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Spatial Structures of Manufacturing Clusters in Cambodia, Lao People's Democratic Republic, and Thailand

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Abstract

Examining the spatial structure of clusters is essential for deriving regional development policy implications. In this study, we identify the manufacturing clusters in Cambodia, the Lao People's Democratic Republic, and Thailand, using two indices—global extent (GE) and local density (LD)—as proposed by Mori and Smith (2013). We also analyze four different combinations of these indices to highlight the spatial structures of industrial agglomerations. Since industrial clusters often spread over administrative boundaries, the GE and LD indices—along with cluster mapping—display how the detected clusters fit into specific spatial structures.

Keywords: Industrial agglomeration, Cluster analysis, Cambodia, Lao PDR, Thailand

JEL classification: L60; R12; R14

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1. Introduction

The formation of industrial clusters is necessary for successful economic development. In particular, industrial deepening—the formation of local linkages by creating a robust supplier base and expanding ancillary services (Asian Development Bank 2013)—is necessary for sustained industrial development. The benefits of industrial clusters are multi-faceted. First, the clustering of economic activities reduces the costs of obtaining intermediate inputs and shipping goods to downstream customers. Second, clustering induces the emergence of a large pool of labor, which facilitates better matching of workers to employers. Third, information and technology spillovers are more likely when firms are clustered (Marshall 1920, Fujita and Thisse 2002). Consequently, firms have more incentives to locate near each other, so that industrial agglomerations are shaped to strengthen the competitiveness of industries and promote sustained industrial development.

Trade liberalization and economic integration offer various opportunities for latecomer countries to participate in global value chains (GVCs). Cambodia and Lao People's Democratic Republic (Lao PDR) joined the GVCs of labor-intensive industries—in particular, the apparel and footwear industries—after they began to liberalize trade and investment in the 1990s. In recent years, they have begun to attract more technologically sophisticated industries, such as electronics and automobile parts. It should be noted, however, that rural manufacturing industries, such as rice milling and noodle products, still hold substantial shares, and supplier industries are extremely weak in Cambodia and Lao PDR.

In Thailand, import substitution industries, such as automobiles and household electrical appliances, attracted significant foreign direct investment in the 1960s, especially from Japan. However, Thailand changed its policy orientation and became actively involved in the GVCs organized by multinational firms after the mid-1980s, when there was a surge in investment from Japan and other East Asian economies. Because Thailand has a longer experience of industrial development and has implemented industrial policies, including higher trade barriers and local content requirements (LCRs)—which were effective to develop supplier industries, but later prohibited by the current World Trade Organization rules—it is not surprising that

Thailand's economy has established a more robust industrial base than Cambodia and Lao PDR.

Against this backdrop, this study attempts to identify the manufacturing clusters in Cambodia, Lao PDR, and Thailand, using the method proposed by Mori and Smith (2013) and to classify the spatial structure of clusters. Examining the spatial structure of clusters is essential to derive policy implications for regional industrial development. Thus, it is crucial to investigate how the spatial structure of manufacturing clusters has been shaped in these countries.

As discussed below, Mori and Smith (2013) provide a map of industrial clusters by industry, which was tested against the hypothesis of spurious clusters. Moreover, Mori and Smith indicate the spatial patterns of industrial agglomerations using the global extent (GE) and local density (LD) indices. Note that understanding these spatial patterns is extremely useful, as the industrial clusters often spread over a wider geographical area and as the GE and LD indices—along with the cluster mapping—display how the respective clusters fit into specific spatial patterns.

The remainder of this paper is organized as follows. Section 2 explains the theoretical background of the method applied in this study. Section 3 presents the empirical results in the sequence of Cambodia, Lao PDR, and Thailand. Finally, Section 4 concludes with a summary of the findings.

2. Methodology

This section discusses two indices to identify the spatial structure of industrial agglomeration introduced by Mori and Smith (2013). It also discusses the method to derive the two indices and the way the values of these indices are actually calculated in this study.

2.1. The GE and LD Indices

The GE and LD indices developed by Mori and Smith (2013) were intended to identify the *spatial structure* of industrial agglomeration. The spatial structure may vary depending on the spatial scale. For example, firms may agglomerate at the global scale, but disperse at the local scale and vice versa. Thus, using any single index faces the

limitation of discerning such difference of spatial structure. Thus, two indices—GE and LD—were introduced by Mori and Smith (2013).

The process for deriving GE and LE can be divided into three steps: first, the clusters are detected; second, the essential containment is found; and third, the GE and LD are calculated.

The first step is to find the cluster scheme \mathbb{C}^* with a maximum value of Bayes information criteria (BIC) among each candidate cluster scheme:

$$BIC_{\mathbb{C}} = L_{\mathbb{C}}(\hat{P}_{\mathbb{C}}|x) - \frac{k_{\mathbb{C}}}{2} \ln n$$

where

$$L_{\mathbb{C}}(\hat{P}_{\mathbb{C}}|x) = \sum_{j=0}^{k_{\mathbb{C}}} n_j(x) \ln \hat{p}_{\mathbb{C}}(j) + \sum_{j=0}^{k_{\mathbb{C}}} \sum_{r \in C_j} n_r \ln \frac{a_r}{a_{C_j}}.$$

The cluster scheme \mathbb{C} is simply one or more disjoint clusters (i.e., convex solids, which will be discussed below), C_j , $j = 1, \dots, k$, and the residual set of all non-cluster regions. BIC increases with a larger log-likelihood of $\hat{P}_{\mathbb{C}}$, the location probability of cluster scheme \mathbb{C} for each basic region, given an observed location pattern x , whereas BIC decreases with the penalty term composed by $k_{\mathbb{C}}$, which expresses the number of clusters in the cluster scheme \mathbb{C} , and n , which expresses the number of establishments in the entire area.

Because each region is included as part of a certain cluster C_j , $j = 1, \dots, k$ or the residual set of all non-cluster regions, the right-hand side of the log-likelihood function of the location probabilities (i.e., a probability that a randomly sampled establishment locates in a region within a certain cluster) expresses the law of total probability: the log-likelihood function can be divided into two parts: the first term, which gives the location probabilities that n_j establishments locate in a cluster C_j , $j = 1, \dots, k$, and the second term, which gives the location probability that n_r establishments locate in region r in cluster C_j , $j = 1, \dots, k$, given that individual establishments choose their location completely randomly within each cluster.

For the first term, the location probability of a cluster C_j , $j = 1, \dots, k$, can be written as $\hat{p}_{\mathbb{C}}(j) = n_j(x)/n$, where $n_j(x)$ denotes the sum of the number of

establishments in cluster $j = 1, \dots, k$ and n represents the total number of establishments in the entire region.

For the second term, the location probability of region r under the condition that an establishment locates in a cluster C_j , $j = 1, \dots, k$, is given by a_r/a_{C_j} , where a_r denotes the economic area in region r and a_{C_j} represents the economic area in a cluster C_j , $j = 1, \dots, k$.⁵ In the process of choosing an additional region within a cluster, the shortest path distance is used.

The second step is divided into two parts. The first part is to find the essential clusters, which are the most significant in terms of incremental contributions to BIC under the condition that the sum of incremental contributions to BIC exceeds a certain proportion (λ) of BIC_C . The last part of the second step is to find the smallest convex-solid set in the total area containing the set of essential clusters. Intuitively, a convex-solid set means that the set is connected and has not only no dents in its perimeter, but also no internal cavities. Then the regions in the smallest convex-solid set can be regarded as an essential containment.

Finally, we can obtain the GE for an industry by dividing the total economic area of essential containment for an industry by the total economic area of the whole country. Likewise, we can obtain the LD for the industry by dividing the total economic area of the essential clusters for the industry by the total economic area of the essential containment.

2.2. A Test of Spurious Clusters

The recent trend in the index of industrial agglomeration is to test the “the null hypothesis” that spatial distribution could simply have emerged by chance (Ellison and Glaeser, 1997; Duranton and Overman, 2005; and Mori, et al., 2005). Mori and Smith (2013) conducted a test of spurious clusters to examine whether the BIC of the best cluster scheme is significantly better than that under a random location pattern generated by a Monte Carlo test. As a result, only the significant clusters are selected for the analysis on industrial agglomerations. In this study, all industries in the three countries passed a test of spurious clusters.

