecommunications-GNP relation which appeared in the estimated equation (1) is not supported by the new specification of the GNP equation including telephone services, labor and capital. This result shows that the role played by telephone services in the production process has not changed during the study period. Namely, telephone services remain as an input factor which is used in the production activities.

The production factor characteristic of telephone services can be examined more specifically by analyzing the telecommunications input coefficients of various industries. In Korea, the telecommunications input coefficient of the total industry has increased steadily since the early 70s from 0.00325 in 1973 and 0.00384 in 1975 to 0.00492 in 1980. And it has more than doubled to 0.00755 in 1983. (Table 1) This implies that industrial activities have used more telecommunication services during the period. And thus the importance of telecommunications in the production activities has been increased in the recent years in Korea. This result is sharply contrasting with the result that the relationship between telecommunications and GNP has become weaker in the 80s suggested by the equation (1). But it is consistent with the result suggested by the new specification that the role played by telephone services in the production activities has not changed during the studying period.

Then how do we explain the reduced slope of the telephone coefficient revealed in Figure 1 and equation (1) concerning GNP? Analysing the telecommunications input coefficients of each industry and estimating an aggregate telephone demand function will answer the question. The following section will deal with the task.

C. Demand Aspect of Telecommunications

Current macro-economic regression based papers on telecommunications are basically supply- or production- oriented studies. To capture the whole picture

of telecommunications in an economy, the demand side should be considered along with the supply aspect. The demand for informations increases rapidly as society becomes more complex and interrelated. And the expansion of economic activities and the ever-increasing trend of production and consumption activities make producers and consumers need more informations To meet those rising information needs, the demand for telecommunication services increases. In this section the demand side of telecommunications is introduced treating business and residential telephone demands separately. And then whether there was any change in the socio-economic structure in related with telecommunications during the late 70s is investigated.

More people use telephone services as per capita GNP increases (Fig 2). The number of telephone subscribers has grown much faster than the GNP since the late 70s, which results in a sharp increase of the slope in the Figure.

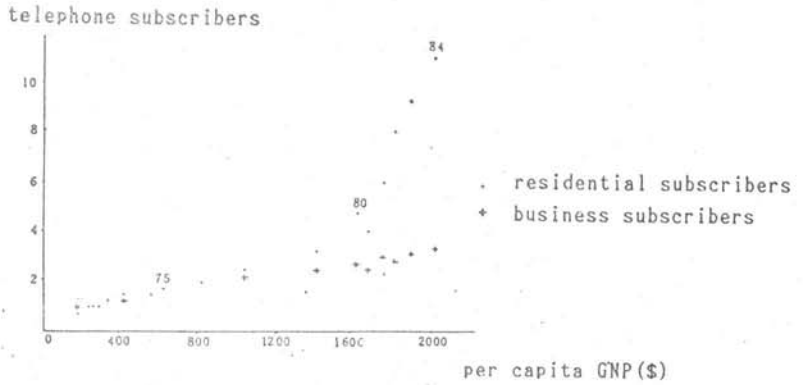

Fig. 2. The Number of Telphone Subscrbiers Trend
Source: op. cit.

An aggregate demand for telephone subscriptions is estimated by fitting ⟨figure 2⟩ using income, slope dummy and time as explanatory variables. The result is in equation (4). The estimated demand of telephone services turns out to be income (GNP) elastic as expected. This tells us that telephone uses have increased as economic activities expand.

(4) $\log T = -10.3 + 1.694 \log Y + 0.044 \log DY + 0.0047 \log TIME$
$\qquad\qquad\qquad\qquad (8.35) \qquad (5.20) \qquad (0.043)$
$\qquad\qquad R = 0.99 \qquad DW = 1.20$

where T=the number of telephone subscribers,
Y=GNP (1980 constant price),

DY= the slope dummy for Y (1 for 1964-78, Y for 1979-84),
TIME=trend variable (1∼21)

and t-values are in parentheses as in the above.

