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Industry Location and Variety Growth: Empirical Examination of Regional Exports

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Abstract

Recognizing that goods are produced in different sub-regions within a country, we offer new evidence of variety expansion in nation's export. We decompose Japanese national exports into 41 prefecture sub-regions over 7,000 product categories and construct export margins for sub-regions between 1988 and 2005. First, we find that extensive margin accounts for over 60 percent of the greater exports of larger sub-regions. Second, we find export variety of most prefectures expands in our sample periods, but differ both in initial levels and in growth rates. We conclude that export expansion in terms of new exports from sub-regions within a country can account significant portion of product variety and export production is being dispersed among regions rather than going through the process of agglomeration.

Keywords: Agglomeration, Export Variety; Extensive Margin; Japan, Regional Export.
JEL Classifications: F12, F43.

1. Introduction

Following new developments of international trade theory with product differentiation, importance of accounting product variety in empirical examination of international trade is well recognized. First, price index should reflect increases in product variety. Failure to account for new product varieties in price index may wrongly attribute corresponding demand increase for new varieties to income. Faced with previously estimated high income elasticity of demand for US imports, Feenstra (1994) constructs import price index reflecting increases in import variety. Second, growth in international trade is driven more by increase in new product variety than increase in volume of existing products. Hummels and Klenow (2005) constructed extensive margins, i.e., measure of export variety, of 126 exporting countries and find that the extensive margin accounts 60 percent of the greater exports of larger economies. Third, expansion of product variety should increase welfare of economy. Broda and Weinstein (2006) construct price index of total US imports and estimate welfare increase due to variety expansion in US imports. Their estimates imply that the value of consumers increased 2.6 percent of GDP for US.

In this empirical export variety literature, the empirical definition of variety measure is very important. For a given imported product category in Feenstra (1994) a product from newly supplying country is considered as a new product variety. This is the Armington-type *country dimension* for variety definition and for example can distinguish German automobiles from Japanese automobiles. In Hummels and Klenow (2005) vey fine disaggregate product categories over 5,000 HS 6-digit products are used for the entire export product space. This very detailed *product space dimension* for variety definition allows very fine distinction between products such as compact cars and mid-sized cars. However, as noted by many authors, these definitions cannot uncover distinct differentiated products within a category, i.e., within-category variety[1]. Exports of GM mid-sized cars and Ford mid-sized cars are both classified to the same category.

Ideally empirical variety definition should be required to distinguish even different models of mid-sized cars of the same automobile manufacturer. It may be possible to collect such detailed data for a few categories; however, it is certainly impossible to do the same for entire categories over 5,000 HS 6-digit products. Therefore, current state of art for measuring export product variety for nation's export is to use both Armington-type *country dimension* and finest *product space dimension* simultaneously, leaving within-category variety problem aside.

In this paper we suggest a new dimension of empirical product variety and construct export margin indices for Japanese exports using this new dimension. Casual observation on production locations of manufacturing industries reveals competing manufactures often

1 For example, Hummels and Klenow (2005) points out that Japan exported 56 different car models in 1995 while there are only 7 six-digit categories covering passenger motor vehicles.

choose different locations for manufacturing plants and a manufacture may establish distinct plants in different regions to produce different models of their products[2]. Recognizing goods produced in different sub-regions within a country as distinct differentiated products, we offer new evidence of variety expansion in nation's export. We might call this new dimension as the Armington-type *sub-region dimension*.

For example, HS 6-digit code "870323" is defined as "automobiles with reciprocating piston engine displacing over 1,500 cc to 3,000 cc." Given discretion to add extra digits after HS 6-digit, Japan adds three more digits for finer product categories. "870323.929" is "automobiles with reciprocating piston engine displacing over 2,000 cc to 3,000 cc." For this category, 11 out of 41 prefectures actually export to the US in 2005[3]. The highest six values of Japanese prefecture exports to the US for this category in 2005 are 502 billion yen for Aichi, 287 billion yen for Chiba, 159 billion yen for Kanagawa, 71 billion yen for Yamaguchi, 55 billion yen for Shizuoka, and 41 billion yen for Hiroshima. We suggest sub-regional dimension definition in which these exports from different sub-regions are counted as distinctly differentiated products.

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[2] This is not to deny agglomeration of industry in particular regions such as Silicon Valley. In Japan, we have semiconductor plant clusters in three different regions.

[3] Note that in this example we are restricting to single destination for the ease of exposition, however, in the following empirical section we exploit export data for all possible destination countries.

Before we elaborate more precisely on our strategy to use international trade at sub-regional level, it is noteworthy to give brief review of two related literature. One literature is theoretical researches to model with explicit regions to investigate international trade and the other literature is empirical examination of subnational regional trade. While many international trade models bypass explicit incorporations of regions within countries, it is well recognized that it is important to distinguish clearly regions within a country in international models. Trade liberalization for example affect industry locations across regions within a country. Incorporating two domestic regions and one foreign region in two country framework, Krugman and Elizondo (1996) show that lowering protection level of the country can shift production away from a giant metropolis to the other region. In a framework of two countries each consisted of two regions, Behrens et al. (2007) examines the impact of fall of trade cost internationally and intra-nationally on the welfare of two countries.

A number of empirical investigations exploit trade flow data at subnational level. McCallum (1995) documents that Canadian provinces trade much heavily with other Canadian provinces than with US states controlling distance and size, so called '*border effect*'. Wolf (2000) further examines trade of subnational regions by investigating trade flows across US states as well as within a state. Gravity regression with intra-state dummy variable reveals that shipments of products to own state is excessively high, so named as '*intranational home bias*' in trade.

While agglomeration (or dispersion) of economic activity (production and/or export) among regions is central issue in Krugman and Elizondo (1996), Behrens et al. (2007) and many other theoretical researches in new economic geography, empirics of international trade of subnational regions in MaCallum (1995) and Wolf (200) do not directly examine agglomeration issues. In framework of differentiated products, agglomeration of economic activity implies both high intensive margin and extensive margin for core region. Our examination of prefecture export margins can provide valuable empirical evidence in terms of product variety agglomeration.

This paper empirically examines export growth of sub-regions in terms of variety expansion. Using port-level export data from Japan Custom, we construct exports of 41 prefectures in Japan at highly detailed product categories. We then calculate extensive margin and intensive margin for each prefecture from 1988 to 2005[4].

