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Input-Output Based Economic Impact Evaluation System for Small City Development: A Case Study on Saemangeum's Flux City Design*

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Abstract

The paper aims to develop a quasi-dynamic interregional input-output model for evaluating the macro-economic impacts of small city development. The features of the model are summarized as follows: (1) the consumption expenditure of households is regarded as an endogenous variable, (2) the technological change is determined by the change of industrial Location Quotient caused by firm's investment activities. (3) a strong feedback function between the city design and the economic analysis is provided. For checking the performance of the model, Saemangeum's Flux City Design Plan is used as the simulation target in our paper.

Keywords: Input-Output, city design, economic impact

JEL classification: C67, R52, R58

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1 Backgroud

From Google map, it is easy to find the longest tide embankment (33 km) of the world in Saemangeum region of Jeollabuku-do province, Korea, which is located in Korea's central west coast. This embankment was completed in 2006, after about 15 years of turns and twists duo to some environmental related issues. It is the main construction of the Saemangeum Reclamation Project, which is originally proposed by Korea's Ministry of Agriculture and Forestry in 1991, for the purpose of farmland creation and water resource development. During its construction, there have been various plans for the development of Saemangeum proposed by different agencies. For example, Plans for Developing Saemangeum as an International Fee Economic Zone (1994), Comprehensive Development of Saemangeum (1998) by Jeollabuk-do province, the Rural Community and Agriculture Corporation General Plan (1998) by MAF, Ocean City Proposal (2003) by Prof. Kim, Seokcheol, Environmental Bodies' Saemangeum New Plan (2003) by Resident Meeting for Saemangeum led by Prof. Oh, Changwhan, and Business City Plan(2007) by Organization Committee of Distribution Exhibition of Jeollabuk-do. (see Jeollabukudo and UDIK [1])

For reflecting various development ideas, the government instructed related research institutes to propose a new Saemangeum's land use development plan in 2006. By adjusting various ideas, the new plan has become more practical, but still focuses on developing farmland reflecting the former plans of the MAF and environmental bodies. Considering the location importance of Saemangeum as a newly rising center of the Yellow Sea Rims, it seems more constructive proposal which can significantly reflect the changing domestic and foreign condition that Saemangeum is facing, are expected now.

Later, the newly elected president proposed 3 basic directions (Dubai of Northeast Asia, center of specialized economy, new development sites based on canal and inland harbor) and 7 projects (International free economic zone, plans for metropolitan cities, Yellow Sea rims marine tourist resort, a complex for Honam canal and inland harbor, specialized economic zone, healthy town, Honam high-speed railway-east-west highway network) for Saemangeum, thus Saemangeum development is to become more accelerated.

Under this background, Jeollabuku-do government organized an international idea competition to find design plan based on realizable and innovative development concept of the people's sincere desire. As one of the competition participants, the design team of Tokyo Institute of Technology led by Prof. Tsukamoto provided a design plan with the name of "Saemangeum Flux City Design"(SFCD).

The SFCD was started from original consideration on Saemangeum's special reclamation pattern. As shown in Figure 1, the reclamation in Tokyo Bay adopts a kind of gradual pattern, which makes the reclaimed area far away from the original coastline. As a result, the residents around Tokyo Bay just can enjoy relatively less coastline, and the city design also tends to become very monotonous. Comparing with Tokyo Bay, the 33 kilometer-long Saemangeum's dike not only creates large farmland, but also makes it possible to fold more resident-friendly and nature-oriented coastline. This provides the basic idea to design a city with the concept of multiple "Flux", namely the flux of human, goods/services, money, knowledge and information.

Based on this concept, a daring and complex development program was provided by our design team. As shown in Figure 2, the program takes advantages of Saemangeum's special geographical location, economic potential and industrial tradition under significant

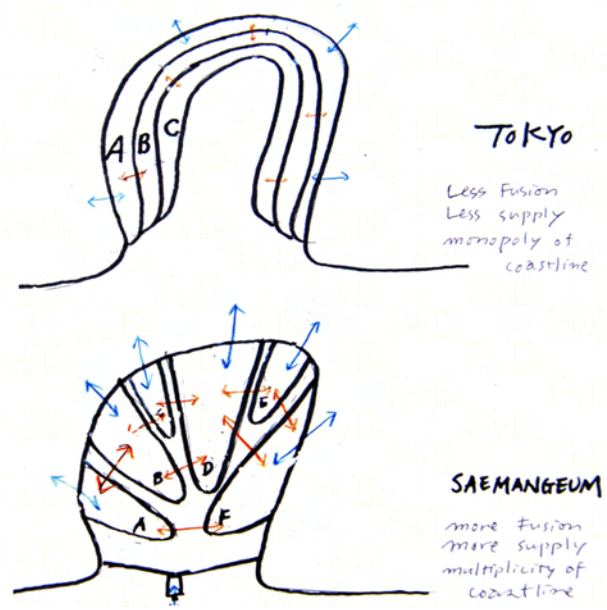

Figure 1: Reclamation Pattern (Source:[2])

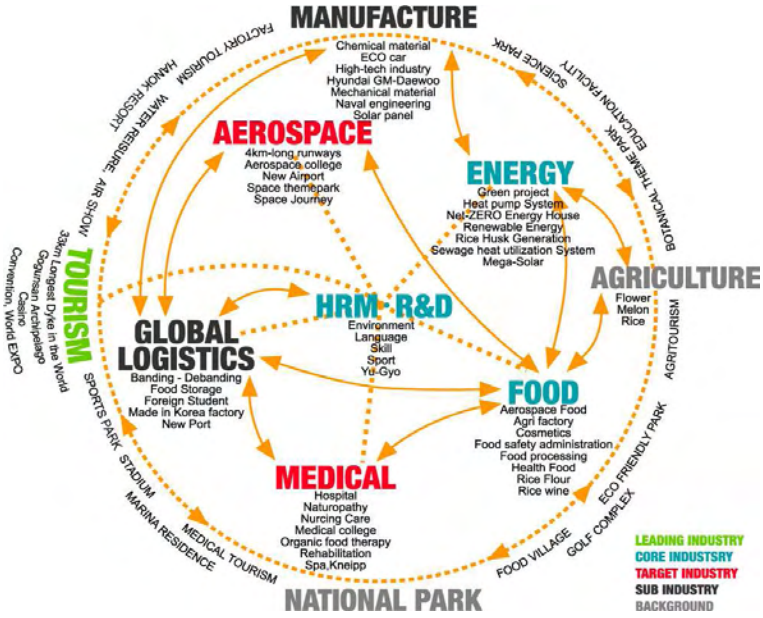

Figure 2: Development Concept and Program (Source:[2])

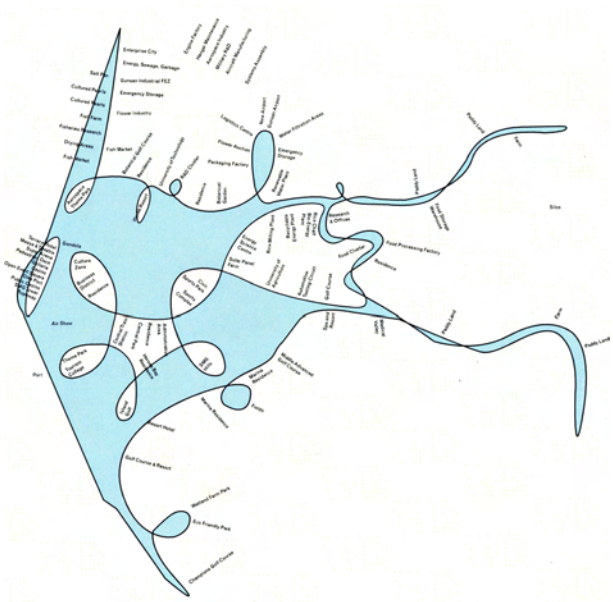

Figure 3: One Line Coast (Source:[2])

consideration on the schedule of public investment, existing land use pattern, and other various policy restrictions.

In addition, for balancing the positive qualities of single-mass and archipelago-style reclamation from the viewpoint of architecture, the active revolving line was employed to design a one-line coast for Saemangeum (see Figure 3). This design not only breaks down the reclaimed areas into more manageable, flexible and scalable dimensions, but also adds the symbolic value of Saemangeum. For detailed information about the SFCD, one can refer to the Design Guidelines 2008([2]) and Analysis Guidelines 2008([3]).

The purpose of this paper is to develop an interdisciplinary interface to evaluate the macro-economic impacts of the SFCD on Korea's regional economy.

The paper proceeds as follows: Section 2 introduces the analysis framework used for the impact evaluation of SFCD. Section 3 shows the models in detail. Section 4 gives a brief explanation of the available data used. Section 5 applies the model shown in Section 3 to the evaluation of SFCD and discusses the simulation results in detail. The concluding remarks are given in Section 6.

2 Analysis Framework

Today, the following three economic models are probably the most utilized tools globally for the evaluation of city development planning. They are macro-econometric model, Computable General Equilibrium (CGE) model, and Input-Output (IO) model. For the economic impact analysis of SFCD, which model should be the best fit?

Macro-econometric models have traditionally been considered to be one of the major tools for the analysis of national or regional development plan. However, it is generally difficult to obtain sufficient statistical data to estimate model parameters that cover relatively smaller regions. Since the GDP share of Jeollabuk-do to the whole Korea is just about

3% in 2007, and the GDP share of Saemangeum to the whole Korea will be further small because it is still in the process of development at present. This is particularly true when such small economies are studied; reliable regional statistics are difficult to obtain. In addition, the macro-econometric models cannot give a detailed analysis on the inter-industrial relationships.

CGE models are a class of empirical economic models used to simulate economy-wide reactions to changes in policy, technology or other external factors. They are based on the Keynesian set of macro balancing equations arranged within a social accounting matrix (SAM). In this meaning, they can be considered a descendant of Leontief's IO model. This kind of model is basically made up of a non-linear simultaneous equation system, for solving the system, a number of exogenous parameters should be quantified in advance. However, when small regional economy is the analytical target, it will be quite difficult to calibrate the parameters. If the parameters used compose arbitrary elements, the analysis results will lose their reliability.

IO models should be useful due to their smaller data requirements; many regression equations in their macro-econometric counterpart may be replaced by linear equilibrium conditions based on microeconomic theory. According to Leontief, "Input-Output analysis is a practical extension of the classical theory of general interdependence which views the whole economy of a region, a country and even of the entire world as a single system and sets out to describe and to interpret its operation in terms of directly observable basic structural relationship" (see Leontief [4]). In addition, comparing with the availability of SAM data required by CGE models, the IO data is easier to obtain; the parameters required by IO model can be easily calibrated under the officially published IO table. In this regard, IO model should be the first choice for our analysis.

The pioneering theoretical works in the field of IO analysis can be traced to Leontief [5], Isard [6], Moses [7], Polenske [8], Round [9], the early extensions can be found in Miller and Blair [10], Sasaki [11] and for recent developments one can refer to Michael and Dietzenbacher [12] and so on.

For the estimation of Saemangeum's economic impacts, we developed two kinds of IO models. One is a Static Closed IO (SCIO) model based on Korean national IO table. The merits of this model can be summarized as follows: 1) it is easy to use; 2) it does not require any special supplement data, and 3) it can give very brief and compact analysis on the impact of the development plan at national level. The demerit of the model is that the aspects of time and space are ignored. Therefore this model can not reflect the dynamic and spatial technological changes explicitly. For overcoming the above problem, we developed a Quasi-dynamic Interregional IO (QIRIO) model, in which the technological change (input coefficients of IO table) is determined by the change of industrial Location Quotient (LQ) induced by firm's new investment. In comparison with the widely used open IO model, the both models used for Saemangeum's project are closed model, in which the consumption expenditure of households is regarded as an endogenous variable. This means that the impact of investment via resident's income can be estimated endogenously in our models.

The whole analysis framework can be given as follows (see Figure 4):

1) Based on government's development direction, the city design will be done by our design team.

2) Two kinds of IO models described above will be constructed respectively for the impact estimation of SFCD.