⁵ For the derivation of economic area, see Section 2.3

2.3. The Derivation of the GE and LD Indices for the Three Countries

To obtain the GE and LD indices for Cambodia, Lao PDR, and Thailand, we applied the above-mentioned method to the data on these countries with respect to distance, economic area, and the number of establishments.⁶ The distances are calculated by the direct line between the centroid of each region in the shape files rather than the road network distance. The shape files for Lao PDR and Cambodia were the Global Administrative Unit Layers that were produced by the Food and Agriculture Organization of the United Nations. The shape files for Thailand were downloaded from DIVA-GIS (diva-gis.org). The economic areas were obtained from the Global Land Cover 2000 (the Joint Research Center of the European Commission). Omitting any area that is not suitable for economic activity, the economic area of each region is calculated using the shape files. The explanation about the establishment data is provided in the following sections. Finally, we have chosen the value of λ appropriately, following the recommendation by Mori and Smith (2014).⁷

2.4. The Combination of the GE and LD Indices

The combination of the GE and LD reflects the *spatial structure* of industrial agglomeration because the value of GE indicates the share of the total area of essential containment (black and grey squares in Figure 1), which is the smallest convex-solid set containing the set of essential clusters, relative to that of the entire country (the entire area in Figure 1-1). The value of LD expresses the share of the total area of essential clusters (black squares in Figure 1), relative to that of the essential containment (black and grey squares in Figure 1).

For instance, a larger GE represents a relatively dispersed spatial distribution of an industry throughout a country, whereas a larger LD represents that throughout the essential containment. Using the terminology of Mori and Smith (2013), industries with a low GE are regarded as exhibiting a relatively “confined” spatial pattern, while those with a high GE demonstrate a relatively “dispersed” pattern. Likewise, industries with a high LD indicate a relatively “dense” pattern, while those with a low

⁶ The computer programs for these analyses introduced by Mori and Smith (2013) are available at http://www.mori.kier.kyoto-u.ac.jp/data/cluster_detection.html.

⁷ We choose λ to ensure least correlation between GE and LD.

LD demonstrate a relatively “sparse” pattern. Thus, we obtain four patterns of spatial structure: the “globally dispersed and locally dense” pattern; “globally dispersed and locally sparse” pattern; “globally confined and locally dense” pattern; and “globally confined and locally sparse” pattern.

To get a clearer image of the four patterns of spatial structure, we exemplify the GE and LD using a box composed of 36 blocks. We obtain the four simplified figures for the GE and LD for each pattern in Figure 1, and λ is set as 1 for simplicity. Each of the four boxes has 36 blocks, which implies there are 36 regions in the entire country. The number of black and grey regions is used to calculate the GE and LD. The black regions show the regions in an essential cluster. The grey regions are not essential clusters, but are included in the essential containment.

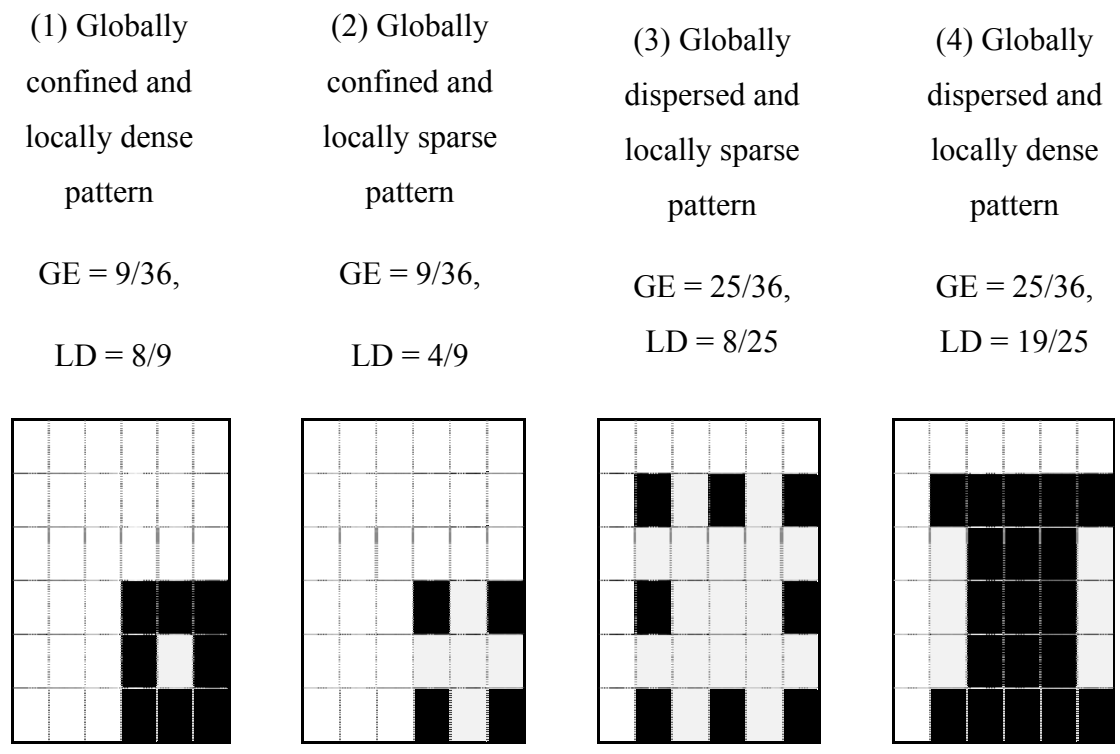


Figure 1: Four Combinations of Global Extent and Local Density

Note: GE = global extent; LD = local density.

Source: Drawn by the authors

The first figure in Figure 1 indicates the globally confined and locally dense pattern. From the number of regions of the total area, the essential containment, and essential cluster, which are respectively 36, 9, and 8, we calculate the GE as $9/36 = 0.25$ and LD as $8/9 = 0.89$. In the same manner, we can obtain the GE and LD for the other three spatial structure patterns.

Notice the differences in the spatial structure, although the numbers of regions contained in the essential clusters are identical between the first and the third figures. The usage of GE and LD clarifies the differences in spatial structure.

3. Empirical Results

This section presents the empirical results of the analyses on spatial patterns of manufacturing agglomerations that were introduced in Section 2. The section is separated into three subsections, each of which discusses the cases for Cambodia, Lao PDR, and Thailand, respectively.

3.1. The Case of Cambodia

This study uses the Economic Census data of Cambodia for 2011. The data covers 70,355 manufacturing firms. The GE and LD indices—and the combination of these two indices—indicate the spatial patterns of industrial agglomerations. As shown in Figure 2.1-1, the four location patterns of manufacturing agglomerations are demonstrated in line with Mori and Smith (2013).

Before describing each of the four location patterns, it is worth noting that, unlike the case of Japan (see Figure 6 in Mori and Smith 2014), the distribution of GE and LD are U-shaped rather than uniformly dispersed. Thus, LD has a lower value when GE takes on a mid-range value.