First, we decompose nation's exports to sub-regions and uncover one unexploited aspect of heterogeneity in a nation's exports. Heterogeneity among exporting firms is given full considerations in Melitz (2003) and Helpman et al. (2004). Sub-regional decomposition may also capture part of this heterogeneity among exporting firms if distribution of efficient firms is not even across sub-regions. By constructing extensive margin indices for 41

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[4] Intensive margin is measure for the *size* of trade for given products and extensive margin accounts for the number of *kinds* of products. The precise definitions of intensive and extensive margins are given in the following section.

prefectures for the period between 1988 and 2005, we find disparity in export varieties among prefectures. For six prefectures extensive margins are above 60 percent (high EM group), for eight prefectures between ten percent and 60 percent (middle EM group) over the sample period and for 27 prefectures below ten percent at the initial year. The geographical map of these prefectures is shown in figure A1 in the appendix.

Second, empirical evidence of sub-regional export within a nation is so far quite limited. The result of our paper becomes one of first evidences of sub-regional development of exports. We regress extensive and intensive margins of prefecture exports on income per capita, employment and gross domestic product for prefectures. Quite similar with the result of cross country examination in Hummels and Klenow (2005), we find that extensive margin accounts for over 60 percent of the greater export of larger prefectures, with qualifications discussed just below. Our result confirmed that variety expansion in export growth is as important in even subnational economies as in national economies.

Third, by using over 18 years of time series data, we point out growth aspect of export margins is significant. With cross section regression at three different sample years, extensive margins only accounts for less than half of the greater export. When we pool sample years to construct panel data to account for growth of variety in time, we, however, obtain the results that extensive margin accounts for over 60 percent of export growth.

Last, we find the uneven growth of extensive margins among prefecture groups. We observe almost no growth in extensive margin for high EM group while low and lowest EM groups demonstrate about 10 percent annual growth. With regard to the export variety of a nation's export, this result implies that product variety measured in terms of *product space* and *sub-regional* dimension increased over the sample period. This increase in s*ub-region dimension* in export variety has not empirically documented in previous researches.

The rest of the paper is structured as follows. In Section 2 we define extensive and intensive margins for Japanese prefectures. In Section 3 we describe the data. We present our empirical findings in Section 4 and we offer discussions and conclusion in Section 5.

2. Variety and Export Margins

Before we define export margin indices, let us demonstrate the importance of examining sub-regional exports by considering the following two cases. A country consists of four sub-regions and exports four kinds of products. Each figure represents billion dollars of exports for product in that row and from region in that column. The bottom row is the sum of export for each region and the rightmost column represents value of national export for each product. We should note that these aggregate values of exports are equal between two cases. In other words, researchers observing disaggregate product exports at national level, i.e., the rightmost column, cannot distinguish one from another. It is also impossible to discriminate between two cases from only observing total exports of each regions, i.e., the bottom row.

Case I					
	Region				National
product	A	B	C	D	sum
1	15	15			30
2	15	15			30
3			15	15	30
4			15	15	30
sum	30	30	30	30	

Case II					
	Region				National
product	A	B	C	D	sum
1	10		10	10	30
2	10	10		10	30
3	10	10	10		30
4		10	10	10	30
sum	30	30	30	30	

When regional export data at product level is available on the other hand, Case II reveals that export of each product is diversified among more regions. While each region is specialized in just half of nation's export products in case I, each region exports three-quarter of nation's export products in Case II. Recognizing goods produced in different sub-regions within a country as distinct differentiated products, variety of export is more expansive in Case II. For these obvious cases table representation above is helpful; however, it is useless when product categories are in order of thousands. We need to construct aggregate index which represents size of variety for nation's export accounting goods produced in different sub-regions within a country as distinct differentiated products[5].

Following Hummels and Klenow (2005), we construct export margin indices for prefecture exports for overall exports, the intensive margin, the extensive margin, and the price and quantity components of the intensive margin. These indices for prefectures are

[5] In the following we take the approach to construct export margins for each regions instead of constructing single index for national export margins. This is because we do not have any other countries' export margin indices calculated in the latter way for comparison.

calculated with respect to Japanese national exports. The indices are constructed with respect to each importing country, in our sample 226 countries. Then, we take the geometric average of prefecture's margins across all importing countries.

We denote price and quantity of export product *i* to country m from prefecture *j* as p_{jmi} and x_{jmi}. In order to construct these indices, reference economy *k* needs to be defined. For the case of Feenstra (1994) reference economy is the same economy in previous period. The world economy is chosen as a reference economy for cross country analysis in Hummels and Klenow (2005). Our reference economy *k* is Japan as a nation.

$\mathbf{I_{jm}}$ is the set of observable product categories in which prefecture *j* has positive exports to country *m*, i.e., $x_{jmi} > 0$. **I** is the set of all categories. The extensive margin and intensive margin are defined as

(1) $$\mathbf{EM_{jm}} = \frac{\sum_{i \in \mathbf{I_{jm}}} \mathbf{p_{kmi} x_{kmi}}}{\sum_{i \in \mathbf{I}} \mathbf{p_{kmi} x_{kmi}}}$$

(2) $$\mathbf{IM_{jm}} = \frac{\sum_{i \in \mathbf{I_{jm}}} \mathbf{p_{jmi} x_{jmi}}}{\sum_{i \in \mathbf{I_{jm}}} \mathbf{p_{kmi} x_{kmi}}}.$$

Extensive margin is the ratio of subtotal of national export for the set of products in which a prefecture *j* has positive exports to the sum of national exports. Extensive margins in above examples are 0.5 in case I and 0.75 in case II. Intensive margin is the ratio of total exports of prefecture *j* to subtotal exports of national export for the same product categories, $\mathbf{I_{jm}}$. Intensive margins in above examples are 0.5 in case I and 0.33 in case II. In both cases the share of regional export in national export, i.e., 0.25, can be obtained by the product of extensive margin and intensive margin[6].