The significant and positive coefficient of the income slope dummy variable indicates that the income elasticity of telephone demand has risen from 1.694 during the period of 1964∼78 to 1.738 (=1.694+0.044) for the later period (1979∼84). This shift of the estimated GNP coefficient of telephone demand implies that there was a structural change in the relationship between telecommunications and GNP. A separate analysis of business and residential telephone demands is required to explain how the telecommunication-GNP relation has changed in the late 70s in Korea.

1. Business telephone demand

Business telephone demand is characterised by an intermediate demand for production inputs of labor and capital. The business telephone demand function is estimated by regressing the number of business telephone subscribers on GNP, slope dummy and time. The result is shown in equation (5). Positive coefficient of the GNP variable shows that telephone uses increases as production increases.

(5) $\log TB = -8.45 + 1.4342 \log Y + 0.0099 \log DY + 0.0175 TIME$
(15.45) (2.35) (0.33)
$R = 0.99$ $DW = 1.41$

where TB is the number of business telephone subscribers and others are defined as in equation (4).

However, the estimated coefficient of the slope dummy variable turns out to be statistically significant but its magnitude is very small at 0.0099. This indicates that the fundamental role of telephone services as a production factor has not changed much during the study period.

The production factor characteristic of telephone services is shown well in Table 1 which contains communication input coefficients of industries in Korea. In the table the communication input includes the postal, telex and telephone services. But the postal services takes only 7.5% in total output of the telecommunication services. Therefore, the communication input can be used as the telecommunications input without significant distortions.

The increasing trend of telecommunications input coefficients implies that telecommunication services are used more in production sectors as a whole.

The table shows that the input coefficients of service industries are in general greater than those of manufacturing and primary industries. Especially, for the cases of retail and wholesale services, transport industry and private and social services, the input coefficients have been raised sharply since the early 70s.

On the other hand, banking and insurance service industries have a relatively small increase in the telecommunication input coefficient (0.01769 in 1973 to 0.1894 in 1983). The relatively small rise of the coefficient in those sectors is mainly due to the earlier introduction of computer and on-line systems compared with other service sectors. Computerization of business activities would require more non-voice informations such as data than plain voice informations. Therefore, the need for telephone uses which transmit voice informations becomes rather weaker than the need for non-voice data transmitters or carriers such as office automation facilities. This kind of structural change from voice to non-voice information needs has made the telecommunication input coefficients of the banking and insurance services more slowly.

It is noteworthy that the telecommunication input coefficient of the manufacturing sector has been stable at around 0.00210 in the 70s. This implies that the investment on telecommunication facilities fell behind in the 70s compared with the rapid growth of manufacturing output and investment. However, a big jump of the coefficient to 0.00335 in 1983 shows that the manufacturing sector has used more telecommunication services in recent years. Along with the steady and slow growth of business telephone subscribers, the large increase in the input coefficient indicates that the manufacturing sector has used existing telecommunication facilities more intensively in the 80s. Meanwhile, the manufacturing sector requires more data processing or transmission equipments as the office and factory automation facilities are introduced in the sector. In other words, non-voice information needs are growing rapidly in the manufacturing sector recently.

On the other hand, the telecommunication input coefficients of agricultural and fishing sectors have risen from 0.00056 in 1973 to 0.00065 in 1983 and the coefficient of mining industry has realized a large increase from 0.00187 in 1973 to 0.00468 in 1983. This is mainly due to the introduction of the market economy in the primary sector, which increases the needs for information exchange. Another reason is the expanding of telecommunication