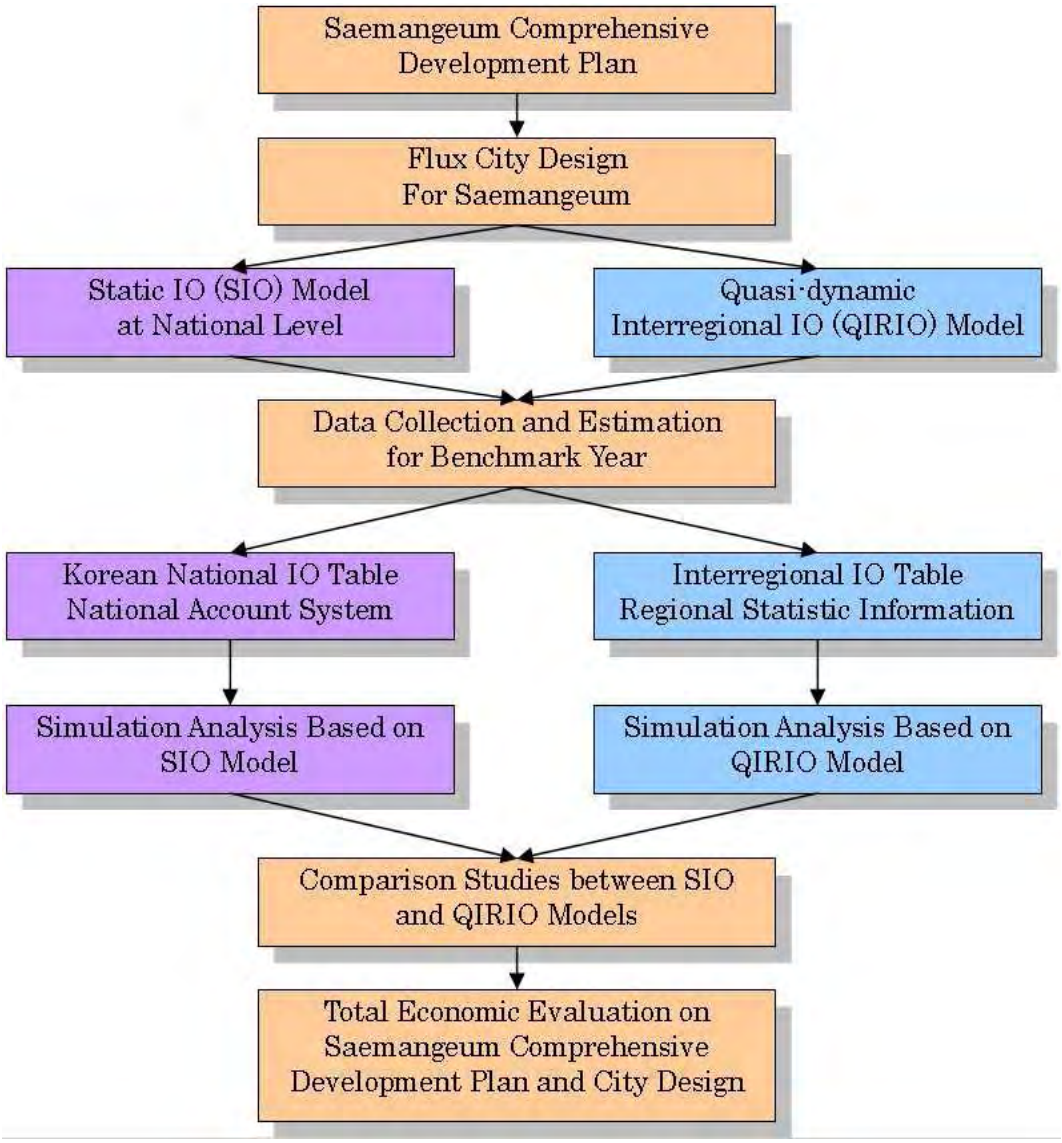

Figure 4: Analysis Framework

3) Under the model requirement, the related data for economic analysis will be collected and estimated (for the detailed information on data one can refer to Design Guidelines 2008 ([3]).
4) Two kinds of IO tables will be compiled. One is the Korean national IO table for the SCIO model. The other one is the Jeollabuk-do and the rest of Korea interregional IO table. Both of them are based on the officially published data for the year of 2000.
5) The simulation analyses will be done for each model.
6) Based on the simulation results and the comparison study between the two models, the total impacts of SFCD will be evaluated.

Since the QIRIO model used is specially designed for the SFCD, we need to give a detailed introduction on its analysis framework, which is shown in Figure 5:
1) At the beginning point of Saemangeum development, the local government is planning to provide the fundamental social infrastructure, which can be achieved by the initial public

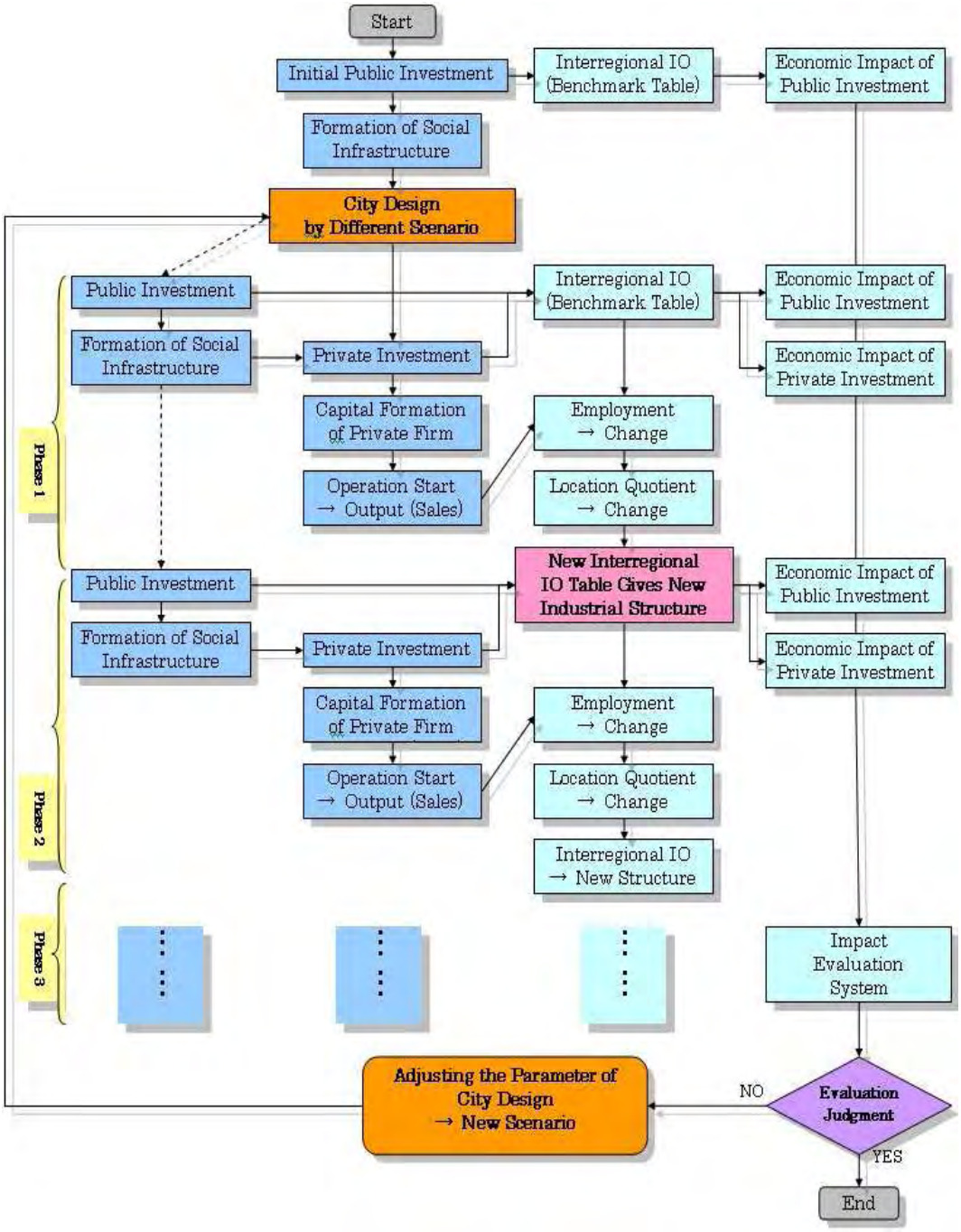

Figure 5: Analysis Framework of QIRIO Model

investment. The economic impact of such initial investment will be measured by the benchmark interregional IO table.
2) According to government development directions and the completed initial public investment, the city design by different scenario has been done by our design team. Though the city designs mainly focus on the private sectors, the related public sectors are also carefully considered within the whole design.
3) We separate the whole development period into 4 phases, each phase covers several years.
4) At the beginning of phase 1, the related public investment will be done. The economic impact of such investment can be measured by the benchmark interregional IO table.
5) The public investment in phase 1 will form the related social infrastructure. Such infrastructure becomes an important incentive for private sector to invest in Saemangeum.
6) The possibility of private investment under the existing and the planning social infrastructure is investigated and discussed, and then the spatial location, the economic scale and the industrial type of the expected private sector are designed. The expected private investment will be used as the input data for its economic impact analysis.
7) The private investment will form industrial capital stock and then provide the production capacity for the private sector.
8) Based on the amount of expected private investment, the expected sales can be estimated. Using the employment coefficients calculated from the benchmark interregional IO table, the expected employment will be obtained.
9) Since the LQ used in our model is based on the relative scale of industrial employment, the change of employment will cause the relative change of LQ.
10) The input coefficients of IO table are determined by LQ in our model, therefore the change of LQ will induce the change of input coefficients. Then the new interregional IO table for the next phase can be estimated in terms of the new input coefficients. Such new table reflects the new spatial production network and industrial structure.
11) From phase 2, the impacts of new investment will be evaluated by the updated interregional IO table.
12) The economic impacts estimated in each phase will be summarized and adjusted under our Impact Evaluation System.
13) If the total economic impacts can satisfy our expected results, the evaluation procedure will be finished. Otherwise, we will change the parameter of city design to estimate the impacts of new design by the same methodology.

The main merits of the above model can be summarized as follows:
1) The impacts of public investment and private investment are estimated separately.
2) Since the interregional IO table is updated phase by phase, the quasi-dynamic change of industrial structure can be grasped.
3) According to the simulation results of economic impacts, the city design is adjusted. In this meaning, the model provides a very strong feedback function between the city design and the economic analysis.
4) At the end of the procedure, the relatively significant and effective city design can be obtained under the given Saemangeum development directions by government and various budget and resources restrictions.

3 Model

3.1 Static Closed IO Model

The classic Leontief's open IO model can be given as follows:

$$X = (I - A)^{-1}Y, \tag{1}$$

where, X, A, $(I - A)^{-1}$ and Y are respectively the n-sector column vector of gross outputs, the $n \times n$-element matrix of input coefficients, the Leontief inverse, and the column vector of final demands. They are defined as the following forms.

$$X = \begin{pmatrix} X_1 \\ X_i \\ \vdots \\ X_n \end{pmatrix}, \ A = \begin{pmatrix} a_{11} & a_{1j} & \cdots & a_{1n} \\ a_{i1} & a_{ij} & \cdots & a_{in} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{nj} & \cdots & a_{nn} \end{pmatrix}, \ Y = \begin{pmatrix} Y_1 \\ Y_i \\ \vdots \\ Y_n \end{pmatrix}.$$

If IO table is available, the A matrix can be calculated. Using equation 1, the impacts of newly increased exogenous final demand (household expenditure, government expenditure, investment, export and import) on output can be easily measured, namely:

$$\Delta X = (I - A)^{-1}\Delta Y. \tag{2}$$

In addition, from IO table, the value added ratio v_i for sector i can be calculated too, then the impact of final demand on gross value added (GDP) can be measured by the following equation:

$$\Delta GDP = V(I - A)^{-1}\Delta Y. \tag{3}$$

where, V is the diagonal matrix constructed from v_i.

Furthermore, if supplement data on employment by sector is available, the impact of final demand on employment can also be estimated under the following equation:

$$\Delta E = L(I - A)^{-1}\Delta Y. \tag{4}$$

where, E represents the employment vector, L represents the diagonal matrix constructed by employment ratio l_i.

In the above open model, the household expenditure is regarded as an exogenous variable. However, this "exogenous" categorization is something of a strain on basic economic theory. For grasping the impact of exogenous investment on households' income, one could move the household sector from the final demand column and place it inside the intermediate input table, that is, make it one of the endogenous sectors. This is known as closing the model with respect to households. Such closed IO model can be given as the following form:

$$\bar{X} = (I - \bar{A})^{-1}\bar{Y} \tag{5}$$

or

$$\left(\begin{array}{c} X \\ \hline X_{n+1} \end{array}\right) = \left(\begin{array}{c|c} I - A & -C \\ \hline -V & 1 \end{array}\right)^{-1} \left(\begin{array}{c} Y^* \\ \hline Y^*_{n+1} \end{array}\right),$$

where, $\bar{X}$, $\bar{A}$ and $\bar{Y}$ are respectively the $(n+1)$-sector vector of output, the $(n+1)(n+1)$-element matrix of input coefficients, and $(n+1)$-sector vector of final demands, C and V

are respectively the household column and household row. Y^* is the n-element vector of remaining final demands for output of the original n sectors.

Using the above equation, the development impacts on output, GDP and employment under the closed model can also be estimated by the similar way as shown in equation (2), (3) and (4).

3.2 Quasi-dynamic Interregional IO Model

Since the Saemangeum development project will not only affect Saemangeum itself but also has a great influence on Jeollabuk-do and the rest of the Korea. From a policy maker's or city designer's viewpoint, a national-level IO model is insufficient because it cannot describe regional disparities that a policy or development plan can bring. This is especially true in the countries, like Korea that has many provinces. Therefore, the interregional IO model seems necessary for our analysis.

For the application of QDIO model, the interregional IO table should be given in advance. The widely used methods for the construction of interregional IO table consist of: 1) survey-based method, 2) non-survey method, and 3) hybrid-approach-based method which can be regarded the combination of the former two methods, sometimes it is also called partial survey or semi-survey based method. It is very ideal to conduct detailed survey on regional purchase and sales by sector or commodity. However, in reality, it is impossible to conduct such survey frequently, since such kind of survey needs huge amount of time, fund and manpower. Therefore, for making the detailed regional economic analysis possible, non-survey based method, no dependent on the survey, has been developed in the United States, Japan, Australia and so on. Although the accuracy and reliability of non-survey methods has been widely discussed, in many cases it is the first choice for regional economist because of the unavailability of data. In addition, it is also very convenient in terms of saving time and money under the limited budget capacity.