Price index can be constructed as weighted geometric average of relative price for each product categories.

$$\textbf{(3)} \qquad \mathbf{P_{jm}} = \prod_{\mathbf{i}\in\mathbf{I_{jm}}} \left(\frac{\mathbf{p_{jmi}}}{\mathbf{p_{kmi}}}\right)^{\mathbf{w_{jmi}}}.$$

Weight in price index is the logarithmic mean of the share of category *i* in prefecture *j*'s export to importing country *m* and the share of category *i* in national export to *m*.

$$s_{jmi} = \frac{p_{jmi}x_{jmi}}{\sum_{i\in I_{jm}} p_{jmi}x_{jmi}}$$

$$s_{kmi} = \frac{p_{kmi}x_{kmi}}{\sum_{i\in I_{jm}} p_{kmi}x_{kmi}}$$

$$w_{jmi} = \frac{\frac{s_{jmi} - s_{kmi}}{\ln s_{jmi} - \ln s_{kmi}}}{\sum_{i\in I_{jm}} \frac{s_{jmi} - s_{kmi}}{\ln s_{jmi} - \ln s_{kmi}}}$$

Given intensive margin in (2) and price index in (3), implicit quantity index can be calculate as

$$\textbf{(4)} \qquad \mathbf{X_{jm}} = \frac{\mathbf{IM_{jm}}}{\mathbf{P_{jm}}}$$

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6 For other cases which are observationally equivalent at national level, one can assume each region specializes exclusively in one of products and export 30 billion dollars, namely case III and all region export 30/4 billion dollars equally for each product, namely case IV. Extensive margins are 0.25 and 1 for case III and case IV, respectively. Intensive margins are 1 and 0.25 for case III and case IV, respectively.

So far for each export margin definition for each prefecture we have 226 indices each representing destination countries. For each prefecture we then construct weighted geometric average of each export margin across importing countries. The weight a_{jm} is the logarithmic mean of the shares of importing country *m* in the overall exports of prefecture *j* and the shares of importing country *m* in the overall exports of Japan in a similar fashion as w_{jmi}. For example, extensive margin for prefecture *j* is defined as

(5) $$\mathbf{EM_j = \prod_{m \in M} (EM_{jm})^{a_{jm}}}$$

The set ***M*** consists of 226 importing country in this study. On taking weighted geometric average over importing countries, some EM_{jm} can be zero, i.e., no export by prefecture *j* to importing county *m*. In this case $(EM_{jm})^{a_{jm}}$ is equal to one when both weight and importing-country specific extensive margin approaches zero. Therefore, it is equivalent to use the set ***M’*** which only consists of countries with positive export from prefecture *j*.

In a very special case, we should note weighted geometric average of extensive margin defined in equation (5) may overstate the degree of variety for prefecture *j* when this prefecture exports only to one importing country *m* which, on the other hand, imports only a few types of products from Japan. In this case EM_{jm} can be large and consequently is EM_j because the set *M’* consists only one country *m*. We observed this special case only once for Shimane prefecture in 1997.

3. Data Description

We construct prefecture export data using export by local ports from the Japan Custom. For each of 166 exporting ports/airports/branch of Custom office, the Japan Custom provides annual export data that include nine-digit HS code, the country of destination, value, and quantity. The nine-digit HS code for Japan covers 7,772 highly detailed goods categories over 226 destinations. At least a single separate file is provided for annual exports of each port and multiple files are necessary for a larger port. Complete export data by all ports is therefore dispersed among 375 files for each year. When a prefecture has multiple exporting ports, we aggregate values and quantities for each nine-digit HS code and importing country pair. As a reference economy in calculating export margin indices defined in previous section, we also collect national export of Japan from the Japan Custom.

For calculation of export margin we collected eighteen years of export by ports for the sample period between 1988 and 2005. Out of 47 prefectures, six prefectures do not have any ports at all or reporting no positive value of exports. These are Gunma, Saitama, Yamanashi, Nagano, Gifu and Nara prefectures. Tochigi and Shiga prefectures report positive values of exports since 1998 and since 1997 respectively.

Data on prefecture employment come from *Population Census*. Since the government collects data for *Population Census* only every five years, our data for employment are 1990, 1995, 2000, and 2005. Data on prefecture gross domestic product come from *Annual Report on Prefectural Accounts*, only available up to 2004 at the time of research. When we regress exports margins on employment and GDP, our sample years are restricted to four five-year intervals. For the regression of export margin in 2005, GDPs in 2004 are substituted as proxies for GDPs in 2005.

4. Empirical Results

For each exporting prefecture, we construct over-all exports, the intensive margin, the extensive margin, and the price and quantity components of the intensive margin as defined in section 2. These indices for prefectures are calculated with respect to Japanese nation as a reference economy. These indices for each prefecture in 1990 are shown as an example in table A1 in the appendix. Shares of prefecture exports in Japanese national exports, *OverAll*, in the third column show that large portion of exports is concentrated only in several prefectures. Variety measure, *ExtMargin*, in the fourth column and share measure restricted to prefecture's exporting products, *IntMargin*, reveal that there are wider gap in extensive margins among prefectures.

Hummels and Klenow (2005) discuss several different theoretical models to explain these differences in export indices of different economies. In Armington (1969) model a country exports only one goods, so there is no concept of export variety. The Armington model predicts that intensive margin grows with equal proportion to the size of an economy. In Krugman (1979), as the other extreme case, differentiated products model predicts that extensive margin grows one by one with respect to the size of an economy. Hummels and Klenow (2005) tests predictions of these models by regressing export indices on GDP per worker, employment, and GDP. One of their important finding is that the extensive margin accounts for around 60 percent of the greater exports of larger countries. So they conclude that variety expansion is the driver of export growth in cross-country analysis.

In this section we first examine whether this cross-country evidence of variety expansion in export growth also apply to exports of sub-regions within a country. Table 1 presents regression results for overall exports, the extensive margin and intensive margins for the years in 1990, 1995, 2000, and 2005. Sample years are chosen to be five-year intervals due to the availability of employment data at prefecture level. The data covers exports by 39 prefectures in first two sample years and two more prefectures are added in last two sample years. Each index is regressed on GDP per workers and workers in the first specification and on GDP in the second specification.

Conforming to the result of cross-country sample in Hummels and Klenow (2005), estimated coefficients of GDP per worker for extensive margin are significant for any sample years. This implies that richer prefectures export substantially more variety than poorer prefectures. On the other hand, from estimates for intensive margin suggests that estimated coefficients of GDP per worker for intensive margin are not significantly different from zero for any sample years.

With respect to employment variable, the results of export margins are quite similar to the results for cross-country samples in Hummels and Klenow (2005). Prefectures with more workers export more and extensive margin plays larger role in all sample years, varying from 63 percent to 76 percent[7].

With respect to gross domestic product, extensive margin plays a larger role only slightly for 1990 data. For the rest of sample years the ratio of coefficient for extensive margin to overall index is less than half and shows declining trend; 45 percent in 1995, 42 percent in 2000, and 39 percent in 2005, see Table 3. We suspect that this diminishing importance of variety in export is spurious. Even if variety in exports is very important component of export growth and variety is expanding in each prefecture, convergence in extensive margin among prefectures may underestimates the impact of variety growth.

