



# The Analysis of the Industrial Structures of Pyongyang\*

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## Abstract

Although it is crucial, the industrial status of Pyongyang has never been analyzed. Many articles have proposed strategies for industrial cooperation between the two Koreas, however, the feasibility of such cooperation is low without a detailed analysis of the situation. This study scrutinizes Pyongyang's industrial structure by mainly utilizing the data from the North Korean census, which included the number of working inhabitants by region and industry in the country. These data have been used by few studies related to this subject. Pyongyang's agglomerated industry and human resources, along with the level of industrial diversity, were calculated using the aforementioned data. The following are industrial characteristics of Pyongyang that were observed when compared to cities and countries with a similar gross domestic product (GDP) per capita. From our observations, first, it is estimated that there is a higher rate of manufacturing productivity. Second, the agglomerated industry in Pyongyang further focuses on knowledge intensive fields such as science and technology activities and the information and communication industry than its counterparts. Finally, a noted urbanization effect in the city can be attributed to industrial diversity. The implications of these results can lead to significant improvement in the policies regarding industrial cooperation between the two Koreas.

**Keywords** Pyongyang, Industry, Location Quotient (LQ), North Korea, Entropy Index  
**주제어** 평양, 산업, 입지계수, 북한, 엔트로피 지수

## 1. Introduction

There is no clear answer to the seemingly straightforward question "What are Pyongyang's specialized industries?" The reason is simply due to the lack of data. North Korea does not disclose its statistics related to industrial status.

As such, existing studies faced the issue because of the limitation of data availability. For instance, Shin (2009) estimated the input-output tables of North Korea by combining the 2008 data to the already estimated the input-output

tables prior to 2007. The studies conducted without relevant statistical data cannot ensure the reliability of the analysis results as it adds estimations to the previous estimations, which is regarded as the common limitations of the existing studies. The studies that did not adopt the estimation of macro indices mainly used the information of North Korea's official media outlet (Lee and Lee, 2014) and the interview footage of North Korean defectors (Hong et al., 2016). These studies are useful in roughly understanding the industrial status of North Korea. However, the only partial

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analysis focused either on a specific region or industry and cannot generalize the entire industrial status of North Korea. Furthermore, there are some limitations such as the lack of North Korea's media credibility and the limited number of interview samples.

Therefore, to overcome these problems, this study used the data on the number of the working population by region and industry and the population with tertiary education by region which are included in the 2008 North Korea census data, which wasn't previously used in a lot of studies. Although the data is 13 years old as of 2021, it can still be useful in analyzing the industrial status of Pyongyang and North Korea when there is no publicly available statistical data, and it will help conduct quantitative analysis by supplementing the limitations of existing studies.

The analysis of Pyongyang's industrial structures is required because of the following rationale. First, since the financial resources available for investment in North Korea are limited, the investment should be prioritized with a focus on industries with large implications (Shin et al., 2014), and the results of regional industrial structure analysis serve as a basis for policy decisions. For example, if the transportation infrastructure is proactively established in an area with a high level of wholesale and retail trade industry aggregation, it is easy to spread the ripple effect of the wholesale and retail industry to the surrounding area due to an efficient distribution system. Similarly, if the communication network infrastructure is created in an area with a high level of information and communication industry agglomeration, the ripple effect of information distribution can increase, thereby creating external benefits. Stepwise investment plans for regional SOC can also be developed by identifying industries that are highly concentrated by region or that are evenly distributed.

Second, specific inter-Korean industrial cooperation policies can be formulated. When proposing a network economic region between Seoul and Pyongyang (Min, 2013), more concrete industrial policies can be included in the area of strategic cooperation with Seoul if Pyongyang's specialized industries are understood. However, if there is no analysis result on the industry, a detailed strategy cannot be drawn up.

This study analyzed Pyongyang's agglomerated industry, human resources, industrial scale in the region, and level of

industrial diversity based on the aforementioned data. On the basis of the analysis results, the characteristics of Pyongyang's industry were observed by comparing Pyongyang and other provinces in North Korea and comparing Pyongyang city with other capital cities across the globe in terms of industry. As such, this study aims to analyze Pyongyang's industrial structures and characteristics. Although this study does not propose a new hypothesis or theory, it is significant in that it targets the Pyongyang industry, which has not been thoroughly analyzed in the past, as a research subject and presents the results of quantitative analysis.

The following chapters are outlined as follows. Chapter 2 describes the limitations of existing studies and the uniqueness of this study stemming from the data and methodology used in this study. Chapter 3 describes the methodology to quantitatively analyze the industrial structures of Pyongyang. Chapter 4 discusses the industrial characteristics and analysis results of Pyongyang identified from various comparisons. Chapter 5 presents the conclusions and implications when inter-Korean cooperation is considered.

## II. Review of previous studies

There are few studies on the urban structure of Pyongyang or inter-city cooperation with Pyongyang (Hwang, 2020; Kwak and Moon, 2018; Min, 2013). Since, no study has investigated the industrial characteristics of Pyongyang, the scope of review of existing studies was expanded to those that analyzed the industry of North Korea.

Existing studies that examined North Korean industries can be categorized into '*studies on individual industries*' and '*studies on industrial structure*'. Studies on an individual industry are mainly focused on investigating the location, status, and development history of a specific industry. Since they focus on microscopic aspects of the industry, all of them used the data from interviewing North Korean defectors or literature review as a methodology.

Research on industrial structure mainly analyzes the industrial structure of North Korea based on macroeconomic indices such as the number of population, GDP, and estimated input-output tables, and predicts the change in North Korea's industrial structure through a comparative study with transition countries and development of scenarios for each type of the industrial structure.

## 1. Individual industry analysis

Lee and Lee (2014) identified the establishment or closure of companies based on the names of individual companies cited in the *Rodong Sinmun* and official North Korean media and estimated the number of companies by region in North Korea, including Pyongyang. The status of manufacturing, mining, and energy industries was examined, and it was noteworthy that the manufacturing sector was investigated after it was subdivided into 12 sub-categories. The investigation was carried out for each province and Pyongyang as a city. Furthermore, as a follow-up study continues by Lee et al. (2018), time series changes in some industries can be investigated. Hong et al. (2016) identified the status of the official markets in North Korea by a rough assumption of the location of the official markets based on interviews with North Korean defectors and then comparing it with satellite images of Google Earth.

By estimating the number of official markets, location, regional distribution, and the number of workers by province and city, the status of wholesale and retail business and the logistics and distribution structure in North Korea were identified. Lee (2017) analyzed the classifications of service industries in North Korea and the status of management authorities using North Korean literature and interviews with North Korean defectors. Yoon (2019) used the data from the National Statistical Office to examine the status of North Korea's electric power industry. It was pointed out that the shortage of electricity supply was the main cause of North Korea's economic hardship, and predicted the electricity demand for each scenario type by applying the scenario methodology. Kang (2020) analyzed the changes in the tourism industry using North Korean tourism-related literature, North Korean laws, and media coverage. It discovered that the tourism industry is growing as a counter-strategy to the deteriorating foreign trade balance due to the sanctions against North Korea, and analyzed the spatial characteristics and limitations of the tourism development zone. As such, the individual industry analysis has in common that the scope of research is focused on a small number of specific industries and that the status of industries was investigated at a microscopic level.

