The Economic Value of Korean Nuclear Power Industry in the National Economy: An Input-Output Analysis

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1. Introduction

In 1978, Korea introduced the first nuclear power plant, Kori-1 unit, in parallel with the nation's industrialization policy. Thereafter, Korea has carried out a very ambitious nuclear power program and sustained a strong commitment to nuclear power development. Thus, nuclear is a prime energy source which presently meets about 30 percent of Korea's power demands. Also, Korea won a contract for APR-1400 NPPs to the UAE in 2009 which led to Korea as a significant exporter in the world nuclear market.

Recently, the new government of Korea has been launching "Creative Economy", from this perspective, the quantitative contributions of nuclear sector to the national economic growth are required to be estimated.

This paper is to estimate quantitatively the economic values created by nuclear power industry in the framework of national economy.

2. Analysis Methods

As a methodology to estimate economic values created by nuclear power industry, Input-Output-Analysis (IOA) is mainly adopted in the study. The IOA developed by Leontief (1941)[1] has been widely applied to assess inter-industry related issues in a national economic context because it recognizes the interdependence of all sectors of the economy.

The standard non-competitive import input-output model is defined as follows:

$$A^d X + F^d = X \tag{1}$$

Where X is the total output vector and F^d is the final demand vector which is consist of only domestic goods. A^d is a direct input coefficients matrix demonstrating the relationship among all sectors, in which $a_{ij}^d = X_{ij}^d / X_j$ ($i, j = 1,2, \ldots, n$) is the amount of domestic input from sector i required directly to produce output from sector j [2].

While a traditional I-O model addresses direct and indirect effects, the present study extends the coverage to include induced effects, which estimate the economy wide effects induced by the circular flow of income, consumption and production in a national economy. This is given as

$$X = A^d X + CP + F^* + F^{new} \tag{2}$$

$$YD = wagerateX + surplusrateX + Ad \tag{3}$$

$$CP = [exp(const + mpc(log(YD)))] \tag{4}$$

$$CP_i = CP_{whh} \tag{5}$$

Where X is the total output vector, CP is the private domestic consumption vector, F^* is the final demand vector except the private consumption and F^{new} is the new economic activity by construction and operation of nuclear power plant, YD is disposable income, CP_i is private domestic consumption of i sector and W_{hh} is sectoral share of total domestic consumption.

3. Data and results

3.1 Data

The economic values created by nuclear power industry are designed in the study to include economic values attributable not only to the construction and operation of nuclear power but also to the electricity generated by nuclear power. The economic contribution of the electricity generated by nuclear power includes forward linkage effect, electricity price stabilization effect and mitigating Greenhouse Gas emissions.

Considering the availability of data, nuclear power industry is analyzed for the period of 2009. The original I-O table is comprised of 403 sectors. In this study, we classified to 38 sectors in order to better reflect the effects of the nuclear industry. The 38 sectors are listed in the Table 1.

Table 1: Sector classification

No.	Sector name	No.	Sector name
1	Agriculture, forestry, and fisheries	20	Thermal power generation
2	Mining and Quarrying	21	Nuclear power generation
3	Food, beverage and tobacco	22	Other generation
4	Textile and apparel	23	Gas and water supply
5	Wood and paper products	24	Construction(excep 25sector)
6	Printing and reproduction of recorded media	25	Electric power plant construction
7	Petroleum and coal products	26	Wholesale and retail trade
8	Chemicals, drugs and medicines	27	Accommodation and food services

9	Inorganic basic chemical products	28	Transportation
10	Nonmetallic mineral products	29	Communications and broadcasting
11	Basic metal products (except 9 sector)	30	Finance and insurance
12	Primary metal products	31	Real estate agencies and rental
13	Fabricated metal products	32	Business services
14	General machinery and equipment	33	Public administration and defense
15	Electronic and electrical equipment	34	Research and Development
16	Precision instruments	35	Education
17	Transportation equipment	36	Medical and health services, and social welfare
18	Furniture and other manufactured products	37	Other services
19	Hydro power generation	38	Dummy sectors

3.2 Results

The major results are shown in Figs 1 to 3.

Fig.1 shows the sectoral backward linkage effects by NPPs construction in 2009. Several sectors are identified to be greatly affected by the construction of nuclear power plant. Those are general machinery, electronic and electric sector, electric power construction sector and finance & insurance sector. Induced effects are greatly observed in commercial sectors.