Let us consider the following hypothetical extreme case. In the first sample year larger prefectures in fact export more variety. This will be captured by estimated positive coefficient of prefecture income. In the second sample year extensive margins for all prefectures become equal reflecting the fact that prefectures with less variety export catch up with prefectures with more variety. In the second sample year estimated coefficient will not be significantly different from zero. What we are missing in this example is that dynamic

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[7] These percentages are calculated as dividing the coefficient in extensive margin by the coefficient in overall index.

growth effect of export variety in sub-regions over the sample years.

We, therefore, pool cross-section data for all sample years to construct panel data in order to capture the variety growth effect. The estimated results for panel data analysis are presented In Table 2. With panel data, we obtained that extensive margin accounts for 68 and 67 percent of the greater export for larger prefectures in terms of more workers and larger GDP, respectively. For the ease of exposition, we summarized in Table 3 what extent extensive margins account for total export margin.

Growth of Export Margin

From comparing the result of cross-section analysis and the panel data analysis, we hypothesized that convergence of extensive margins among prefectures may bias our estimates downward for cross section data in recent years. We investigate this hypothesis more closely by constructing extensive margin indices for continuous time series of 18 years.

With time-series extensive margins for each prefecture, we are able to define prefecture group by four categories. The high EM group consists of prefectures with extensive margin above 0.5 in 1988, the beginning of our sample period. Prefectures in the middle EM group have extensive margins between 0.1 and 0.5 in 1988. The rest of prefectures have extensive margins below 0.1 in 1988. From these prefectures we selected prefectures with extensive margins above 0.1 by 2005, the end of our sample period, as low EM group. For those prefectures with extensive margins remained below 0.1 are defined as lowest EM group. Figure 1 through Figure 4 presents dynamic paths of extensive margins for prefectures in each group.

While prefectures in the high EM and middle EM groups do not show much growth in variety during sample periods, those prefectures in low and lowest EM groups demonstrate rapid expansion of export variety. In Table 6 we present number of prefectures by whether variety increased during sample period and average annual growth for each group. It is striking that for low and lowest EM group variety growth show very high magnitudes of 8 percent and 13 percent respectively while variety in middle EM group only grows by a few percent annually and almost no growth for high EM group. We confirmed from this time-series investigation that extensive margins across prefectures are converging in our sample periods and this is part of spurious decline in importance of extensive margins in cross section analysis in previous sub-section.

It is also noteworthy that prefecture with declining variety only appears in extreme cases, i.e., high EM group and lowest EM group. For high EM group, variety of export covers almost all categories and prefecture may find some categories not profitable and stop exporting. For lowest EM group, some prefectures may lag behind the sustainable level of maintaining efficient exporting facility such as port capacity and transportation utility.

Quality and Quantity Component of Intensive Margin

The results for intensive margins in Table 1 and 2 suggest that countries with more employment or larger GDP export higher export within categories. This result can be obtained from either higher prices or larger quantities, or possibly both. We decomposed intensive margins into price and quantity components as in equation (3) and (4).

These price and quantity indices are also regressed on GDP per worker and employment in the first specification and on prefecture GDP in the second specification. The results are shown in Table 4 and 5.

First, fitness of regression in terms of adjusted R^2 is extremely low for price equation in any sample years. None of relative income level, employment and GDP has significant explanatory power for difference in relative price indices observed in table A1 in the appendix. This result is partially contradicting the cross-county results in Hummels and Klenow (2005) in which GDP per worker is significantly positive while employment and GDP variables are not statistically significant in the price equation. The result of GDP per worker is interpreted as evidence that high income countries tend to export products with relatively higher price. We could not confirm their results for export price by sub-regions within a country.

Second, in the quantity equation estimated coefficients of both employment and GDP are statistically positive at any significant levels and they are substantially larger than cross-country counterparts.

While we confirm for sub-regions within a country that larger economies tend to export more quantity, price differences among sub-regions seem to require other variables for explanations.

5. Discussions and Conclusions

Consistent with the results of cross-country investigation in Hummels and Klenow (2005), we find that extensive margin accounts more than half of the greater exports of prefectures with more workers. On the other hand, extensive margin only accounts smaller portion of the larger exports with prefecture GDP in any single year. When we pool four sample years for panel analysis to capture the effect of prefecture variety growth relative to prefecture GDP growth, extensive margin actually accounts for 67 percent of the greater exports of larger GDP. The result of this analysis provides very important implications for cross-country investigations that previous analysis might underestimate the role of extensive margin in export growth in cross-section framework.

We also provide evidence that extensive margins of prefectures are converging in our sample periods. For high EM group there is not many product categories left to increase export product variety. For prefectures in other EM groups firms acquiring new technologies move up the efficiency ladder to become new exporters as in Melitz's model and consequently the variety of exports increases.

These results taken together show that production for exports are being dispersed among subnational regions for our sample periods. This result is quite consistent with theoretical developments we pointed out in the introduction section. Lowering of protection in Krugman and Elizondo (1996) and faster decline in international trade cost relative to domestic trade cost in Behrens et al. (2007) can lead to dispersion of production among regions. Our results provide empirical supporting evidence to dispersion of production predicted by these theoretical models only if international trade cost is actually declining during sample periods. This point is assured in Hummels (2007). With regard to the international transportation cost, Hummels (2007) argues that technological change in air shipping and the declining cost of rapid transportation by sea significantly lowered cost of international trade.

We also find some prefectures with declining of extensive margins but these prefectures only appear in extreme groups. For high EM group variety of export covers almost all categories and prefecture may find some categories not profitable and stop exporting. For lowest EM group, some prefectures may lag behind sustainable level of maintaining efficient exporting facility such as port capacity and transportation utility.

What our analysis suggests is that the variety of a nation is not only in a dimension of product categories but also in a dimension of production regions within a nation, namely *sub-region* dimension. With export variety increasing in most of sub-regions, it implies that variety of exports measured in terms of both product categories and production regions is expanding in much greater degree than previously estimated. We provide a new evidence of export variety of a nation by decomposing a country into sub-regions.

Considering a little growth of export variety for high EM group regions during last decades, extensive margin at national aggregate level can be expected to demonstrate a little growth. Investigations for extensive margins at national level for other developed countries may show same results. However, we should note that product variety measured in finer categories as in our paper may reveal substantial growth of product variety for these developed countries as well as developing countries in current periods and in future to come.