## 2. Industrial structure analysis

Shin (2009) conducted research based on the Bank of Korea's estimates of the economic growth rate in North Korea and the data from the Ministry of Unification on the comprehensive evaluation of the North Korean economy. The input-output tables of North Korea were estimated by applying the principle of cross-entropy minimization. The social accounting matrix was estimated and the accounting multiplier for investment in North Korea was identified based on the estimated input-output tables. Shin et al. (2014) estimated the input-output tables in North Korea and analyzed the forward and backward linkage effects by industry. As a result, it was found that both the light industry and primary metal industry in North Korea have high forward and backward linkage effects. On the other hand, the machinery and electronics industries showed low forward and backward link effects. Consequently, it was concluded that the investment priority in the former is high whilst the priority is low in the latter.

Kim and Lee (2008) found that the industrial structure of North Korea was mainly centered on the heavy industry from the establishment of the regime to right before the end of the Cold War, however, since 2000, the agriculture and forestry, light industry, trade and service industries have grown, diversifying major industries. Jung and Yoon (2004) pointed out that North Korea has pursued an imbalanced growth strategy that prioritizes the heavy industry related to the military industry over other industries since the Korean War, and the resulting industrial structure acts as an obstacle to hamper the economic growth of North Korea. North Korea's heavy industry-oriented policy that both Kim and Lee (2008) and Jung and Yoon (2004) pointed out, helps understand the background in which the manufacturing industry takes up a large share of the industries in Pyongyang and North Korea.

Lee et al. (2014) selected Nampo, Cheongjin, Sinuiju, Rason, and Wonsan as major base cities in North Korea based on city population, city location, and socioeconomic characteristics. Furthermore, considering the development cases of transition countries abroad, the study proposed the industries to be strategically fostered and the urban development promoters. Unlike previous studies, it analyzed the industrial structures considering the size and location of cities, and understood the implications from the transition

cases of the base industry among the development cases of transition countries abroad. Park et al. (2019) examined the industrial status of North Korea based on macroeconomic indicators such as GDP, GDP per capita, population, and GDP contribution rate by industry, and presented macroscopic indices and industry forecasts based on the scenarios. Further, the study predicted the economic growth rate according to the growth scenario of North Korea's GDP and projected the development stage by industry to present the demand for the labor force by industry.

### 3. Uniqueness of this study

Previous studies had common limitations as follows. First, the reliability of the analysis results. Although the interview data used in individual industry studies provide detailed information on industries in the region where North Korean defectors resided, it is likely to be inaccurate for non-resident areas. The study of industrial structure conducted estimation such as a scenario analysis in addition to the use of macroeconomic indices estimation data as the basis, indicating poor reliability of the analysis result.

Second, it is impossible to determine the industrial status by region. There was no information at the city and provincial level in North Korea in the data used in the industrial structure analysis based on macroeconomic indicators. This made it impossible to analyze the industrial structure at the city and provincial level, and only the analysis results at the national level were presented. Therefore, information such as the level of agglomeration and the diversity of industries in each region could not be identified.

Third is the difficulty of generalization. In the study of individual industries, it is difficult to generalize the industrial status due to a small number of interview samples, and impossible to compare the study results with other cities and countries as the industry classification developed for the study is different from the Korean standard industry classification.

This study enhanced the reliability of the estimation with quantitative indicators derived from the North Korean census. Furthermore, this study is significant in that it generalizes the industrial structure of Pyongyang using data on working population by region and industry and population with tertiary education in North Korea, and compares the industrial structure with other countries and areas other

than Pyongyang to present the analysis results on the industrial characteristics of Pyongyang.

## III. Research method

### 1. Research data

In 2008, North Korea conducted the second census. There is no information on the working population by region or industry in the 1993 census data, and there is no census data open to the public from 2008 to 2021. Therefore, a time series analysis of changes in the industrial structure of Pyongyang cannot be conducted. Although the analysis is based on single-year data, this study helps address the difficulties of generalizing the industrial structure which previous studies faced.

As shown in <Table 1>, the 2008 North Korean census data shows 12,184,720 North Korean working population aged 16 and over, by grouping them into 18 industries and regionally into 9 provinces and Pyongyang city. The 18 industrial classifications used in the census are consistent with the 21 major classifications of the Korean Standard Industrial Classification. “Real estate industry”, “activities of households as employers & undifferentiated producing activities of households for own use”, and “activities of extraterritorial organizations and bodies” are not included in the 18 industry classifications, and “membership organizations, repair and other personal services” in the Korean Standard Industrial Classification is denominated as “Other service industry”.

Pyongyang city and nine provinces of North Korea were the focus of this study. As such, the industry classification of the North Korean census data is almost akin to the Korean standard industry classification, and can be used in the industry comparisons with other countries including South Korea since the Korean standard industry classification is built based on the International Standard Industry Classification of the United Nations Statistics Office (Statistics Korea, 2021). The Central Bureau of Statistics (2009) states that the census data applied the UN Principles and Recommendations on Census of Population and Housing (2<sup>nd</sup> Revision) with necessary modifications to prepare the questionnaire. However, due to the social and cultural background of North Korea, there are some limitations that the industry classification used in the census may be interpreted

Table 1. Working population 16 years old and over by major industry group

Unit: person

Industry	DPR Korea	South Phyongan	Pyongyang	South Hamgyong	North Phyongan	North Hamgyong	South Hwanghae	North Hwanghae	Kangwon	Ja gang	Ryang gang
All industry groups	12,184,720	2,149,974	1,660,667	1,597,885	1,458,191	1,226,316	1,199,874	1,088,581	744,519	691,981	366,732
Agriculture, forestry and fishing	4,386,895	676,771	224,639	641,750	602,637	377,032	697,379	496,895	313,999	228,486	127,307
Mining and quarrying	718,195	258,754	37,422	121,829	58,941	91,598	41,184	42,425	21,748	21,443	22,851
Manufacturing	2,882,982	579,856	478,723	340,432	369,678	318,749	166,265	221,466	132,340	223,116	52,357
Electricity, gas, steam and air conditioning supply	149,569	35,643	18,503	19,137	12,577	15,052	10,015	10,074	9,600	11,755	7,213
Watersupply; sewerage, waste management and remediation activities	66,713	12,378	25,539	6,520	5,426	5,246	2,109	3,641	2,650	1,532	1,672
Construction	367,650	65,089	97,414	36,363	35,544	34,679	23,196	38,220	14,940	13,554	8,651
Wholesale and retail trade; repair of motor vehicle	557,355	72,157	82,321	96,051	67,254	60,421	34,126	57,071	38,439	32,643	16,872
Transportation and storage	355,383	59,802	76,237	45,110	27,585	57,944	16,988	19,100	19,817	16,050	16,750
Accommodation and food service activities	141,205	24,234	37,448	11,514	12,184	19,833	8,203	8,341	9,228	5,263	4,957
Information and communication	126,775	13,569	41,870	12,601	9,970	11,001	8,102	9,178	7,275	6,784	6,425
Financial and insurance activities	26,228	4,253	4,336	3,003	2,381	2,668	2,464	2,596	1,391	1,743	1,393
Professional, scientific and technical activities	118,132	17,182	57,421	13,248	6,085	6,759	3,696	5,283	3,234	1,904	3,320
Administrative and support service activities	451,336	64,876	67,288	53,240	48,500	49,302	36,343	39,062	33,944	33,293	25,488
Public administration and defense; compulsory social security	724,178	101,631	199,501	66,350	81,431	58,430	53,920	45,486	71,260	25,568	20,601
Education	548,132	78,878	85,864	68,582	63,441	56,943	52,301	47,830	31,872	36,628	25,793
Human health and social work activities	330,702	53,241	62,322	36,550	35,165	37,938	27,425	26,085	17,010	21,112	13,854
Arts, entertainment and recreation	130,582	12,378	46,143	12,305	9,884	11,398	8,557	9,219	8,965	5,794	5,939
Other service activities	102,708	19,282	17,676	13,300	9,508	11,323	7,601	6,609	6,807	5,313	5,289