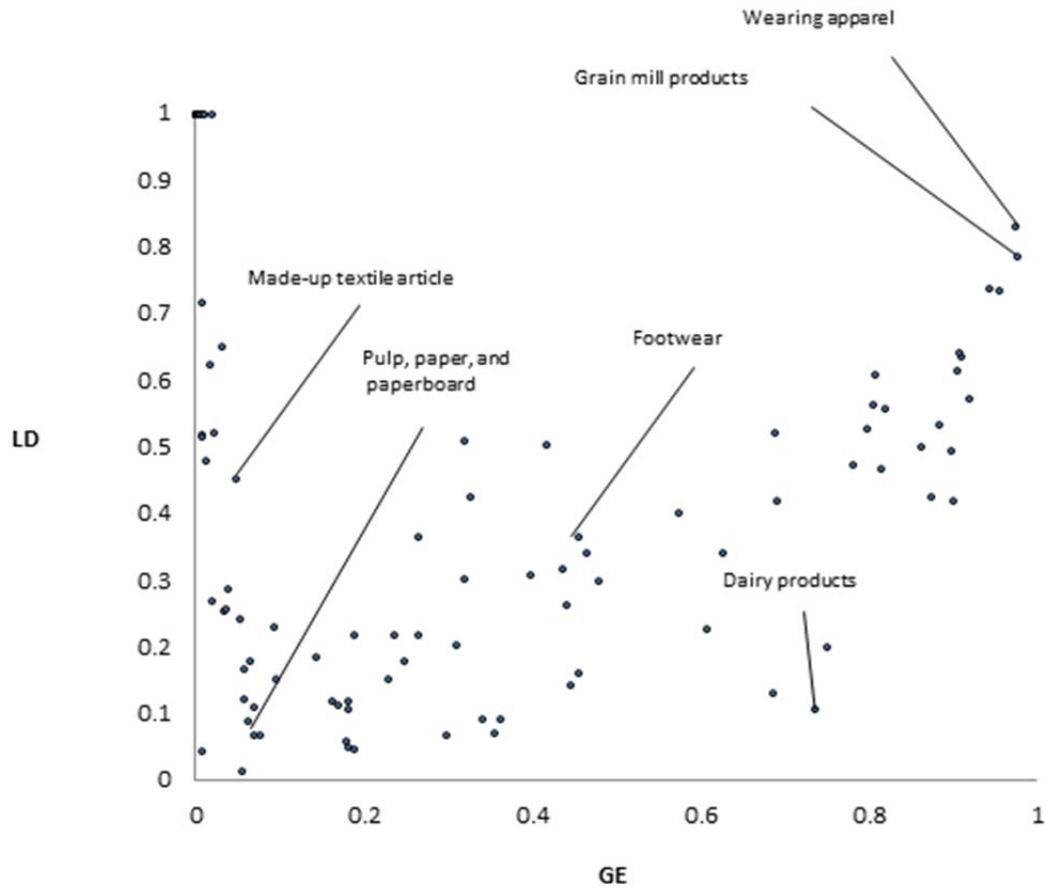


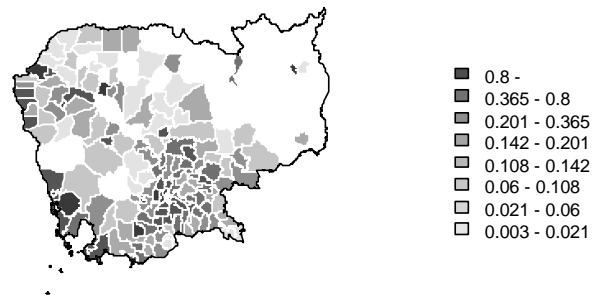
Figure 2.1-1: Global Extent and Local Density in Cambodia, 2011

Note 1: GE = global extent; LD = local density.

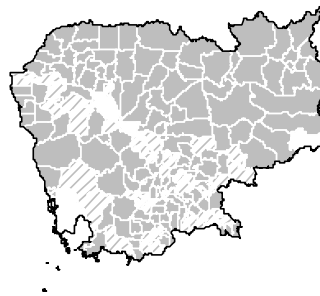
Note 2: Figure 2.1-1 demonstrates the four location patterns of industrial agglomeration. In addition, Figure 2.1-1 indicates the values of GE and LD of significant industries in terms of the number of firms, number of employees, and number of employees per firm. For example, grain mill products was the largest industry in terms of the number of establishments (19,476) : similarly, wearing apparel (except fur) and footwear were the largest industries in terms of the number of employees (280,192) and the number of employees per establishment, respectively (362).

(1) Globally Dispersed and Locally Dense Patterns

Industries with relatively high values of GE and LD exhibit globally dispersed and locally dense patterns of industrial agglomeration. As discussed above, wearing apparel (except fur) and grain mill product industries—both of which are positioned near the northeast corner in Figure 2.1-1—are suitable examples of this pattern of industrial agglomeration. Note that these industries have a large number of establishments and are quite ubiquitous, except in non-economic areas (see Figure 2.1-2 for wearing apparel except fur).



(a) Density of establishments



(b) Clusters and essential containment (GE=0.972, LD=0.83)

Figure 2.1-2: Manufacture of Wearing Apparel, Except Fur (1410): Cambodia

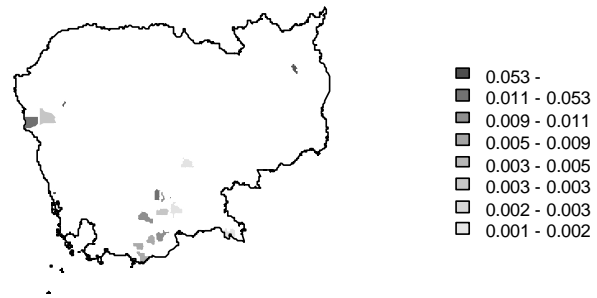
Note 1: GE = global extent; LD = local density.

Note 2: Note that in figure (b), industrial clusters are expressed by the dark area, while an essential containment is represented by the meshed area.

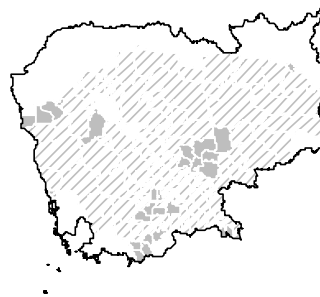
(2) Globally Dispersed and Locally Sparse Patterns

Industries with relatively high values of GE and low values of LD—which are positioned near the southeast corner in Figure 2.1-1—exhibit globally dispersed and locally sparse patterns. A clear example of such a location pattern is the dairy products industry (ISIC 1050). As shown in Figure 2.1-3, the essential containment of this industry is spread across a wider area, but the industrial clusters are geographically sparse within the essential containment: in particular, they are

concentrated in the suburbs of Phnom Penh, as well as in a few districts near the national border.



(a) Density of establishments



(b) Clusters and essential containment (GE=0.734, LD=0.108)

Figure 2.1-3: Manufacture of Dairy Products (1050): Cambodia

Note: GE = global extent; LD = local density.

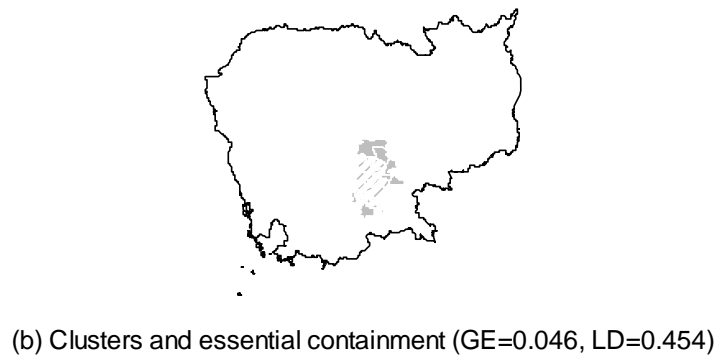
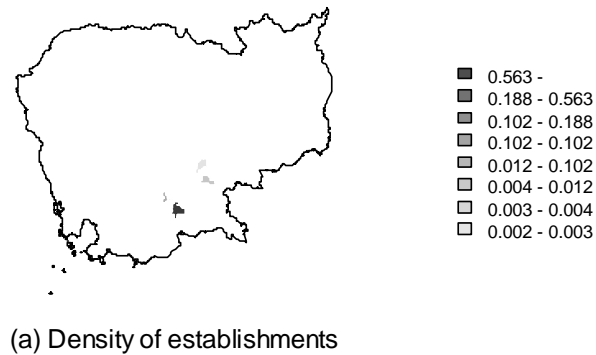


Figure 2.1-4: Manufacture of Made-Up Textile Articles, Except Apparel (1392): Cambodia

Note: GE = global extent; LD = local density.

(3) Globally Confined and Locally Dense Patterns

Industries with relatively low values of GE and high values of LD—which are positioned near the northwest corner in Figure 2.1-1—exhibit globally confined and locally dense patterns. However, it should be noted that there are several industries whose values of GE are near zero and those of LD are all one. Many of these industries exhibit such an extreme location pattern because they contain only one establishment. It is clearly not appropriate to draw any conclusion on location

patterns from such a small number of establishments, and thus, they are excluded from the selections of location patterns.⁸

Figure 2.1-4 indicates the location patterns of made-up textile articles, except apparel (ISIC 1392): the number of establishments for made-up textile articles is 322. It is shown that the industrial agglomerations are spread around Phnom Penh and its suburbs.