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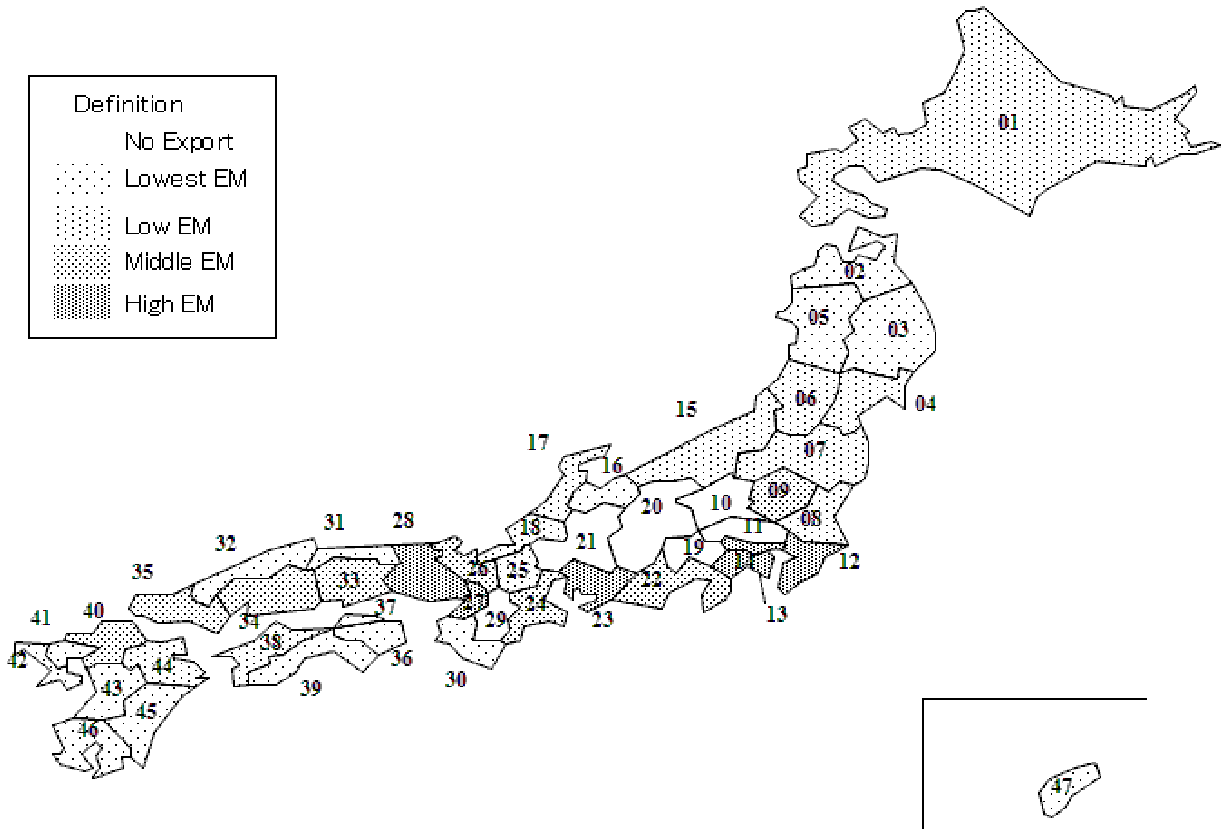
Appendix:

Table A1

PN	Prefecture	OverAll	ExtMargin	IntMargin	Price(IM)	Q(IM)
14	Kanagawa	0.19847	0.8804	0.2254	0.9976	0.2260
23	Aichi	0.14280	0.7623	0.1873	1.0450	0.1793
28	Hyogo	0.13391	0.8185	0.1636	0.9818	0.1666
12	Chiba	0.12669	0.7514	0.1686	1.6506	0.1021
13	Tokyo	0.11950	0.7151	0.1671	1.0494	0.1593
27	Osaka	0.07084	0.6856	0.1033	1.1073	0.0933
34	Hiroshima	0.03161	0.3387	0.0933	1.0056	0.0928
40	Fukuoka	0.03026	0.4431	0.0683	1.0074	0.0678
22	Shizuoka	0.02861	0.4145	0.0690	1.1247	0.0614
24	Mie	0.01468	0.1862	0.0788	1.0312	0.0764
35	Yamaguchi	0.01137	0.1457	0.0781	0.9537	0.0819
33	Okayama	0.00823	0.1481	0.0556	1.0040	0.0554
26	Kyoto	0.00392	0.1934	0.0203	1.3925	0.0146
38	Ehime	0.00343	0.0598	0.0574	0.9184	0.0625
30	Wakayama	0.00315	0.0454	0.0693	0.9891	0.0701
8	Ibaragi	0.00306	0.0364	0.0839	0.8709	0.0963
1	Hokkaido	0.00149	0.0462	0.0324	1.2212	0.0265
44	Oita	0.00124	0.0133	0.0932	0.9833	0.0948
42	Nagasaki	0.00095	0.0441	0.0216	1.5972	0.0135
46	Kagoshima	0.00056	0.0349	0.0159	2.4634	0.0065
37	Kagawa	0.00056	0.0179	0.0311	0.9686	0.0321
18	Fukui	0.00055	0.0195	0.0283	1.2931	0.0219
31	Tottori	0.00048	0.0166	0.0291	1.3876	0.0210
16	Toyama	0.00031	0.0280	0.0112	1.4368	0.0078
39	Kouchi	0.00031	0.0047	0.0658	1.4296	0.0460
36	Tokushima	0.00028	0.0045	0.0610	0.8812	0.0693
47	Okinawa	0.00027	0.0156	0.0171	0.5668	0.0301
43	Kumamoto	0.00022	0.0375	0.0059	1.6038	0.0037
6	Yamagata	0.00021	0.0411	0.0051	1.7474	0.0029
15	Niigata	0.00015	0.0177	0.0083	2.5082	0.0033
4	Miyagi	0.00013	0.0244	0.0054	2.9335	0.0018
3	Iwate	0.00012	0.0014	0.0831	0.8014	0.1037
17	Ishikawa	0.00009	0.0184	0.0047	1.5296	0.0030
32	Shimane	0.00006	0.0009	0.0647	1.0128	0.0639
5	Akita	0.00005	0.0159	0.0028	1.0799	0.0026
2	Aomori	0.00004	0.0007	0.0627	0.8075	0.0776
41	Saga	0.00004	0.0012	0.0317	0.5845	0.0543
45	Miyazaki	0.00003	0.0062	0.0043	2.2056	0.0019
7	Fukushima	0.00001	0.0004	0.0132	1.0782	0.0123

Notes: All variables are for 1990. Data for other sample years can be available from the author upon requests. PN corresponds to the numbers in the prefecture map in Figure A1. *OverAll* is the shares of prefecture exports in Japanese national exports, , Variety measure, *ExtMargin*, is extensive margin in equation (5). *IntMargin* is intensive margin deduced from equation (2). *Price(IM)* is in equation (3) and Q(IM) is in equation (4).