Source: Central Bureau of Statistics (2009)

in a way that is different from other countries. For example, the working patterns and the details of the job between North Korean and South Korean workers in professional, scientific and technical activities may differ from each other.

Data on population with tertiary education by region and field of study included in the 2008 census were also used. Population with tertiary education is an indicator that

shows the status of human resources that can be mobilized in a city and a variable that shows the potential of regional economic development. This study identified the status of human resource agglomeration by region by applying the same formula to estimate the location quotient (LQ) of industries to the population with tertiary education.

As shown in <Table 2>, 2,972,852 North Korean residents

**Table 2.** Population 16 Years old and over with at least 3 years of post-secondary education by field of study Unit: person

Field of study	DPR Korea	Pyongyang	South Phyongan	South Hamgyong	North Phyongan	North Hamgyong	North Hwanghae	South Hwanghae	Kangwon	Ja gang	Ryang gang
Total	2,972,852	693,376	438,698	361,624	304,851	298,771	238,531	232,729	180,844	122,142	101,286
Teacher training and education science	591,387	91,342	91,049	60,801	70,007	65,687	58,390	64,189	40,620	30,288	19,014
Arts	57,021	34,031	3,488	3,995	2,371	3,039	3,222	1,720	1,756	1,640	1,759
Humanities	67,919	31,440	4,415	11,659	3,552	2,378	2,609	1,515	2,459	2,345	5,547
Social and behavioural science	87,148	27,481	9,821	6,583	10,800	7,870	3,106	10,008	6,688	2,524	2,267
Journalism and information	2,055	1,487	97	112	66	75	67	37	55	20	39
Business and administration	220,533	60,375	35,136	21,721	19,387	18,041	23,119	11,368	14,015	8,229	9,142
Law	8,054	3,901	736	599	543	492	397	568	305	228	285
Life sciences	13,738	7,122	895	1,858	648	490	762	418	611	293	641
Physical sciences	46,405	15,708	5,156	7,424	2,973	4,375	3,946	2,071	1,656	1,353	1,743
Mathematics and statistics	49,930	15,067	5,546	9,521	3,538	3,633	3,186	1,875	2,724	1,987	2,853
Computing	26,432	16,303	1,756	2,846	1,173	1,380	711	634	816	534	279
Engineering and engineering trades	594,041	149,972	105,010	83,071	59,590	71,807	34,220	25,883	26,385	25,637	12,466
Manufacturing and processing	138,297	36,878	23,603	15,421	12,663	14,536	11,999	8,261	6,147	3,804	4,985
Architecture and building	80,184	26,068	10,728	8,563	6,718	8,080	6,197	5,242	4,191	2,225	2,172
Agriculture, forestry and fishery	463,951	44,738	63,331	64,304	60,400	39,716	46,455	64,086	39,395	20,633	20,893
Veterinary	26,984	4,860	4,608	3,643	2,980	2,881	2,279	1,760	2,037	1,034	902
Public health	273,324	61,274	43,580	31,836	27,245	27,540	23,390	20,360	16,062	11,547	10,490
Social services	716	97	140	64	239	30	51	27	43	15	10
Welfare services	61,536	25,470	5,555	5,159	4,112	5,078	4,708	3,096	3,302	2,617	2,439
Transport services	57,572	14,722	8,997	7,777	4,888	11,117	3,107	1,881	2,962	875	1,246
Environmental protection	839	331	92	110	40	102	76	24	18	23	23
Security services	99,140	24,414	14,959	12,146	10,848	9,949	5,952	7,519	8,427	3,217	1,709
Not known or unspecified	5,646	295	0	2,411	70	475	582	187	170	1,074	382

Source: Central Bureau of Statistics (2009)

aged 16 and over with at least 3 years of tertiary education are classified into Pyongyang city and nine provinces and 23 fields of study. Furthermore, the UN statistics data, census data by country, and international statistical data from Statistics Korea were used to analyze the industrial status of Pyongyang and North Korea.

## 2. Analysis method

Location Quotient (LQ) is an indicator showing how much a specific industry is agglomerated in a region. It can be calculated with Equation (1) (Choi, 2004). Equation (1) divides the proportion of the industry *i* in region *j* by the proportion of the industry *i* in the country. Variables for location quotient calculation may include the number of businesses, production amount, and the number of employees depending on the purpose of the study (Cho et al., 2019).

*Location Quotient (LQ)*

$$= \frac{\text{working population of region } j \text{ in industry } i \div \text{working population of region } j}{\text{working population of country in industry } i \div \text{working population of country}} \quad (1)$$

When analyzing the location quotient, a value of 1.0 indicates that the level of agglomeration of the corresponding industry is equal to the average. There are no clear criteria to determine whether an industry is agglomerated, but in general, if the location quotient is 1.25 or higher, it is regarded that the corresponding industry is reasonably more agglomerated than other regions (Segarra-Oña et al., 2012; Mans et al., 2008; Park et al., 2015). Choi (2004) pointed out that it should be carefully interpreted when the overall industrial scale of the analysis region is small. In this case, even a small concentration of a specific industry can be classified as an agglomerated industry. To overcome the limitations of the location quotient interpretation as mentioned above, Cho et al. (2019) identified an agglomerated industry of Seoul if that industry satisfies both “relative and absolute” criteria. The relative criteria were set for the location coefficient exceeding 1.0 based on the number of businesses or employees. Three absolute criteria were set for the number of corporations of 100 or more, the ratio of the working population in Seoul to that of South Korea exceeding 2%, the ratio of the working population of a specific industry to the industrial

size of Seoul exceeding 3%. Satisfying two or more of the three criteria was set as the conditions of satisfaction the absolute criteria.