Among the non-survey methods used for constructing the regional and interregional IO model, most widely used method is Quotient Approach. In the existing literature, a number of variation of the quotient approach has been developed and discussed, which includes the Simple Location Quotient, Purchase-only Location Quotient, Cross industry Quotient, Supply-Demand Approach, Regional Purchase Coefficient, Fabrication Effect Approach and so on (see Miller and Blair [10]). According to the empirical works in United States, in general, Simple Location Quotient method is the best one among the various location quotient techniques (see Schaffer and Chu [13], Morrison and Smith [15], Sawyer and Miller [14], Miller and Blair [10]).

For the impact analysis of Saemangeum project, the following interregional IO model based on Location Quotient (LQ) is introduced. Here, assuming that we have only two regions R and S in the nation, let a_{ij}^{RR} and a_{ij}^{SS} denote regional input coefficient for R and S region respectively, and t_i^R and t_i^S for self-sufficient ratio within the region for R and S, then, regional input coefficient in each region can be estimated from the national input coefficient (a_{ij}^N) as follows:

$$a_{ij}^{RR} = t_i^R a_{ij}^N; \qquad a_{ij}^{SS} = t_i^S a_{ij}^N. \tag{6}$$

Since we assume that there are only two regions in the nation, interregional commodity input

of each region will be shown in the following form:

$$a_{ij}^{SR} = (1 - t_i^R)a_{ij}^N; \qquad a_{ij}^{RS} = (1 - t_i^S)a_{ij}^N. \tag{7}$$

Then, the input coefficient matrix of interregional IO model can be given as the follows:

$$\begin{pmatrix} A^{RR} & A^{RS} \\ A^{SR} & A^{SS} \end{pmatrix} = \begin{pmatrix} T^R & (I - T^S) \\ (I - T^R) & T^S \end{pmatrix} \begin{pmatrix} A^N & 0 \\ 0 & A^N \end{pmatrix},$$

where, T is the interregional transaction diagonal matrix constructed by t_i^k. For estimating T, the following method is employed:

$$t_i^k = LQ_i^R \quad if \quad LQ_i^R < 1; \quad t_i^k = 1 \quad if \quad LQ_i^R \geq 1 \quad (k = R, S). \tag{8}$$

For calculating LQ, GDP, total output, and employment data are normally used. Based on the SFCD, the expected industrial sales is given, which can be used to estimate the employment data by the benchmark IO table. Therefore, the employment data is used as the determination factor in our model. The LQ used is defined as follows:

$$LQ_i^R = \frac{E_i^R/E^R}{E_i^N/E^N}, \tag{9}$$

where, E represents the employment.

LQ represents the percentage of the region's total employment in activity compared to that for the nation. It also provides us the information on what industry the region has or does not have and the extent to which each industry is under- or over- represented in the region compared to the nation. Furthermore, LQ also represents trade pattern of that region, if it is larger than or equal to unity, that industry is concentrated in that region compared to the national average and it is considered as the supply of that commodity meets the demand of it within the region, and more, that sector exports that commodity outside region. If LQ is less than unity, it is viewed as less concentrated in that region and less capable of satisfying regional demand for its output, as a result, that commodity is imported from outside region for meeting the regional demand of that commodity. Thus, it is assumed that national coefficient will apply to the region and regional surplus produced in the region will be exported to the rest of the nation when LQ is bigger than 1, on the other hand, national coefficient will be adjusted downwards in case of LQ less than 1, regional coefficient are estimated from the national coefficient by multiplied them by LQ. In other words, LQ means the self-coefficient ratio. If LQ is bigger than 1, the commodity is produced by using fully domestic intermediate goods. In contrast, if LQ is less than 1, the intermediate goods are imported from other region for the production.

Given LQ, we can estimate the interregional input coefficient matrix by adjusting T matrix in each Phase. So our QIRIO model (input coefficient) is defined as follows:

$$\begin{pmatrix} A_p^{RR} & A_p^{RS} \\ A_p^{SR} & A_p^{SS} \end{pmatrix} = \begin{pmatrix} T_p^R & (I - T^S)_p \\ (I - T^R)_p & T_p^S \end{pmatrix} \begin{pmatrix} A^N & 0 \\ 0 & A^N \end{pmatrix},$$

where, p represents the phase. The quasi-dynamic determination process is given as follows:

$$T_p = f_1(LQ_p) = f_2(E_{p-1}), \tag{10}$$

where, f_1 represents the function relationship between T_p and LQ_p, f_2 the function relationship between LQ_p and E_{p-1}. Therefore, the interregional transaction matrix in phase p, is determined by the employment of phase p-1.

As the same as the SCIO model, we introduce the household activity into the model. Therefore our QIRIO model can be given as the following form:

$$\dot{X} = (I - \dot{A})^{-1}\dot{Y} \tag{11}$$

or

$$\begin{pmatrix} X^R \\ X^R_{n+1} \\ X^S \\ X^S_{n+1} \end{pmatrix} = \begin{pmatrix} I - A^{RR} & -C^{RR} & -A^{RS} & -C^{RS} \\ -V^R & 1 & 0 & 0 \\ -A^{SR} & -C^{SR} & I - A^{SS} & -C^{SS} \\ 0 & 0 & -V^S & 1 \end{pmatrix}^{-1} \begin{pmatrix} Y^{R*} \\ Y^{R*}_{n+1} \\ Y^{S*} \\ Y^{S*}_{n+1} \end{pmatrix}.$$

3.3 How to Estimate the New Industry Impacts in IO Model

The input-output model provides a framework within which to assess the economic impact associated with the introduction of a new industry into an economy. For example, Aerospace industry is proposed in the SFCD. This industry will be set up NEWLY in the target region and the impact will be calculated by our IO model.

In our model, final demand approach introduced by Isard and Kuenne [16] will be used for the new industry impact analysis. At the moment, IO table for Korea does not have a sector for Aerospace industry. Therefore we have to estimate the IO data for this industry. In the practice, we get it from IO table of other region or countries (in our case, United States) and we estimate what and how much Aerospace industry inputs from other industries. Assume that we can estimate the total sale or output for this industry, then we can calculate the new demand on existing sector in the region by multiply the input coefficient of Aerospace industry by the estimated total sales as follows:

$$\Delta Y_{iN} = a_{iN} X_N \tag{12}$$

where, ΔY_{iN} is the new demands of commodity i induced by the in-movement of new sector N, a_{iN} input coefficient of the new industry's production, X_N the estimated total output after new industry starts production. Then the impact induced by the introduction of new industry into the region can be estimated under the following model:

$$\Delta X = (I - A)^{-1}\Delta Y_N \tag{13}$$

3.4 International IO link Model

The impacts of Saemangeum development on the other countries is also one concern from the international viewpoint. For estimating such impacts, we developed the following international-national IO link model.

$$\Delta M = M(I - A)^{-1}\Delta Y_{SMG} \tag{14}$$

where, ΔM is the import demands induced by Saemangeum development, M the dialog matrix of import ratio, A the input coefficients in national IO table, ΔY_{SMG} the investment

for Saemangeum development. According the above equation, the imports induced by Saemangeum development can be obtained, which will be used as input data in the following international IO model:

$$\Delta X_{AIO} = (I - A_{AIO})^{-1} \Delta M' \tag{15}$$

where, ΔX_{AIO} are the newly increased outputs in other countries induced by Saemangeum development via Korea's imports ($\Delta M'$). A_{AIO} is the input coefficients of AIO table. It should be noted that $\Delta M'$ is the increased Korea's imports by country (other countries' exports), which is obtained by splitting ΔM into the ten AIO countries in terms of Korea's import shares by origin.

4 Data Collection and Estimation

4.1 Basic Configuration of the Data

4.1.1 Sector classification

Considering the requirement of SFCD, the model size and the data availability, 40-sector classification is adopted in our models. These 40 sectors are completely consistent with the 76-sector classification used in Asian International IO (AIO[17]) tables . The detailed description of sector and the concordance code are shown in Table 1.

4.1.2 Spatial dimensions

Under the model requirement and the data availability, the following three dimensions are used in our analysis:
(a) National level: the whole Korean economy
(b) Domestic regional level: Jeollabuk-do and the rest of Korea
(c) International level: the economies covered in AIO table

4.1.3 Development periods

According to the SFCD made by our design team, we separate Saemangeum's development period into the following four phases:
(a) Phase 1: 2008-2012
(b) Phase 2: 2013-2015
(c) Phase 3: 2016-2020
(d) Phase 4: 2021-2030

4.1.4 Currency unit and time discount rate

For the simplicity of international comparison, the US$ is used as the common currency unit in our analysis. The exchange rates among different national currencies are the monthly average values in June 2008 based on the IFS[1] data. In addition, since the Saemangeum development project will last to 2030, the future economic impacts are estimated at present value. For simplicity, the time discount rate used is based on the average interest rate

[1]IFS is the International Financial Statistics service of the International Monetary Fund

Table 1: Sector Classification

KIO code	Description	AIO code
1	Grain	001, 002
2	Food crops	003
3	Non-food crops	004
4	Other agriculture, forestry and fishery	005-007
5	Mining	008-011
6	Milled Grain and flour	012
7	Fish and meat products	013, 014
8	Food products	015
9	Other food products	016, 017
10	Apparel products	018-023
11	Other light industry	024-028
12	Industrial chemical	029, 030
13	Chemical Fertilizer and pesticides	031
14	Drugs and medicine	032
15	Other chemical	033-037
16	Non-metal products	038-040
17	Metal products	041-043
18	Machinery	044-048
19	TV, Audio and communication equipment	049
20	Electronic Computing equipment	050
21	Semiconductors and integrated circuits	051
22	Other electronic products	052-054
23	Moter vehicle	055
24	Other transport equipment	056-058
25	Other manufacture	059-060
26	Electricity and gas	061
27	Water supply	062
28	Building construction	063
29	Other construction	064
30	Wholesale and retail trade	065
31	Transportation	066
32	Telephone and telecommunication	067
33	Finance and insurance	068
34	Real estate	069
35	Education and research	070
36	Medical and Health service	071
37	Restraunts	072
38	Hotel	073
39	Other services	074
40	Public administration and unclasisfied	075-076
$*$24a+25a	Aerospace industry (included in KIO24-25)	058, 060

			Intermediate Demand (A)		Final Demand (F)		Export		
		Code	Jeollabuk-do (AJ)	the rest of Korea (AK)	Jeollabuk-do (FJ)	the rest of Korea (FK)	Export to R.O.W. (LW)	Discrepancy (QX)	Total Outputs (XX)
	Jeollabuk-do	(AJ)	A^{JJ}	A^{JK}	F^{JJ}	F^{JK}	L^{JW}	Q^{J}	X^{J}
	the rest of Korea	(AK)	A^{KJ}	A^{KK}	F^{KJ}	F^{KK}	L^{KW}	Q^{K}	X^{K}
Freight and Insurance		(BF)	BA^{J}	BA^{K}	BF^{J}	BF^{K}			
Import from the R.O.W.		(CW)	A^{WJ}	A^{WK}	F^{WJ}	F^{WK}			
Duties & Import Taxes		(DT)	DA^{J}	DA^{K}	DF^{J}	DF^{K}			
Value Added		(VV)	V^{J}	V^{K}					
Total Inputs		(XX)	X^{J}	X^{K}					

Figure 6: Layout of Jeollabuk-do-the Rest of Korea Input-Output Table

published by the Bank of Korea. The detailed information is shown below:
1 US dollar = 1029.27 Korean Won
1 Japanese Yen = 9.63 Korean Won
The yearly time discount rate = 5.5%

4.2 Data Requirements

4.2.1 Korean national IO table

The 2000 AIO table are available for us, which includes Korean part. Therefore, aggregating the original 78 sectors of AIO into 40 sectors, we could have the Korean national IO table. This table is used as the benchmark data for the SCIO model.

4.2.2 Interregional IO table for Jeollabuk-do and the rest of Korea

The Jeollabuk-do and the rest of Korea IO table is estimated by the so-called non-survey based methodology.[2] The main control totals (CTs) used for the estimation are the data of Korean national IO table and the officially published statistical data (output, final demand, GDP and so on) of Jeollabuk-do. This table is used as the benchmark data for the QIRIO model. The layout of the interregional table is shown in Figure 6.

4.2.3 Asian International IO Table

The AIO table is compiled by the Institute of Developing Economies (IDE). This table covers ten economies (Korea, China, Taiwan, the Philippines, Malaysia, Singapore, Thailand and Indonesia, Japan and the United States) and 76 sectors. For detailed information, one can refer to IDE's Statistical Data Series (see SDS[17]). The 2000 AIO table is used as the

[2]For detailed introduction of the non-survey based methodology, one can refer to the previous section.

Table 2: The Investment for Social Infrastructure

(Unit: Million US$)	PHASE1	PHASE 2	PHASE 3	PHASE 4	Total
Reclaiming Cost and Seawall	1265	1442	171	151	3029
Road	-	2646	1824	1824	6293
Lifeline	-	2514	1732	1732	5978
Railway	-	1410	-	-	1410
Bridge	-	60	-	-	60
Green Belt	-	603	602	602	1807
Total	1265	8674	4329	4309	18577

benchmark data for the international IO link model. The layout of the AIO table is given in Figure 7.

4.2.4 Investment for social infrastructure and industrial investment

The investment for social infrastructure is mainly estimated from the governmental officially publish development plan, the industrial investment is based on the Facility List (see Design Guidelines[3]) estimated by our design team. The investment is considered as an exogenous variable and is used as the input data for the economic impact analysis. The related information is summarized in Table 2 and 3.

