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An Analysis of the Economic Effects of NetworkIndustry by Applying Household Endogenous Model

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Abstract

Currently the Republic of Korea is planning a government-sponsored project to build a new network infrastructure in order to provide better services with citizens in spite of the already established world class network infrastructure. For past few years, there were several investments on network infrastructure development projects which resulted in high ROI(Return on Investment) rates in Korea. The clear definition and objective analysis of the project is an important task to be completed prior to the beginning of carrying out the project which aimed to promote network industry with government support.

This report applies an analysis of inter-relationship among industries including an influence process of income and consumption by considering the effects of an increase in consumption, resulting from the growth of household income, on production. It might be worthy to review input-output table with household endogenous model when it investigates the effectiveness of investment on network infrastructure.

1. Introduction

In the past few years, a large amount of money was invested in network industry and it achieved good results. However, it is still difficult to figure out economic, technical and social achievement and ripple effects of network industry. The clear definition and objective analysis of the project is an important task to be completed prior to the beginning of carrying out the project which aims to promote network industry with government support

This paper is to analyze the quantitative effect of network industry. In other words, it analyzes the economic effects of network construction and examines the features of industrial structure and inter-industry structure by approaching to quantitative aspects at the same time.

This paper distinguishes itself from the existing researches by applying an analysis of inter-relationship among industries including an influence process of income and consumption with considering of the effects of an increase in consumption, resulting from the growth of household income, on production. It might be worthy to review input-output table with household endogenous model when investigating the effectiveness of investment on network infrastructure.

2. Advanced Research

A management consulting company, McKinsey, defined internet economy regarding network influence in a new way and analyzed an effect of internet on economy.(McKinsey, 2011) As a result of analysis on 13 major countries, internet made a

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contribution to 3.4% of GDP on average. Additionally, 75% out of the internet effects was not directly related to the internet.[1]

ITU Researches(2012) dealt with various aspects from the effects on GDP development and export increase to the effects of broadband communication network, changes of intermediate demand and import substitution. According to the research, broadband communication network positively affects GDP development but results are varying. The majority of research conclude that the penetration rate of broadband communication network definitely affects GDP; as the rate increases by 10%, GDP increases from 0.25% to 1.38% in general.[2]

Researches on the effects of network construction on job creation are Crandall *et al.* (2003), Atkinson *et al.* (2009), Liebenau *et al*. (2009) and Katz *et al*.(2008), and all of them conduct researches by assuming a fixed quantity of capital investment with using input-output analysis. Consequently, the indirect effects of European states are lower than that of the US, and there is a comparatively important employment inducement effect as a result of household expense based on income produced by direct and indirect effects.

Table 1. Employment Inducement Effect of Network Construction using Input-Output Analysis (unit: million dollar)

	Investment amount	Employment Inducement(jobs)				multiplier	
		First effect		Second effect	Total	Type I*	Type II**
		direct effect	indirect effect				
U.S.A	6,390	37,300	31,000	59,500	127,800	1.83	3.42
Swiss	10,000	80,000	30,000	n.a	110,000	1.38	n.a
Germany	47,660	281,000	126,000	134,000	541,000	1.45	1.93
U.K.	7,463	76,452	134,541	211,000	-	2.78	

* ; (direct+indirect)/direct, ** ; (direct+indirect+2nd effect)/direct
the origin of source: Dr. Raul L. Katz, Columbia Business School, 2009.

The advanced researches which endogenize consumer's expenditure and income are as follows: Miyazawa's research (1995) initially suggested a model endogenizing household sector which has been dealt as an exogenous one. Hayashi's research(2006) explained household endogenous input-output model in depth and Sano(2000, 2012) conducted a research on household endogenous model by using inter-industry relation table.

3. Research Methodology

This paper aims to analyze the national economic effects of network construction on production, add value and employment inducement by using inter-industry relation table(R. Stone (1961))[3]. For analysis, it is essential to use inter-industry relation table presented by the Bank of Korea; thus, 2013 inter-industry relation table is estimated by using that of 2009 with RAS methodology in order to analyze economic effects created by investments between 2013 and 2017. Additionally, This paper also examines economic effects by applying household endogenous model with the consideration of the effects of an increase in consumption, resulting from the growth of household income, on production. In Regard of defining network industry's scope and classification of next

[1] McKinsey (2011), “Internet matters: The Net's sweeping impact on growth, jobs, and prosperity”
[2] According to Thompson and Garbacz(2008), as productivity or effectiveness increases by 1% GDP increases by 1%. By applying this general rule, GDP increase can be calculated to 0.36%
[3] R. Stone (1961), "Input-output and National Accounts," OEEC Paris.

generation, this research categorizes network industries by considering the features of the industry, based on industry classifications consisting of 403 defined by the Bank of Korea. However, the classification tries to reflect new characteristics of network industry.[4] As the table below shows, related industries are re-classified by 12 industries based on inter-industry relation table which consists of 403.

