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北九州市立大学長 様

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公立大学法人北九州市立大学特別研究推進費に係る研究実績について、次の通り報告します。

研究課題名	日本の地域産業多角化: 輸出構造の経路依存的進化から Regional Industrial Diversification in Japan: From Path-dependent Evolution of Export Structures					
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研究分野：地域経済学、進化経済学

キーワード：地域、多角化、輸出構造、経路依存性

研究成果の概要（和文）

本研究の主な目標は、輸出構造を研究することにより、日本の地域産業構造の進化を明らかにし、各地域の効果的かつ効率的な産業発展の方向性を提供することである。本研究では、1988年から2020年にかけて各都道府県に所在する税関から地域輸出データベースを構築し、産業構造の変化を推計した。本研究の分析結果は韓国学会（2022 Korea Technology Innovation Society Spring Conference）と国際学会（Asia Pacific Innovation Conference 2022）で発表された。本研究の学問的成果は、1）輸出異質性や産業構造変化の経路依存性を地域レベルで分析すること、2）日本地域におけるデータの解析により、アジアからの実証的証拠を提供すること、である。

研究成果の学術的意義や社会的意義

Only a few studies until now have attempted to analyze the Japanese regional export structures from the evolutionary economic perspective of path-dependence and economic complexity. By linking the two keywords of complexity in export structure and path-dependent diversification, this research enriches the current discussion of evolutionary economic geography by providing empirical evidence on the dynamics of export structures. Also, this study has strong implications on both Japanese industrial policies and SDGs. Japanese government has been investing much effort on regional revitalization. This study provides a direction for what industry each prefecture should be targeting at by looking at the past patterns of structural changes and current export structures. In addition, this study is closely linked with job opportunities and economic growth (SDG 8) and industry and innovation (SDG 9). Sustainable economic/industrial growth and job creation in regions are key interests of both developed and developing economies. This study suggests an effective way to set target industries for sustainable regional development, by studying the past and present of Japanese prefectural export structures.

1. 研究の背景

Recently, Japanese government has been focusing on re-vitalizing the local economies (地方創生), and local economies in Japan have been experiencing a continuous decrease in population, and aging societies. As a result, local economies are experiencing stagnated growth over few decades, and local governments are supporting local industries with policy measures with substantial budget. However, there was a limited success in developing new industries or industrial upgrading in terms of economic complexity. It is hard to tell which comes first between decrease in population or slowing economic growth and job creation, but it is certain that “what to do” for the Japanese local economies is a key issue for revitalization. Therefore, it is necessary to understand the differences and dynamic changes of regional industrial structures of Japanese regions, so that it is clearer to see which industries are promising for efficient and effective diversification of each prefecture.

2. 研究の目的

By analyzing the patterns of export structural changes, this research aims to provide answers of what industries Japanese regions should focus on, for eventual efficient and effective regional revitalization.

- H1-1) Japanese regions show heterogeneous export structures.
- H1-2) Japanese regions show heterogeneous export concentration.
- H2-1) Japanese regions showed divergence in export structures over time.
- H2-2) Japanese regions showed path-dependent development of export structure over time.

3. 研究の方法

In order to answer these questions, this study constructs a regional export database based on 125 customs (税関) across prefectures from 1988 to 2020 to estimate industrial structure changes. It uses both statistical and econometric methodologies to test the heterogeneity of regional industrial structures, and their evolution patterns over years.

4. 研究成果

The results confirm that there is a heterogeneity among the Japanese regional export structures, and a strong path-dependence during the regional export diversification. These results suggest that it is important to recognize the regional differences in Japan, and a uniform policy may not be effective in supporting regional exports. Also, the results show that regions are more likely to use the current capabilities, and diversify into nearby products.

This study has been presented in a Korean domestic conference (2022 Korea Technology Innovation Society Spring Conference), and an international conference (Asia Pacific Innovation Conference 2022) with the results from the Kyushu area.

