

Analysis of Inter-regional industrial relations of major industries in Sejong City -using 2015 Korean Multiregional Input-Output Table

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Abstract

South Korea's capital metropolitan area accounts for more than half of the country's total population and GDP. To overcome this phenomenon, the Korean government implemented various policies for the balanced development of the country, a representative of which was the construction of Sejong City in Chungcheong Province. Sejong City was established in July 2012, and by 2021, 44 government organizations and 15 state-run research institutes had migrated from metropolitan areas. In addition, it actively interacts with various cities in Daejeon, Chungcheongbuk-do, and Chungcheongnam-do, increasing its influence on the size of the economy and surrounding cities. Despite the importance of Sejong City, economic analysis after its establishment of Sejong City is still insufficient. Sejong City is expected to have clear regional characteristics in the public administration sector and research and development (R&D) for construction purposes. The education service industry is expected to revitalize because of the characteristics of the newly created city. Therefore, by using the 2015 Korean Multiregional Input-Output table, this study analyzes the industrial structure of Sejong City and Sejong's industrial characteristics and economic relations with other regions by measuring the industrial linkage between Sejong City and Chungcheong area, Seoul metropolitan area, and other regions by major industry.

1. Introduction

1. Sejong City's Basic Information

Sejong Special Self-Governing City is a Korean independent administrative district established on July 1, 2012, in parts of Chungcheongnam-do and Chungcheongbuk-do. Its goal is to create a planned city to alleviate the excessive concentration of population and economic power in the metropolitan area. As a result, several government organizations and national research and development institutes relocated from Seoul to Sejong City as part of the government's planned city policies. Sejong is made up of a multifunctional administrative city and other suburban areas, with the multifunctional administrative city housing most government organizations and research institutes.

Sejong City, which had a population of approximately 110,000 as of December 2012, had a population of over 370,000 as of December 2021, making it the fourth-largest city in the Chungcheong area after Daejeon, Cheongju, and Cheonan. The first purpose of establishment, the construction of administrative capital, was canceled, but most central administrative organizations, except for the National Assembly, the Blue House, and some administrative organizations, were relocated from Seoul. Between 2012 and August 2020, 44 central administrative organizations, 17,000 employees, 15 national research institutes, and 3,600 people were relocated to Sejong City (Figure 1).

2. Why is research on Sejong City necessary?

The centralization of metropolitan areas is a challenge many countries face, but South Korea is one of the more severe cases. According to Statistics Korea's [Population Census] data, as of 2020, 50.2% of

South Korea's total population lives in the Seoul metropolitan area (Seoul, Incheon, Gyeonggi-do) as of 2020. Moreover, according to Statistics Korea's National Accounts statistics, the Seoul Metropolitan Area accounts for 52.0% of Korea's gross regional domestic product (GRDP). Given this situation, metropolitan cities in each region serve as the region's economic center. Expanding the size of each region's economy is critical in overcoming the phenomenon of centralization in the metropolitan area. The Korean government attempts to achieve balanced development in each region through the Planned City and Innovation City policies.

Furthermore, rising housing prices, environmental pollution, and traffic congestion are serious issues in metropolitan areas due to population and economic concentration, while regional imbalances such as population decline, economic power, and weakening education intensify in other regions.

The economic evaluation of Sejong City is a measure of balanced national development. Article 1 of the SPECIAL ACT ON ESTABLISHMENT, ETC. OF SEJONG SELF-GOVERNING CITY, it says, "The purpose of this Act is to rectify side effects of excessive concentration into the Seoul metropolitan area and promote regional development, the balanced development of the State, and the enhancement of national competitiveness by establishing Sejong Self-Governing City as a multifunctional administrative city." (Korean Law Information Center) As a result, because its establishment aims to promote balanced national development, Sejong City's economic structure and industrial relations with other regions can be viewed as an evaluation of how well the government's balanced national development promotion policy is working.

The Chungcheong area, geographically located in central Korea, is growing in population and economic size. According to their geographical location, Korea's 17 administrative districts are divided into Seoul metropolitan areas, Chungcheong, Jeolla, Gyeongsang, Gangwon, and Jeju areas. Except for the Seoul metropolitan area, the size of the Gyeongsang area vastly exceeds that of the rest of the region; therefore, the Gyeongsang area is divided into northern and southern regions, which are further subdivided into the Gyeongbuk and Gyeongnam areas. Except for Gangwon and Jeju, both small in population and economy, the Chungcheong area is the smallest of these areas. However, as part of the government's balanced national development, several innovation cities, including Daejeon, have been built, and the size of the Chungcheong area has grown. As a result, it has become the third-largest area after the metropolitan and Gyeongnam areas. Nevertheless, it was difficult to assess whether the Chungcheong area formed a single economic zone such as Gyeongnam because it relied heavily on the metropolitan area rather than the region's strong economic relationship. Because the original goal of Sejong City was to establish administrative capital in Chungcheong Province to resolve and develop the underdeveloped local economy, it is critical to assess whether the Chungcheong area has become less reliant on the metropolitan area and the economic relationship between Sejong City and the rest of the country.

As stated previously, one of the primary goals of Sejong City is to promote balanced regional development by relocating government administrative agencies and national research institutes. Therefore, when evaluating the growth of Sejong City, it is necessary to divide the target industries and

assess how much growth has been achieved in the public administration sector as intended by the government. Furthermore, when assessing balanced regional development, it is necessary to consider how industrially close the newly established Sejong City is to the economic area to which it belongs.

As the Multiregional Input-Output (MRIO) analysis uses data by dividing the entire Korean economy by industry and region, it is possible to analyze the growth of the public administration sector and others in Sejong City by industry. Furthermore, it is possible to examine how the notable industries of Sejong City affect other regions of Korea. As a result, in this study, an economic evaluation of Sejong City was conducted using MRIO analysis.