In this study, if both the relative and absolute criteria in <Table 3> were satisfied, the industry was identified to be significantly more agglomerated than other regions considering the criteria adopted by previous studies. As for the relative criteria, the location quotient of 1.25 was used which is more stringent than 1.0 that has been widely used in other studies. Unlike Cho et al. (2019), the number of corporations was not taken into account in the absolute criteria, since the North Korean census data does not contain the number of companies by region. The reason why the ratio of the industry to the total industrial size of the region was reduced from 3% to 2% is that in most developing countries the industries are less diversified compared to developed countries and some industries account for a large proportion of the economy. Therefore, if the conditions of satisfaction for the ratio of the industry to the total industrial size of the region is considerably increased, it will make it difficult to identify agglomerated industries by region.

To measure the level of agglomeration of human resources by region, the working population by industry in Equation (1) was replaced with the population with tertiary education by field of study of <Table 2>, and <Table 3> was used as the criteria to determine the level of agglomeration.

The working population per 1,000 people can be used when comparing the absolute value of the industrial size for each region by standardizing the industrial size based on 1,000 people in a situation where population varies by city and province. The working population per 1,000 people is calculated using Equation (2).

Working Population by industry per 1,000 people

$$= \frac{\text{working population of region } j \text{ in industry } i \times 1,000 \text{ (person)}}{\text{Resident population of region } j \text{ (person)}} \quad (2)$$

**Table 3.** Criteria to measure agglomeration

Division	Contents
Relative criteria	• Location quotient ≥ 1.25
Absolute criteria	• Size of the industry larger than 2% in relation to the national industry • Ratio of the industry is 2% greater than in relation to the local industry





First, there is a wide gap between the agglomeration levels of industry and human resources. Eight industries and human resources in eight fields of study are concentrated in Pyongyang. It can be assumed that the urbanization economy effect, an agglomeration effect between different industries, would be at play since various industries and human resources are evenly distributed. Furthermore, it is considered that the human capital externalities (Enrico, 2014) created by a high level of human capital will be greater than that of other regions. The location quotient of 6 out of 8 agglomerated industries hovered above 1.9, indicating a high level of agglomeration.

〈Table 4〉 shows the inequality of industrial distribution among 18 industries. The minimum value of the entropy

index in relation to inequality of industrial distribution is 0, and the closer to 0, the more the industrial distribution is concentrated in a small number of regions. The maximum value is  $\ln(N)$ , and considering that N is 10, the number of North Korean cities and provinces, the maximum value is  $\ln(10)$ , which is equal to 2.3. It shows that the closer to 2.3, the more evenly distributed the industry is across North Korea. 〈Table 4〉 indicates that the industries such as professional, scientific and technical activities, information and communication industry, and construction industry agglomerated in Pyongyang are highly concentrated in a small number of regions compared to other industries.

In other words, it can be assumed that the industries with a low entropy index in 〈Table 4〉 among the agglomerated industries in Pyongyang are underdeveloped in other regions of North Korea. Only one or two industries are mostly agglomerated in regions other than Pyongyang, and no industry shows the high level of agglomeration with the location quotient of above 1.9, except for the mining and quarrying industry in South Phyongan Province. Whilst the agglomeration of human resources in three fields was found in some regions, some other regions did not show any agglomeration. As a result, it can be seen that there is quite a big difference between Pyongyang and non-Pyongyang regions in terms of the size and level of agglomeration of industries and human resources.

Second, the nature of the agglomeration field is different. As can be seen in 〈Figure 1〉, many of Pyongyang's agglomerated industries are knowledge and technology-intensive industries. Professional, scientific and technical activities, information and communication industry, construction industry, and arts, entertainment and recreation industry are typical industries that require knowledge and technologies. The agglomeration of knowledge and technology-intensive industries outside of Pyongyang was only found in the education sector in Ryanggang Province and the manufacturing industry in Jagang Province. Most agglomerated industries in regions other than Pyongyang are labor-intensive industries such as agriculture, forestry and fishing, transportation and storage, and mining industries, whose nature are different from the agglomerated industries in Pyongyang. The agglomerated knowledge and technology-intensive industries in Pyongyang are also highly related to the agglomeration of human resources. In Pyongyang,

**Table 4.** Inequality of industrial distribution of North Korea

Industry	Entropy index in relation to inequality of industrial distribution	Agglomeration in Pyongyang
Professional, scientific and technical activities	1.71	○
Water supply; sewerage, waste management and remediation activities	1.89	
Mining and quarrying	1.94	
Arts, entertainment and recreation	2.05	○
Information and communication	2.08	○
Construction	2.09	○
Accommodation and food service activities	2.10	○
Public administration and defense; compulsory social security	2.11	○
Transportation and storage	2.13	○
Manufacturing	2.15	
Electricity, gas, steam and air conditioning supply	2.19	
Agriculture, forestry and fishing	2.19	
Other service activities	2.20	
Human health and social work activities	2.21	○
Wholesale and retail trade; repair of motor vehicle	2.21	
Financial and insurance activities	2.23	
Education	2.24	
Administrative and support service activities	2.26	

the agglomeration of human resources takes place in eight fields of study - engineering and natural science such as computer science, physics, architecture, and mathematics and statistics. These fields of study are highly related to the agglomerated industries such as professional, scientific and technical service, information and communication, and construction industries.

Agglomeration of human resources in arts is also associated with the arts, entertainment and recreation industry, and also the human resource in the welfare services is related to the agglomeration of the human health and social work activities industry. This shows that there is a close relationship between the supply of human resources and the agglomerated industry in Pyongyang. Outside of Pyongyang, the only agglomeration of human resources in the fields of engineering and natural science focused on mathematics, statistics and physics in South Hamgyong Province and mathematics and statistics in Ryanggang Province, and no other agglomeration of human resource was found in the field of engineering and science.

Third, the ratio of industrial composition and the level of industrial diversity differ from other regions. The industrial size was compared based on the working population per 1,000 people. In Pyongyang, there were 510 workers per 1,000 people, and 147 of them were engaged in the manufacturing industry with the highest working population. This is equivalent to 28.8% of all working population. The industry with the second-highest number of workers was agriculture, forestry and fishing, with 69 workers. This represents 13.5% of all working population which is very different from the fact that the working population in the agricultural, forestry and fishing industry exceeds 30% in most regions other than Pyongyang. The combined working population in the two industries above accounts for 42.3%, which does not surpass half of all workers in Pyongyang. Other industries showed relatively even industrial size. Unlike Pyongyang, all regions except for Pyongyang had common features as follows. The industry with the largest number of workers is the agriculture, forestry and fishing industry, followed by the manufacturing industry. Furthermore, the combined ratio of working population in the agriculture, forestry, fishing and manufacturing industries exceeded 48%, nearly half of the total number of workers in the region. As such, using the entropy index, whether some industries dominate the entire

industrial ecosystem in the region and whether various industries are evenly distributed can be quantified and compared. The entropy indices for each region of Pyongyang and North Korea calculated by Equation (3) are shown in <Table 5>.