Path-dependent Evolution of Regional Export Structures in Japan

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***Abstract*— The main purpose of this study is to elucidate the regional capability development of Japanese regions through studying export structures, in order to provide directions for effective and efficient regional industrial development. Specifically, this study studies whether and to what extent the past Japanese regional export structure contributes to the diversification in the future in addition to the analysis of current structural heterogeneity. In order to answer these questions, this study constructs a regional export database based on 125 customs across prefectures from 1988 to 2020 to estimate industrial structure changes. This study provides statistical and econometric evidence on the heterogeneity of Japanese regional export structures, and their evolution patterns over years. The results suggest that it is important to recognize the regional differences in Japan, and a uniform policy may not be effective in supporting regional exports.**

I. INTRODUCTION

After decades of stagnant economic growth, Japan has revitalized national industrial policy as a means to spur economic growth. The goal of regional revitalization has spanned administrations and targets industrial policy that seeks to expand into global markets, i.e., exports [1]. Yet, the national policy does not specify what industrial sectors each prefecture should target or if they should even vary between regions. Regional characteristics, however, vary. Although Japan's aging society is well-known, the change in demographics has different effects in various regions around the country. Furthermore, resources vary between regions [2]. Therefore, the aim of this study is to understand implications for Japanese regions by analyzing the past and present of regional (prefectural) export structures of Japan.

Export variety is important in economic performance and export growth [3-4]. Most studies on export variety focuses on firm- or country-level export variety, and suggested heterogeneity among exporting firms [5-6] or heterogeneity among countries [7-8]. In these models, the ex-post efficiency of firms and capability of countries represented by export basket determine the economic status of firms/countries [9]. Yet, differences in regional resources and capabilities also affect economic performance at the regional level [10]. Thus, there is a need to analyze the regional-level diversification and specialization patterns, as regional division may also capture a part of this heterogeneity, if efficient firms are not evenly distributed across regions.

Regarding the dynamics of export variety, recent studies from economic geography argue that regions develop path-dependently. They argue that new industries which emerge in an economy can benefit from existing, related industries, by sharing inputs [8], and studies the spatial externalities and regional growth [11-12, 13]. Looking at the regional developments of export structures is important from the perspectives of region-specific localized capability [14], as the development of capabilities occur through mechanisms that have a strong regional bias [11]. Also, regions more easily absorb knowledge when it is similar to the existing knowledge [15], for example, industry clusters benefitting from technological complementarities [16-17].

Previous path-dependence studies are at firm-level or country-level [5,6, 18-20], and a few regional path-dependence studies are limited to cases from Europe and the US [11,14].

This study fills these two gaps by 1) analyzing the export heterogeneity among within a country at regional-level, and 2) providing an empirical evidence of regional capability development from Asia, with data from Japanese regions. This study aims to analyze the past and present of regional export structures of Japan, in order to give practical industrial policy implications to Japanese regions. Specifically, this research tests whether Japanese regions show heterogeneous export structures and concentrations, and divergence and path-dependent evolution of export structures over time. Specifically, this study will ask the following questions.

H1: Japanese regions show heterogeneous export concentration (HHI) lead to increased exports.

H2: Japanese regions show path-dependent development of export structure over time.

If the prefectures' export structures are different and have different concentration (H1), and if the export structures diverged as current export structures influenced the future export structures (H2), then each prefecture should aim different industries based on their current export structures and capabilities. As a result, this study aims to suggest that rather than one central-government-led revitalization policy, regional policies based on regional export structures should take place.

In order to answer these questions, this study constructs a regional export database based on 125 customs across prefectures from 1988 to 2020 to estimate industrial structure changes. It uses both statistical and econometric methodologies

to test the heterogeneity of regional industrial structures, and their evolution patterns over years. The results confirm that there is a heterogeneity among the Japanese regional export structures, and a strong path-dependence during the regional export diversification. These results suggest that it is important to recognize the regional differences in Japan, and a uniform policy may not be effective in supporting regional exports. Also, the results show that regions are more likely to use the current capabilities, and diversify into nearby products.

II. DATA & METHODOLOGY

A. Data

This study primarily depends on the yearly export data of Japanese prefectures. This data is freely available at Trade Statistics of Japan, in the forms of 1 year, 5 customs, and 10 HS-2 digit dataset. This study covers 34 years, from 1988 through 2021. There are 166 customs offices covering around 1200 industries. In other words, the dataset includes the export data $X_{c,i,t}$ from each customs office, c ; each industry, i ; and each year, t . Fig. 1. shows an example of the data structure.