Figure A1. Prefecture Groups by Extensive Margin



Note: Extensive margins of *High EM* prefectures are always above 0.5, extensive margins of *Middle EM* prefectures are between 0.1 and 0.5 during the sample period between 1988 and 2005. Extensive margins in Low EM and Lowest EM are below 0.1 in 1988 but above 0.1 for Low EM in 2005.

Table 1. Overall, Intensive and Extensive Margins

	1990			1995			2000			2005		
	Overall	Intensive	Extensive	Overall	Intensive	Extensive	Overall	Intensive	Extensive	Overall	Intensive	Extensive
Y/L	4.83	-0.60	5.43	5.62	0.50	5.12	4.96	-0.39	5.35	5.00	0.34	4.66
	(2.08)	(1.12)	(1.6)	(1.67)	(1.05)	(1.42)	(1.36)	(1.06)	(1.2)	(1.32)	(0.84)	(1)
L	2.80	0.65	2.14	2.89	0.97	1.92	2.67	0.76	1.91	2.66	0.98	1.68
	(0.51)	(0.27)	(0.39)	(0.4)	(0.25)	(0.34)	(0.33)	(0.25)	(0.29)	(0.32)	(0.2)	(0.25)
Adj. R^2	0.51	0.20	0.48	0.62	0.33	0.48	0.66	0.21	0.54	0.67	0.41	0.57
Y	1.58	0.77	0.81	1.51	0.83	0.68	1.46	0.83	0.62	1.44	0.88	0.56
	(0.07)	(0.04)	(0.06)	(0.07)	(0.04)	(0.06)	(0.05)	(0.04)	(0.05)	(0.05)	(0.03)	(0.04)
Adj. R^2	0.58	0.22	0.56	0.66	0.35	0.53	0.68	0.23	0.59	0.68	0.41	0.61

Notes: All variables are in natural logs. Number of prefectures are 39 (for 1990 and 1995) and 41 (for 2000 and 2005.) Standard errors are in parentheses. Y = GDP in the exporting prefecture relative to national GDP and L = employment in the exporting prefecture relative to national employment. GDP in 2004 is used for the regression in 2005.

Sources: *Japan Customs* for port exports. *Annual report on prefectural accounts* for GDP. *Population Census* for employment.

Table 2. Balanced Panel Estimation for Intensive and Extensive Margins (1990, 1995, 2000 and 2005)

	Within estimates			Random-effect estimates		
	Overall	Intensive	Extensive	Overall	Intensive	Extensive
Y/L	3.83	0.64	3.19		-0.52	
	(2.97)	(2.11)	(2.53)		(1.97)	
L	2.90	0.92	1.98		0.85	
	(0.21)	(0.15)	(0.18)		(0.13)	
Adj. R^2	0.72	0.35	0.63		0.29	
Hausman	19.10	2.96	18.57			
Y	2.39	0.78	1.61	2.37	0.75	1.62
	(0.17)	(0.12)	(0.14)	(0.14)	(0.09)	(0.12)
Adj. R^2	0.70	0.34	0.61	0.64	0.29	0.55
Hausman	0.03	0.11	0.00			

Notes: All variables are in natural logs. Number of prefectures are set to 39 for a balanced panel data. Standard errors are in parentheses. Random-effect estimates are also presented only when Hausman test can not reject the null hypothesis at ten percent significance level. Y = GDP in the exporting prefecture relative to national GDP and L = employment in the exporting prefecture relative to national employment. GDP in 2004 is used for the regression in 2005.

Sources: *Japan Customs* for port exports. *Annual report on prefectural accounts* for GDP. *Population Census* for employment.

Table 3. Extensive Margin Accounts for the Larger Exports

	1990	1995	2000	2005	Panel (90-05)
Employment	76%	66%	72%	63%	68%
GDP	51%	45%	42%	39%	67%

Note: Percentatges are calculated from the estimated coefficients in Table 1 and 2. For Panel (90-05) the coefficients of within estimates are used.

Table 4. Price and Quantity Components of the Intensive Margin

	1990		1995		2000		2005	
	Price	Quantity	Price	Quantity	Price	Quantity	Price	Quantity
Y/L	0.36	-0.96	0.41	0.09	0.41	-0.80	0.34	0.00
	(0.38)	(1.38)	(0.31)	(1.08)	(0.33)	(1.2)	(0.33)	(0.96)
L	0.05	0.61	0.09	0.89	0.07	0.69	0.06	0.92
	(0.09)	(0.34)	(0.07)	(0.26)	(0.08)	(0.29)	(0.08)	(0.23)
Adj. R^2	-0.01	0.13	0.01	0.28	-0.01	0.15	-0.01	0.33
Y	-0.04	0.81	-0.01	0.84	-0.03	0.86	-0.02	0.90
	(0.01)	(0.05)	(0.01)	(0.04)	(0.01)	(0.04)	(0.01)	(0.04)
Adj. R^2	0.00	0.16	0.02	0.30	0.01	0.16	0.01	0.34

Notes: All variables are in natural logs. Number of prefectures are 39 (for 1990 and 1995) and 41 (for 2000 and 2005.) Standard errors are in parentheses. Y = GDP in the exporting prefecture relative to national GDP and L = employment in the exporting prefecture relative to national employment. GDP in 2004 is used for the regression in 2005.

Sources: *Japan Customs* for port exports. *Annual report on prefectural accounts* for GDP. *Population Census* for employment.

Table 5. Balanced Panel Estimation for Price and Quantity (1990, 1995, 2000 and 2005)

	Within estimates		Random-effect estimates	
	Price	Quantity	Price	Quantity
Y/L	1.18	-0.54		
	(0.7)	(2.37)		
L	0.01	0.91		
	(0.05)	(0.17)		
Adj. R^2	-0.02	0.28		
Hausman	3.36	4.95		
Y	-0.03	0.81	0.01	0.73
	(0.04)	(0.13)	(0.03)	(0.11)
Adj. R^2	-0.03	0.28	0.00	0.23
Hausman	2.69	1.16		

Notes: All variables are in natural logs. Number of prefectures are set to 39 for a balanced panel data. Standard errors are in parentheses. Random-effect estimates are also presented only when Hausman test can not reject the null hypothesis at ten percent significance level. Y = GDP in the exporting prefecture relative to national GDP and L = employment in the exporting prefecture relative to national employment. GDP in 2004 is used for the regression in 2005.
Sources: *Japan Customs* for port exports. *Annual report on prefectural accounts* for GDP. *Population Census* for employment.