Here, the minimum value of the entropy index is 0. Closer the value to 0 indicates that a small number of industries dominate most of the industrial ecosystem in the region. The maximum value is  $\ln(N)$ , and considering that  $N$  is 18, the number of industries, which is equal to 2.89. The closer the value to 2.89 indicates that the industrial ecosystem in the region is evenly filled with various industries.

Pyongyang's industrial diversity index is very high compared to other regions. This shows that various industries are evenly distributed in Pyongyang. The entropy index in Ryanggang, North Hamgyong, South Phyongan, and Kangwon exceeded 2.0, indicating a higher level of industrial diversity when compared to other regions. It is assumed that the above results were obtained as the manufacturing industry in Ryanggang, North Hamgyong, South Phyongan, and Kangwon Province is developed at a level similar to the agriculture, forestry and fishing industry and other industries are evenly distributed despite the high proportion of the agriculture, forestry and fishing industry.

## 2. Comparison with other countries

This study conducted a comparative analysis with other countries to investigate the industrial structures of Pyongyang and North Korea. The World Bank classifies countries into four groups based on GNI per capita. North Korea

**Table 5.** Industrial diversity by region of North Korea

Region	Entropy index (=Industrial diversity)
Pyongyang	2.40
Ryanggang	2.27
North Hamgyong	2.14
South Phyongan	2.06
Kangwon	2.00
South Hamgyong	1.99
Jagang	1.95
North Phyongan	1.89
North Hwanghae	1.88
South Hwanghae	1.63

belongs to a low-income economy, along with Burkina Faso, Afghanistan, and Somalia. Southeast Asian countries, such as Vietnam, Cambodia, and Laos, are classified as the lower middle-income group, a group right above North Korea (World Bank, 2021b). In terms of GNI and GDP per capita, North Korea can be considered as a typical developing country. Comparison countries were listed based on GDP per capita. By setting North Korea's GDP per capita as the median, the comparison group in <Table 6> consisted of the top 15 countries with GDP per capita higher than that of North Korea and the bottom 15 countries with GDP per capita lower than that of North Korea. The base year was set as 2008 when the census was conducted in North Korea, and the industrial ratio in Pyongyang was estimated based on the working population in the 2008 census data, instead of GDP. The average GDP per capita of the comparison group is \$1,043, similar to North Korea's GDP per capita of \$1,029, indicating that the comparison group was appropriately selected.

Since only countries are included in the comparison groups, it may not be appropriate to include Pyongyang, a city, in the comparison target in <Table 6>. However, Pyongyang was included in the analysis to identify the industrial status in the city in the absence of industrial composition data by city and industry of each country. Among various industries, only the ratios of the agriculture, forestry and fishing, manufacturing, and service industries are selected and listed in <Table 6>, hence, the total ratio of the three industries is less than 100%.

As a result of comparing the industrial ratio between countries, Pyongyang and North Korea are characterized by their high proportion of manufacturing. As can be seen from the average values of 30 countries in <Table 6>, the comparison group mainly had a low proportion of manufacturing and a high proportion of service industry. Before explaining this in detail, it is worthwhile to point out a few things regarding the interpretation of the indicators. In the analysis results above, it was explained that there are a number of knowledge and technology-intensive industries in Pyongyang's agglomerated industry. Further, it was explained that Pyongyang's industry had a high proportion of manufacturing compared with other countries. These descriptions may be seen as contrary to each other. However, the index used to examine the characteristics of a

**Table 6.** Industrial compositions of developing countries

Country	GDP per capita (US \$)	Agriculture, forestry and fishing (%)	Manufacturing (%)	Service industry (%)
North Korea	1,029	21.6	22.5	32.2
Pyongyang	-	13.5	28.8	46.9
Average value of 30 countries	1,043	22.2	11.2	45.7
Nicaragua	1,499	16.3	14	52.9
Senegal	1,412	14.5	17.1	54
Zambia	1,394	11.5	8.5	49
Comoros	1,388	29.1	-	55.8
Cameroon	1,372	13.1	12.2	50.8
Sudan	1,305	24.5	5.4	38.7
Cote d'Ivoire	1,236	22.7	14.3	52.9
Yemen	1,229	8.7	7.8	28.4
Djibouti	1,224	-	-	-
Ghana	1,211	29.4	7.5	46.2
Solomon Islands	1,208	-	-	-
Vietnam	1,149	20.4	18.6	42.5
Benin	1,121	26.8	12.2	43.8
São Tomé and Príncipe	1,099	9.9	6.6	68.4
Uzbekistan	1,082	19.7	-	41.4
India	999	16.8	17.1	45.9
Pakistan	991	22.5	14.8	53.1
Kyrgyz	966	23.5	13.2	45.8
Chad	926	54.6	0.8	32.6
Gambia	925	29.8	5.6	53
Kenya	902	22.2	12.1	50.1
Laos	900	24.2	10.1	44.1
Lesotho	885	5.5	21.6	54.2
Cambodia	746	32.8	15.3	38.8
Tajikistan	716	19.9	-	43.9
Guinea	715	16	12.7	43.7
Mali	694	33	2.5	36.7
Tanzania	687	24.8	8.7	43.7
Haiti	679	22.2	9.5	24.2
Burkina Faso	641	27.3	13	45.1

Source: Korean Statistical Information Service (2020); Korean Statistical Information Service (2021b); Korean Statistical Information Service (2021c)

knowledge and technology-intensive industry is location quotient, and the data used to explain the high proportion of manufacturing is the ratio of agriculture, forestry and

fishing, manufacturing, and service industries to the total industries for each country. The location quotient represents the ‘relative degree of specialization’ of an industry by comparing the proportion that a specific industry in a given region with the proportion of the specific industry nationwide (Cho et al., 2019). On the other hand, the ratios of agriculture, forestry and fishing, manufacturing, and service industries simply show the size of each industry rather than a comparison between the ratios of a region to the country. Therefore, it is not contradictory that Pyongyang’s agglomerated industry and large-size industry are found to be knowledge and technology-intensive industries, and manufacturing industries, respectively.

The manufacturing ratios of North Korea and Pyongyang are 22.5% and 28.8%, respectively, higher than the averages of other countries with similar economic levels. North Korea’s manufacturing ratio of 22.5% is the highest among the 30 countries in the comparison group, and Pyongyang’s manufacturing ratio is higher than that of the average of North Korea. It can be said that GDP per capita represents the labor productivity reasonably well in North Korea in which the added values of natural resource-based industries and tourism-based industries are low (Lee, 2019). Considering its high proportion of manufacturing among countries with similar GDP per capita, a proxy indicator for labor productivity, and the accumulation experience while maintaining 17-31% of a high manufacturing ratio between 1990 and 2020 (Korean Statistical Information Service, 2021e), North Korea’s manufacturing sector is expected to have greater productivity than countries with similar economic level. Szirmai and Verspagen (2015) found that the manufacturing industry has a positive (+) impact on economic growth, and that the interaction term between manufacturing and education has a significant effect on the growth. Based on these, it is considered that the high proportion of manufacturing in Pyongyang and North Korea is expected to have a positive impact on North Korea’s economic growth going forward. It was the year 1977 when South Korea’s GDP per capita was similar to that of North Korea (\$1,055) (World Bank, 2021a). As for the working population by industry in Seoul in 1977, 1.2% of the population worked in the agriculture, forestry and fisheries, 31.3% in the mining and manufacturing industry, and 67.5% in SOC and other service industries (Seoul Institute, 2021). Although the aforementioned industry

classification is different from the industry classification in <Table 6>, it was discovered that when the per capita GDP of Pyongyang and Seoul were similar, the proportion of manufacturing was relatively high in the total industries.