Customs Office (c)	Prefecture	Industry (i)	Year (t)	Export Volume ($X_{c,i,t}$)
Narita	Tokyo	Automobile	1999	1,000,000
Narita	Tokyo	Rice	1999	500,000
Hakata	Fukuoka	Automobile	2000	2,000,000
Moji	Fukuoka	Automobile	2001	3,000,000

Fig. 1. Sample of dataset and data structure.

Largely, Japanese customs offices are divided into 9 areas: Tokyo, Yokohama, Kobe, Osaka, Nagoya, Hakodate, Moji, Nagasaki, and Okinawa. The current dataset focuses on Kyushu area that covers 3 (Moji, Nagasaki, Okinawa) out of these 9 areas, between 1988 and 2021. This includes 45 customs offices out of 166 total, such as but not limited to Moji, Hakata, Shimonoseki offices from Moji area, Nagasaki, Kumamoto, Kagoshima offices from Nagasaki area, and Okinawa and Ishigaki offices from Okinawa area.

B. Methodology

Regarding the measurement of export concentration, this study adopts commonly used Herfindahl-Hirschman Index (HHI), which is mathematically expressed as:

$$HHI = \sum_i (ExportShare_i)^2 \quad (1)$$

Regarding the path-dependent development, this study analyzes whether the past existence of comparative advantage of a customs office influences the future comparative advantage of it. To measure the comparative advantage, this study uses Revealed Comparative Advantage (RCA) suggested by [21]. This measurement indicates comparative advantage of a country in an industry at an year, by measures whether export share of a particular product of a country is larger than that of the world. This study uses export data at customs-office-level instead of country-level, and RCA is calculated by comparing the office's share to the country's share, instead of original comparison

between country's share and the world's share. Its mathematical representation is,

$$RCA_{c,p} = \frac{x(c,p)}{\sum_p x(c,p)} \bigg/ \frac{\sum_c x(c,p)}{\sum_{c,p} x(c,p)} \quad (2)$$

where c stands for customs office, i stands for product (HS), and x for value of export volume.

Next, the concept of density is adopted from studies on product space [11,14] to analyze the path-dependent Development of industries. Density measurement is first based on the proximity between products by calculating the probability of co-exporting, or in other words the minimum of the pairwise conditional probability of customs office that export p_1 and p_2 . The mathematical expression of proximity ϕ_{p_1,p_2} between the two products is:

$$\phi_{p_1,p_2} = \min \{P(RCA_{x_{p_1}} > 1 | RCA_{x_{p_2}} > 1), P(RCA_{x_{p_2}} > 1 | RCA_{x_{p_1}} > 1)\} \quad (3)$$

By using the proximities between all products, density can show the distance of a product from current export structure. Density can also be simply stated as average proximity, because it is the sum of proximities between a particular product and products with RCA, divided by the sum of all proximities linked to that product. The mathematical expression of density ω_{p_2} around product p_2 is as follows:

$$\omega_{p_2} = \sum_{p_1} x_{p_1} \phi_{p_1,p_2} / \sum_{p_1} \phi_{p_1,p_2} \quad (4)$$