Table 6. Growth of Export Variety

Extensive margin	number of prefectures: Total	variety expanded	variety decreased	average annual growth between 1998 and 2005
High	6	3	3	0.1%
Middle	8	8	0	2.4%
Low	11	11	0	13.2%
Lowest	16	13	3	8.3%
All	41	35	6	7.3%

Note: Definition of high, middle, low and lowest extensive margin are that extensive margin (EM) in 1988 is above 0.5, EM in 1988 is above 0.1 and below 0.5, EM in 1988 is below 0.1 but EM in 2005 is above 0.1, and EM in 1988 and 2005 are both below 0.1 respectively.

Figure1. Export Variety of High EM Prefectures

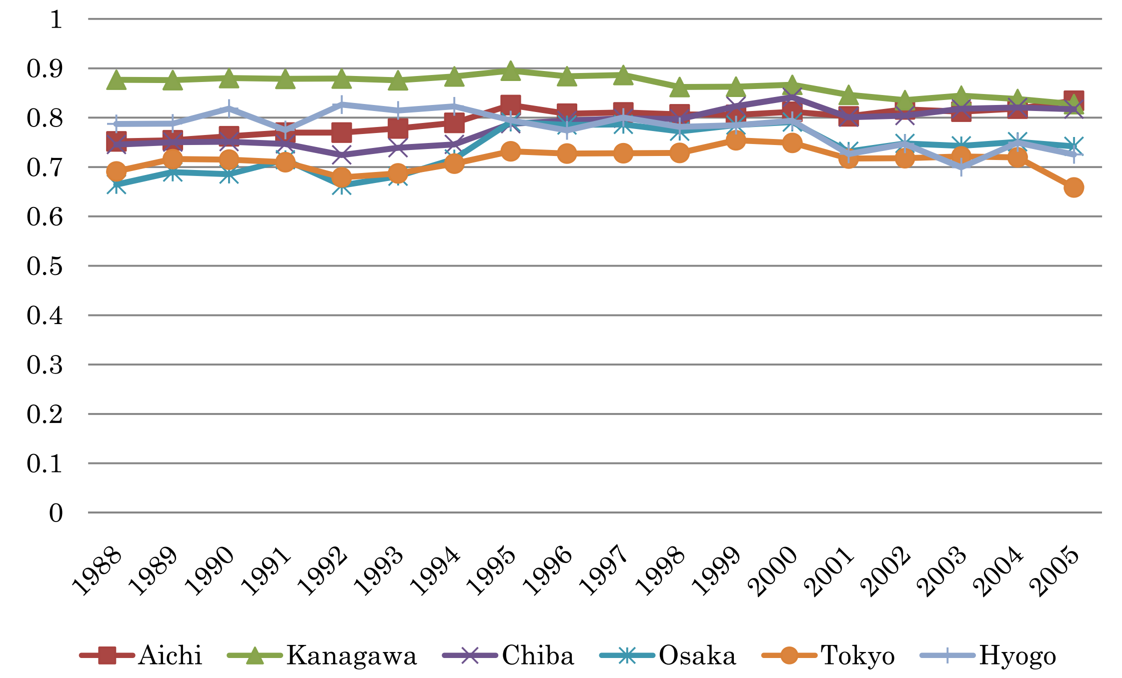
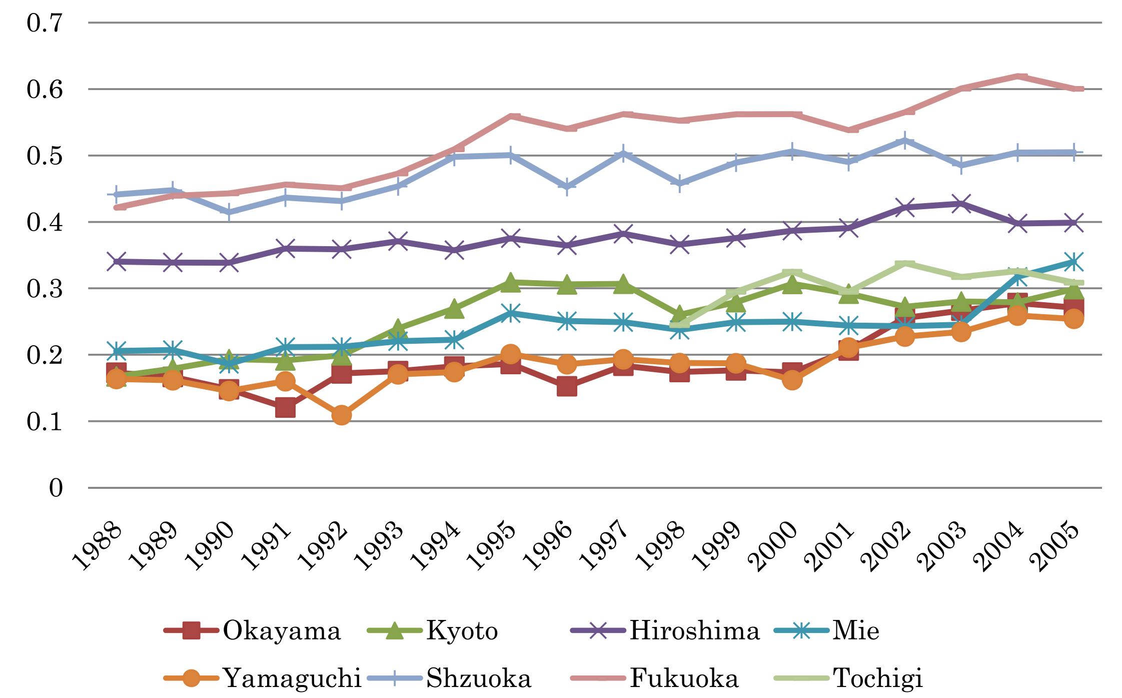