2. Previous Study

Few studies have examined Sejong City economically, and none have examined Sejong City using input-output tables. This may be because few papers in Korea use the regional input-output table, and the Bank of Korea only published the MRIO table, including Sejong City, in August 2020. (Bank of Korea, 2020)

Kim et al. (2017) examined the economics of Sejong City. This study aimed to investigate how the relocation of public institutions, including Sejong City, to the regional economy affected regional economic growth. The panel fixed effect analysis model was used to assess whether the relocation of government-owned companies to the multifunctional administrative city (Sejong City) and Innovation City would positively affect the regional base employment rate, local revenue, and GRDP. The analysis revealed a significant effect on local revenue but no effect on the basic employment ratio or gross regional product.

Various studies on specific industries in a particular region of Korea have been conducted if the target region is not limited to Sejong City. Lee (2012) identified the steel, electronics, and textile industries as the leading manufacturing industries in Gyeongbuk based on value-added and total output. The 2005 MRIO table in Korea examines forward and backward linkage effects in three major industries. According to the findings, the three primary industries in the Gyeongbuk region had the highest correlation with the metropolitan area, followed by the adjacent southeastern region (Gyeongnam region). Furthermore, Kim (2016) used Korea's MRIO in 2013 to analyze the impact of research and development (R&D) consumption in each region on areas and industries in Korea, which is considered one of the main industries in Sejong City. Analyzing production, value-added, and import inducement effects into direct and indirect sectors reveals that the total R&D output in each region of Korea is low compared to the GRDP, and the economic inducement effect by final demand(FD) is also low in both forward and backward linkage effects.

The hypothetical extraction method (HEM) used in this study has been used in several previous studies. Yu et al. (2017) used industry linkage analysis to estimate the economic linkage effect of the spatial information industry. It is impossible to extract and analyze only the numerical values corresponding to the spatial information industry as the classification criteria of the Input-Output (IO) Table in the case of the spatial information industry. Consequently, the economic impact of the spatial information industry

was estimated by matching each industry in the industry classification in the IO table, excluding the number of workers in the industry, and comparing the results to the current value. Furthermore, Byeon et al. (2017) measured the total employment-related effects that occurred when each industry was excluded and the total employment-related effects of social services and discovered industries with strong correlations with social services.

3. Objective

Various studies have been conducted on Sejong City before and after its establishment. Still, most of them analyzed the expected effect of the establishment of Sejong City before the establishment or focused on population movement or real estate after the establishment of Sejong City. Since its establishment, there have been very few studies dealing with industries in Sejong City using actual data. Therefore, this thesis attempts to analyze Sejong City using an MRIO table, an effective tool for analyzing the regional economy.

This study selected public administration and defense, R&D, and education services as the three major industries related to Sejong City. Public administration and R&D industries are expected to grow the most as the government relocates government organizations and national research institutions. Thus, the industry is where the characteristics of Sejong City are most visible, and an examination of these industries is required. Furthermore, public institutions relocating to Sejong City aim to grow the relevant industries in Sejong City and develop the Chungcheong region economy. As a result, to assess the economic impact of Sejong City, it is necessary to consider the changes in those industries and the inducement effect on other industries and regions as major industries grow. This study uses IO analysis to examine how major industries in Sejong City affect each local economy and industry.

Construction and education services are affected by the foundation of Sejong City, besides public administration, defense, and R&D. In addition to public organization buildings, the construction industry is Sejong City's main industry, with plans to build 200,000 houses to meet the city's population goal of 500,000. In the case of the education service industry, as is typical of the Korean economy, the scale of both private and public education has increased primarily in densely populated cities. Although not a direct government target industry, the education service industry is likely to grow in Sejong City. However, the construction industry, a feature of all new cities, is expected to grow slowly during the construction period and contract in size in the future. The construction industry is not expected to have a long-term impact on Sejong City's growth and the surrounding areas. Consequently, the education service industry was chosen as one of the three main industries in this study.

4. Model And Data

The IO tables are statistical tables that record the trade relationship between industries for a certain period in a matrix format according to certain principles. Analyzing the interdependence between industries using this IO table is called IO analysis or industrial linkage analysis. The Bank of Korea

released the 2015 benchmark year table and has since released the updated table every year until the 2019 version (Bank of Korea, 2020)

An MRIO table was used for the IO analysis for each region. The MRIO table is an IO Table prepared to reflect the different production technology structures and transaction types by region and to analyze the interdependence between regions and industries. The latest Korean table is the 2015 table, using the 2015 benchmark year IO table.

This study measured the impact of Sejong City's specific industry on other regions by production inducement and value-added inducement (VAI) effects through the IO table. Assuming that A^d is multi regional input coefficient, x is the gross output by region, and y is the final domestic demand, their relationship is as follows:

$$A^d x + y = x \quad (1)$$

As a result, the equation for the total output x is as follows.

$$x = (I - A^d)^{-1} y \quad (2)$$

$(I - A^d)^{-1}$ is called the production inducement coefficient or Leontief inverse matrix. In addition, the value-added can be expressed by the equation $v = \hat{A}^V x$, and the following expression can be derived by substituting the expression obtained above for x . In the above equation, \hat{A}^V is the diagonal matrix of the value-added rate.

$$v = \hat{A}^V (I - A^d)^{-1} y \quad (3)$$

Assuming that the number of regions is n , the number of industries is m , the number of items of final demand is 1, $(I - A^d)^{-1} y$ is $(m * n) \times n$ matrix, and a_{ij}^k is the output of industry k input from region i to region j . Because it is an intermediate input from region i for the final demand of region j , it corresponds to the interregional export of industry k to region j in region i and the interregional import of industry k to region i in region j . If this element a_{ij}^k is divided by the final domestic demand y_j^k for industry k in area j , the production inducement effect (PI) for industry k in area i by the final demand of industry k in area j is obtained.

HEM is a methodology that evaluates the importance of a specific industry by estimating its disappearance from the overall economy and measuring how it affects other industries or regions. This method can make various assumptions depending on the purpose of the study and the industry and regional structure of the object being analyzed. This study assumes that the intermediate input, demand, and final demand of the target industry in Sejong City become zero. The effect when the target industry is

extracted is calculated by finding the PI effect and VAI effect after the assumption and measuring how different the results are from the existing results.