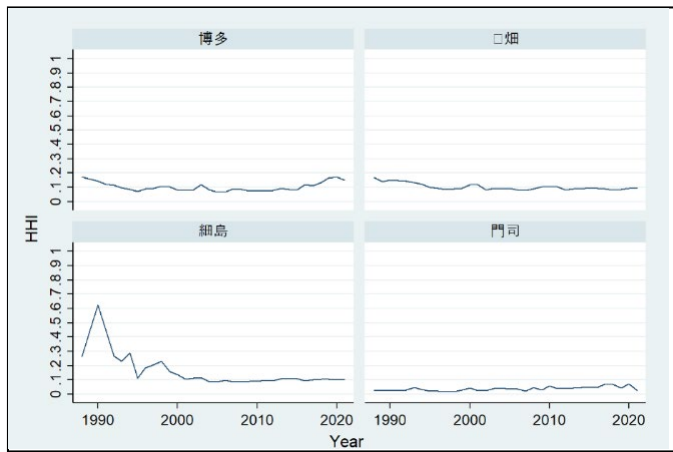
III. RESULTS

A. Stylized Facts

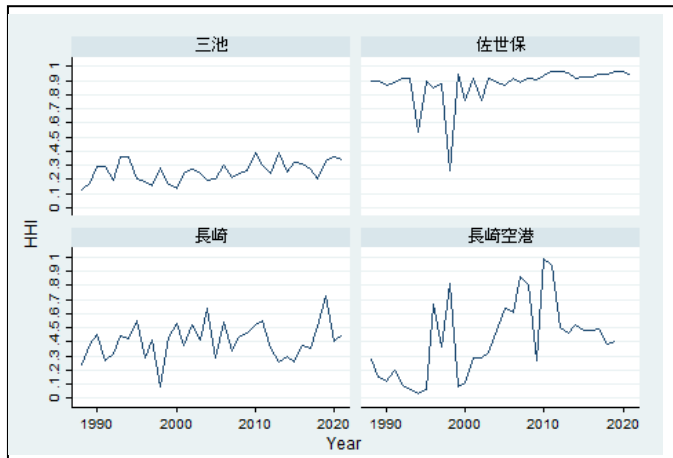
This section presents some stylized Facts on export concentration of customs offices of Kyushu area. First, Fig. 2. shows the export concentration of representative customs offices from the three areas of Moji, Nagasaki, and Okinawa. There are significant differences across these neighboring areas, as offices from Moji (Hakata, Tobata, Itoshima, Moji) shows a lower export concentration in general, whereas offices from the other two areas of Nagasaki (Miike, Sasebo, Nagasaki, Nagasaki airport) and Okinawa (Okinawa, Ishigaki, Naha airport) showed higher export concentration. These results indicate that there is a need to distinguish the customs offices in Japan and analyze the development of each custom, as there are notable differences across the customs offices.

Next, Fig. 3. shows the histogram showing the industry densities across regions when there was a new industry at $t+1$ ($RCA < 1$ at t and $RCA > 1$ at $t+1$) and no comparative advantage emergence at $t+1$ ($RCA < 1$ at t and $RCA < 1$ at $t+1$). As product densities vary across regions and entry into sectors vary across industries, it can be expected that there would be differences in the possibility of new industry emergence depending on the product density. The result shows that products with new

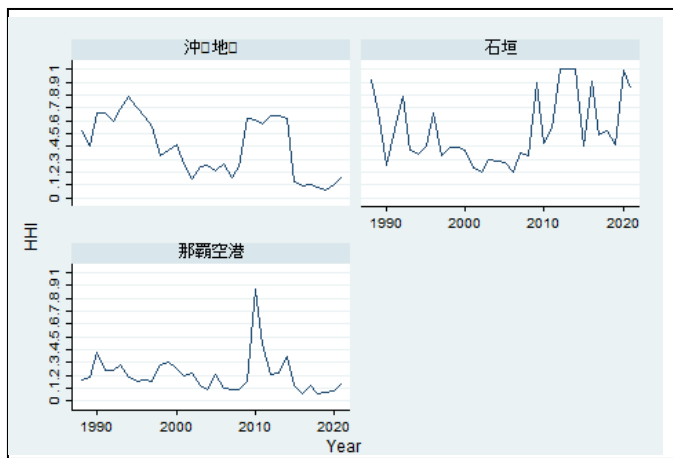
comparative advantage at $t+1$ had higher product density at t . In other words, having comparative advantage in related industries (higher density) at t leads to a higher possibility of acquiring comparative advantage in the next period.