Table 1. Communication Input Coefficients by Industry

	1973	1975	1978	1980	1983
Agri. & Fishing	0. 00056	0. 00054	0. 00041	0. 00065	0. 00065
Mining	0. 00187	0. 00198	0. 00225	0. 00299	0. 00468
Construction	0. 00051	0. 00108	0. 00113	0. 00226	0. 00356
Manufacturing	0. 00205	0. 00200	0. 00252	0. 00212	0. 00335
Electricity & Gas	0. 00211	0. 00067	0. 00072	0. 00104	0. 00179
Wholesale & Retail	0. 01013	0. 01472	0. 01635	0. 02548	0. 03409
Transport	0. 00596	0. 00622	0. 00697	0. 00606	0. 00846
Banking & Ins.	0. 01769	0. 01990	0. 01901	0. 01218	0. 01894
Real Estates	0. 00058	0. 00167	0. 00335	0. 00206	0. 00342
Social & Priv. Serv	0. 00474	0. 0073	0. 00756	0. 00635	0. 01204
Total Industry	0. 00329	0. 00384	0. 00432	0. 00492	0. 00755

Sources: The Bank of Korea, *Input-output Tables*

networks to rural areas.

So far we have examined how the telecommunication services have been used in industrial sectors. Dependency on telephone services has become relatively weaker recently as demand for non-voice information rises in the manufacturing and service sectors. On the other hand, demand for telephone services are still rising in the primary sector and in the local or rural areas.

2. Residential demand for telephone services

Residential telephones are used for transmitting informations on consumption activities. As consumption activities including buying goods and services expand, the needs for exchanging informations increase. Therefore, the demand for residential telephone increases as income grows. The positive effect of income or consumption activites on residential telephone uses are well reflected in the estimated residential telephone demand equation in Korea; see equation (6) and (7). The estimated coefficients of GNP(Y) and private consumption expentiture(PCE) are positive, 1. 65 and 2. 02 respectively.

(6) $\log TR = -11.05 + 1.6544 \log Y + 0.0626 \log DY + 0.2080\ TIME$
$\qquad\qquad\qquad\qquad (6.98) \qquad (5.83) \qquad (1.56)$
$\qquad R = 0.98 \quad DW = 1.14$

(7) $\log TR = -13.95 + 2.0235 \log PCE + 0.0606 \log DPCE + 0.1823\ TIME$
$\qquad\qquad\qquad\qquad (6.21) \qquad (4.72) \qquad (1.19)$
$\qquad R = 0.98 \quad DW = 1.0$

where TR=the number of residential telephone subscribers

PCE=private consumption expenditure

and others are defined as in equation (4).

Generally the demand for telephone explodes once income has passed a certain critical level. In the case of Korea, per capita income reached around two thousand dollars in the late 70s and the demand for telephones exploded around that period. In Figure 3 residential telephone subscribers increased at a faster rate than those of the business telephone in the late 70s. The rapid increase in the demand for residential telelphones is supported by the significant and positive coefficients of the slope dummy variables, DY and DPCE, in equation (6) and (7).

It is noteworthy that the estimated coefficient of the slope dummy variable for the residential telephone demand function, 0.0626 in eq. (6) is much greater than that of the business telephone demand function, 0.0099 in eq. (5). This implies that the change in slope in the GNP-telecommunication relation which appeared in the late 70s in Korea is mainly caused by the sharp shift from the residential demand side.

D. Conclusions

The new method suggested in this paper which uses telephone services instead of telephone equipments as a explanatory variable for GNP estimation turns out to be more appropriate for examining the role of telecommunications in a national economy. The alternative method shows that telecommunication's role as a production factor has not changed during the studying period of 1964~1984 in Korea. This unchanging production factor charateristic of the telecommunication services is supported by the telecommunication input coefficient analysis.

The separate analysis of the business and residential demands for telephone makes it clear that the change in the slope of telecommunications which appeared in the simple telecommunication-GNP regression analysis is mainly due to a sharp increase in the residential demand.

The spread of computers and automation equipments in manufacturing and service sectors increases non-voice information needs. Therefore, the demand for telephone which transmits only voice information has been relatively weaker recently. Instead, the demand data processing or carrying facilities

are increasing at a great speed. Consequently, improving existing telephone facilities to meet those growing needs for data communications should be considered as a urgent telecommunication policy. In the meanwhile, telecommunication facilities should be expanded to rural areas to satisfy the rising demand for telephone in the agricultural and rural sectors.

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