Assume that a_{ij}^k is the intermediate input of industry k from area i to area j , and y_j^k is the final demand of industry k in area j and assume that the target region to be analyzed is S and the target industry is T. When the hypothetical extraction method is applied to industry T in region S, the existing elements x_{ij}^k and y_j^k change, as follows:

$$a_{iS}^T = a_{Sj}^T = 0, \forall i, j \quad (4a)$$

$$y_S^T = 0 \quad (4b)$$

Assuming that the new input coefficient modified in the above way is \bar{A} and the final demand is \bar{y} , the equations to determine the new PI effect and VAI effect are as follows:

$$\bar{x} = \left(I - \bar{A} \right)^{-1} \bar{y} \quad (5a)$$

$$(5b)$$

$$\bar{v} = \bar{A}^V \left(I - \bar{A} \right)^{-1} \bar{y}$$

Finally, the change in the PI effect and VAI effect by the HEM can be obtained by subtracting the existing effect from the modified effect. The above HEM calculation yields negative results for each region. This regional result is the loss of each region's production and VAI effect when industry T is excluded from region S. Consequently, the smaller the corresponding value (the greater the absolute value), the greater the impact of the presence of industry T in region S in the corresponding region.

In this study, Korea's MRIO table for 2015 was used to analyze the economic effects of Sejong City. The IO table of Korea, produced by the Bank of Korea, began in 1960, and the MRIO table was produced in 2003. The 2010 and 2013 tables were created for 16 regions in Korea based on the 2010 benchmark year table because Sejong City was not yet established in the 2010 benchmark year. The 2015 MRIO table, including that of Sejong City, was published in 2020.

The 2015 Korean MRIO table was divided into 17 regions, including Sejong City. In terms of industry classification, the 2015 IO table consists of 33 large categories, 83 medium-sized categories, 165 small categories, and 381 basic categories. However, the basic classification is omitted from the regional table; therefore, the 2015 Korean MRIO is divided into 17 regions and 181 industrial classifications.

5. Result

1. Growth and inducement effect of the entire industry in Sejong City

Before examining the industrial relationship between Sejong City and other regions, it is necessary to understand the industrial structure of Sejong City and the Chungcheong Area. Table 1 shows the overall industrial structure of Sejong and other regions in the Chungcheong area. The industry is broadly classified into five types, among which three service industries belonging to the industry of major interest in this study are additionally indicated. Among them, the R&D industry belongs to business services.

Table 1

Changes in the industrial structure of the Chungcheong Area

unit: %

	<i>Sejong</i>		<i>Daejeon</i>		<i>Chungcheong</i>		<i>Chungcheong</i>		<i>Domestic</i>	
	2013	2020	2013	2020	2013	2020	2013	2020	2013	2020
<i>Agriculture, forestry and fishing</i>	3.1	1.3	0.1	0.1	4.3	2.8	4.6	4.1	2.3	1.9
<i>Mining & Manufacturing</i>	35.7	22.9	17.1	16.3	43.8	48.8	54.3	50.6	30.4	27.2
<i>Electricity, gas, steam and air conditioning supply</i>	1.8	1.5	0.9	1.1	0.4	0.9	3.5	4.0	1.6	1.7
<i>Construction</i>	20.2	11.2	4.4	5.1	5.6	5.8	6.1	6.2	5.0	6.0
<i>Services</i>	39.2	63.2	77.4	77.4	45.9	41.7	31.4	35.0	60.8	63.2
<i>Business services</i>	3.7	5.1	17.1	19.4	5.4	5.4	4.3	4.9	9.0	10.1
<i>Public administration and defense</i>	14.7	30.3	9.9	10.4	8.5	8.9	5.1	6.7	6.3	7.3
<i>Education</i>	5.3	6.7	8.1	7.2	6.1	5.2	4.2	4.3	5.5	5.2

First, in the case of Sejong City, the share of manufacturing and service industries was similar at the time of its foundation, but the service industry gradually grew significantly. In the case of the public administration and defense industry, the main industry of Sejong City at the time of its creation was

relatively high compared to other regions. Public administration and defense have grown significantly, accounting for a higher proportion than the overall manufacturing industry and about half of the service.

In the case of construction, it was very high in 2013, reflecting the characteristics of the newly created city, but it gradually decreased. Business services, including R&D, showed slight growth. Educational services also grew slightly, accounting for a higher share than the Korean average.

In the entire Chungcheong area, Daejeon and Sejong had a service-oriented industrial structure, whereas Chungcheongbuk-do and Chungcheongnam-do had manufacturing-oriented industrial structures. The government established Daejeon and Sejong, which has the goal of balanced national development, and moved the science and engineering-oriented R&D industry to Daejeon. Most administrative institutions in Sejong, Chungcheongbuk-do, and Chungcheongnam-do are manufacturing industries supplied to the geographically adjacent Seoul metropolitan area. Because it is a product factory, the proportion of the manufacturing industry is relatively high.

Table 2 shows I production and VAI effect by the final demand of Sejong City (export effect) and the production and VAI effect in Sejong City by the final demand in other regions (import effect)

Table 2

Production Inducement (PI) Effects by Region in Sejong City

unit: billion won, %

	PI by Sejong's FD [Exports]	Sejong's PI By FD	Net Exports [Imports]	PI % by Sejong's FD	Sejong's PI % By FD
Seoul	1,400	2,265	-865	16.1	14.1
Incheon	369	588	-218	4.2	3.7
Gyeonggi	1,911	2,416	-505	17.1	19.2
Daejeon	1,702	2,201	-499	15.6	17.1
Sejong	9,267	9,267	-	-	-
Chungcheongbuk-do	515	680	-165	4.8	5.2
Chungcheongnam- do	1,246	2,104	-858	14.9	12.5
Gwangju	181	172	9	1.2	1.8
Jeollabuk-do	254	472	-218	3.3	2.6
Jeollanam-do	207	452	-245	3.2	2.1
Daegu	215	195	21	1.4	2.2
Gyeongsangbuk-do	390	764	-374	5.4	3.9
Busan	312	494	-181	3.5	3.1
Ulsan	681	533	148	3.8	6.8
Gyeongsangnam-do	320	501	-181	3.6	3.2
Gangwon	192	202	-10	1.4	1.9
Jeju	56	68	-12	0.5	0.6