The expected industrial investment is mainly estimated by our design team. Based on the existing literatures (see Erenburg [18], Monadjemi [19]), we use the average investment inducement coefficient (induced private investment/public investment=3.35) to fix the total private investment expected ($18,577 * 3.35 = 62,219.48$). Then, the detailed programs of SFCD are designed under the total private investment scale. In addition, for detailed estimation, the scale of land use, the limitation of population capacity, the feasibility of spatial design and other related information are also used as the constraint conditions.

4.2.5 The input and sale structure of aerospace industry

The aerospace industry is one of the key sectors in the SFCD. For estimating the economic impact of this new industry, the information of its input and sale structure should be given in advance. However, such information for Korea is not available for us. Since the USA has such industry, its input and sale structure can be used as the alternative information. The detailed information is estimated from the USA's 1997 IO table, in which two aerospace related industries stand alone, namely, guided missile and space vehicle manufacturing (UIO354) and propulsion units and parts for space vehicles and guided missiles (UIO355).

4.2.6 The expenditure structure of foreign tourist

The impact of foreign tourist on Saemangeum is also a big concern for us. For estimating such impact, the information on expenditure structure of foreign tourist is required. Since it is difficult to have the related data from Korea's statistics at present, Japanese expenditure structure in foreign countries is used as the proxy data. The tourist from China has also high potential, however, the existing statistical data is very rough, so for simplicity, we assume that Chinese tourist has the similar overseas expenditure pattern as Japanese.

			Intermediate Demand (A)										Final Demand (F)										Export (L)				
		code	Indonesia (AI)	Malaysia (AM)	Philippines (AP)	Singapore (AS)	Thailand (AT)	China (AC)	Taiwan (AN)	Korea (AK)	Japan (AJ)	U.S.A. (AU)	Indonesia (FI)	Malaysia (FM)	Philippines (FP)	Singapore (FS)	Thailand (FT)	China (FC)	Taiwan (FN)	Korea (FK)	Japan (FJ)	U.S.A. (FU)	Export to Hong Kong (LH)	Export to EU (LO)	Export to R.O.W. (LW)	Statistical Discrepancy (QX)	Total Outputs (XX)
	Indonesia	(AI)	A^{II}	A^{IM}	A^{IP}	A^{IS}	A^{IT}	A^{IC}	A^{IN}	A^{IK}	A^{IJ}	A^{IU}	F^{II}	F^{IM}	F^{IP}	F^{IS}	F^{IT}	F^{IC}	F^{IN}	F^{IK}	F^{IJ}	F^{IU}	L^{IH}	L^{IO}	L^{IW}	Q^{I}	X^{I}
	Malaysia	(AM)	A^{MI}	A^{MM}	A^{MP}	A^{MS}	A^{MT}	A^{MC}	A^{MN}	A^{MK}	A^{MJ}	A^{MU}	F^{MI}	F^{MM}	F^{MP}	F^{MS}	F^{MT}	F^{MC}	F^{MN}	F^{MK}	F^{MJ}	F^{MU}	L^{MH}	L^{MO}	L^{MW}	Q^{M}	X^{M}
	Philippines	(AP)	A^{PI}	A^{PM}	A^{PP}	A^{PS}	A^{PT}	A^{PC}	A^{PN}	A^{PK}	A^{PJ}	A^{PU}	F^{PI}	F^{PM}	F^{PP}	F^{PS}	F^{PT}	F^{PC}	F^{PN}	F^{PK}	F^{PJ}	F^{PU}	L^{PH}	L^{PO}	L^{PW}	Q^{P}	X^{P}
	Singapore	(AS)	A^{SI}	A^{SM}	A^{SP}	A^{SS}	A^{ST}	A^{SC}	A^{SN}	A^{SK}	A^{SJ}	A^{SU}	F^{SI}	F^{SM}	F^{SP}	F^{SS}	F^{ST}	F^{SC}	F^{SN}	F^{SK}	F^{SJ}	F^{SU}	L^{SH}	L^{SO}	L^{SW}	Q^{S}	X^{S}
	Thailand	(AT)	A^{TI}	A^{TM}	A^{TP}	A^{TS}	A^{TT}	A^{TC}	A^{TN}	A^{TK}	A^{TJ}	A^{TU}	F^{TI}	F^{TM}	F^{TP}	F^{TS}	F^{TT}	F^{TC}	F^{TN}	F^{TK}	F^{TJ}	F^{TU}	L^{TH}	L^{TO}	L^{TW}	Q^{T}	X^{T}
	China	(AC)	A^{CI}	A^{CM}	A^{CP}	A^{CS}	A^{CT}	A^{CC}	A^{CN}	A^{CK}	A^{CJ}	A^{CU}	F^{CI}	F^{CM}	F^{CP}	F^{CS}	F^{CT}	F^{CC}	F^{CN}	F^{CK}	F^{CJ}	F^{CU}	L^{CH}	L^{CO}	L^{CW}	Q^{C}	X^{C}
	Taiwan	(AN)	A^{NI}	A^{NM}	A^{NP}	A^{NS}	A^{NT}	A^{NC}	A^{NN}	A^{NK}	A^{NJ}	A^{NU}	F^{NI}	F^{NM}	F^{NP}	F^{NS}	F^{NT}	F^{NC}	F^{NN}	F^{NK}	F^{NJ}	F^{NU}	L^{NH}	L^{NO}	L^{NW}	Q^{N}	X^{N}
	Korea	(AK)	A^{KI}	A^{KM}	A^{KP}	A^{KS}	A^{KT}	A^{KC}	A^{KN}	A^{KK}	A^{KJ}	A^{KU}	F^{KI}	F^{KM}	F^{KP}	F^{KS}	F^{KT}	F^{KC}	F^{KN}	F^{KK}	F^{KJ}	F^{KU}	L^{KH}	L^{KO}	L^{KW}	Q^{K}	X^{K}
	Japan	(AJ)	A^{JI}	A^{JM}	A^{JP}	A^{JS}	A^{JT}	A^{JC}	A^{JN}	A^{JK}	A^{JJ}	A^{JU}	F^{JI}	F^{JM}	F^{JP}	F^{JS}	F^{JT}	F^{JC}	F^{JN}	F^{JK}	F^{JJ}	F^{JU}	L^{JH}	L^{JO}	L^{JW}	Q^{J}	X^{J}
	U.S.A.	(AU)	A^{UI}	A^{UM}	A^{UP}	A^{US}	A^{UT}	A^{UC}	A^{UN}	A^{UK}	A^{UJ}	A^{UU}	F^{UI}	F^{UM}	F^{UP}	F^{US}	F^{UT}	F^{UC}	F^{UN}	F^{UK}	F^{UJ}	F^{UU}	L^{UH}	L^{UO}	L^{UW}	Q^{U}	X^{U}
Freight and Insurance		(BF)	BA^{I}	BA^{M}	BA^{P}	BA^{S}	BA^{T}	BA^{C}	BA^{N}	BA^{K}	BA^{J}	BA^{U}	BF^{I}	BF^{M}	BF^{P}	BF^{S}	BF^{T}	BF^{C}	BF^{N}	BF^{K}	BF^{J}	BF^{U}					
Import from Hong Kong		(CH)	A^{HI}	A^{HM}	A^{HP}	A^{HS}	A^{HT}	A^{HC}	A^{HN}	A^{HK}	A^{HJ}	A^{HU}	F^{HI}	F^{HM}	F^{HP}	F^{HS}	F^{HT}	F^{HC}	F^{HN}	F^{HK}	F^{HJ}	F^{HU}					
Import from EU		(CO)	A^{OI}	A^{OM}	A^{OP}	A^{OS}	A^{OT}	A^{OC}	A^{ON}	A^{OK}	A^{OJ}	A^{OU}	F^{OI}	F^{OM}	F^{OP}	F^{OS}	F^{OT}	F^{OC}	F^{ON}	F^{OK}	F^{OJ}	F^{OU}					
Import from the R.O.W.		(CW)	A^{WI}	A^{WM}	A^{WP}	A^{WS}	A^{WT}	A^{WC}	A^{WN}	A^{WK}	A^{WJ}	A^{WU}	F^{WI}	F^{WM}	F^{WP}	F^{WS}	F^{WT}	F^{WC}	F^{WN}	F^{WK}	F^{WJ}	F^{WU}					
Duties and Import Commodity Taxes		(DT)	DA^{I}	DA^{M}	DA^{P}	DA^{S}	DA^{T}	DA^{C}	DA^{N}	DA^{K}	DA^{J}	DA^{U}	DF^{I}	DF^{M}	DF^{P}	DF^{S}	DF^{T}	DF^{C}	DF^{N}	DF^{K}	DF^{J}	DF^{U}					
Value Added		(VV)	V^{I}	V^{M}	V^{P}	V^{S}	V^{T}	V^{C}	V^{N}	V^{K}	V^{J}	V^{U}															
Total Inputs		(XX)	X^{I}	X^{M}	X^{P}	X^{S}	X^{T}	X^{C}	X^{N}	X^{K}	X^{J}	X^{U}															

Figure 7: Layout of AIO Table (Source: SDS[17]

Table 3: Expected Industrial Investment Based on the SFCD

	Sector	Total	Phase 1	Phase 2	Phase 3	Phase 4
1	Grain	-	-	-	-	-
2	Food crops	-	-	-	-	-
3	Non-food crops	976.25	-	976.25	-	-
4	Other agriculture, forestry and fishery	-	-	-	-	-
5	Mining	-	-	-	-	-
6	Milled Grain and flour	124.75	-	-	124.75	-
7	Fish and meat products	99.26	-	-	99.26	-
8	Food products	935.94	-	-	935.94	-
9	Other food products	201.20	-	-	201.20	-
10	Apparel products	-	-	-	-	-
11	Other light industry	-	-	-	-	-
12	Industrial chemical	-	-	-	-	-
13	Chemical Fertilizer and pesticides	-	-	-	-	-
14	Drugs and medicine	1269.99	-	-	1269.99	-
15	Other chemical	50.30	-	-	50.30	-
16	Non-metal products	-	-	-	-	-
17	Metal products	-	-	-	-	-
18	Machinery	1173.70	-	-	1113.33	60.36
19	TV, audio and communication equipment	101.60	-	-	101.60	-
20	Electronic Computing equipment	-	-	-	-	-
21	Semiconductors and integrated circuits	-	-	-	-	-
22	Other electronic products	-	-	-	-	-
23	Moter vehicle	1938.91	-	1938.91	-	-
24	Other transport equipment	299.85	-	58.41	-	241.45
25	Other manufacture	181.08	-	181.08	-	-
26	Electricity and gas	-	-	-	-	-
27	Water supply	-	-	-	-	-
28	Building construction	-	-	-	-	-
29	Other construction	-	-	-	-	-
30	Wholesale and retail trade	2687.29	123.76	2538.13	25.40	-
31	Transportation	15792.39	-	9476.21	-	6316.18
32	Telephone and telecommunication	-	-	-	-	-
33	Finance and insurance	25.40	-	-	25.40	-
34	Real estate	17328.14	-	7050.01	5849.52	4428.61
35	Education and research	3556.48	-	769.31	1770.32	1016.86
36	Medical and Health service	332.68	-	160.60	24.58	147.50
37	Restraunts	523.85	523.85	-	-	-
38	Hotel	4916.19	3858.75	558.37	196.45	302.62
39	Other services	9704.21	4361.86	1339.23	3321.80	681.32
40	Public administration and unclasisfied	-	-	-	-	-
	Total	62219.48	8868.22	25046.51	15109.84	13194.90

(Unit: million US$)

5 Simulation Analysis

5.1 Simulation Analysis Based on the Static Closed IO Model

The total economic impacts of Saemangeum project evaluated by the SCIO model are shown in Table 4. The total impact on GDP is 87,833.41 million US$, which is about 9.05% of Korean GDP of 2007 (970 billion US$). The yearly average contribution of total investment to Korean GDP is 3,818.84 million US$, which is about 0.39% of Korean GDP. The total impact on employment shows that the Saemangeum project will give 4,159,621 job opportunities during the project period. This also means that there will be newly increased employment of 180,853 persons every year. In addition, Table 4 also shows that the "Private/Public" ratio of employment is bigger than the ratios of GDP and other items. This means that the public investment in Saemangeum is GDP-oriented, the private investment is employment-creation-oriented. Figure 8 shows the detailed impacts on GDP at 40-sector level. Since the investment in Saemangeum during the development period is mainly used in construction industry, it is easily to understand that the sector of Building construction and Other construction will have big impacts. The construction investment will cause new intermediate demands of goods and services, and then the new GDP of other related sectors will be induced by the way of inter-industrial production network. Therefore, we can also see from Figure 8 that Other services, Finance and insurance, Real estate, Whole sale and retail trade shows relatively strong GDP impacts, followed by Metal products, Machinery and Other Chemical. For detailed results of impacts on output, GDP and employment, one can refer to Table 13.

Figure 9 shows the impacts of private investment on GDP by area. Obviously, the center and north of Saemangeum enjoy relatively higher benefit than the east and south. This is mainly due to the difference of industrial location and investment scale.