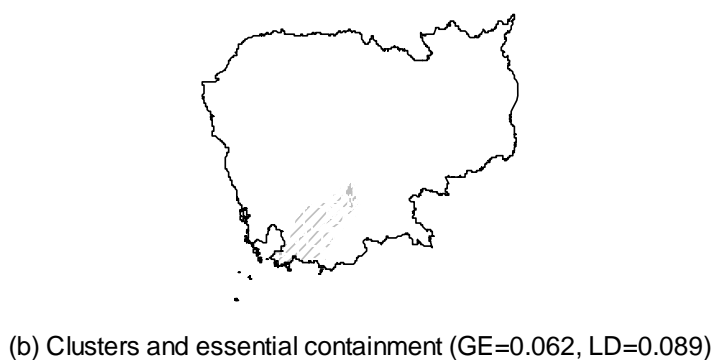
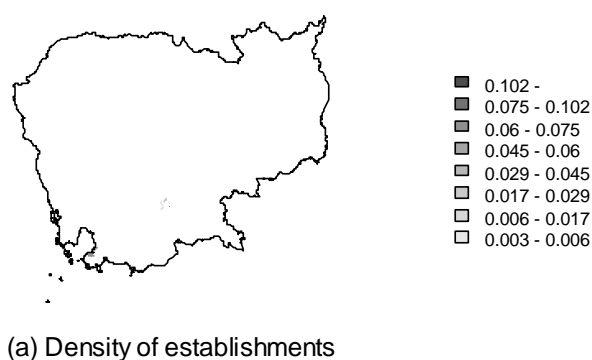


Figure 2.1-5: Manufacture of Pulp, Paper, and Paperboard (1701): Cambodia

Note: GE = global extent; LD = local density.

⁸Many industries in Cambodia have only a small number of establishments (including only one establishment in an extreme case). Thus, there is always the possibility that some Cambodian industries are seemingly geographically concentrated not due to economies of scale in production or agglomeration externalities, but rather due to immaturity in industrial development.

(4) Globally Confined and Locally Sparse Patterns

Industries with relatively low values of GE and LD—which are positioned near the southwest corner in Figure 2.1-1—exhibit globally confined and locally sparse patterns. A clear example of this location pattern is provided by the pulp, paper, and paperboard industry (ISIC 1701). As shown in Figure 2.1-5, the geographical extension of the essential containment is relatively narrow, and the industrial clusters of pulp, paper, and paperboard establishments are geographically sparse within the essential containment: these clusters are mainly located either in Preah Sihanouk Province or the Phnom Penh metropolitan area.

3.2. The Case of Lao PDR

The dataset used for the study of Lao PDR is the Economic Census for 2006. The data covers 126,913 establishments, among which 22,935 establishments (18 percent) are in the manufacturing sector categorized according to the Central Product Classification (CPC) 4 digit codes. Using the data for the manufacturing sector, the cluster patterns of significant industries as well as the four location patterns of manufacturing agglomeration in Lao PDR with the GE and LD indices are demonstrated in Figure 2.2-1.

Figure 2.2-1 shows that, similar to Cambodia, the distribution of GE and LD are U-shaped, so that LD has a lower value when GE takes on a mid-range value.

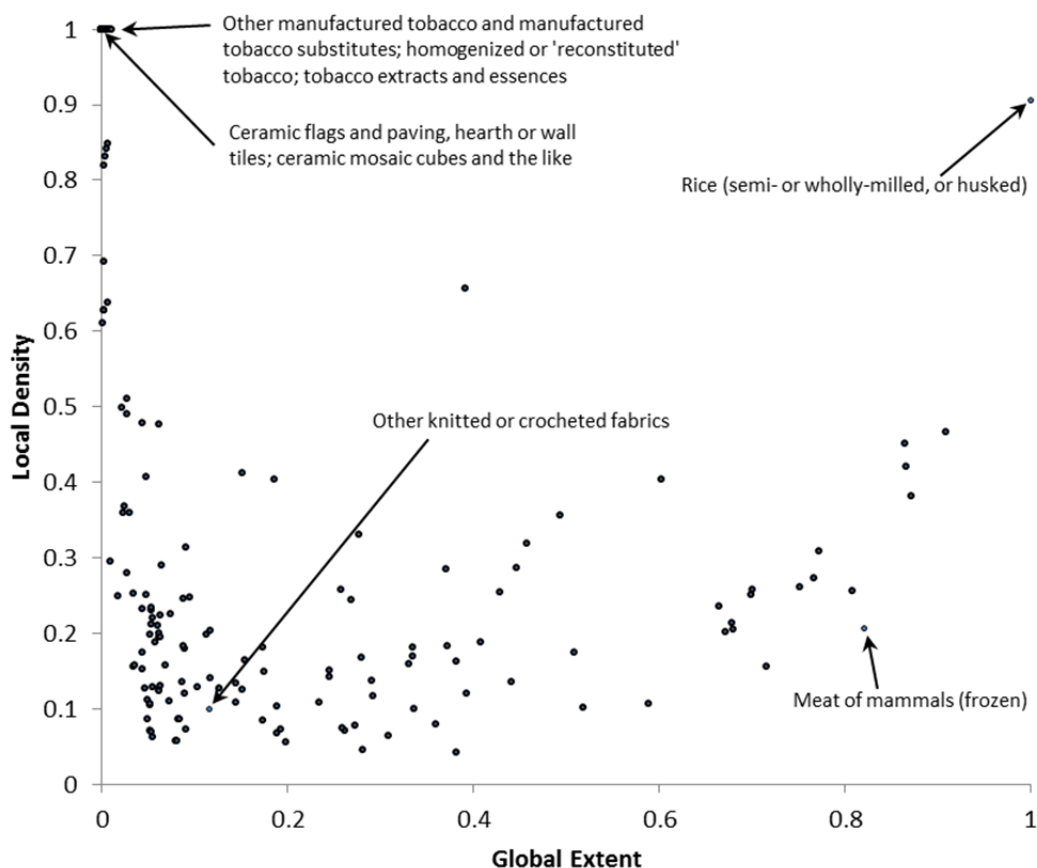


Figure 2.2-1: Global Extent and Local Density in Lao People’s Democratic Republic, 2006

Note: Together with the values of GE and LD of the industries exhibiting four distinct location patterns of industrial agglomerations, Figure 2.2-1 demonstrates significant industries in Lao PDR. Rice milling (precisely, CPC 2316: rice, semi- or wholly-milled, or husked) is the most significant sector in terms of the number of establishments (12,591): it is simultaneously the largest sector in terms of the number of employees (280,192). Moreover, tobacco products manufacturing (CPC 2509: other manufactured tobacco and manufactured tobacco substitutes; homogenized or “reconstituted” tobacco; tobacco extracts and essences) is the largest sector in terms of the number of employees per establishment (575).

(1) Globally Dispersed and Locally Dense Patterns

The rice milling (CPC 2316: rice, semi- or wholly-milled, or husked) industry, which is positioned near the northeast corner in Figure 2.2-1, is an example of a globally dispersed and locally dense pattern of industrial agglomeration. This industry has a large number of establishments and is quite ubiquitous except in non-economic areas, as shown in Figure 2.2-2. Rice milling establishments are spread across the country, and the GE (1) and LD (0.905) values are also significantly high. Similar to

Cambodia, since the rice fields are spread across arable land and rice is the staple food of Lao PDR, it is not surprising that the locations of rice mills are quite ubiquitous.

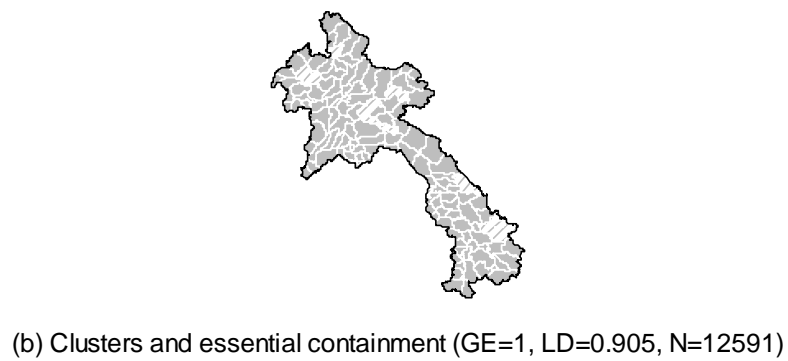
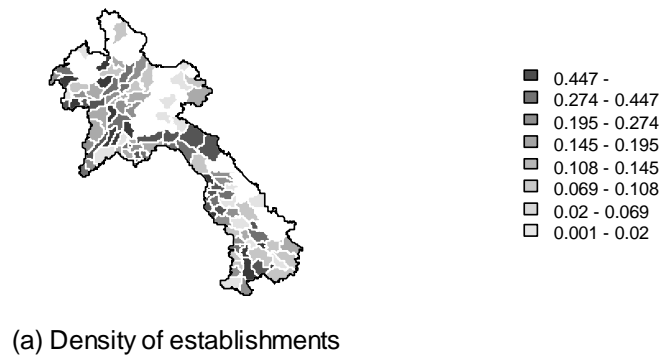


Figure 2.2-2: Rice, Semi- or Wholly-milled, or Husked (2316): Lao People's Democratic Republic

Note: GE = global extent; LD = local density.