Note: PI = Production Inducement; FD = Final Demand

Except for Gwangju and Daegu, Sejong City's imports exceeded their exports. Gyeonggi has the greatest PI effects on both exports and imports. The four regions of Seoul, Gyeonggi, Daejeon, and Chungcheongnam-do outperform the other regions in both exports and imports. In the case of Chungcheongbuk-do, despite being in the same area, none displayed high values. Import and export effects had the greatest impact in the Seoul metropolitan area, accounting for 37.4% and 37.0%,

respectively, and in the Chungcheong area, accounting for 35.3% and 34.8%, respectively. In all areas, Sejong's imports exceeded exports (Table 3).

Table 3

Value Added Inducements (VAI) by Region in Sejong

unit: billion won, %

	VAI by Sejong's FD [Exports]	Sejong's VAI By FD [Imports]	Net Exports	VAI % by Sejong's FD	Sejong's VAI % By FD
Seoul	446	1,049	-603	14.3	18.6
Incheon	94	187	-93	3.0	3.3
Gyeonggi	481	973	-492	15.4	17.3
Daejeon	783	1,208	-425	25.1	21.4
Sejong	2,903	2,903	-	-	-
Chungcheongbuk-do	203	239	-36	6.5	4.2
Chungcheongnam-do	471	825	-354	15.1	14.6
Gwangju	49	65	-16	1.6	1.1
Jeollabuk-do	60	133	-73	1.9	2.4
Jeollanam-do	56	137	-81	1.8	2.4
Daegu	66	66	0	2.1	1.2
Gyeongsangbuk-do	94	228	-135	3.0	4.0
Busan	84	155	-72	2.7	2.8
Ulsan	81	121	-41	2.6	2.2
Gyeongsangnam-do	72	146	-74	2.3	2.6
Gangwon	60	75	-16	1.9	1.3
Jeju	19	31	-13	0.6	0.6

Note: VAI = Value Added Inducement; FD = Final Demand

The result of the VAI amount in Sejong City is similar but slightly different from the production inducement amount. This is similar to the fact that the import effect is greater than the export effect in almost all regions. The four regions of Seoul, Gyeonggi, Daejeon, and Chungcheongnam-do are significantly greater than those of other regions. However, in terms of VAI, Daejeon has the highest figures in both exports and imports, whereas Gyeonggi has the highest figures in production inducement. In addition, Chungcheongbuk-do ranked fifth in both exports and imports for VAI instead of production inducement.

The Chungcheong and metropolitan areas are reversed in terms of area, so both export and import effects are greatest in the Chungcheong area. When the two regions are combined, the export effect is 79.5%, and the import effect is 79.5%, which are greater than the production inducement. (74.4% and 70.1%, respectively) In contrast to the production inducement, the Gyeongnam area showed no significant difference, despite being slightly higher than the other areas except the metropolitan and Chungcheong areas.

2. Inducement effect in Sejong City's major industries

Table 4 lists the production inducements effect in public administration and defense of Sejong.

Table 4

Sejong's PI effect in Public Administration and Defense

unit: million won, %

	PI by Sejong's FD [Exports]	Sejong's PI By FD [Imports]	Net Exports	Regional Exports %	Regional Imports %
Seoul	4,431	1,285	3,146	14.8	12.9
Incheon	1,458	414	1,044	4.9	4.2
Gyeonggi	6,092	1,646	4,446	20.4	16.5
Daejeon	3,041	2,443	598	10.2	24.5
Sejong	1,664,507	1,664,507	-	-	-
Chungcheongbuk-do	1,311	376	935	4.4	3.8
Chungcheongnam-do	3,429	670	2,759	11.5	6.7
Gwangju	658	126	533	2.2	1.3
Jeollabuk-do	824	448	376	2.8	4.5
Jeollanam-do	992	452	540	3.3	4.5
Daegu	834	182	652	2.8	1.8
Gyeongsangbuk-do	1,206	455	751	4.0	4.6
Busan	1,171	307	864	3.9	3.1
Ulsan	2,291	76	2,215	7.7	0.8
Gyeongsangnam-do	1,231	343	887	4.1	3.4
Gangwon	630	622	8	2.1	6.2
Jeju	315	112	202	1.1	1.1

Note: PI = Production inducement; FD = Final Demand

PI effects in the region occupy a considerable portion of the public administration and defense industry. Sejong is induced in 98.2% of the cases based on exports and 99.4% based on imports. Excluding the effect of regional production inducement, the export effect is in the order Gyeonggi, Seoul, Chungcheongnam-do, and Daejeon, and the import effect is in the order Daejeon, Gyeonggi, and Seoul.

Table 5 shows the Value added Inducement Effect in Public Administration and Defense in Sejong.