5.2 Simulation Analysis Based on the Quasi-dynamic IO Model

5.2.1 Evaluation of the SFCD

Suppose that investment by each Phase is performed like Table 3, thereby, employment changes by each Phase. The variation of employment changes LQ. Then the new LQ is used

Table 4: Total Economic Impacts under the SCIO Model

Total impacts for the whole development period (2008-2030)				
Unit: Million US$	Investment	Output	GDP/Income	Employment(person)
Public	18,577.00	65,757.89	21,271.67	889,688
Private	62,219.48	213,598.41	66,561.73	3,269,934
Total (Public+Private)	80,796.48	279,356.30	87,833.41	4,159,621
Private/Public	3.35	3.25	3.13	3.68
Yearly average impacts				
	Investment	Output	GDP/Income	Employment(person)
Public	807.70	2,859.04	924.86	38,682
Private	2,705.19	9,286.89	2,893.99	142,171
Total (Public+Private)	3,512.89	12,145.93	3,818.84	180,853

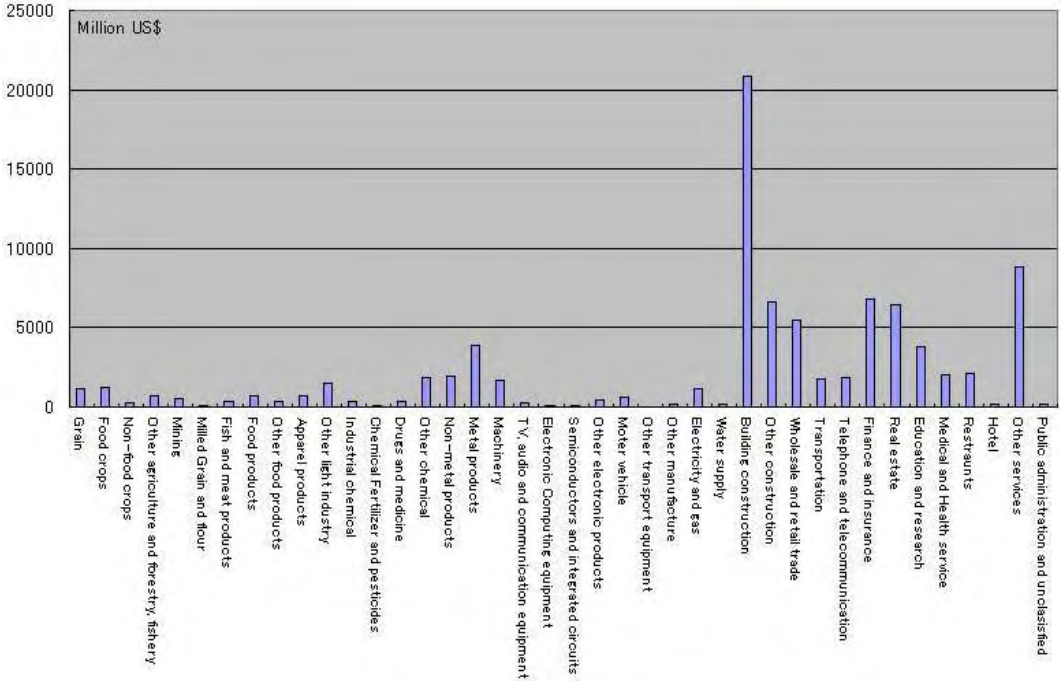

Figure 8: Impacts of Total Investment on Sectoral GDP

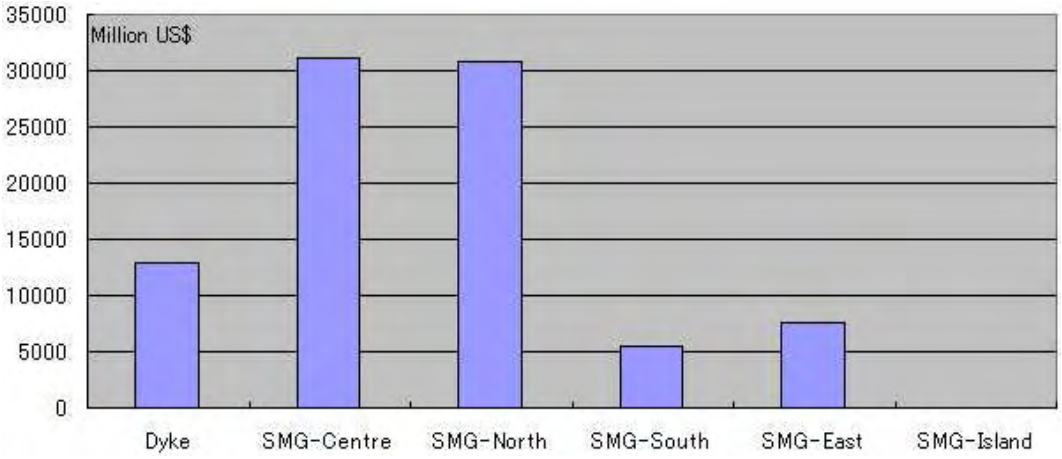

Figure 9: Impacts of Private Investment on GDP by Area

Table 5: Income and Industry Multiplier in QIRIO Model

Initial		Income multiplier		Industry multiplier	
		AJ	AK	AJ	AK
	AJ	1.4526	0.0291	2.1358	0.0807
	AK	0.2989	1.7254	0.8213	2.8824
Phase 1	AJ	1.4615	0.0292	2.1521	0.0804
	AK	0.3019	1.7254	0.8287	2.8825
Phase 2	AJ	1.4641	0.0293	2.1679	0.0812
	AK	0.3137	1.7265	0.8595	2.8852
Phase 3	AJ	1.4608	0.0552	2.1555	0.1573
	AK	0.3118	1.7359	0.8531	2.9096
Phase 4	AJ	1.4604	0.0551	2.1530	0.1568
	AK	0.3115	1.7358	0.8524	2.9095

for constructing the new interregional IO table for each Phase. Table 5 shows the multiplier took out from Leontief inverse matrix of the interregional IO model. Since household sector is used as an endogenous variable in our model, the Income multiplier and Industry multiplier can be calculated in one model at the same time. AJ and AK represent Jeollabuk-do and the Rest of Korea respectively.

Looking at the result first from Income multiplier, at present SFCD, Income multiplier of only Jeollabuk-do increases without giving any influence on the Rest of Korea in Phase 1. Income multiplier in Jeollabuk-do area is going up to 1.464 in Phase 2, and the spillover effect (interregional impact) on the Rest of Korea is also as the largest as 0.314. In the Rest of Korea, in Phase 3 and Phase 4, multiplier inside region is going up to 1.736 and spillover effect on Jeollabuk-do increase to 0.055, and it is the largest figure among the Phases. Here we look at Industry multiplier. In Phase 1, multiplier of Jeollabuk-do goes up from 2.136 to 2.152. It comes up to 2.168 and is the largest at Phase 2. Although it decreases in Phase 3 and Phase 4, multiplier inside the Rest of Korea becomes 2.910 and the highest in Phase 3. Moreover, spillover effect on Jeollabuk-do is also going up to 0.157. It is as follows when the above result is summarized:
Phase 1: The development effect is appeared only in Jeollabuk-do
Phase 2: Industry output and Income impacts are the biggest in Jeollabuk-do
Phase 3: The development effect spreads to the Rest of Korea. Industry output and income impacts are the biggest in the Rest of Korea. The connection between Jeollabuk-do and Rest of Korea become close.
Phase 4: The connection between Jeollabuk-do and Rest of Korea is still close.

5.2.2 The Economic Impacts of Tourism

In our city design, tourism industry is one of the most important programs. In order to analyze its impact brought by the expenditure of foreign (especially Chinese) traveler, we use the open IO model which excludes the household sector because the consumption expenditure of foreign guest is regarded as the final demand. The impact of tourism by phase is shown in Table 6.

Expected number of visitors in our design is 11.8 million people for Phase 1, 13.2 million for Phase 2, 19.7 million for Phase 3 and 25.2 million for Phase 4. Assumed that the visitors

Table 6: The Economic Impacts of Tourism

(million US$)	Impact on Output			
	Phase 1	Phase 2	Phase 3	Phase 4
Jeollabuk-do	9023	10130	15230	19172
Rest of Korea	1231	1382	2088	2643
Total	10254	11512	17317	21815
	Impact on GDP			
	Phase 1	Phase 2	Phase 3	Phase 4
Jeollabuk-do	2976	3348	4981	6353
Rest of Korea	352	396	595	755
Total	3328	3744	5576	7108
	Impact on Employment(Person)			
	Phase 1	Phase 2	Phase 3	Phase 4
Jeollabuk-do	228407	256552	383155	490252
Rest of Korea	12553	14107	21215	26923
Total	240960	270658	404370	517175

spend the money of 500 dollars (it comes from the figure in Las Vegas), GDP in Jeollabuk-do will increase by 2,976 million in Phase 1, 3,348 million in Phase 2, 4,981 million in Phase 3 and 6,353 million in Phase 4. Compared with 23,873 million dollar, the GDP of Jeollabuk-do in 2005, tourism industry increase GDP around 3.6% in each year. As for the job creation, 228 thousand in Phase 1, 256 thousand in Phase 2, 383 thousand in Phase 3 and 490 thousand in Phase 4 will be increased. Thinking of 2,280 persons employed in Jeollabuk-do in 2005, tourism industry increases the job the same percentage as GDP.

If the part of this economic profit becomes the income of the local government in Jeollabuk-do, it will contribute as treasury funds of Saemangeum development.

5.2.3 Impact by investment for social infrastructure and private industry

Table 7 shows the total impacts evaluated by the QIRIO model. The total impacts on output, GDP and employment are respectively 193,294 million US$, 59,231million US$, and 2,820,035 persons, which are all less than the impacts under the SCIO model (see Table 4). Since the aspect of time and space are ignored in the SCIO model, this means the average production technique of Korea is adopted for Jeollabuk-do in the SCIO model. However, the real industrial structure and technique of Jeollabuk-do is far from Korea's national level, as a result, the impacts will be overestimated in the SCIO model. Therefore, it can be concluded that the QIRIO model is more rational and reliable method for the economic impact analysis.

The detailed impact by both investment for social infrastructure and private industry is shown in Table 8.

The total output in industrial sector and income in household sector in Jeollabuk-do, induced by the investment for social infrastructure, is 1,769 and 1,009 in Phase 1, 12,442 and 7,051 in Phase 2, 6,192 and 3,499 in Phase 3 and 6,069 and 3,456 in Phase 4. The biggest impact will appear in Phase 2. With regard to the job creation in Jeollabuk-do, 28,460 in Phase 1, 202,085 in Phase 2, 101,400 in Phase 3 and 99,597 in Phase 4 will be generated.

The total output in industrial sector and income in household sector in Jeollabuk-do, induced by the investment of private industry, is 11,353 and 6,416 in Phase 1,32,736 and

Table 7: Total Economic Impacts under the QIRIO Model

Total impacts for the whole development period (2008-2030)				
Unit: Million US$	Investment	Output	GDP/Income	Employment(person)
Public	18,577.00	46,069.87	14,287.92	673,750
Private	62,219.48	147,224.28	44,943.32	2,146,285
Total (Public+Private)	80,796.48	193,294.15	59,231.24	2,820,035
Private/Public	3.35	3.17	3.15	3.19
Yearly average impacts				
	Investment	Output	GDP/Income	Employment(person)
Public	807.70	2,003.04	621.21	29,294
Private	2,705.19	6,401.06	1,954.06	93,317
Total (Public+Private)	3,512.89	8,404.09	2,575.27	122,610

18,425 in Phase 2, 19,649 and 11,051 in Phase 3 and 16,964 and 9,594 in Phase 4. The biggest impact will appear in Phase 2 in the same way as social infrastructure. With regard to the job creation in Jeollabuk-do, 184, 417 in Phase 1, 536,601 in Phase 2, 325,935 in Phase 3 and 281,768 in Phase 4 will be generated. The impacts in Jeollabuk-do stimulate the total output, income, GDP and employment of the Rest of Korea. It means that the development of Saemangeum induce not only the growth of Jeollabuk-do economy but also whole country economy.

5.2.4 The Economic Impacts of Aerospace Industry

As a special feature of Saemangeum development, Aerospace industry is a big attraction. We would like to measure the influence of the Aerospace industry on Saemangeum. The result is shown in Table 9.

A part of factories for Aerospace industry will begin to work from Phase 2. The expected sales are estimated as 524 (Phase 2), 383 (Phase 3), and 531(Phase 4) million dollars. Intermediate materials are needed by operation of Aerospace industry. The intermediate-materials purchase serves as generating of final demand. Total Output of Jeollabuk-do to meet the final demand is 852 (Phase 2), 625 (Phase 3), and 858(Phase 4) million dollars. On the other hand, the income generated to the residents of Jeollabuk-do is 507 (Phase 2), 369 (Phase 3), and 512 (Phase 4) million dollars. GDP of 194 to 289 million dollars has occurred also by the activity of industry, and the figures is by no means small.

Looking at employment, Aerospace industry contributes to the economy of Jeollabuk-do in also employment expansion. The job creation effect is 13,936 (Phase 2), 10,114 (Phase 3), and 14,038 (Phase 4). So, 10,000 or more job opportunities are made by Aerospace industry in every Phase.