The high manufacturing ratios in North Korea and Pyongyang stem from the industrial structure of socialist countries in the early 1990s. <Table 7> shows the proportion of each industry as well as GDP in the early 1990s in socialist countries that have undergone regime transition. The base year in <Table 7> is the year at which statistics were collected after the regime transition took place, which is within 5 years after the transition. Thus, the base year of some countries is different from the time of transition. Countries with a point of transition and base years of available data exceeding 5 years were excluded from the table.

The average manufacturing ratio in all transition countries is 19.6%, which is higher than that of high-income countries, OECD member countries, the global average, and least developed countries. At that time, the manufacturing ratio of transition countries in Europe was 21.2% and the manufacturing ratio in transition countries in Asia was 14.3%. In Asia, only North Korea (24.6%) and China (28%) had a high proportion of manufacturing, which is considerably higher than the average manufacturing ratio of transition countries in Europe. As such, as a socialist country, North Korea is assumed to have maintained a high manufacturing ratio as a result of pursuing a ‘heavy-industry-first’ policy for a long time which is similar to Stalin’s industrialization model (Yang, 2015).

The industrial diversity of North Korea was compared with other countries by estimating the entropy index using the UN data (United Nations Statistics Division, 2021).

In <Table 8>, the possible maximum entropy index for a country with 17 industry classifications is 2.83, and a country with 21 industry classifications records a possible maximum entropy index value of 3.04. The higher the entropy index, the less unevenly developed industries in the country, indicating that various industries are evenly developed. Although it is difficult to compare on an equal basis since the number of industrial classifications as well as the time of census by country are different, a rough comparison between countries can be made using <Table 8>.

With South Korea as a basis, all countries with high per capita GDP have an entropy index above 2.5 and it can be

**Table 7.** Industrial compositions of transition countries

Division	Country	Base year	GDP per capita (US \$)	Agriculture (%)	Manufacturing (%)	Service (%)
Asia	Cambodia	1993	254.1	45.3	8.6	39.4
	China	1992	366.5	21.3	28.0	35.2
	Laos	1989	172.5	47.5	3.8	44.4
	Mongolia	1992	587.3	25.6	18.6	33.7
	Vietnam	1990	95.2	38.7	12.3	38.6
Europe	Albania	1996	1,010.0	36.4	4.9	39.8
	Bosnia and Herzegovina	1994	319.0	35.9	11.5	38.3
	Croatia	1995	4,877.6	5.7	18.4	50.2
	Czech	1993	3,956.2	4.3	21.0	50.5
	Hungary	1995	4,494.7	7.2	18.2	51.7
	Poland	1995	3,686.8	5.6	19.4	49.1
	Romania	1991	1,260.7	18.9	31.7	32.6
	Slovak	1995	4,819.1	2.3	19.0	56.6
	Slovenia	1995	10,730.5	4.0	21.6	52.2
	Azerbaijan	1992	60.5	26.1	21.9	28.8
	Belarus	1994	1,739.8	13.6	27.0	44.4
	Estonia	1995	3,130.8	4.1	17.0	57.0
	Kazakhstan	1995	1,288.2	12.3	14.6	54.0
	Kyrgyz	1991	575.6	35.3	27.5	26.3
	Latvia	1995	2,328.2	7.8	17.6	54.2
	Lithuania	1995	2,167.8	9.9	16.7	51.3
	Moldova	1995	593.8	29.3	22.3	33.1
	Russian Federation	1992	3,098.8	7.3	24.4	48.7
	Tajikistan	1991	250.3	36.1	24.0	26.0
	Ukraine	1992	1,378.6	20.9	44.6	29.4
Comparison groups	North Korea	1992	963.1	28.5	<b>24.6</b>	23.5
	Average value of Asia	-	295.1	35.7	<b>14.3</b>	38.3
	Average value of Europe	-	2,588.4	16.1	<b>21.2</b>	43.7
	Average value of transition countries	-	2,129.7	20.0	<b>19.6</b>	42.6
	High income countries	1997	24,328.5	2.0	17.5	65.0
OECD members	1997	21,618.6	2.3	17.7	64.9	
World	1997	5,357.6	5.6	17.5	59.2	
Least developed countries: UN classification	1997	299.9	29.7	9.3	39.1	

Source: World Bank (2021c)

**Table 8.** Industrial diversity by country

Country	Entropy index (Industrial diversity)	GDP per capita (in base year, US \$)	Number of industry groups	Base year
USA	<b>2.77</b>	65,280	21	2019
Canada	<b>2.69</b>	52,224	21	2011
Germany	<b>2.62</b>	46,645	21	2011
Japan	<b>2.59</b>	34,524	18	2015
South Korea	<b>2.55</b>	31,929	19	2019
Mongolia	<b>2.48</b>	2,643	21	2010
Pyongyang	<b>2.43</b>	-	18	2008
North Korea	<b>2.08</b>	1,029	18	2008
Ghana	<b>1.89</b>	1,299	21	2010
Vietnam	<b>1.69</b>	1,217	22	2009
Kenya	<b>1.53</b>	1,817	21	2019
Nepal	<b>1.51</b>	800	17	2011
Laos	<b>1.23</b>	2,135	22	2015
Cambodia	<b>1.19</b>	746	22	2008

Source: Korean Statistical Information Service (2021d); United Nations Statistics Division (2021)

seen that they have reached a state of even development of various industries. The Jacobs' School of Thought argued that the more diverse the local industry, the more positive impact it has on the local economy (Kim and Song, 2019), and Moon et al. (2014) found that there is a positive (+) relationship between industrial diversity and economic growth in the region. In this context, it can be interpreted that the higher the entropy index that represents industrial diversity, the more positive impact it can have on a country's economy. The entropy index of the developing countries with a smaller GDP than South Korea did not surpass 2.5, and the entropy index that showed the industrial diversity of North Korea was 2.08.

Although the GDP per capita of Ghana, Vietnam, Kenya, and Laos was higher than that of North Korea, their industrial diversity was poorer than North Korea. In short, it can be said that the level of industrial diversity in Pyongyang and North Korea is relatively high compared to the GDP per capita.