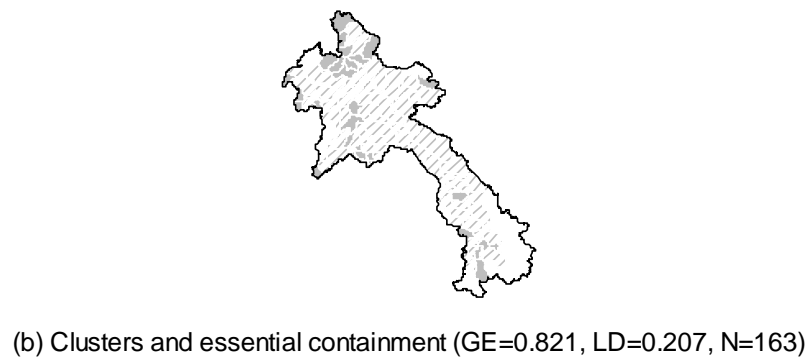
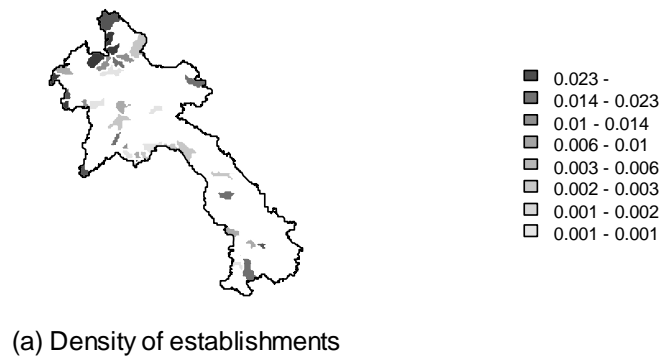


Figure 2.2-3: Meat of Mammals, Frozen (2113): Lao People’s Democratic Republic

Note: GE = global extent; LD = local density.

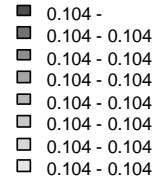
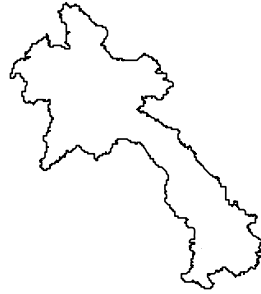
(2) Globally Dispersed and Locally Sparse Patterns

The frozen meat of mammals industry (CPC 2113) is an example of a globally dispersed and locally sparse pattern of industrial agglomeration. This industry has a relatively high GE value (0.821) and low LD value (0.207), and is positioned near the southeast corner in Figure 2.2-1. As shown in Figure 2.2-3, the essential containment of establishments dealing with frozen meat of mammals is spread across a wider area; however, the industrial clusters of these establishments are geographically sparse

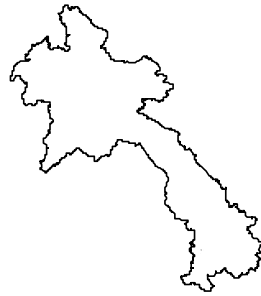
within the essential containment. It is noteworthy that, compared to the fresh or chilled meat of mammals industry (CPC 2111), whose GE and LD values are respectively 0.865 and 0.451, the LD for the frozen meat of mammals industry is considerably low (0.207).

(3) Globally Confined and Locally Dense Patterns

The ceramic product sector (CPC 3737: ceramic tiles and paving, hearth or wall tiles; ceramic mosaic cubes and similar) is an example of a globally confined and locally dense pattern of industrial agglomeration in Lao PDR. This industry has a relatively low GE value (0.00057) and high LD value (1), and is positioned near the northwest corner in Figure 2.2-1. Consistent with Mori and Smith (2013), it is clear that an industry with a small number of establishments exhibits a globally confined and locally dense pattern. Figure 2.2-4 illustrates that this industry, which has 11 establishments, is clustered only in Pakse and Champasak provinces.



(a) Density of establishments



(b) Clusters and essential containment (GE=0.001, LD=1, N=11)

Figure 2.2-4: Ceramic Flags and Paving, Hearth or Wall Tiles; Ceramic Mosaic Cubes and the Like (3737): Lao People's Democratic Republic

Note: GE = global extent; LD = local density.

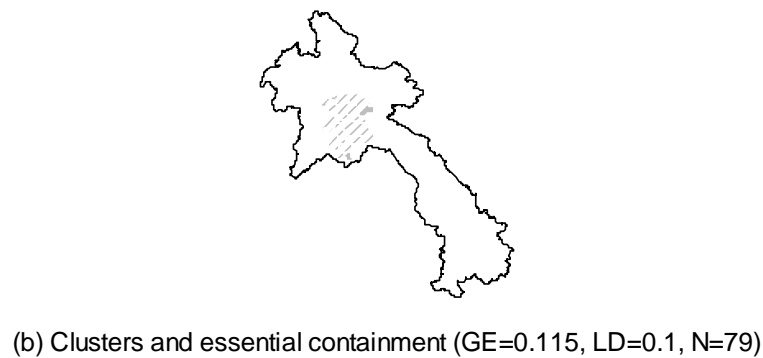
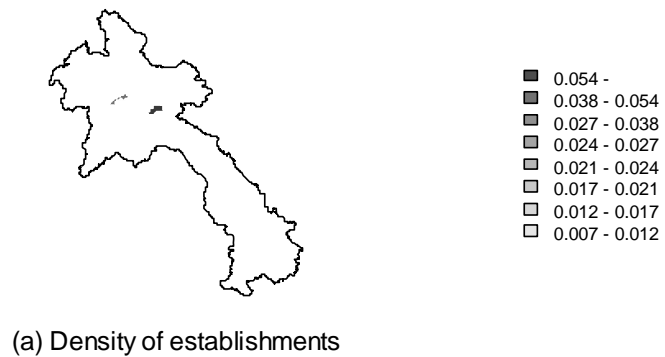


Figure 2.2-5: Other Knitted or Crocheted Fabrics (2819): Lao People's Democratic Republic

Note: GE = global extent; LD = local density.

(4) Globally Confined and Locally Sparse Patterns

An example of globally confined and locally sparse pattern is other knitted or crocheted fabric products sector (CPC 2819) with relatively low GE (0.115) and LD (0.100) values. This industry is positioned near the southwest corner in Figure 2.2-1. Figure 2.2-5 illustrates a relatively extensive, but confined area of essential containment, and the industrial clusters of other knitted or crocheted fabric establishments are geographically sparse within the essential containment. This may reflect the current situation, where traditional fabric-related production, such as that

of silk, may spread across the country, while a modern fabric-related industry is located in the capital region.

3.3. The Case of Thailand

The industrial census data of Thailand was for 2007. The data covers 73,931 manufacturing firms in 127 ISIC-Rev.3 sectors. Figure 2.3-1 shows the GE and LD values for these industries. It can be seen that most industries in Thailand exhibit a globally dispersed and locally sparse pattern of agglomeration, as they have a moderate to high level of GE, but low to moderate level of LD. Figure 2.3-1 also shows that, similar to the previous two countries, the distribution of GE and LD are U-shaped: in particular, LD has the lowest value, while GE is in the mid-range.

In this section, we summarize the key findings of the agglomeration pattern of some of the most significant and interesting industries in Thailand.