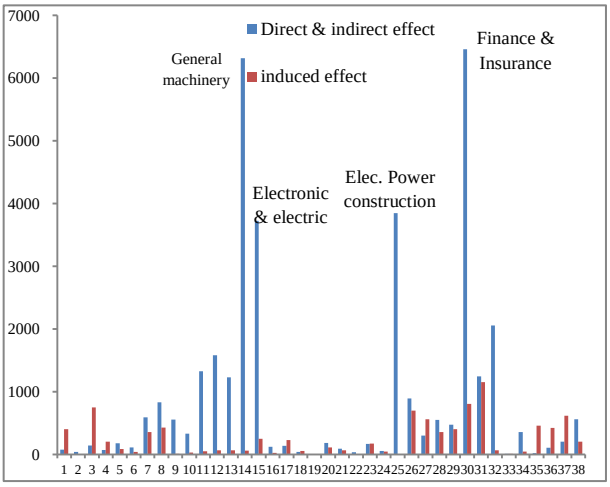

Fig.1. Sectoral backward linkage effects by NPPs construction (100million won, 2009).

Sectoral backward linkage effects attributable to the operation of nuclear power are shown in Fig.2. The backward linkage effects from the operation of nuclear power spread over almost all sectors of the economy. Inorganic basic chemical products and business service sectors are identified to be great among them.

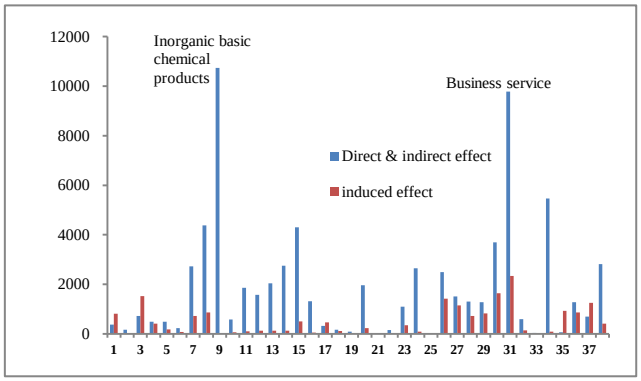

Fig.2. Sectoral backward linkage effects by NPP operation (100million won, 2009).

Fig.3 shows the forward linkage effect from the electricity provided by NPPs and total contribution is estimated to be 28 trillion won.

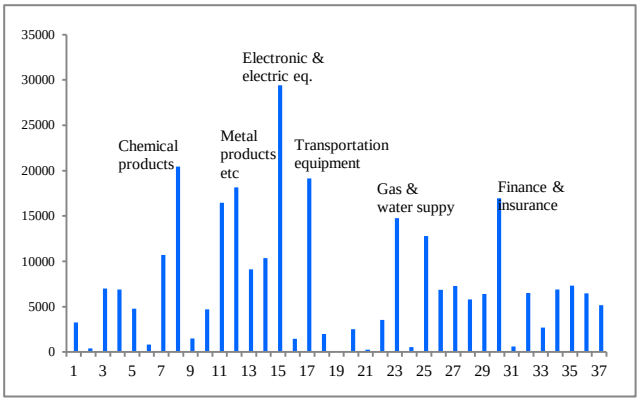

Fig. 3. Sectoral outputs contributed from the electricity provided by NPPs (100 million won, 2009).

There are two other major contributions from NPPs.

One is electricity price stabilization effects. Electricity price stabilization effects are estimated as follows.

Electricity price stabilization effects from NPP = Electricity price elasticity of GDP x *GDP* x *electricity price stabilized by NPP*(%) (6)

According to Samil PWC [4], electricity price elasticity of GDP is 0.0364 and price stabilized by NPPs is 7.54%, so the amount of electricity price stabilization effects by NPPs is 7.7 trillion won. The other contribution is GHG emissions mitigation from NPPs. If total nuclear power generation had been replaced with coal power in 2009, GHG emissions would have been 120 million ton CO_2. According to 6th Basic Plan for Electricity Demand & Supply [2], unit cost of CO_2 emissions is 21,000 won per ton CO_2, so the avoidable GHG emissions can be transformed to be 2.5 trillion won.

4. Conclusion

The total economic values created by nuclear power industry are estimated to be 63.6 trillion won for the study period. They are divided into 25.3 trillion won for nuclear power industry, 38.2 trillion won for electricity supply by nuclear. This amount of economic values accounts for 2.3% if the total outputs of the country in 2009.

Table 2: Summary of economic values created by nuclear industry (Unit: Million Won)

Nuclear power(2009)	Construction	4,436,305
	Operation	9,100,626
	Nuclear sector in IO	11,812,584
	Sub total	25,349,515
Electricity supply by nuclear(2009)	Forward linkage effect	27,990,479
	Electricity price stabilization	7,733,000
	Mitigating GHG emission	2,520,000
	Sub total	38,243,479
Grand total		63,592,994

The result of this study can be actively used as a reference to the reasonable estimation of the contribution from nuclear power.

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