Figure2. Export Variety of Middle EM Prefectures



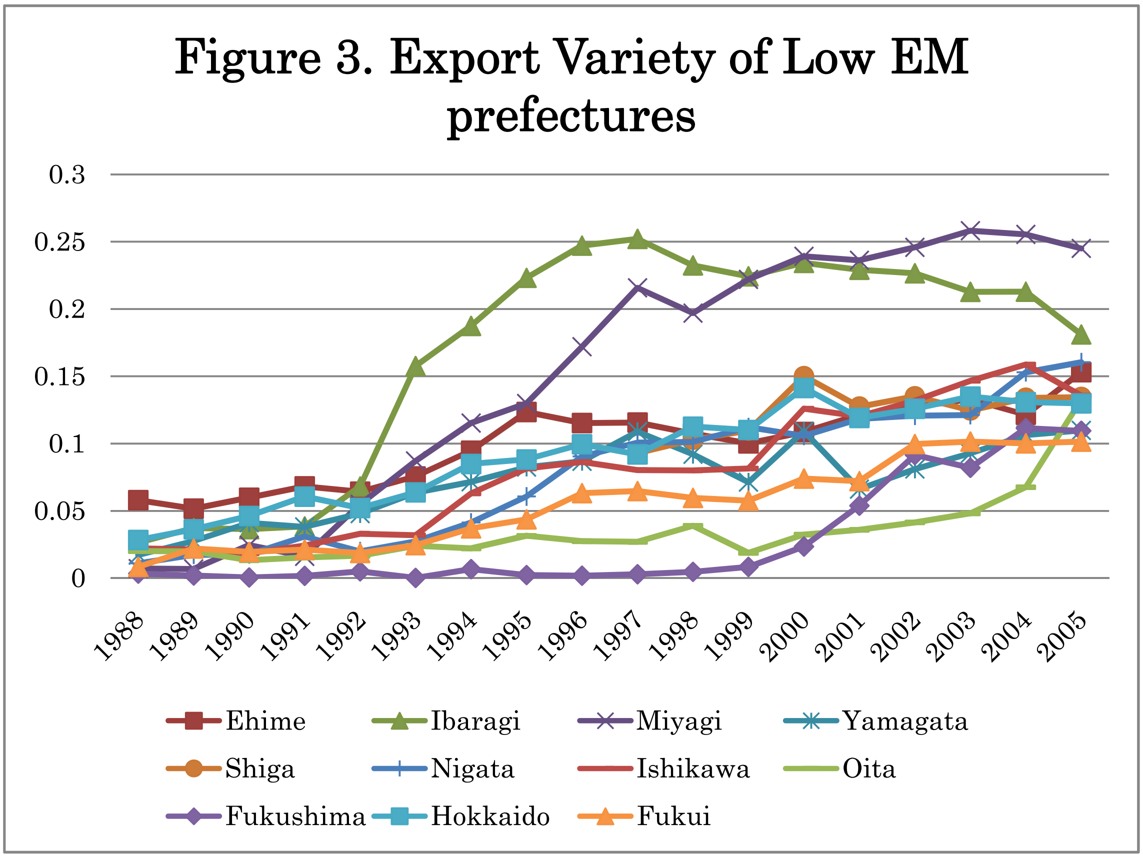
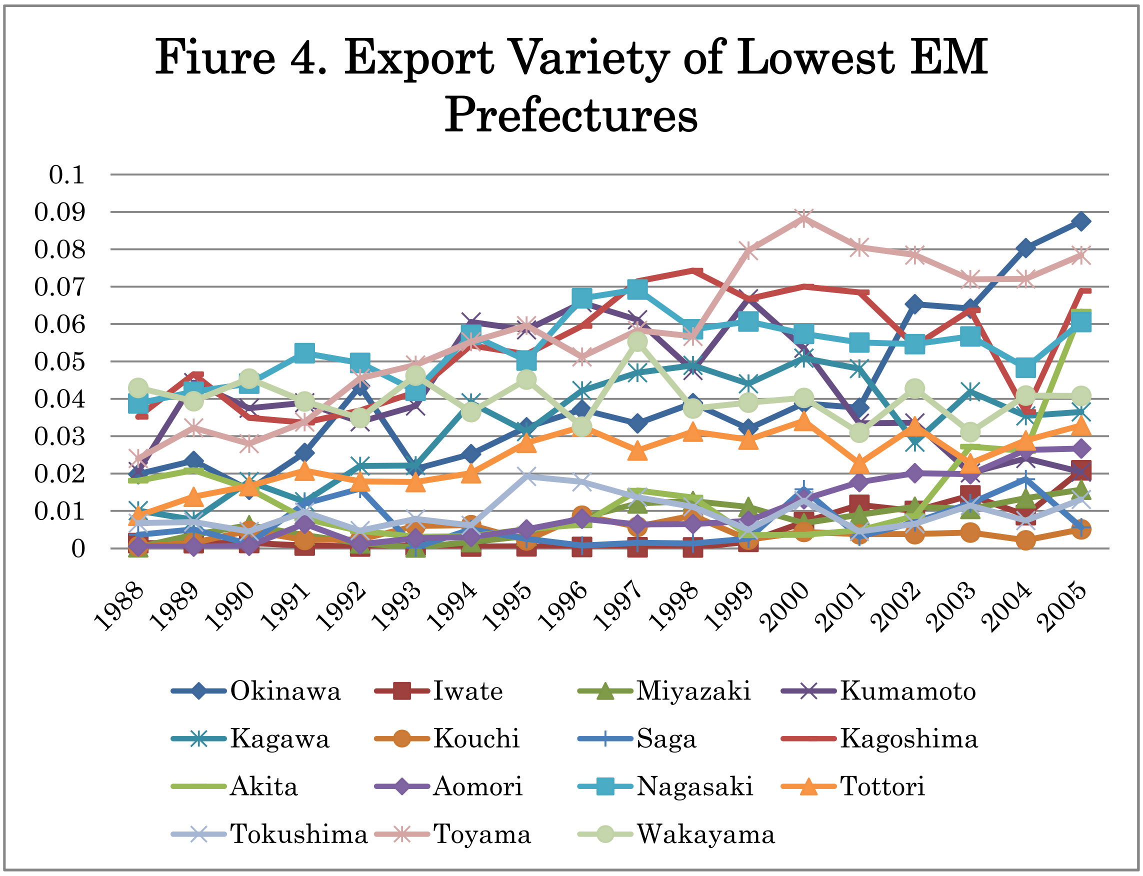


Figure 3. Export Variety of Low EM prefectures
0.3
0.25
0.2
0.15
0.1
0.05
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Ehime
Ibaragi
Miyagi
Yamagata
Shiga
Nigata
Ishikawa
Oita
Fukushima
Hokkaido
Fukui


Fiure 4. Export Variety of Lowest EM Prefectures
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Okinawa
Iwate
Miyazaki
Kumamoto
Kagawa
Kouchi
Saga
Kagoshima
Akita
Aomori
Nagasaki
Tottori
Tokushima
Toyama
Wakayama