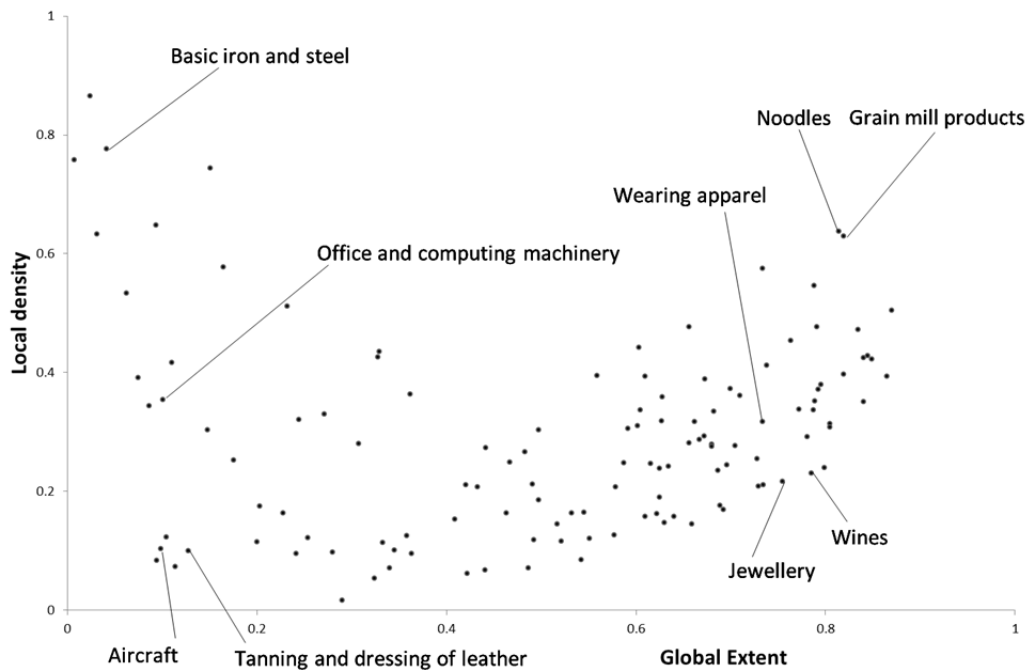


Figure 2.3-1: Global Extent and Local Density in Thailand, 2007

Note: Together with the GE and LD values of the industries exhibiting four distinct location patterns of industrial agglomerations, those of two significant industries in Thailand—the wearing apparel and the office, accounting, and computing machinery—are demonstrated. The wearing apparel industry is the largest in Thailand in terms of the number of establishments (5,475) and number of employees (311,931), while the office, accounting, and computing machinery industry is, on average, the largest in terms of the number of employees per establishment (661).

(1) Globally Dispersed and Locally Dense Patterns

There are two industries in Thailand that markedly exhibit a globally dispersed and locally dense pattern of agglomeration, as they have noticeably high GE and LD values. These include the manufacture of grain mill products (ISIC 1531) and that of macaroni, noodles, couscous, and similar farinaceous products (ISIC 1544). The GE and LD values of the former are 0.819 and 0.629, while those of the latter are 0.814 and 0.637, respectively (Figure 2.3-2 and Figure 2.3-3).

Regarded as “the rice bowl of Asia,” Thailand has a vast and fertile flood plain in many provinces throughout the country suitable for rice cultivation. After harvesting, rice is milled and further processed to yield a variety of products, e.g., farinaceous products. The technology and machinery for rice milling and processing are generally not complicated. In addition, milled rice and farinaceous products have long been served in many Thai dishes regardless of any regional variation. As a result, the two industries are ubiquitous and exhibit a globally dispersed and locally dense pattern of industrial agglomeration.

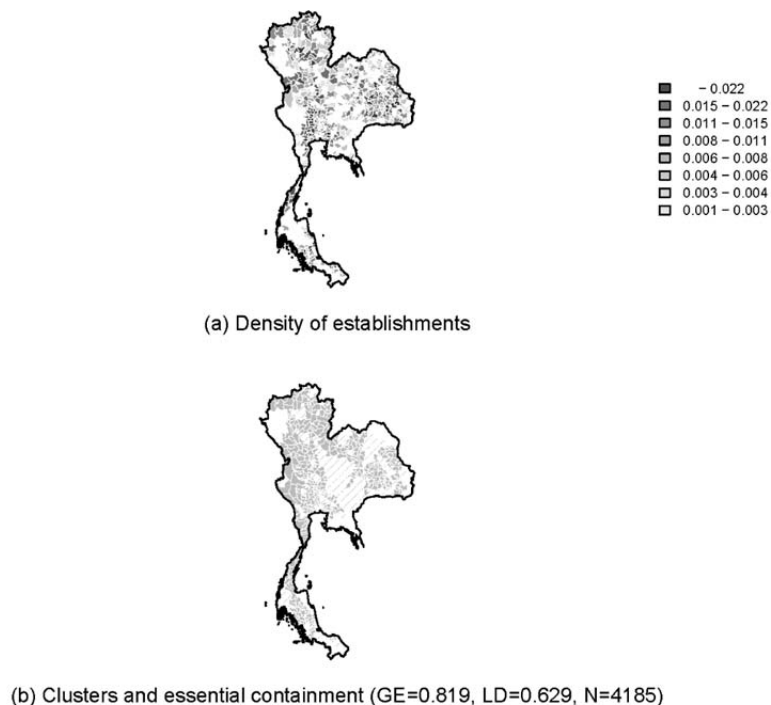


Figure 2.3-2: Manufacture of Grain Mill Products (1531): Thailand

Note: GE = global extent; LD = local density.

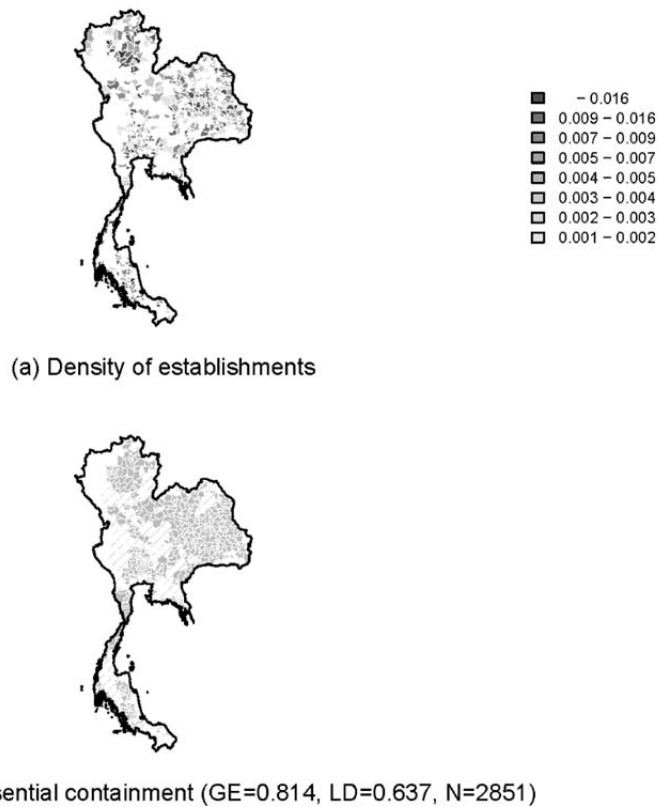


Figure 2.3-3: Manufacture of Macaroni, Noodles, Couscous, and Similar Farinaceous Products (1544): Thailand

Note: GE = global extent; LD = local density.

(2) Globally Dispersed and Locally Sparse Patterns

There are six industries in Thailand that exhibit a relatively globally dispersed and locally sparse pattern of agglomeration, as they have noticeably high GE values, but fairly low LD values. These include processing and preserving of fish and fish products (ISIC 1512), manufacture of wines (ISIC 1552), glass and glass products (ISIC 2610), non-structural non-refractory ceramic ware (ISIC 2691), furniture (ISIC 3610), and jewellery and related articles (ISIC 3691). The GE and LD values of these industries range from 0.728 to 0.799 and from 0.208 to 0.255, respectively. Figures 2.3-4 and 2.3-5 show in detail this pattern of agglomeration of two selected industries.

Although these industries have different characteristics, they share at least two features that may cause the same pattern of agglomeration. First, key raw materials for these industries cannot be found in many parts of Thailand, while consumers of these industries are ubiquitous in the country.

Second, local sparseness may suggest the existence of scale economies in production for these industries (Mori and Smith, 2014). Furthermore, their production processes may require workers with specific skills, craftsmanship, or specialty. To survive and thrive in these sectors, a location where good-quality raw materials are available is not the only key success factor. In fact, firms also have to develop unique recipes. This explains why firms flock together in rural clusters, where they can share the benefit of labor market pooling.



(a) Density of establishments



(b) Clusters and essential containment (GE=0.785, LD=0.23, N=1627)

Figure 2.3-4: Manufacture of Wines (1552): Thailand

Note: GE = global extent; LD = local density.