Table 2. Network Industrial Classification

	Sector	Classification
1	Agriculture, Forestry and Fishing /Mining and quarrying	Crops, Animals, Forest Products, Fishery products, Agriculture, forestry and fishery, Mining of coal, crude petrol, Metal ores, Non-metallic minerals
2	Electricity/gas/steam and water supply	Electric utilities, Gas and water supply
3	Construction	Building construction and repair, Civil engineering (except Communications line construction)
4	Wholesale and retail trade/Accommodation and food services/Transportation	Wholesale and retail trade, Accommodation and food services, Land transport, Water and air transport, Support activities for transportation
5	Finance and insurance/Real estate and business services	Finance and insurance, Real estate, Research and development, Business services(except Computer soft wares development and supply, Computer related services), Other business services
6	Public administration and defense	Public administration and defense
7	Education and Health	Education, Medical and health services, Social work activities, Sanitary services
8	Social and Other services	Publishing and cultural services, Amusement and sports activities, Social organizations, Other services
9	Dummy sectors	Postal services, Office supplies, Business consumption expenditures, Nonclassifiable activities
10	Non-IT Manufacture	Food, beverages and tobacco products/Textile and apparel/Wood and paper products/Printing and reproduction of recorded media/Petroleum and coal products/Chemicals, drugs and medicines/Non-metallic mineral products/Basic metal products/Fabricated metal products except machinery and furniture/General machinery and equipment/Precision instruments(except Industrial automatic regulators, Measuring and analytical instruments)/Transportation equipment/Furniture and other manufactured products
11	IT Industry(except Network)	Electrical equipment, and supplies(except Insulated wires and cables), Electronic components and accessories, Household electrical appliances, Computer and office equipment
12	NetworkIndustry	Insulated wires and cables, Audio and video equipment, Line telecommunication apparatuses, Wireless telecommunication apparatuses, Wireless communication systems, Industrial automatic regulators, Measuring and analytical instruments, Communications line construction, telephone, Communications services, High-speed network services, Value added communication, Information services, Terrestrial Broadcasting, Cable Broadcasting, Computer related services, Computer softwares development and supply,

The household endogenous model is a analytical model which includes the ripple process of consumption and income. The household endogenous model is as follows:

$$AX + (Y - M) + (Y - M)c = X$$
$$X - AX = (Y - M) + (Y - M)c$$

[4]the classification of industry of 2013 to 2016 is different from that of 2013 to 2017. Due to the prevalence of M2M/IoT and smart devices, the classification of industry of the future will express different features from that of the past. Reflecting this changes, automatic control component, control component, measuring device and analysis machinery are newly added.

$$X = (I - A)^{-1}(Y - M) + (I - A)^{-1}(Y - M)c \text{.....(1)}$$

The model$(Y - M)c$for the input output analysis of interindustry relationships of using the family finances section endogenousmodel is the column vector showing the consumption of common people among the final demand. The first term shows the direct effect and indirect effect as the production induction (primary effect). The second shows the indirect production induction in which the induction employer income generated due to the production induction of the first term shows up through the family budget consumption (secondary effect).
The secondary production induction corresponding to second can be shown in the method below.

$$(Y - M)c = c'Y = c'\omega X \text{.....(2)}$$

Where $Y = \omega X$

Here, as to a c', the column vectoras the consumption coefficient, and Y is the row vector as the income caused by output X. Therefore, a ω says to be the index showing the rate of the employer income about the turnout of each section in terms of the employer income rate

$$c' = \left[\frac{\sum_{i=1}^{n} C_i}{\sum_{j=1}^{n} Y_j}\right]\frac{C_i}{\sum_{i=1}^{n} C_i} = \frac{C_i}{\sum_{j=1}^{n} Y_j} \text{ .....(3)}$$

The consumption coefficient c' can define as the value multiplying the rate(scalar) indicated as the consumption of common people outlay total amount about the employer income sum of the consumption conversion coefficient by the configuration(column vector) of each by field outlay about the consumption of common people outlay sum.The consumption of common people outlay can be shown in terms of the sum of the compensation of employee on the Input-output table.

$$\text{X} = (I - A)^{-1}(Y - M) + (I - A)^{-1}c'\omega(I - A)^{-1}(Y - M) \text{.....(4)}$$

$$= X_1 + (I - A)^{-1}c'\omega X_1 = X_1 + X_2 \text{.....(5)}$$

If it readjusts equation (1) by using the consumption coefficient c', the total production induction is shown in equation (5).$X_1$is primary effect and X_2 is secondary effect

The RAS technique is one of the methods for estimating the input coefficient matrix A (1) of the forecast year based on the input coefficientmatrix $A(0)$of the benchmark year, which is an × n matrix. As the RAS technique, systematized by Stone (1961)[5], gets part of the data through actual investigation, it is considered as partial enumeration. The minimum information necessary for estimation is the vector information for each of the total output of the forecast year, the total intermediate demands, and the total intermediate inputs, consisting ofn elements.