Table 5

Sejong's VA Inducement Effect in Public Administration and Defense

unit: million won, %

	VAI by Sejong's FD [Exports]	Sejong's VAI By FD [Imports]	Net Exports	Regional Exports %	Regional Imports %
Seoul	1,258	997	261	14.8	13.1
Incheon	414	328	86	4.9	4.3
Gyeonggi	1,729	1,234	495	20.4	16.3
Daejeon	863	1,637	-774	10.2	21.6
Sejong	472,481	472,481	-	-	-
Chungcheongbuk-do	372	308	64	4.4	4.1
Chungcheongnam-do	973	546	428	11.5	7.2
Gwangju	187	107	80	2.2	1.4
Jeollabuk-do	234	378	-145	2.8	5.0
Jeollanam-do	282	324	-43	3.3	4.3
Daegu	237	149	88	2.8	2.0
Gyeongsangbuk-do	342	378	-36	4.0	5.0
Busan	332	260	72	3.9	3.4
Ulsan	650	66	584	7.7	0.9
Gyeongsangnam-do	349	282	67	4.1	3.7
Gangwon	179	496	-317	2.1	6.5
Jeju	89	95	-5	1.1	1.2

Note: VAI = Value Added Inducement; FD = Final Demand

In the public administration and defense industries, the VAI effect, like the PI effect, accounts for an absolute proportion of the inducement effect in the region. Within Sejong City, 98.2% of the total export effect and 98.4% of the import effect were induced. Gyeonggi, Seoul, Chungcheongnam-do, and Daejeon had the greatest export effects, while Daejeon, Gyeonggi, and Seoul had the greatest import effects. This appears to be comparable to the production-inducement effect.

The next target industry is R&D. Although it does not occupy as much weight as the public administration and defense industries, the government relocated research institutes as part of its planned city policy. Sejong City has minimal PI effects in the R&D industry. This is equivalent to 4.8% based on exports and 3.5% based on imports. In the case of the import effect, 92.3% of Gyeonggi was concentrated, while Chungcheongnam-do was concentrated in 54.9% of the export effect. Except for Gyeonggi, the export

effect is greater than the import effect in all regions. However, the import effect in Gyeonggi accounts for a disproportionately large proportion, so Sejong has a larger import effect overall.

The PI effect Regions in R&D in Sejong can be seen in Table 6 whereas the VA Inducement Effect in R&D are presented in Table 7.

Table 6

Sejong's PI effect Regions in Research and Development

unit: million won, %

	PI by Sejong's FD [Exports]	Sejong's PI By FD [Imports]	Net Exports	Regional Exports %	Regional Imports %
Seoul	18,380	2,307	16,073	5.7	0.5
Incheon	2,003	1,035	969	0.6	0.2
Gyeonggi	59,269	418,615	-359,346	18.3	92.3
Daejeon	22,083	8,357	13,727	6.8	1.8
Sejong	16,318	16,318	-	-	-
Chungcheongbuk-do	8,695	26	8,669	2.7	0.0
Chungcheongnam-do	177,997	23,129	154,868	54.9	5.1
Gwangju	7,082	21	7,061	2.2	0.0
Jeollabuk-do	5,065	19	5,046	1.6	0.0
Jeollanam-do	4,169	20	4,149	1.3	0.0
Daegu	3,298	23	3,274	1.0	0.0
Gyeongsangbuk-do	7,453	2	7,451	2.3	0.0
Busan	1,650	10	1,640	0.5	0.0
Ulsan	2,049	21	2,027	0.6	0.0
Gyeongsangnam-do	3,563	18	3,546	1.1	0.0
Gangwon	969	115	854	0.3	0.0
Jeju	665	2	663	0.2	0.0
Note: PI = Production Inducement					

Table 7

Sejong's VA Inducement Effect in Research and Development

unit: million won, %

	VAI by Sejong's FD [Exports]	Sejong's VAI By FD [Imports]	Net Exports	Regional Exports %	Regional Imports %
Seoul	10,944	1,620	9,324	5.7	0.6
Incheon	1,193	687	506	0.6	0.3
Gyeonggi	35,293	243,212	-207,919	18.3	91.5
Daejeon	13,150	4,710	8,440	6.8	1.8
Sejong	9,717	9,717	-	-	-
Chungcheongbuk-do	5,177	17	5,160	2.7	0.0
Chungcheongnam-do	105,991	15,254	90,737	54.9	5.7
Gwangju	4,217	14	4,203	2.2	0.0
Jeollabuk-do	3,016	14	3,002	1.6	0.0
Jeollanam-do	2,482	13	2,469	1.3	0.0
Daegu	1,964	17	1,947	1.0	0.0
Gyeongsangbuk-do	4,438	1	4,437	2.3	0.0
Busan	983	7	975	0.5	0.0
Ulsan	1,220	14	1,206	0.6	0.0
Gyeongsangnam-do	2,122	12	2,110	1.1	0.0
Gangwon	577	82	494	0.3	0.0
Jeju	396	1	394	0.2	0.0

Note: VAI = Value Added Inducement; FD = Final Demand

Similar to the PI effect, the VAI effect is insignificant in the region. The import effect on Gyeonggi was very large (91.5%), the export effect was more than half in Chungcheongnam-do, and the proportion of Gyeonggi was also very high.

Combining the results of the R&D industry in Sejong's production and VAI effects, the R&D industry in Sejong is closely related to Chungcheongnam-do and Gyeonggi. Compared to the export effect to other

regions or the import effect from other regions, the inducement effect within Sejong City occupied a very small proportion. In terms of the export effect, the export effect to Chungcheongnam-do accounted for more than half of the total. In contrast, the import effect was greater than that of Gyeonggi-do, which recorded an overwhelming figure of more than 90%.

Table 8 shows the PI effect in Education Services in Sejong and Table 9 shows the VAI Effect in Education Services.

Table 8

Sejong's PI effect in Education Services

unit: million won, %

	PI by Sejong's FD [Exports]	Sejong's PI By FD [Imports]	Net Exports	Regional Exports %	Regional Imports %
Seoul	4,660	5,202	-542	0.8	0.8
Incheon	2,376	411	1,964	0.4	0.1
Gyeonggi	8,216	2,170	6,046	1.4	0.3
Daejeon	534,403	659,034	-124,630	89.7	98.0
Sejong	1,347	1,347	-	-	-
Chungcheongbuk-do	10,284	2,276	8,008	1.7	0.3
Chungcheongnam-do	17,899	1,224	16,675	3.0	0.2
Gwangju	464	215	249	0.1	0.0
Jeollabuk-do	2,318	333	1,985	0.4	0.0
Jeollanam-do	1,664	196	1,468	0.3	0.0
Daegu	1,063	254	809	0.2	0.0
Gyeongsangbuk-do	5,164	377	4,786	0.9	0.1
Busan	771	361	410	0.1	0.1
Ulsan	623	206	417	0.1	0.0
Gyeongsangnam-do	2,781	295	2,487	0.5	0.0
Gangwon	2,607	182	2,424	0.4	0.0
Jeju	260	56	204	0.0	0.0

Note: PI = Production Inducement; FD = Final Demand

The educational services industry has a strong industrial relationship with Daejeon. In the exports effect, 89.7% of the total inducement effect, and in the effect of the import, 98.0% of the total inducement effect corresponded to Daejeon. In each region, the export effect was greater than the import effect in all regions, except Seoul and Daejeon. The PI effect in Sejong City by the final demand in Sejong City was not large compared with that in Daejeon and other regions. This phenomenon can be interpreted as a large dependence on Daejeon because the educational infrastructure in Sejong City is not well established, as the infrastructure for schools or private education is provided after the city is stably established.