5.3 Impacts of Saemangeum Development on Other Countries

The induced imports by origin and sector are shown in Table 23. The Saemangeum development will increase 18,027 million US$ imports, which are mainly from China (9,190 million US$), Japan (3,677 million US$) and the USA (3,109 million US$) followed by Indonesia, Singapore, Taiwan, Malaysia, Thailand and the Philippines. The major goods imported from China are Metal products, Other chemical, Apparel products, Industrial chemical and

Table 8: The Economic Impacts Estimated by QIRIO Model

Economic Impacts of Social Infrastructure Related Investment													
		Total Output				Value Added				Employment(Person)			
		Phase 1	Phase 2	Phase 3	Phase 4	Phase 1	Phase 2	Phase 3	Phase 4	Phase 1	Phase 2	Phase 3	Phase 4
Jeollabuk-do	Industry	1769	12442	6192	6069	560	3975	1964	1927	28460	202085	101400	99597
	Household	1009	7051	3499	3456								
Rest of Korea	Industry	1308	9101	4628	4561	392	2729	1381	1361	16168	112628	57106	56306
	Household	392	2729	1381	1361								
Total		4477	31323	15701	15447	952	6703	3345	3289	44627	314713	158506	155903

Economic Impacts of Industrial Investment													
		Total Output				Value Added				Employment(Person)			
		Phase 1	Phase 2	Phase 3	Phase 4	Phase 1	Phase 2	Phase 3	Phase 4	Phase 1	Phase 2	Phase 3	Phase 4
Jeollabuk-do	Industry	11353	32736	19649	16964	3538	10298	6149	5313	184417	536601	325935	281768
	Household	6416	18425	11051	9594								
Rest of Korea	Industry	9342	26676	16332	14173	2761	7893	4814	4178	114845	328231	200467	174021
	Household	2761	7893	4814	4178								
Total		29871	85729	51847	44909	6299	18191	10963	9491	299262	864832	526402	455788

Table 9: The Economic Impacts of Aerospace Industry

(million US$)		Impact on Output			
		Phase 1	Phase 2	Phase 3	Phase 4
Jeollabuk-do	Industry	0	862	625	868
	Household	0	507	369	512
Rest of Korea	Industry	0	486	352	489
	Household	0	147	107	148
Total		0	2001	1453	2018
		Impact on GDP			
		Phase 1	Phase 2	Phase 3	Phase 4
Jeollabuk-do	Industry	0	267	194	269
	Household				
Rest of Korea	Industry	0	147	107	148
	Household				
Total		0	414	300	417
		Impact on Employment			
		Phase 1	Phase 2	Phase 3	Phase 4
Jeollabuk-do	Industry	0	13936	10114	14038
	Household				
Rest of Korea	Industry	0	6033	4379	6083
	Household				
Total		0	19969	14493	20121

Other light industrial goods; the major goods shipped from Japan are Other chemical, Metal products, Machinery, Other electronic products and Motor vehicle; imports from the USA are similar as Japan. These imports will be the exports of the counterpart countries, for producing such export goods, the new outputs will be induced in each counterpart country. Such output impacts via imports or exports are normally called spillover impacts in IO analysis. Table 10 shows the detailed spillover impacts by country and sector. China, Japan and the USA will enjoy relatively large spillover impacts from Saemangeum development project followed by Taiwan, Indonesia and so on. At the sectoral level, Other chemical , Metal products, Industrial chemical, Mining, Machinery, and Electricity and gas show relatively high output impacts.

5.4 Simulation Analysis Based on Different Scenarios

Different city designs will have different economic impacts. The SFCD proposed is just one of the possible design options. For checking the performance of such design, we should compare its economic impacts with other possible designs.

The public investment for social infrastructure is basically fixed for each possible design, therefore the main proxy reflecting the difference among the possible city designs should be the industrial investment. Table 12 gives three different scenarios which respectively represent three different industrial investment patterns. Scenario 1 is a Manufacturing-oriented-type city, which is based on Taiwan's industrial structure; scenario 2 shows an Agriculture-oriented-type city, which is based on Philippines's industrial structure; scenario 3 reflects a Foreign-dependent-type city, which is based on Singapore's industrial structure. For the simplicity of comparison, the total amount of industrial investment is fixed for each

Table 10: The Spillover Impacts on Other Countries

Sector	China	Indonesia	Japan	Korea	Malaysia	Taiwan	Philippines	Singapore	Thailand	USA	Total
1	162.80	18.27	3.78	0.37	0.56	0.22	1.25	0.00	9.01	23.00	219.25
2	83.68	7.64	4.60	0.28	6.35	0.23	6.80	0.00	6.46	30.15	146.19
3	76.59	16.46	1.82	0.14	8.21	0.58	0.20	0.13	8.58	20.69	133.39
4	261.71	21.28	20.57	0.89	23.83	3.64	0.66	0.21	3.88	88.87	425.56
5	1548.28	158.93	20.89	1.72	53.56	5.52	1.70	0.16	11.57	262.95	2065.28
6	38.08	23.95	4.51	0.38	0.64	0.32	2.23	0.12	14.47	10.50	95.18
7	57.16	2.68	10.23	0.70	0.65	1.31	0.69	0.30	4.84	79.97	158.53
8	166.72	25.25	42.40	1.19	60.39	10.05	14.82	5.25	29.06	164.57	519.71
9	50.64	0.50	27.08	0.43	1.07	0.12	0.31	1.92	0.25	9.57	91.87
10	1200.62	34.90	87.53	27.42	4.70	65.96	1.13	0.93	14.92	50.83	1488.95
11	431.65	148.86	249.36	12.14	65.72	20.90	1.83	8.89	26.77	414.37	1380.49
12	1092.68	42.66	775.36	110.04	23.40	99.83	2.93	25.31	22.93	438.39	2633.52
13	89.01	6.71	16.47	0.48	4.66	1.02	0.42	0.00	0.40	64.89	184.07
14	31.58	1.32	34.16	0.18	0.32	1.69	0.08	7.26	0.52	34.93	112.03
15	5159.11	291.03	1443.46	73.44	153.39	153.72	26.39	271.65	107.06	1186.46	8865.70
16	247.18	16.90	247.86	4.32	6.90	15.81	1.12	5.72	10.99	130.18	686.98
17	6032.82	37.98	1808.53	85.67	45.74	156.04	5.89	51.61	15.26	599.65	8839.19
18	714.10	9.09	548.61	16.31	12.32	35.10	0.64	20.24	12.84	295.00	1664.25
19	198.90	4.28	36.26	5.57	29.95	50.22	5.64	17.15	8.65	386.89	743.51
20	111.04	4.11	81.02	3.84	66.84	61.93	12.73	122.78	46.21	94.19	604.68
21	156.76	0.61	96.20	33.82	37.38	37.93	18.89	31.37	9.07	124.54	546.59
22	364.64	1.53	488.62	19.72	44.55	93.85	2.54	9.73	10.78	109.41	1145.37
23	291.83	5.85	272.08	2.08	1.80	5.67	0.25	0.99	4.68	106.24	691.46
24	58.50	3.52	10.35	0.34	0.59	1.40	0.00	1.28	0.29	18.95	95.21
25	120.53	0.76	62.80	2.50	6.16	5.88	1.98	3.36	2.31	74.31	280.61
26	1174.28	8.10	207.64	11.69	11.17	8.46	3.68	5.93	11.16	102.91	1545.02
27	47.18	0.17	22.36	0.29	1.17	0.45	0.33	0.28	0.39	4.04	76.65
28	54.32	1.22	66.50	1.07	0.41	4.38	0.00	0.76	0.16	21.56	150.38
29	9.11	2.85	0.00	0.00	2.54	3.02	0.40	1.29	0.01	0.28	19.49
30	1114.69	51.72	555.02	17.09	45.55	69.19	20.11	49.12	38.30	463.09	2423.88
31	742.75	38.38	261.46	8.78	15.93	29.40	10.86	15.68	11.49	342.82	1477.55
32	236.80	3.14	67.19	3.45	2.73	6.08	1.15	4.61	2.21	60.84	388.21
33	384.61	12.19	192.08	10.85	5.19	28.99	3.20	20.78	5.31	133.51	796.70
34	61.94	4.06	60.50	4.44	3.05	8.70	1.32	9.70	0.84	87.38	241.94
35	30.88	0.31	9.93	3.92	0.61	0.46	0.03	0.44	0.55	40.67	87.80
36	8.72	0.44	4.40	0.17	0.02	1.18	0.08	0.98	0.16	0.22	16.37
37	142.35	3.57	74.19	3.46	2.75	0.90	0.89	3.00	1.38	21.64	254.14
38	31.45	0.28	21.62	0.29	1.26	0.74	0.06	0.13	0.35	10.75	66.95
39	352.32	8.77	379.28	12.31	14.84	39.89	4.52	24.06	6.97	498.91	1341.87
40	4.34	1.25	47.34	0.49	0.51	11.69	0.22	3.07	1.64	22.98	93.52
Total	23142.34	1021.54	8364.05	482.27	767.40	1042.49	157.97	726.18	462.73	6631.09	42798.03

Table 11: Simulation Analysis Based on Different Scenarios

Impact on (million US$) →	Output	GDP	Employment(person)
FSFCD	147,224.28	44,943.32	2,146,285
Manufacture-oriented (Taiwan)	149,441.30	44,048.75	1,797,843
Agriculture-oriented (Philippines)	139,444.37	41,354.01	1,645,269
Foreign-dependent (Singapore)	152,591.54	44,491.29	1,902,323

scenario, which is as same as the one used in the SFCD.

The economic impacts based on different investment patterns can be estimated by the IO model we proposed in the previous sectors. The simulation results based on the different scenarios are shown in Table 11. Obviously, the SFCD gives the largest impacts on employment and GDP comparing with other scenarios. The output impact of SFCD is less than that of the Manufacture-oriented-type and foreign-dependent type. If the policy-maker's purpose is to maximize the output, the design which gives relatively big output impacts maybe the best choice. However, in many case, GDP and Employment are more meaningful and desirable index to be used, since they are more closed to the concept of social welfare. At this meaning, the SFCD seems to be a good choice for us.

6 Conclusion

The paper developed an interdisciplinary interface between economics and architecture for evaluating the economic impacts of small city development. Two kinds of closed IO models, namely static IO model and quasi-dynamic interregional IO model were employed in the paper. For checking the performance of these models, Saemangeum's Flux City Design Plan was used as an analysis target. According to the simulation results, it can be concluded that (1) when traditional open IO model is employed in economic impact analysis, underestimation may occur since the impact by the way of household income can not be evaluated significantly. (2) when static IO model is used, overestimation may occur since the average production technique is assumed and the dynamic technique change is not explicitly considered, (3) a strong feedback function can be achieved by linking the detailed program of city design plan with the quasi-dynamic interregional closed input-output model.

Table 12: Different Industrial Investment Scenarios

Sector	Manufacture-oriented (Taiwan)	Agriculture-oriented (Philippines)	Foreign-dependent (Singapore)
1	153	1412	0
2	366	1786	0
3	198	193	39
4	975	2884	49
5	0	0	0
6	223	2654	32
7	803	2313	97
8	959	4701	317
9	446	1104	254
10	2644	1687	379
11	1487	974	800
12	2024	256	1292
13	80	86	0
14	188	311	626
15	3513	3268	6005
16	898	584	276
17	4130	988	1462
18	2709	453	1839
19	1188	241	1643
20	3317	568	7879
21	2168	7360	5407
22	4246	815	757
23	1536	832	220
24	902	130	1017
25	873	1824	660
26	0	0	0
27	0	0	0
28	0	0	0
29	0	0	0
30	5876	7472	8067
31	2887	2699	5318
32	1034	794	1018
33	3425	2372	4609
34	966	3053	3300
35	1607	2057	227
36	1121	1264	913
37	836	1436	1371
38	177	264	324
39	8266	3385	6023
40	0	0	0
Total	62219	62219	62219

Table 13: Detail Impacts Estimated by the SCIO Model

	Impacts of public investment			Impacts of private investment		
Sector	Output	GDP	Employment	Output	GDP	Employment
1	507.37	284.06	42165.73	1594.64	892.79	132525.65
2	597.87	293.04	49838.29	1875.37	919.19	156331.52
3	125.02	69.76	4775.07	352.17	196.50	13450.87
4	635.15	167.36	26115.28	2005.74	528.51	82469.58
5	365.67	185.27	2970.01	724.44	367.05	5883.98
6	553.64	24.08	1784.03	1740.07	75.67	5607.11
7	749.49	77.86	3703.20	2354.43	244.59	11633.20
8	869.88	167.01	7896.41	2738.43	525.76	24858.18
9	588.08	81.65	1680.71	1849.20	256.76	5284.95
10	718.16	162.56	8582.53	2303.41	521.40	27527.54
11	1293.90	280.25	13293.49	5656.00	1225.06	58109.62
12	799.23	78.54	1289.89	2668.66	262.26	4306.97
13	114.36	16.09	436.45	355.54	50.02	1356.86
14	354.61	92.03	2129.56	1108.99	287.82	6659.87
15	3432.99	421.12	11518.83	11685.28	1433.41	39208.06
16	2314.99	553.12	17450.46	5706.67	1363.50	43017.10
17	5521.85	948.19	29643.21	17368.19	2982.38	93238.44
18	1259.78	286.08	8485.80	6251.19	1419.56	42107.64
19	453.10	67.69	2546.68	1484.78	221.81	8345.31
20	278.44	23.72	753.39	871.30	74.22	2357.49
21	61.26	13.03	180.86	216.67	46.11	639.74
22	450.05	86.70	2763.97	2000.49	385.39	12285.82
23	1078.35	150.92	7242.91	3264.33	456.86	21925.39
24	33.55	7.46	245.05	103.97	23.13	759.49
25	224.19	46.80	3019.31	724.05	151.15	9751.16
26	1374.67	270.12	3001.87	4361.28	856.97	9523.74
27	114.38	36.80	919.82	358.63	115.40	2884.00
28	414.01	135.25	7088.40	63526.39	20752.86	1087658.00
29	18577.00	6640.58	200490.29	0.00	0.00	0.00
30	2565.74	1228.97	120066.45	8909.22	4267.44	416916.43
31	1398.36	421.53	24354.49	4504.10	1357.75	78445.60
32	1427.24	439.27	5684.19	4481.34	1379.26	17847.66
33	3162.02	1665.14	39416.96	9815.87	5169.10	122362.16
34	3911.00	1572.07	14018.17	12231.49	4916.59	43841.28
35	1321.79	935.78	37461.34	4006.87	2836.73	113560.06
36	1232.95	490.83	22565.29	3862.03	1537.47	70682.65
37	1717.35	505.19	65010.47	5452.30	1603.89	206397.48
38	96.86	44.93	3665.86	309.69	143.65	11720.92
39	4979.54	2260.82	94069.01	14523.95	6594.21	274373.59
40	84.03	39.98	1364.15	251.23	119.53	4078.39
Total	65757.89	21271.67	889687.83	213598.41	66561.73	3269933.50