(a) Moji



(b) Nagasaki



(c) Okinawa

Fig. 2. Export concentrations of custom offices

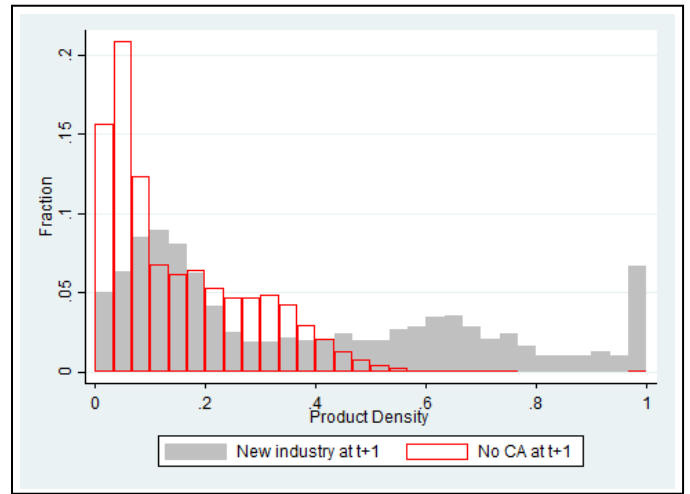


Fig. 3. Industry densities across regions and entry into sectors across industries

B. Regression Analysis

This section presents some preliminary results of regression analyses on the relationship between export growth and export concentration, and path-dependent industrial development. First, Fig. 4. tests whether higher export concentration at year t leads to higher export growth at year $t+1$. The results show that higher export concentration, or higher HHI leads to lower export growth in the future.

Dependent variable $ExportGrowth_{c,t+1}$	Baseline FE (1)	Baseline FE (2)
HHI _(c,t)	-2.722 *** (0.805)	-3.019 *** (0.817)
Year dummy	No	Yes
Constant	2.778 *** (0.373)	3.122 *** (0.859)
R-squared	0.18	0.111
Observations	1,308	1,308

Fig. 4. Regression results for export sector concentration

Next, Fig. 5. shows the results of the path-dependence analysis, testing whether customs offices tend to have comparative advantage in related export products to their current export structures. The key independent variable is density measure at t , and it shows positive and significant correlation with RCA at $t+1$ across all models. Also, RCA at t is positively and significantly correlated with RCA at $t+1$. This result shows that not only the current comparative advantage, but also comparative advantage in related industries influences the future advantage in exports.

Dependent variable	Baseline OLS (1)	Baseline Probit (2)	Baseline OLS (3)	Baseline Probit (4)
$RCA_{c,t+1}$	0.693***	1.400***	0.644***	1.301***
	-0.002	-0.016	-0.003	-0.017
Density_(c,t)	0.101***	0.800***	0.196***	1.097***
	-0.004	-0.034	-0.006	-0.043
Year dummy	No	No	Yes	Yes
Country dummy	No	No	Yes	Yes
Constant	0.130***	-0.849***	0.127***	-0.771***
	-0.002	-0.014	-0.008	-0.051
R-squared	0.532		0.539	
Log-likelihood		-43290.6		-42552.8
Observations	116,485	116,485	116,485	116,485

Fig. 5. Regression results for path-dependence

IV. DISCUSSION & CONCLUSION

This study examines factors of regional export performance by constructing a novel dataset. The study considers different industrial export structures as possible drivers of export growth. The findings support the hypotheses that heterogeneous export concentrations lead to increased export growth by sector (H1) and that export structures of Japanese regions are path dependent (H2). Regions in Japan show diverse structures of export concentration, eventually leading to different export growth.

The implication of these findings is that economic development policies at the national should consider development of regional industrial structures for export rather than the unified policy that is currently proposed. Since industrial capabilities are largely defined by local capabilities and resources, the variation across a country needs targeted policies based on regional characteristics. Further, the granular understanding of regional resources increase technological management decisions based on strategic targets that are most appropriate for each region.

It is important to recognize the regional differences in Japan, and a uniform policy may not be effective in supporting regional exports. Moreover, since path-dependence occurs as a part of regional export diversification, regional resources capabilities should build on existing resources and capabilities. Yet, when diversifying new resources and capabilities, it is important to diversify into sectors, products, and technologies that are ‘near’ to existing sectors, products, and technologies.

The study has certain limitations that call for further research. First, this study uses a limited dataset from certain prefectures in Japan. Data collection is currently ongoing. When the data collection has been completed, an analysis of all the prefecture data across Japan would provide improved results. Second, the models employed can be improved by adding control variables. Lastly, the results can be dissected to examine which sectors each region has relative comparative advantage that define each prefecture.

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