Table 9

Sejong's VAI Effect in Education Services

unit: million won, %

	VAI by Sejong's FD [Exports]	Sejong's VAI By FD [Imports]	Net Exports	Regional Exports %	Regional Imports %
Seoul	3,224	3,419	-195	0.8	0.7
Incheon	1,643	286	1,358	0.4	0.1
Gyeonggi	5,683	1,507	4,177	1.4	0.3
Daejeon	369,674	456,068	-86,394	89.7	98.0
Sejong	932	932	-	-	-
Chungcheongbuk-do	7,114	1,579	5,535	1.7	0.3
Chungcheongnam-do	12,381	848	11,533	3.0	0.2
Gwangju	321	147	174	0.1	0.0
Jeollabuk-do	1,604	235	1,369	0.4	0.1
Jeollanam-do	1,151	143	1,009	0.3	0.0
Daegu	735	178	557	0.2	0.0
Gyeongsangbuk-do	3,572	272	3,300	0.9	0.1
Busan	533	258	275	0.1	0.1
Ulsan	431	136	295	0.1	0.0
Gyeongsangnam-do	1,924	213	1,711	0.5	0.0
Gangwon	1,803	132	1,672	0.4	0.0
Jeju	180	39	141	0.0	0.0

Note: VAI = Value Added Inducement; FD = Final Demand

Similar results were obtained for value-added induction. Both the import and export effects of Daejeon were overwhelmingly high, and there was little value-added effect in Sejong. Even except for Daejeon, which accounts for an overwhelming proportion of educational services, the industrial relationship with the adjacent regions, Chungcheongbuk-do and Chungcheongnam-do, was relatively closer than that of the metropolitan area.

3. Hypothetical Extraction Method effect in Sejong City's major industries

Assuming that the intermediate demand, intermediate input, and final demand of the three major industries in Sejong City disappear, the change in the production-inducement effect in each region is shown in Table 10.

Table 10

Change in PI effects in each region when major three industries in Sejong are extracted

unit: million won

	Public Administration and Defense	R&D	Education Services
Seoul	-391,398	-35,148	-60,141
Incheon	-65,394	-9,301	-12,746
Gyeonggi	-239,815	-33,210	-47,480
Daejeon	-204,130	-18,920	-34,398
Sejong	-291,128	-26,444	-53,090
Chungcheongbuk-do	-71,226	-8,904	-14,533
Chungcheongnam-do	-296,644	-27,494	-50,597
Gwangju	-19,588	-2,502	-3,339
Jeollabuk-do	-48,636	-9,595	-8,800
Jeollanam-do	-50,110	-6,362	-8,625
Daegu	-24,386	-2,806	-4,371
Gyeongsangbuk-do	-91,680	-11,827	-13,032
Busan	-53,219	-5,964	-7,689
Ulsan	-75,953	-12,114	-10,349
Gyeongsangnam-do	-50,601	-5,994	-8,129
Gangwon	-25,118	-2,472	-4,755
Jeju	-12,492	-1,352	-2,195
Domestic Total	-2,011,520	-220,409	-344,271

The decrease in the overall PI effect was in the following order: public administration and defense, education services, and R&D. Since the final demand of each industry is excluded, the decrease in demand increases according to the size of the major industries. Among all the regions, the decrease in the PI effect was the largest in Seoul for all industries. After Seoul, the regions most affected by each

industry differed slightly. In public administration, defense, and education services, Chungcheongnam-do and Sejong were greatly affected, and in R&D, Gyeonggi-do showed a large decrease.

The change in the VAI effects in each region when major three industries in Sejong are extracted is shown in Table 11.

Table 11

Change in VAI effects in each region when major three industries in Sejong are extracted

unit: million won

	Public Administration and Defense	R&D	Education Services
Seoul	-198,352	-16,684	-28,438
Incheon	-24,846	-3,359	-4,574
Gyeonggi	-107,290	-13,723	-18,874
Daejeon	-104,593	-9,076	-15,297
Sejong	-116,293	-11,910	-24,948
Chungcheongbuk-do	-30,692	-3,785	-5,597
Chungcheongnam-do	-147,419	-10,829	-20,410
Gwangju	-9,059	-1,072	-1,490
Jeollabuk-do	-16,919	-3,372	-2,985
Jeollanam-do	-19,339	-2,321	-3,342
Daegu	-10,495	-1,109	-1,758
Gyeongsangbuk-do	-32,427	-4,171	-4,792
Busan	-21,109	-2,449	-3,408
Ulsan	-24,506	-3,520	-3,433
Gyeongsangnam-do	-18,690	-2,219	-3,069
Gangwon	-11,831	-1,118	-2,127
Jeju	-6,244	-678	-1,007
Domestic Total	-900,104	-91,396	-145,549

The decrease in the VAI effect was also large in the following order: public administration and defense, education services, and R&D. Among the regions, all three industries showed the largest decrease in value added in Seoul. However, there was a slight change in second-tier regions. In Public Administration and

Defense and Education Services, the decrease in production inducement was similar to Sejong and Chungcheongnam-do. For value-added inducement, the decrease in Chungcheongnam-do in Public Administration and Defense and the decrease in Sejong in Education Services appeared large. Similar to the production-inducement effect, R&D showed a large decline in Gyeonggi-do. On the other hand, Chungcheongbuk-do was less affected than the metropolitan area or other regions in the Chungcheong area in both the production induction VAI and VAI effects.