〈Table 9〉 is the result of investigating the industrial diversity, the most agglomerated industry in the city, and the level of agglomeration of information and communication, professional, scientific and technical activities based on the working population by industry in Beijing, Seoul, Pyong-

**Table 9.** Comparison of industrial characteristics of capital cities

Category	City (Country)					
	Beijing (China)	Seoul (S. Korea)	Pyongyang (N. Korea)	Ho chi min (Vietnam)	Phnom pehn (Cambodia)	
Industrial diversity (=Entropy index)	2.67	2.59	2.40	2.11	2.26	
Highly agglomerated industry in the area	Leasing and business services	Information and communication	Professional, scientific and technical activities	Manufacturing	Professional, scientific and technical activities	
Agglomeration	Information and communication (LQ)	○ (4.48)	○ (2.47)	○ (2.42)	-	-
	Professional, scientific and technical activities (LQ)	○ (3.36)	○ (1.93)	○ (3.57)	-	○ (4.66)
GDP per capita of country (in base year, US \$)	3,468	21,340	1,029	1,217	1,643	
Base year	2008	2008	2008	2009	2019	

Source: Central Bureau of Statistics (2009); Central Population and Housing Census Steering Committee (2010); Korean Statistical Information Service (2021a); Korean Statistical Information Service (2021d); National Bureau of Statistics of China (2009); National Institute of Statistics (2020)

yang, Ho Chi Minh City, and Phnom Penh. As for Vietnam, the working population by industry in the census data was not formulated by city, thus the value of the southeastern region including Ho Chi Minh City was used. The maximum entropy index also varies because of the different number of major industry classifications for each country. The possible maximum entropy index values are 2.94 in Beijing and Seoul, 2.89 in Pyongyang, 3.04 in Ho Chi Minh City, and 2.89 in Phnom Penh. It indicates that the closer to the maximum value, the more evenly distributed the industrial ecosystem is with various industries in the city. The level of industrial diversity in Pyongyang was estimated to be lower than that of Beijing or Seoul. Based on the year of the survey, Vietnam's per capita GDP was higher than that of North Korea, but Pyongyang's industries were more diverse than that of Ho Chi Minh City. For Cambodia, 2019 data was used, where its GDP per capita was higher than that of North Korea in 2008. When Phnom Penh and Pyongyang were compared, North Korea's per capita GDP was lower than Cambodia's, but Pyongyang's industrial diversity is higher than that of Phnom Penh. As such, Pyongyang showed higher industrial diversity than other capitals, compared to its economic size, which can be the basis for the assumption that the urbanization effect within Pyongyang would be greater than that of other cities with a similar economic size.

According to <Table 9>, the information and communi-

cation industry was the most agglomerated industry in Seoul while it was the professional, scientific and technical activities in Pyongyang and Phnom Penh, and the manufacturing industry in Ho Chi Minh City. Beijing's most agglomerated industry was the leasing and business services followed by the information and communication industry. As such, the agglomeration of knowledge-intensive industries such as professional, scientific and technological activities, and information and communication in the capital is a universal characteristic of industries that can be found in many countries. However, the agglomeration high enough to satisfy both the absolute and relative criteria in <Table 3> was not found in Ho Chi Minh City. In Phnom Penh, the agglomeration of the professional, scientific and technical activities satisfied the criteria in <Table 3>, but no agglomeration was found in the information and communication industry. On the other hand, Pyongyang, like Beijing and Seoul, showed the agglomeration in all the professional, scientific and technical activities, and information and communication industries, indicating that Pyongyang is relatively more specialized in knowledge-intensive industries than other developing countries.

## V. Conclusions and Implications

In this study, a comparative study was conducted between Pyongyang and non-Pyongyang regions followed by North

Korea and other countries using location quotient and entropy indices in an effort to analyze the industrial characteristics of Pyongyang, a city with potential economic cooperation. As a result, the industrial structure of Pyongyang has distinctive characteristics that were different from the comparison group.

First, the agglomerated industries in Pyongyang are considered to be relatively knowledge-intensive. There are eight agglomerated industries and human resources are agglomerated in eight fields in Pyongyang. The agglomerated industry includes professional, scientific and technical activities, information and communication, and arts, entertainment and recreation. Human resources are mostly agglomerated in engineering, science and art fields. Based on this, the relation between knowledge-intensive industries and human resources can be identified. Pyongyang, similar to Beijing and Seoul, had agglomerated professional, scientific and technical activities and information and communication industries. On the other hand, such agglomeration was not found in Ho Chi Minh, and was found only in professional, scientific and technical activities in Phnom Penh. The high level of agglomeration of knowledge-intensive industry and human resources indicates that the future target industries for inter-Korean cooperation in Pyongyang do not have to be confined to labor-intensive industries. Industries related to the 4th industrial revolution should take on a strong knowledge-intensive nature with sufficient labor supply (Lee, 2019). Therefore, the Fourth Industrial Revolution-related industries that can partially satisfy the above conditions should be taken into account in the inter-Korean cooperation in Pyongyang.

Second, the productivity of the manufacturing industry is expected to be high. When comparing the productivity with 30 countries with similar economies based on the per capita GDP, the proportion of manufacturing in North Korea (22.5%) was the highest among all 30 countries. The particularly high manufacturing ratio of North Korea is considered to be attributable to its regime pursuing the heavy industry-first policy and Stalin's industrialization model, which has maintained the basic framework since the 1960s, the Cold War era (Yang, 2015). Pyongyang's manufacturing ratio (28.8%) is even higher than the average of North Korea's manufacturing ratio. It is assumed that the manufacturing productivity of Pyongyang and North Korea was

higher than that of the comparison group since North Korea showed a higher manufacturing ratio compared to other countries with similar GDP per capita, a proxy indicator for labor productivity, and maintained a high manufacturing ratio for 30 years from 1990 to 2020. In South Korea, the proportion of manufacturing in total GDP is thought to be high (27.7%), which makes it economical to consider Pyongyang as a target for reshoring of manufacturing companies and manufacturing cooperation.

Third, the level of industrial diversity is high. North Korea's industrial diversity was higher than that of the countries of similar economic size with, Pyongyang having the highest industrial diversity index in North Korea. This indicates that Pyongyang's industrial ecosystem is diversified and developed by various industries. Hence, it is assumed that the urbanization economic effect may be at play in Pyongyang, which is the agglomeration effect of different industries.

Pyongyang, the capital city of North Korea, showed some different characteristics in the industrial structure from that of other underdeveloped countries of a similar size. In particular, the high level of agglomeration in the knowledge-intensive industry and the extensively accumulated experience in the manufacturing sector are the elements that can be positively viewed considering inter-Korean economic cooperation in the future.

This study analyzed the industrial characteristics of Pyongyang using the data from the 2008 North Korean census. It carries limitations in that it failed to analyze industrial transformation as the study was conducted based on single-year data rather than time series analysis. However, the study is significant in that it generalized and measured the industrial structure that was regarded as common limitation of existing studies, using indicators, and identified the industrial characteristics of Pyongyang by comparing them with other groups. In the future, if further census data are released from North Korea, additional research on industrial transformation in Pyongyang and North Korea will be possible based on a time series analysis.