Table 14: The Economic Impacts of Tourism on Jeollabuk-do

	Impacts on Output				Impacts on GDP				Impacts on Employment			
Sector	Phase 1	Phase 2	Phase 3	Phase 4	Phase 1	Phase 2	Phase 3	Phase 4	Phase 1	Phase 2	Phase 3	Phase 4
1	111	124	185	236	62	70	103	132	9207	10328	15336	19646
2	67	75	112	143	33	37	55	70	5592	6273	9322	11940
3	10	11	17	22	6	6	9	12	387	434	646	827
4	136	153	226	290	36	40	60	76	5592	6273	9312	11930
5	8	8	13	15	4	4	7	8	61	68	107	126
6	121	136	202	259	5	6	9	11	391	439	652	835
7	164	183	272	349	17	19	28	36	808	906	1346	1724
8	158	178	265	339	30	34	51	65	1438	1613	2404	3081
9	236	265	394	505	33	37	55	70	675	757	1126	1444
10	265	296	435	557	60	67	98	126	3167	3539	5193	6659
11	83	92	122	158	18	20	26	34	850	946	1253	1618
12	118	128	266	208	12	13	26	20	190	207	429	335
13	14	15	27	26	2	2	4	4	53	59	102	100
14	6	7	12	15	2	2	3	4	38	42	71	90
15	478	529	915	949	59	65	112	116	1605	1776	3069	3184
16	36	40	63	76	9	10	15	18	273	305	477	571
17	83	91	120	155	14	16	21	27	447	490	646	830
18	16	18	28	39	4	4	6	9	107	118	186	260
19	5	6	9	15	1	1	1	2	30	34	48	86
20	3	3	14	18	0	0	1	2	8	9	39	49
21	6	7	9	12	1	1	2	3	18	20	27	35
22	25	28	38	49	5	5	7	9	153	170	232	302
23	17	19	62	80	2	3	9	11	115	128	414	536
24	5	5	8	10	1	1	2	2	34	38	61	71
25	650	728	1088	1395	136	152	227	291	8752	9799	14658	18783
26	242	271	408	514	48	53	80	101	529	593	891	1122
27	21	23	35	45	7	8	11	14	168	188	281	358
28	43	47	61	79	14	15	20	26	731	807	1049	1359
29	0	0	0	0	0	0	0	0	0	0	0	0
30	186	206	348	440	89	99	167	211	8708	9640	16291	20602
31	476	532	789	1017	143	160	238	307	8284	9261	13740	17709
32	245	273	387	498	76	84	119	153	977	1089	1542	1983
33	144	159	212	275	76	84	111	145	1793	1980	2638	3426
34	172	192	258	334	69	77	104	134	618	687	923	1196
35	49	54	76	110	34	38	54	78	1377	1526	2164	3115
36	6	6	9	12	2	3	4	5	106	118	167	215
37	1592	1786	2651	3397	468	525	780	999	60268	67604	100372	128588
38	2522	2825	4214	5398	1170	1310	1955	2504	95446	106928	159501	204310
39	464	563	815	1051	211	256	370	477	8763	10639	15399	19863
40	40	44	64	83	19	21	31	39	644	721	1042	1342

Table 15: The Economic Impacts of Tourism on the Rest of Korea

	Impacts on Output				Impacts on GDP				Impacts on Employment			
Sector	Phase 1	Phase 2	Phase 3	Phase 4	Phase 1	Phase 2	Phase 3	Phase 4	Phase 1	Phase 2	Phase 3	Phase 4
1	1	1	2	2	1	1	1	1	82	92	139	176
2	1	1	1	1	0	0	1	1	54	61	91	115
3	0	0	0	0	0	0	0	0	8	9	14	18
4	2	2	3	3	0	0	1	1	64	72	107	136
5	1	2	3	3	1	1	1	2	12	14	20	26
6	1	2	2	3	0	0	0	0	4	5	7	9
7	2	2	3	4	0	0	0	0	10	11	17	21
8	2	3	4	5	0	0	1	1	20	23	34	44
9	2	2	3	3	0	0	0	0	4	5	8	10
10	101	113	168	214	23	26	38	48	1206	1350	2009	2559
11	110	124	183	233	24	27	40	51	1132	1277	1880	2399
12	57	63	100	117	6	6	10	12	91	102	162	189
13	2	3	4	5	0	0	1	1	9	10	15	19
14	1	1	2	2	0	0	1	1	7	8	12	15
15	99	110	169	210	12	14	21	26	331	371	566	706
16	8	9	13	16	2	2	3	4	57	64	97	124
17	93	103	155	196	16	18	27	34	497	554	830	1054
18	51	57	88	111	12	13	20	25	344	385	594	747
19	6	7	11	14	1	1	2	2	35	40	60	77
20	6	7	11	14	1	1	1	1	17	19	30	38
21	14	16	24	31	3	3	5	7	42	47	72	92
22	54	60	92	118	10	12	18	23	331	371	563	723
23	27	31	56	72	4	4	8	10	184	206	375	481
24	2	3	4	5	1	1	1	1	18	20	30	39
25	38	43	64	82	8	9	13	17	512	574	860	1099
26	20	22	33	42	4	4	7	8	43	48	72	91
27	1	1	1	2	0	0	0	1	7	8	11	15
28	20	23	34	43	7	7	11	14	346	389	578	738
29	0	0	0	0	0	0	0	0	0	0	0	0
30	43	48	73	92	21	23	35	44	2013	2259	3412	4316
31	27	30	45	57	8	9	14	17	468	526	791	1000
32	62	70	103	132	19	21	32	41	247	277	412	526
33	89	100	149	188	47	52	78	99	1108	1243	1855	2347
34	170	192	287	367	68	77	115	147	611	689	1028	1314
35	12	13	20	25	8	9	14	18	331	372	566	717
36	1	1	1	2	0	0	0	1	13	14	22	27
37	16	17	26	33	5	5	8	10	587	661	992	1257
38	1	1	2	3	1	1	1	1	49	56	83	106
39	85	96	143	182	38	43	65	82	1601	1809	2706	3431
40	4	4	6	8	2	2	3	4	57	64	96	122

Table 16: Impacts on Jeollabuk-do's Output Estimated by the QIRIO Model

	Impacts of Public Investment				Impacts of Private Investment			
Sector	Phase 1	Phase 2	Phase 3	Phase 4	Phase 1	Phase 2	Phase 3	Phase 4
1	25	177	86	85	163	468	276	239
2	30	207	102	101	190	546	325	285
3	7	49	24	24	40	115	69	60
4	31	220	108	106	204	587	347	300
5	23	159	79	78	91	257	154	134
6	25	177	86	85	161	465	274	238
7	34	239	117	115	217	627	370	321
8	40	284	139	153	260	749	442	433
9	27	187	92	96	171	493	291	268
10	10	66	31	29	63	179	102	84
11	28	194	90	85	281	797	448	370
12	26	174	77	70	177	489	259	209
13	5	34	16	15	31	89	50	41
14	14	93	42	69	87	243	132	197
15	145	995	470	455	1036	2909	1656	1410
16	150	1031	514	511	760	2145	1292	1128
17	199	1339	622	583	1268	3512	1969	1622
18	21	139	67	80	229	639	366	386
19	7	51	24	41	50	143	82	122
20	4	30	49	49	27	78	157	136
21	0	3	2	2	3	9	7	6
22	5	37	20	19	60	169	104	88
23	14	96	162	149	84	238	484	393
24	1	7	3	3	6	18	11	9
25	4	27	15	14	25	71	49	41
26	61	422	207	202	390	1115	661	567
27	5	37	18	18	33	96	57	49
28	11	74	33	30	69	196	107	85
29	0	0	0	0	0	0	0	0
30	106	732	412	407	782	2206	1500	1303
31	56	382	192	188	366	1036	629	542
32	45	310	145	136	285	809	459	378
33	105	719	335	319	656	1848	1039	872
34	94	657	309	290	600	1713	974	804
35	57	392	187	208	343	968	559	545
36	53	366	175	165	339	959	553	460
37	73	525	246	231	474	1398	790	654
38	4	32	16	16	27	85	51	44
39	220	1761	872	833	1286	4227	2530	2121
40	3	19	9	8	16	45	26	21
Income	1009	7051	3499	3456	6416	18425	11051	9594

Table 17: Impacts on the Rest of Korea's Output Estimated by the QIRIO Model

	Impacts of Public Investment				Impacts of Private Investment			
Sector	Phase 1	Phase 2	Phase 3	Phase 4	Phase 1	Phase 2	Phase 3	Phase 4
1	7	50	25	25	50	143	87	76
2	8	59	30	29	60	170	104	90
3	1	8	4	4	8	22	14	12
4	9	63	32	31	64	182	111	96
5	2	11	5	5	11	32	19	17
6	10	70	35	35	71	203	123	107
7	14	96	48	48	96	276	168	146
8	15	104	53	52	105	301	183	159
9	11	75	38	37	76	216	132	115
10	36	253	128	125	246	704	427	369
11	57	400	200	197	503	1443	869	753
12	27	184	92	91	190	541	327	282
13	2	16	8	8	16	46	28	24
14	9	62	31	30	61	174	105	90
15	80	555	283	279	575	1639	1005	872
16	7	47	24	24	50	143	88	77
17	174	1193	597	587	1189	3354	2024	1753
18	64	440	226	225	652	1846	1130	993
19	22	151	76	76	149	427	260	227
20	13	94	49	48	89	256	161	140
21	4	25	14	14	27	76	51	46
22	24	165	89	89	215	612	390	343
23	55	384	226	220	352	1009	712	610
24	1	8	4	4	8	22	13	12
25	11	75	38	38	74	212	129	113
26	29	199	101	99	203	580	354	307
27	2	15	7	7	15	42	26	22
28	16	112	56	55	107	307	186	160
29	0	0	0	0	0	0	0	0
30	59	413	210	207	430	1228	750	652
31	35	244	123	121	245	700	426	370
32	47	330	166	163	319	917	556	482
33	100	696	349	344	675	1929	1169	1013
34	156	1094	549	540	1040	2992	1813	1570
35	28	196	99	98	197	562	344	299
36	25	175	88	87	175	500	304	264
37	37	259	131	129	259	742	452	392
38	2	15	8	7	15	43	26	23
39	107	748	376	371	710	2034	1235	1072
40	3	18	9	9	18	51	31	27
Income	392	2729	1381	1361	2761	7893	4814	4178

Table 18: Impacts on Jeollabuk-do's GDP Estimated by the QIRIO Model

	Impacts of Public Investment				Impacts of Private Investment			
Sector	Phase 1	Phase 2	Phase 3	Phase 4	Phase 1	Phase 2	Phase 3	Phase 4
1	14	99	48	48	91	262	155	134
2	14	101	50	50	93	268	159	140
3	4	27	14	14	22	64	39	34
4	8	58	28	28	54	155	91	79
5	12	81	40	40	46	130	78	68
6	1	8	4	4	7	20	12	10
7	4	25	12	12	23	65	38	33
8	8	54	27	29	50	144	85	83
9	4	26	13	13	24	68	40	37
10	2	15	7	7	14	41	23	19
11	6	42	20	18	61	173	97	80
12	3	17	8	7	17	48	25	21
13	1	5	2	2	4	13	7	6
14	4	24	11	18	23	63	34	51
15	18	122	58	56	127	357	203	173
16	36	246	123	122	182	513	309	269
17	34	230	107	100	218	603	338	279
18	5	32	15	18	52	145	83	88
19	1	8	4	6	8	21	12	18
20	0	3	4	4	2	7	13	12
21	0	1	0	0	1	2	1	1
22	1	7	4	4	12	33	20	17
23	2	13	23	21	12	33	68	55
24	0	2	1	1	1	4	2	2
25	1	6	3	3	5	15	10	8
26	12	83	41	40	77	219	130	111
27	2	12	6	6	11	31	18	16
28	3	24	11	10	23	64	35	28
29	0	0	0	0	0	0	0	0
30	51	351	197	195	375	1057	718	624
31	17	115	58	57	110	312	190	163
32	14	95	45	42	88	249	141	116
33	55	379	176	168	346	973	547	459
34	38	264	124	116	241	689	392	323
35	40	278	133	147	243	686	396	386
36	21	146	70	66	135	382	220	183
37	22	155	72	68	139	411	232	192
38	2	15	7	7	12	39	24	21
39	100	800	396	378	584	1919	1148	963
40	1	9	4	4	8	22	12	10