6. Conclusion

In this study, we used the 2015 Korean MRIO table to examine the industrial relationship between Sejong City and other South Korean regions, as well as the inter-regional industrial relationship between Public Administration and Defense, R&D, and Education Services, chosen as the main industries of Sejong City. Using HEM, we also examined the change in the inducement effect on each region when Sejong City was excluded.

The findings of this study are as follows. First, Sejong City has a strong industrial relationship with Seoul, Gyeonggi, Daejeon, and Chungcheongnam-do, identified as a production and VAI effect. However, in the case of Chungcheongbuk-do, it was discovered that the industrial relationship with Sejong City is not strong, which is thought to be due to the characteristics of Chungcheongbuk-do's economic structure which is centered on manufacturing industries.

Second, when examining only the three major industries, we concluded that there are almost no industrial relationships between other regions within the industry for both production and VAI effects in the public administration and defense industry. In the case of R&D, the Gyeonggi-do and Chungcheongnam-do regions are closely related to Sejong City, whereas, in the case of Education Service, Sejong City has an extremely close relationship with Daejeon.

Finally, the HEM was used to determine how the three major industries would affect the entire region if each major industry in Sejong City were to be eliminated. Consequently, all three industries had the largest value-added effect in Seoul. Following Seoul, the most influential regions were Chungcheongnam-do for Public Administration and Defense, Gyeonggi-do for R&D, and Sejong for educational services. In the case of public administration, defense, and R&D industries, which are representative industries that have relocated from the metropolitan area, many office workers commuted to and from other regions in 2015 without completing their migration to Sejong City. These results are thought to be a result of this factor.

Combining these results, Sejong City has a very high industrial relationship with the Seoul and Gyeonggi regions as of 2015, as its central industries have moved from the metropolitan area. In addition, as it is geographically close, the industrial relationship between Chungcheongnam-do and Daejeon is also strong. The public administration and defense industries, which have grown significantly since the establishment of Sejong City, have had a significant impact on the growth of Sejong City rather than

affecting other regions, helping to develop the economic scale of Sejong City. Additionally, assuming the absence of major industries in Sejong, it affects the metropolitan and Chungcheong areas evenly.

The industrial relationship between Sejong City and other regions was identified in this study using the Korean Multi-regional Input-Output Table in 2015. Still, there is a possibility that there are some insufficient points due to the timeliness of statistics. Sejong City was established in July 2012, and official statistics have been released since 2013. The relocation of government offices was incomplete in 2015. Given that the population and economic size have been steadily increasing since 2015, if there is a more up-to-date MRIO table, the results will be significantly different from the results of this analysis, and a comparative analysis will be able to derive the characteristics of each industry more accurately.

The following sections address the timeliness problem in the MRIO table. The construction industry accounts for a significantly higher proportion than other regions; the public administration and defense industries have a relatively low GRDP ratio compared to 2020, and the effects of production and VAI appear higher in other regions than in their own regions. If the most recent MRIO table and the table used in this study are analyzed concurrently, a more accurate and in-depth evaluation of Sejong City is possible.

Abbreviations

FD: final demand; GRDP: gross regional domestic product; HEM: hypothetical extraction method; IO: input–output; MRIO: Multi regional input output; PI: production inducement; R&D: research and development; VAI: value-added inducement

Declarations

Availability of data and materials

The datasets generated and analyzed during the current study are available from the Bank of Korea's Economic Statistics System repository, <http://ecos.bok.or.kr/>.

Competing interests

The author declares that they have no competing interests.

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Author's contributions

Lee Seongha calculated data, analyzed results, and wrote the manuscript. Ishiro Taku checked the calculation data and its plausibility, and inspected the graph and manuscript.

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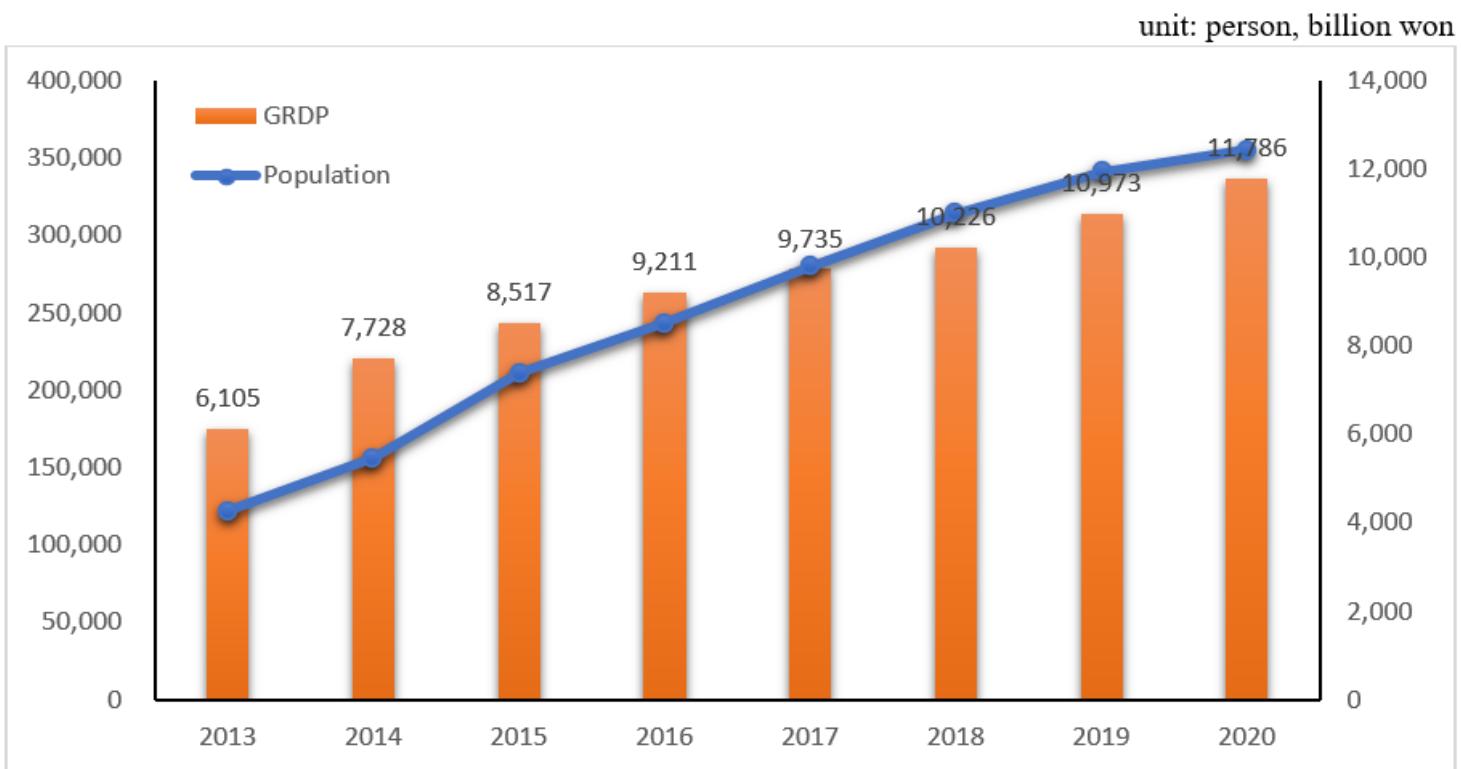
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Figures