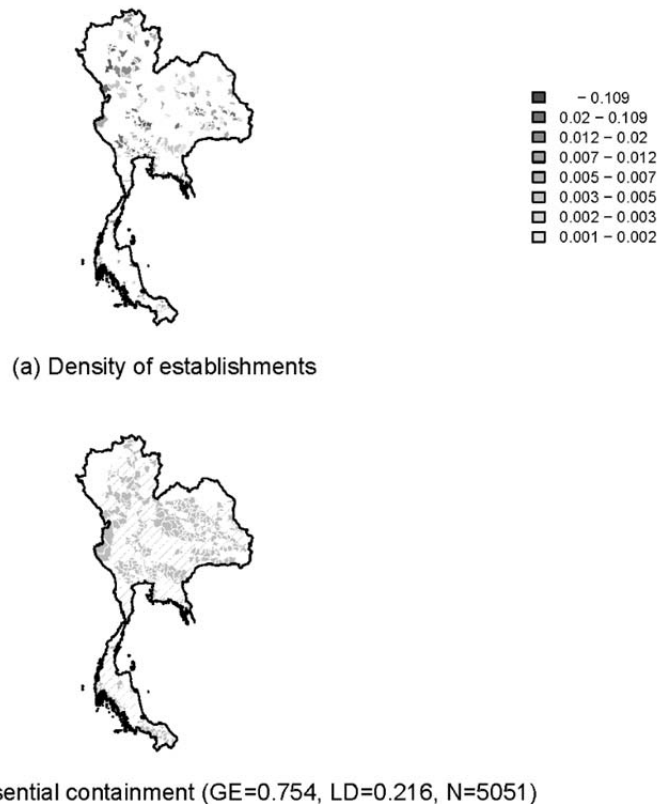


Figure 2.3-5: Manufacture of Jewellery and Related Articles (3691): Thailand

Note: GE = global extent; LD = local density.

(3) Globally Confined and Locally Dense Patterns

There are four industries in Thailand that exhibit a globally confined and locally dense pattern of agglomeration, as they have a remarkably low GE value, but noticeably high LD value. These include the manufacture of basic iron and steel (ISIC 2710), lifting and handling equipment (ISIC 2915), electric lamps and lighting equipment (ISIC 3150), and industrial process control equipment (ISIC 3313). The GE and LD values of these industries range from 0.007 to 0.151 and from 0.743 to 0.865, respectively. Figures 2.3-6 and 2.3-7 show in detail this pattern of agglomeration of two selected industries.

There are two plausible explanations why these four industries exhibit globally confined and locally dense patterns of agglomeration: economies of scale and close proximity to suppliers.

Economies of scale may be a crucial and plausible factor why the basic iron and steel sector is densely located only in Samut Prakan, Rayong, Chonburi, and Prachuap Khiri Khan provinces, while the electric lamps and lighting equipment sector predominately exists in Bangkok and the metropolitan area.

The proximity to suppliers is a possible reason for globally confined and locally dense patterns of lifting and handling equipment and industrial process control equipment manufacturers. The production of these products requires a considerable number of parts and components supplied by nearby suppliers. As a result, a number of firms producing industrial process control equipment are agglomerated in Bangkok, Samut Prakan, and Pathum Thani, whereas the manufacturers of lifting and handling equipment are located in Bangkok, Samut Prakan, PhraNakhon Si Ayutthaya, Rayong, Chonburi, and Chachoengsao.

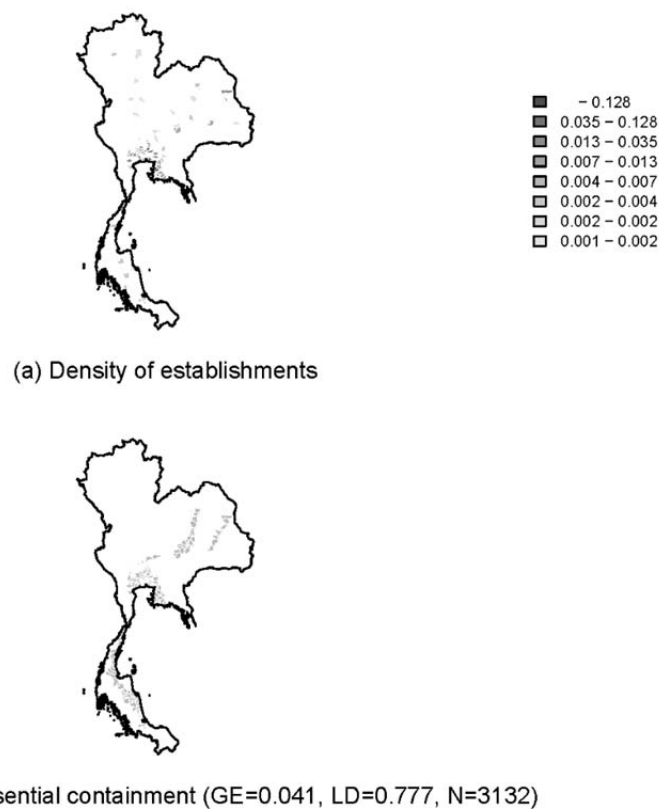


Figure 2.3-6: Manufacture of Basic Iron and Steel (2710): Thailand

Note: GE = global extent; LD = local density.

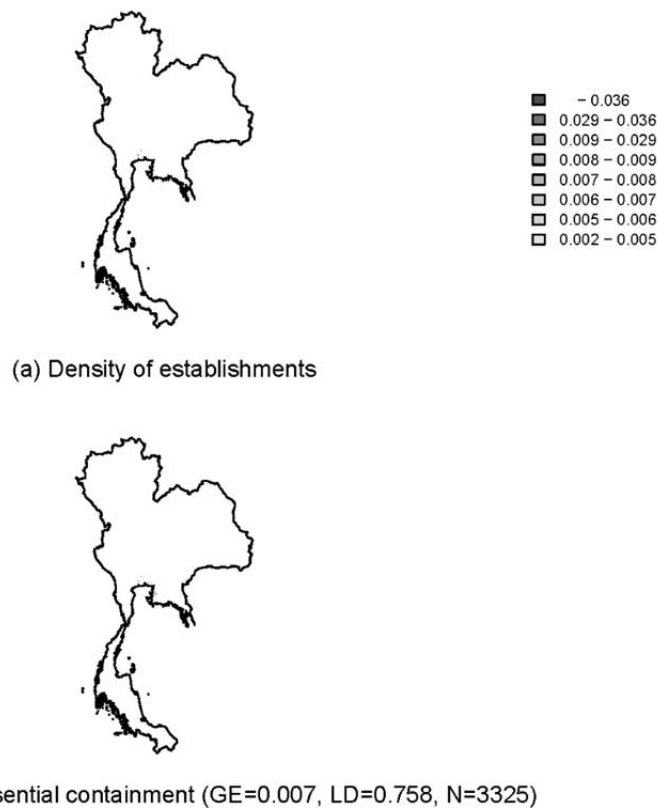


Figure 2.3-7: Manufacture of Industrial Process Control Equipment (3313): Thailand

Note: GE = global extent; LD = local density.

(4) Globally Confined and Locally Sparse Patterns

There are five industries in Thailand that clearly exhibit a globally confined and locally sparse pattern of agglomeration, as they have extremely low GE and LD values. These include tanning and dressing of leather (ISIC 1911); reproduction of recorded media (ISIC 2230); manufacture of steam generators except central heating hot water boilers (ISIC 2813); instruments and appliances for measuring, checking, testing, navigating, and other purposes except industrial process control equipment (ISIC 3312); and aircraft and spacecraft (ISIC 3530). The GE and LD values of these industries range from 0.094 to 0.127 and from 0.073 to 0.123, respectively. Figures 2.3-8 and 2.3-9 show in detail this pattern of agglomeration of two selected industries.

Although there are not many domestic competitors, they are struggling to compete against imported products. Close proximity to the customers as well as suppliers is thus a key factor in determining locations. In addition, to increase

competitiveness, a multitude of leather tanning and dressing firms have organized themselves collectively as an association to develop their own industrial zones.

While there are some tanning and dressing of leather manufacturers in Bangkok, Rayong, and Chonburi, the main clusters are mostly located in Samut Prakan. The media reproduction firms are located in Bangkok, Nakhon Pathom, and Pathum Thani. The key players in the manufacture of steam generators are located in Ratchaburi and Samut Prakan. The manufacturers of instruments and appliances for measuring, checking, testing, navigating, and other purposes are located in Bangkok, Pathum Thani, and Chachoengsao. The manufacturing activity for aircraft and spacecraft is concentrated in Pathum Thani, Chonburi, and Rayong.

“Global confined and locally sparse” agglomeration patterns suggest a relatively narrow essential containment. Moreover, as shown above, their actual locations are geographically confined to Bangkok and its neighboring provinces in the Central and Eastern Thailand.