The first step of estimation is to make the primary tentative transaction matrix $\text{M}(1)$ by multiplying the square matrix $\text{A}(0)$to the forecast year's total output $\hat{\text{X}}(1)$of each industry consisting of the diagonal matrix, and obtain the row total, i,e, the tentative total intermediate demands U^{-1} .

$$M(1) = A(0)\hat{X}(1) \text{.....(6)}$$

[5]R. Stone (1961), "Input-output and National Accounts," OEEC Paris.

The next step is to compare the total tentative intermediate demands U^{-1} consisting of column vectors, and the total tentative intermediate demands $\mathrm{U}(1)$ of the forecast year. In general, as these numbers are inconsistent, the row correction factorR^1, the substitution effect for tentative transactions, is obtained in the following way, and these numbers are approximated.

$$R^1 = U(1)(U^{-1})^{-1} \text{.....(7)}$$

Next, the row correction factor R^1 and the primary tentative transaction matrix $\mathrm{M}(1)$ are used to make the secondary tentative transaction matrix$\mathrm{M}(2)$.

$$M(2) = \widehat{R^1}M(1) = \widehat{R^1}[A(0)\hat{X}(1)] \text{.....(8)}$$

Next, the column total of the matrix expressed by equation (8), i.e, the total tentative intermediate input $\mathrm{V}(1)$ is obtained. The tentative intermediate inputV^1 consisting of row vectors and the total intermediate input of the forecast year $\mathrm{V}(1)$ are compared, and the column modification factor S^1 to approximate them will be made.

$$S^1 = V(1)(V^1)^{-1} \text{ .....(9)}$$

Then, the secondary tentative transaction matrix $\mathrm{M}(2)$ and the column modification factor S^1 are used to make the tertiary tentative transaction matrix$\mathrm{M}(3)$.

$$M(3) = M(2)\widehat{S^1} = \widehat{R^1}\left[\mathrm{A}(0)\hat{X}(1)\right]\widehat{S^1} \text{.....(10)}$$

The next step is to obtain the total tentative intermediate demandsU^2, the row total of the matrix expressed as equation (10). The modified calculation of rows and columns are repeated until $U^k = U(1)$, $V^k = V(1)$is established. As it is not easy to get a matrix that satisfy these two equations at the same time, it is commonplace to repeat the calculation until the row modification factor $R$and the column modification factor Sapproach 1. One often-used standard is as follows:

$$|U(1) - U^k| \le \epsilon, |V(1) - V^k| \le \epsilon \text{ .....(11)}$$

Korean government and private sector plan to invest network construction such as enhanced wire-wireless service, virtualization, intellectualization, contents circulation efficiency and platform openness and integration. The total amount of money invested between 2013 and 2017 will be KRW 39.1353 trillion.

4. Conclusion

This paper analyzes secondary effect reflecting consumption resulting from an increase in household income other than direct-indirect primary effect through inter-industry relation by using household endogenous model. In addition, it also analyzes the economic effects of network construction which has promoted since 2013 by using RAS technique. Inter-industry relations table of 2009 was updated to that of 2013 when policy investment was made. It might be noteworthy that the update and application of inter-industry relation table of the year which would appropriate for business enforcement in order to improve reliability.

Consequently, it is expected that the total amount of production inducement, resulting from network industry, will reach KRW 77.5225trillion between 2013 and 2017. Among them, the primary effect will reach KRW 77.1723trillion and the secondary effect will KRW 353billion. Besides this, by the year of 2017, 120 thousands job will be created. This is the related that employment inducement coefficient is 0.7773 by every KRW

100million in network industry. Thus, it can be concluded that 603thousands employment will be created by 2007, as a result of network industry.