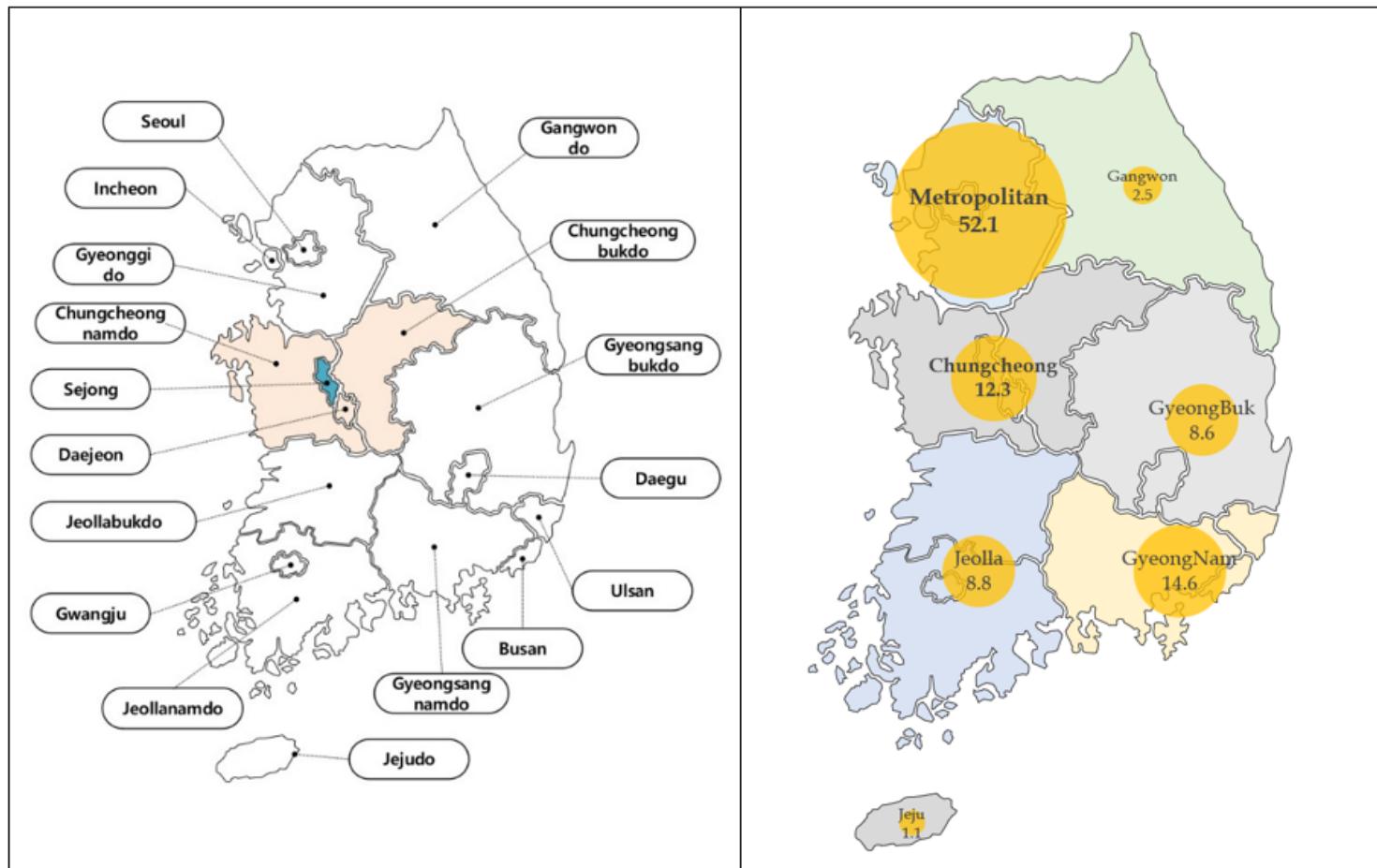


Data: Korean Statistical Information Service (kosis.kr)

Figure 1

Population and GRDP Changes in Sejong City

data: Korean Statistical Information Service (kosis.kr)



Data: Korean Statistical Information Service (kosis.kr)

Figure 2

Administrative divisions of Korea and GRDP share distribution

data: Korean Statistical Information Service (kosis.kr), <https://pathifinding.co.kr>