## References

- Central Bureau of Statistics, 2009. *DPR Korea 2008 Population Census: National Report*, Pyongyang: Central Bureau of Statistics.
- Central Population and Housing Census Steering Committee, 2010. *The 2009 Vietnam Population and Housing Census: Major Findings*, Hanoi: Ministry of Planning and Investment General Statistics Office.
- Cho, D.H., Joo, J.W., and Yoo, I.H., 2019. "Policies and Spatial Distribution of Start-up in Seoul", Seoul: The Seoul Institute.  
조달호·주재욱·유인혜, 2019. 「서울시 법인 창업의 입지 분포와 정책방향」, 서울: 서울연구원.
- Choi, M.S., 2004. "Location Quotient", *Planning and Policy*, 275: 59-59.  
최명섭, 2004. "입지계수 외", 「국토」, 275: 59-59.
- Enrico, Morretti, 2014. *The New Geography of Jobs*, Translated by Song, C.B., Paju: Gimmyoung.  
Enrico, Morretti, 2014. 「직업의 지리학」, 송철복 역, 파주: 김영사.
- Hong, M., Cha, M.S., Chung, E.E., and Kim, H., 2016. *North Korean Market Information: Focusing on the Official Market Status*, Seoul: KINU.  
홍민·차문석·정은이·김혁, 2016. 「북한 전국 시장 정보: 공식시장 현황을 중심으로」, 서울: 통일연구원.
- Hong, S.H., 2015. *A Study on Multi-dimensional Industrial Structure for Stable Growth of Regions*, Anyang: KRIHS.  
홍사흠, 2015. 「안정적 지역성장을 위한 다차원적 지역산업구조 분석 연구」, 안양: 국토연구원.
- Hwang, J.T., 2020. "Where is 'Gangnam of Pyongyang'?", *Journal of The Korean Association of Regional Geographers*, 26(3): 245-259.  
황진태, 2020. "「평양의 강남은 어디인가?」", 「한국지역지리학회지」, 26(3): 245-259.
- Jung, J.S. and Yoon, H., 2004. "The Present Situation and the Task of Industrial Structure in North Korea", *Journal of Industrial Economics and Business*, 17(6): 2149-2167.  
정진상·윤황, 2004. "북한의 산업구조 현황과 과제", 「산업경제연구」, 17(6): 2149-2167.
- Kang, C.Y., 2020. "Internationalization Strategy of Tourism Industry and Selective Double Structure of Cooperation in the Kim Jong-un Regime", *Journal of Northeast Asian Studies*, 25(2): 101-125.  
강채연, 2020. "김정은 시대 관광산업의 국제화전략과 협력의 선택적 이중구조", 「한국동북아논총」, 25(2): 101-125.
- Kim, S.M. and Song, C.S., 2018. "Effects of Industrial Concentration and Diversity on Economic Growth in Local Industrial Cities: Asan, Ansan, Geoje, Gwangyang City", *Modern Society and Public Administration*, 28(1): 71-107.  
김선명·송창식, 2018. "산업집중도와 산업다양성이 지방산업도시의 경제성장에 미치는 영향 분석: 아산·안산·거제·광양시를 중심으로", 「현대사회와 행정」, 28(1): 71-107.
- Kim, T.W. and Lee, K.B., 2008. "Changes and Future Prospects in Industrial Structure in North Korea", *The Journal of Asian Studies*, 11(2): 107-134.  
김태운·이강복, 2008. "북한의 산업구조 변화 추이와 향후 전망", 「아시아연구」, 11(2): 107-134.
- Kwak, I.O. and Moon, H.N., 2018. "Restructuring of Urban Space of Pyongyang According to the Structural Changes in the North Korean Economy", *Productivity Review*, 32(2): 183-216.  
곽인옥·문형남, 2018. "북한 경제구조변화에 따른 평양지역 도시 공간의 재구조화", 「生産性論集」, 32(2): 183-216.
- Lee, S.J., Park, S.H., Nam, G.C., and Lee, G.M., 2014. *A Study on Major City Development Model of North Korea and Strategies for Improving Fundamental Basis of Reunification*, Anyang: KRIHS.  
이상준·박세훈·남기찬·이건민, 2014. 「통일기반 강화를 위한 북한 거점도시 발전모형과 남북협력 실천전략 연구」, 안양: 국토연구원.
- Lee, S.G. and Lee, S.Y., 2014. *Status of North Korean Companies in 2000s: Analysis Based on North Korean Media*, Sejong: KIET.  
이석기·이승엽, 2014. 「2000년대 북한기업 현황: 북한 공식매체 분석을 중심으로」, 세종: 산업연구원.
- Lee, S.G., Byun, H.M., and Na, H.S., 2018. *Industry and Policy of North Korea in Kim Jung-un Era*, Sejong: KIET.  
이석기·변학문·나혜선, 2018. 「김정은 시대 북한의 산업 및 산업정책」, 세종: 산업연구원.
- Lee, Y.J., 2017. "Changes and Prospects of North Korean Service Industries: Focusing on Convenience Service", *KDB North Korea Development*, 11: 87-131.  
이유진, 2017. "북한의 서비스산업 변화와 전망: 편의서비스를 중심으로", 「KDB 북한개발」, 11: 87-131.
- Lee, Y.S., 2019. "Direction of South-North Korean Industrial Cooperation and Innovation of City and Region", *North Korean Land and Housing Review*, 3(1): 20-27.  
이영성, 2019. "남북 산업협력의 방향과 도시·지역의 혁신", 「북한토지주택리뷰」, 3(1): 20-27.
- Mans, P., Alkemade, F., van der Valk, T., and Hekkert, M.P., 2008. "Is Cluster Policy Useful for the Energy Sector? Assessing Self-declared Hydrogen Clusters in the Netherlands", *Energy Policy*, 36(4): 1375-1385.
- Min, K.T., 2013. "The Growth Strategy through the Establishment of Network Economy between Seoul and Pyongyang", *North Korean Studies Review*, 17(2): 203-236.  
민경태, 2013. "서울-평양 네트워크 경제권 성장전략 구상", 「북한연구학회보」, 17(2): 203-236.
- Moon, D.J., Lee, S.G., and Hong, J.H., 2014. "Diversity of Industrial Structure and Regional Economic Growth: Based on Jacob's Theory of Industrial Diversity", *Korean Journal of Policy Analysis and Evaluation*, 24(4): 35-66.  
문동진·이수기·홍준현, 2014. "산업구조의 다양성과 지역 경제 성장: Jacobs의 산업 다양성 이론을 바탕으로", 「정책분석평가학회보」, 24(4): 35-66.
- National Bureau of Statistics of China, 2009. "Number of





ment&d=POP&f=tableCode%3a323

41. World Bank, 2021a, “GDP Per Capita (Current US\$) - Korea, Rep.”, Accessed December 31, 2021. <https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=KR>
42. World Bank, 2021b, “World Bank Country and Lending Groups”, Accessed September 7, 2021. <https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups>
43. World Bank, 2021c, “World Development Indicators”, Accessed September 23, 2021. <https://databank.worldbank.org/source/world-development-indicators>

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