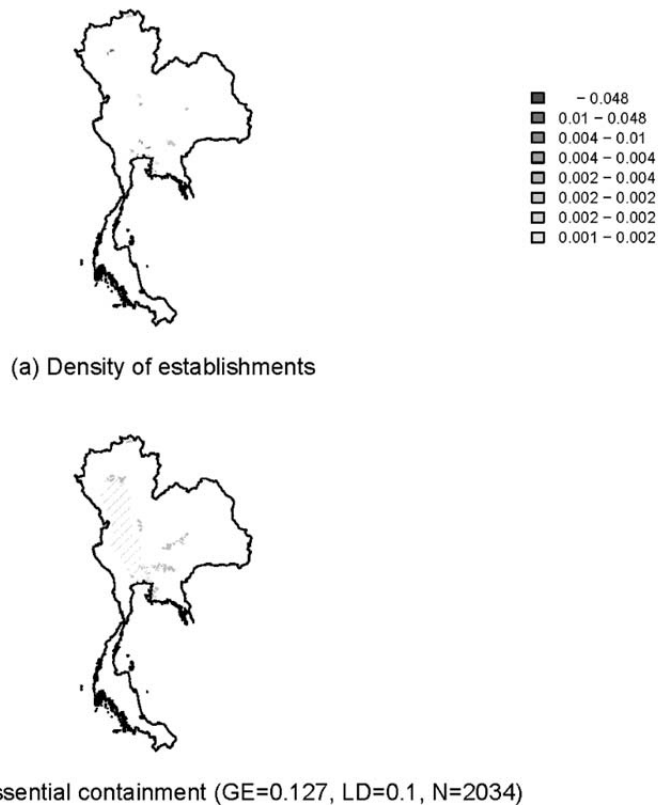


Figure 2.3-8: Tanning and Dressing of Leather (1911): Thailand

Note: GE = global extent; LD = local density.

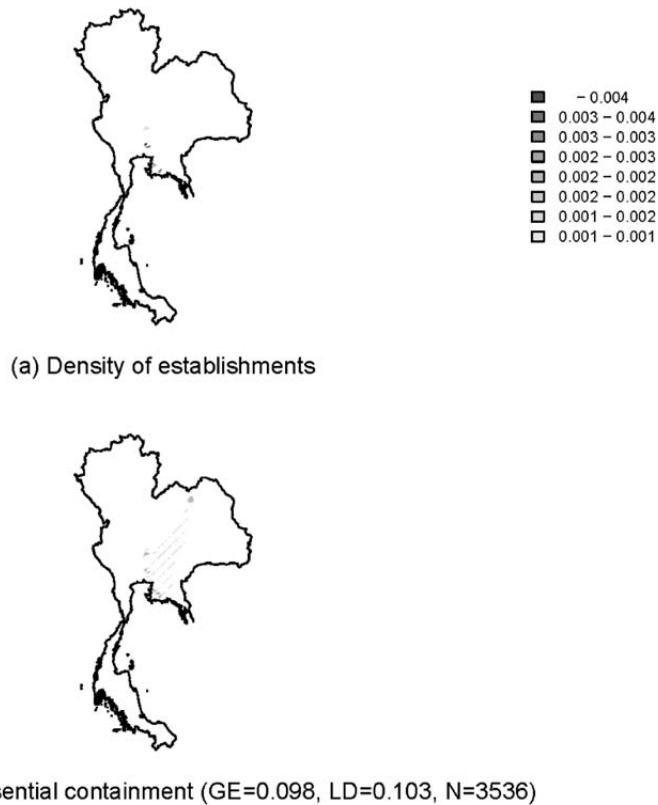


Figure 2.3-9: Manufacturing of Aircraft and Spacecraft (3530): Thailand

Note: GE = global extent; LD = local density.

4. Conclusion

We applied the Mori and Smith (2013) method to identify major manufacturing activities and detect manufacturing clusters in Cambodia, Lao PDR, and Thailand. The establishment-level official statistics for the three countries enabled us to categorize the agglomeration of manufacturing establishments into four spatial patterns at either the detailed industry or product level.

Regarding the distribution of GE and LD, there is a distinct difference between the case of Japan (Mori and Smith 2014) and the cases of Cambodia, Lao PDR, and Thailand. The former indicates no clear relationship between GE and LD, whereas the latter shows a U-shaped relationship between the two indices, where there is no high LD industry in the mid-range of GE. Note that such a relationship might be caused by

differences in the size distribution of cities. For example, developed countries like Japan have many industrial cores (which constitutes an industrial belt), while industrial areas are dominated by the capital city and its neighborhood in developing countries such as Cambodia, Lao PDR, and Thailand. Therefore, future research must develop a method of analysis that takes into account the size distribution of cities. Regarding the specific location patterns of the manufacturing clusters, the grain and rice milling industry—as well as its related industries, such as farinaceous products—exhibits a globally dispersed and locally dense pattern in all the three countries, which reflects the fact that rice and other grains are cultivated and consumed ubiquitously in these countries.

A globally dispersed and locally sparse location pattern is observed for some industries such as dairy products (Cambodia); frozen meat of mammals (Lao PDR); and fish products, wines, jewellery, glass products, ceramic ware, and furniture (Thailand). Considering the characteristics of these industries, such a location pattern can be observed when the consumers of these products are spread across economically active areas, while the production needs productive factors that are not available ubiquitously. Such factors include raw materials and skilled workers, which are only available locally.

There are some industries that exhibit a globally confined and locally dense pattern in Cambodia and Lao PDR: made-up textile articles, except apparel in Cambodia; and ceramic products in Lao PDR. One of the reasons for this location pattern is that these industries contain only a few establishments and thus automatically illustrate this location pattern. However, the case of Thailand attributes economies of scale in production as one of the reasons for exhibiting this location pattern—as exemplified by the basic iron and steel sector. Nevertheless, a case like that of ceramic products in Lao PDR should be further investigated from the viewpoint of both economic and non-economic factors, as this location pattern is often governed by historical circumstances (Mori and Smith, 2014).

There are various industries that exhibit a globally confined and locally sparse pattern: pulp, paper, and paperboard in Cambodia; other knitted or crocheted fabrics in Lao PDR; as well as leather; recorded media; steam generators; instruments and appliances for measuring, checking, testing, and other purposes; and aircraft and spacecraft, in Thailand. One of the reasons for this location pattern may be a limited

number of industrial clusters that constitute a relatively narrow essential containment. Examples of this pattern include the paperboard industry in Preah Sihanouk province and Phnom Penh, Cambodia, the modern fabric-related industry in Vientiane, Lao PDR, and the leather and other industries in Bangkok and its neighboring provinces in Central and Eastern Thailand.

Our study has several limitations. The first is the lack of analysis on the collocation pattern of different industries. Agglomeration of an industry can attract other industries through agglomeration externalities. This limitation makes it difficult for policymakers to predict which clusters will induce the development of which new industries. The second is that our study calculates the distance between two areas based on a direct line between the centroids of each region, whereas Mori and Smith (2014) recommend using network distance. Our streamlined procedure for calculating the inter-area distance may identify different regions as a part of clusters from the regions detected by the Mori and Smith (2014) approach. The third is the difference among the three countries in the industrial classification system and the year when each country conducted the survey. These differences make it difficult to conduct a rigorous cross-country comparison. The fourth is the usage of cross-sectional data. Panel data are needed to observe whether agglomeration is associated with industrial growth by the existing industries or the generation of new industries.

References

- Asian Development Bank (2013), 'Asia's Economic Transformation: Where to, How, and How Fast?' *Key Indicators for Asia and the Pacific*. Part 1 Special Chapter.
- Duranton, G. and H. G. Overman (2005), 'Testing for Localization Using Micro-Geographic Data', *Review of Economic Studies*, 72(4), pp.1077–1106.
- Ellison, G. and E. L. Glaeser (1997), 'Geographic Concentration in U.S. Manufacturing Industries: A Dartboard Approach', *Journal of Political Economy*, 1997, 105(5), pp.889–927.
- Fujita, M. and J.-F. Thisse (2002), *Economics of Agglomeration Cities, Industrial Location and Regional Growth*. Cambridge: Cambridge University Press.
- Kuroiwa, I. (2015), 'Industrial Deepening in East Asia', IDE Discussion Paper No. 489.
- Marshall, A. (1920), *Principles of Economics*. London: Macmillan and Co.Ltd.
- Mori, T. and T. E. Smith (2013), 'A Probabilistic Modeling Approach to the Detection of Industrial Agglomerations', *Journal of Economic Geography* 14(3), pp.547–588.
- Mori, T. and T. E. Smith (2014), 'On the Spatial Scale of Industrial Agglomerations', *Journal of Urban Economics*, forthcoming.
- Mori, T., K. Nishikimi, and T. E. Smith (2005), 'A Divergence Statistic for Industrial Localization', *Review of Economics and Statistics*, 87, pp.635–651.

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