Table 19: Impacts on the Rest of Korea's GDP Estimated by the QIRIO Model

	Impacts of Public Investment				Impacts of Private Investment			
Sector	Phase 1	Phase 2	Phase 3	Phase 4	Phase 1	Phase 2	Phase 3	Phase 4
1	4	28	14	14	28	80	49	42
2	4	29	15	14	29	83	51	44
3	1	4	2	2	4	12	8	7
4	2	17	8	8	17	48	29	25
5	1	5	3	3	6	16	10	9
6	0	3	2	2	3	9	5	5
7	1	10	5	5	10	29	17	15
8	3	20	10	10	20	58	35	31
9	1	10	5	5	11	30	18	16
10	8	57	29	28	56	159	97	84
11	12	87	43	43	109	312	188	163
12	3	18	9	9	19	53	32	28
13	0	2	1	1	2	6	4	3
14	2	16	8	8	16	45	27	23
15	10	68	35	34	70	201	123	107
16	2	11	6	6	12	34	21	18
17	30	205	103	101	204	576	348	301
18	14	100	51	51	148	419	257	225
19	3	23	11	11	22	64	39	34
20	1	8	4	4	8	22	14	12
21	1	5	3	3	6	16	11	10
22	5	32	17	17	41	118	75	66
23	8	54	32	31	49	141	100	85
24	0	2	1	1	2	5	3	3
25	2	16	8	8	15	44	27	24
26	6	39	20	20	40	114	69	60
27	1	5	2	2	5	14	8	7
28	5	36	18	18	35	100	61	52
29	0	0	0	0	0	0	0	0
30	28	198	100	99	206	588	359	312
31	11	73	37	37	74	211	128	111
32	15	101	51	50	98	282	171	148
33	53	366	184	181	355	1016	615	533
34	63	440	221	217	418	1203	729	631
35	20	138	70	70	139	398	244	212
36	10	70	35	35	70	199	121	105
37	11	76	38	38	76	218	133	115
38	1	7	4	3	7	20	12	11
39	49	339	171	169	322	923	561	487
40	1	9	4	4	9	24	15	13

Table 20: Impacts on Jeollabuk-do's Employment Estimated by the QIRIO Model

	Impacts of Public Investment				Impacts of Private Investment			
Sector	Phase 1	Phase 2	Phase 3	Phase 4	Phase 1	Phase 2	Phase 3	Phase 4
1	2092	14684	7166	7058	13507	38925	22945	19879
2	2461	17231	8477	8447	15837	45542	27069	23742
3	270	1872	932	929	1534	4382	2636	2310
4	1291	9063	4428	4361	8381	24151	14254	12348
5	189	1293	642	637	741	2091	1251	1088
6	81	570	278	274	519	1498	883	765
7	168	1180	576	568	1074	3100	1827	1586
8	367	2574	1258	1388	2359	6795	4011	3932
9	76	536	262	273	488	1409	832	767
10	115	793	373	349	757	2140	1215	1000
11	285	1995	928	872	2888	8186	4602	3804
12	42	280	123	113	286	788	418	338
13	19	131	60	57	120	341	189	157
14	82	559	252	414	521	1459	795	1180
15	488	3338	1576	1526	3476	9760	5558	4731
16	1133	7771	3874	3854	5727	16172	9739	8501
17	1069	7189	3340	3128	6808	18853	10570	8707
18	138	937	450	538	1546	4304	2468	2600
19	42	286	135	230	284	803	459	685
20	12	81	134	131	74	210	426	368
21	1	9	6	6	9	25	21	19
22	33	227	122	118	371	1041	636	539
23	94	643	1085	1002	564	1595	3251	2639
24	7	51	26	24	46	130	79	65
25	52	361	205	194	337	956	657	547
26	133	922	452	441	853	2436	1442	1237
27	42	294	145	143	268	770	458	396
28	183	1261	568	516	1185	3352	1826	1461
29	0	0	0	0	0	0	0	0
30	4982	34264	19291	19056	36602	103237	70175	60992
31	967	6657	3346	3276	6379	18036	10956	9433
32	178	1234	578	541	1134	3223	1829	1503
33	1308	8963	4172	3982	8179	23036	12955	10869
34	338	2353	1106	1038	2152	6141	3493	2881
35	1616	11113	5308	5881	9709	27447	15840	15451
36	973	6704	3201	3027	6199	17543	10127	8416
37	2767	19891	9299	8752	17936	52914	29902	24749
38	155	1197	596	587	1015	3220	1937	1679
39	4165	33267	16479	15731	24294	79849	47786	40069
40	45	313	147	134	260	739	417	333

Table 21: Impacts on the Rest of Korea's Employment Estimated by the QIRIO Model

	Impacts of Public Investment				Impacts of Private Investment			
Sector	Phase 1	Phase 2	Phase 3	Phase 4	Phase 1	Phase 2	Phase 3	Phase 4
1	590	4115	2081	2052	4154	11880	7242	6285
2	705	4910	2484	2448	4960	14183	8646	7504
3	42	295	149	147	298	853	520	451
4	371	2585	1307	1289	2618	7487	4563	3960
5	13	88	45	44	91	259	158	137
6	32	226	114	113	228	653	398	345
7	68	472	239	235	476	1362	830	721
8	136	945	478	471	955	2732	1665	1445
9	31	214	108	107	216	619	377	327
10	434	3028	1525	1498	2935	8409	5108	4415
11	584	4115	2058	2027	5164	14820	8924	7736
12	43	297	149	146	307	873	527	455
13	9	63	31	31	61	176	106	92
14	53	371	185	182	365	1042	629	543
15	268	1863	949	935	1928	5500	3371	2924
16	51	354	182	179	377	1075	664	577
17	935	6405	3206	3153	6385	18003	10867	9411
18	430	2962	1521	1516	4392	12431	7612	6687
19	121	847	428	425	837	2398	1462	1276
20	36	256	133	131	241	694	436	378
21	10	73	42	42	78	224	151	135
22	145	1015	548	549	1317	3759	2394	2107
23	370	2578	1519	1479	2367	6779	4783	4097
24	8	59	30	29	56	162	98	85
25	145	1013	511	506	998	2861	1740	1517
26	63	435	220	217	444	1267	772	670
27	17	118	59	59	119	340	207	180
28	273	1911	956	939	1829	5258	3178	2747
29	0	0	0	0	0	0	0	0
30	2777	19339	9809	9679	20118	57465	35097	30495
31	609	4242	2139	2111	4265	12188	7412	6437
32	188	1313	660	649	1272	3650	2216	1918
33	1245	8675	4354	4288	8410	24051	14569	12626
34	559	3922	1967	1937	3726	10725	6497	5628
35	796	5542	2816	2782	5575	15931	9752	8483
36	459	3199	1615	1593	3196	9143	5565	4830
37	1404	9789	4942	4872	9817	28089	17098	14838
38	81	568	287	283	571	1633	994	862
39	2024	14126	7108	7015	13405	38422	23333	20255
40	43	300	151	148	291	834	506	438

Table 22: The Economic Impacts of Aerospace Industry on Jeollabuk-do

	Impacts on Output				Impacts on GDP				Impacts on Employment			
Sector	Phase 1	Phase 2	Phase 3	Phase 4	Phase 1	Phase 2	Phase 3	Phase 4	Phase 1	Phase 2	Phase 3	Phase 4
1	111	124	185	236	62	70	103	132	9207	10328	15336	19646
2	67	75	112	143	33	37	55	70	5592	6273	9322	11940
3	10	11	17	22	6	6	9	12	387	434	646	827
4	136	153	226	290	36	40	60	76	5592	6273	9312	11930
5	8	8	13	15	4	4	7	8	61	68	107	126
6	121	136	202	259	5	6	9	11	391	439	652	835
7	164	183	272	349	17	19	28	36	808	906	1346	1724
8	158	178	265	339	30	34	51	65	1438	1613	2404	3081
9	236	265	394	505	33	37	55	70	675	757	1126	1444
10	265	296	435	557	60	67	98	126	3167	3539	5193	6659
11	83	92	122	158	18	20	26	34	850	946	1253	1618
12	118	128	266	208	12	13	26	20	190	207	429	335
13	14	15	27	26	2	2	4	4	53	59	102	100
14	6	7	12	15	2	2	3	4	38	42	71	90
15	478	529	915	949	59	65	112	116	1605	1776	3069	3184
16	36	40	63	76	9	10	15	18	273	305	477	571
17	83	91	120	155	14	16	21	27	447	490	646	830
18	16	18	28	39	4	4	6	9	107	118	186	260
19	5	6	9	15	1	1	1	2	30	34	48	86
20	3	3	14	18	0	0	1	2	8	9	39	49
21	6	7	9	12	1	1	2	3	18	20	27	35
22	25	28	38	49	5	5	7	9	153	170	232	302
23	17	19	62	80	2	3	9	11	115	128	414	536
24	5	5	8	10	1	1	2	2	34	38	61	71
25	650	728	1088	1395	136	152	227	291	8752	9799	14658	18783
26	242	271	408	514	48	53	80	101	529	593	891	1122
27	21	23	35	45	7	8	11	14	168	188	281	358
28	43	47	61	79	14	15	20	26	731	807	1049	1359
29	0	0	0	0	0	0	0	0	0	0	0	0
30	186	206	348	440	89	99	167	211	8708	9640	16291	20602
31	476	532	789	1017	143	160	238	307	8284	9261	13740	17709
32	245	273	387	498	76	84	119	153	977	1089	1542	1983
33	144	159	212	275	76	84	111	145	1793	1980	2638	3426
34	172	192	258	334	69	77	104	134	618	687	923	1196
35	49	54	76	110	34	38	54	78	1377	1526	2164	3115
36	6	6	9	12	2	3	4	5	106	118	167	215
37	1592	1786	2651	3397	468	525	780	999	60268	67604	100372	128588
38	2522	2825	4214	5398	1170	1310	1955	2504	95446	106928	159501	204310
39	464	563	815	1051	211	256	370	477	8763	10639	15399	19863
40	40	44	64	83	19	21	31	39	644	721	1042	1342

Table 23: Induced Imports by Origin and Sector

Sector	China	Indonesia	Japan	Korea	Malaysia	Taiwan	Philippines	Singapore	Thailand	USA	Total
1	10.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.05	15.10
2	3.00	1.04	0.18	0.00	0.47	0.01	3.27	0.00	0.25	15.26	23.49
3	1.09	0.76	0.20	0.00	0.14	0.12	0.00	0.01	0.36	2.64	5.32
4	13.43	1.58	8.22	0.00	5.79	1.51	0.12	0.19	0.26	18.48	49.57
5	7.57	1.35	0.01	0.00	0.49	0.00	0.00	0.00	0.01	0.11	9.56
6	0.83	21.37	0.08	0.00	0.00	0.00	1.38	0.06	11.36	7.59	42.67
7	20.05	0.60	2.06	0.00	0.14	0.74	0.42	0.21	3.39	61.85	89.45
8	99.16	13.80	24.00	0.00	28.42	6.32	11.38	4.36	25.29	127.12	339.87
9	1.18	0.11	14.56	0.00	0.60	0.06	0.21	1.40	0.01	8.27	26.41
10	459.17	21.91	35.28	0.00	2.28	28.37	0.64	0.31	7.95	22.77	578.69
11	135.76	114.79	72.83	0.00	49.53	5.18	0.77	5.04	18.91	240.33	643.13
12	344.50	9.75	266.29	0.00	5.46	14.08	1.36	9.97	7.32	160.62	819.35
13	2.54	5.07	9.50	0.00	2.97	0.27	0.22	0.00	0.00	44.58	65.16
14	9.94	0.77	29.57	0.00	0.21	1.27	0.01	7.06	0.41	28.62	77.88
15	3178.76	268.03	1040.50	0.00	108.79	83.46	18.65	218.74	81.10	901.25	5899.28
16	65.65	15.76	182.47	0.00	3.92	8.03	0.69	4.66	9.08	96.54	386.80
17	3731.98	26.41	957.33	0.00	25.12	54.63	3.36	39.69	7.02	299.40	5144.93
18	194.28	2.38	330.95	0.00	7.65	16.21	0.35	13.11	7.65	191.19	763.77
19	111.01	3.52	13.06	0.00	25.06	42.51	5.25	8.16	7.59	351.77	567.93
20	70.37	2.12	49.89	0.00	53.42	38.76	11.07	77.74	30.52	72.62	406.51
21	52.83	0.04	26.14	0.00	8.48	9.81	5.14	6.31	2.10	41.04	151.90
22	59.12	0.23	255.51	0.00	40.15	60.75	1.46	6.80	4.76	41.35	470.14
23	8.88	0.19	127.79	0.00	0.05	0.48	0.06	0.13	1.07	53.93	192.58
24	0.59	0.00	0.62	0.00	0.03	0.16	0.00	0.16	0.00	11.51	13.08
25	19.67	0.39	35.93	0.00	0.51	3.19	1.26	1.99	0.95	53.57	117.45
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	334.78	10.15	140.13	0.00	6.76	15.55	10.92	9.02	6.11	152.45	685.87
31	254.02	12.77	53.46	0.00	4.45	5.58	7.85	1.51	3.39	98.55	441.59
32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	9190.21	534.91	3676.57	0.00	380.90	397.10	85.82	416.60	236.89	3108.46	18027.46

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