Table 3. Economic Effects of Network Industry (Unit: 100 Million Won, Number of Jobs)

		2013	2014	2015	2016	2017	합계
Production Inducement effect	**Total**	**150,670**	**155,014**	**159,469**	**155,051**	**155,051**	**775,255**
	Primary effect	149,983	154,308	158,743	154,345	154,345	771,723
	Second effect	686	706	727	706	706	3,532
Value-added Inducement effect	**Total**	**102,757**	**105,720**	**108,758**	**105,745**	**105,745**	**528,726**
	Primary effect	102,289	105,238	108,263	105,263	105,263	526,317
	Secondary effect	468	482	495	482	482	2,409
Employment Inducement effect	**Total**	**117,122**	**120,499**	**123,962**	**120,528**	**120,528**	**602,638**
	First effect	116,588	119,950	123,397	119,978	119,978	599,892
	Second effect	534	549	565	549	549	2,745

Policy suggestions for the network industry vitalizations of next generation are as follows. Firstly, favorable conditions for new service vitalizations should be created. The establishment of stable market and the vitalizations of services are the requisites of success for new industry led by new investment. It is necessary to create appropriate market condition for paradigm transformation from supply centered system based on technique in the past to demand centered system. In the network market of the future, market-dominating enterpriser will be more influential, but institutional device for creating market environment for small business is still insufficient. Therefore, it is necessary to create favorable conditions for small business to improve business environment and prepare institutional device to encourage fair competition of market. In order to create stable market condition, it is required to discover promising service and form support system for service virtualization through choice and concentration. Secondly, it is necessary to produce mid-long term roadmap and possesses key technology. As the creation of new technology and business through future network become highly possible, it is also required to conduct a research in depth on commercialization and strategy methodology toward non visible service and business with the development of key technology. Additionally, the level of dependence of core technology such as smart node technique, wire-wireless network enhancement, sensor network on other countries should be decreased. In order to create add value and lead market, it is impossible to emphasize the importance of the localization of key technology too much and it is also critical to make an appropriate investment based on technology roadmap. In order to improve the localization of core technology, professional manpower training for the future network, technology development and the establishment of fair evaluation system for R&D should be considered as one of the top priority tasks.

References

[1] R. Atkinson, D. Castro and S. J. Ezell, “The digital road to recovery: a stimulus plan to create jobs, boost productivity and revitalize America, The Information Technology and Innovation Foundation, **(2009)**.
[2] R. Crandall, C. Jackson and H. Singer, “The Effect of Ubiquitous Broadband Adoption on Investment, Jobs, and the U.S. Economy, Criterion Economics, **(2003)**.
[3] H. Hedeki and T. Miho, “Inter-industry relation table involved in household consumption expenditures”, Editorial Keizai, Niigata University, no. 82, **(2006)**.
[4] H. T. Ahn, “An Analysis of the Economic Effects for the Project of Construction BcN”, National Computerization Agency, **(2005)**.
[5] H. W. Ha and H. Y. Kim, “Impact of the secondary source on the RAS technique's reliability”, Human Settlements Research, no. 49, **(2006)**, pp. 25-38.
[6] ITU, “Impact of broadband on the economy”, Regulatory & Market environment, **(2012)**.
[7] R. L. Katz, P. Zenhäusern and S. Suter, “An evaluation of socio-economic impact of a fiber network in Switzerland”, Polynomics and Telecom Advisory Services, LLC, **(2008)**.
[8] K. Miyazawa, “Introduction to inter-industry analysis”, Nikkei Bunko (日経文庫), Nihon Keizai Shinbun, **(1995)**.
[9] J. Liebenau, R. D. Atkinson, P. Kärrberg, D. Castro and S. J. Ezell, The UK's Digital Road to, **(2009)**.
[10] McKinsey, “Internet matters: The Net's sweeping impact on growth, jobs, and prosperity”, **(2011)**.
[11] Miller and Blair, "Input-output Analysis: Foundations and Extentions”, New Jersey: Prentice-Hall, **(1985)**.
[12] Recovery, Retrieved from: http://ssrn.com/abstract=1396687.
[13] R. Stone, "Input-output and National Accounts”, OEEC Paris, **(1961)**.
[14] Sanodakao, “Relations between industry in Asia-Pacific and income”, Nagoya University Graduate School, no. 86, **(2000)**.
[15] Sanodakao, “Analysis of relations between production and income in Asia using Household Endogenous Model”, International Inter-industry Analytics, Institute of Developing Economics, **(2012)**.
[16] W. S. Jeong, “An Analysis of the Economic Effects for Construction Based BcN in farming and fishing Area”, NIA, **(2008)**.
[17] W. S. Jeong and S. H. Kim, “An Analysis of the Economic Effects on the Project to Construct Smart Network”, Journal of Korean Society for Internet Information, vol. 12, no. 4, **(2011)**.
[18] National Information Society Agency, Informatization WhitePaper, Chapter 3 Network Infra, **(2012)**, pp. 628-633.

