Authority's Role, Location, and Agglomeration Trend of Agro Products Manufacturers in Thailand: A Retrospective Study

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ABSTRACT

The purposes of this study are to address the role of Thailand Board of Investment, confirm industrial agglomeration and the trend in the number of factories. We use data from the BOI and factory directory. Regarding the number of factories, we estimate the annual trend using nonlinear regression.

We concluded that the BOI promotion system has contributed to enhancing foreign direct investment and relocation of factory agglomeration. The number has not increased and it will not from now on. This means that there is a carrying capacity of the number of factory.
Introduction

Objective

The purposes of this study is to address the role of BOI (Board of Investment), confirm industrial agglomeration, and trend of the number of factories.

When we visit Thailand, at first, we can enjoy the green scenery. On the ground, there are green mountains covered with trees, ponds, and rivers. As we come closer to Bangkok Metropolis, we can find houses, roads, and farms. Especially during the rice planting season, rice fields look like a beautiful mirror or natural stained glass. Every passenger feels calm and comfortable while looking at them. Also, along the seashore of central Thailand, there are also many fish and shrimp farms. At sunset, their surfaces shine like gems. Of course, under the surface, there are many shrimps and fish and waiting for their delivery dates. Onwards, instead of the natural landscape, we find silver roofs of manufacturers' factories, an artificial scenery. As the proportion of the roofs increase, one rice field disappears. When we are about to reach the Suvarnabhumi Airport, the national gateway to Thailand, and look out of the window of the airplane, we can see only factories extending till the horizon.

If there is a businessman onboard who wants to open a subsidiary in Thailand, he / she might say, "...I wonder where we can locate our factory. No vacant space exists". If someone onboard wants to procure food from the country, he / she might say, "...I wonder where we would purchase the product. Few active farms exist around Bangkok Metropolis. We should visit other regions than Bangkok."

Factory location is one of the most crucial matters for many sectors. When a company makes the decision on where to locate its factory, it investigates the location while considering many risk factors. Depending on its objectives, some companies focus on labor cost, others pay attention to transportation costs.
The number of companies which have expanded to a place consists of such factors. Let us take the case of an area where firms have accumulated. For a company with labor-intensive production technology, the situation in the area will be tough as with regard to recruitment of workers and managers. In such an area, many existing companies recruit them and the workers and managers are able to switch jobs easily. For a company with capital-intensive production technology, the area may not matter because the company is able to earn profit while hiring smaller number of employees. If the trend of the number of expanding company will be made clear, the company will be able to consider the situation more clearly.

For the government, the number of expanding company is vital element for its foreign direct investment (FDI) promotion policy. Depending on the number, the government will change the policy. Historically, when the government would like to invite a company to enhance industrial revolution based on technology transfer, the government established government-owned factories. In a country aiming for an export-oriented industrialization, the government has introduced various industries such as automobile assembly and electric instruments from overseas. If the trend of the number will be made clear, the government will be able to switch its promotion policy effectively.

Traditionally, these questions have been treated as a topic of industrial location theory. Industrial location theory has started to express the mechanism of manufacturer's factory location while considering transportation costs. Alfred Weber published "Über den Standort der Industrie (Theory of the industrial location)", a milestone article of industrial location theory in 1909. In his argument, he proposed some determinants in the choice of factory location. According to his theory, the location is decided mainly by transportation cost from the origin of the material until the final good reaches the market. A company tends to locate its factory to minimize transportation costs.
Currently, as for industrial location, the most pressing issue is industrial agglomeration, which Michael Porter proposed as, “The competitive advantage of nations”. In the argument, he proposed a concept of “industrial cluster”. The cluster means an accumulation of factories, labs, and related apparatus in a small area. He emphasizes the merit of agglomeration which Weber has underestimated. When companies and related sector accumulate in an area, they can achieve the merit of scale.

So far, many researchers have accumulated studies on industrial clusters in this world (Brenner and Muhlig, 2012; Carrie, 2000; Callois, 2007; Coletti, 2010, Luis et al., 2009; Cook, Pandit, and Swann, 2001; Curz and Teixiera, 2010; Goss and Burch, 2001; Feldman and Lender, 2010; Hu, Lin, and Chang, 2005; Kadokawa, 2013; Meijboon and Vos, 1997; Pananond, 2007; Preveser, 1998; Rivera, Sheffi, and Welsh, 2014; Roveda and Vecchiato, 2008; Yamawaki, 2002). Gordon and McCann summarized the researches applying three criteria: Pure agglomeration, industrial complex, and social-network model. According to his classification, researches regarding industrial cluster can be classified depending on discipline, conceptualization and perception to agglomeration (Gordon and McCann, 2000).

At last, however, controversies regarding industrial cluster have become more confusing. Literally, Porter's theory is independent of empirical evidence. He shows that appropriate agglomeration size is less than 320km radius. In current situation, however, sometimes a company overcomes the constraints of distance between production bases. Moreover, unless the distance is below 320km, who can pass over a border without any barriers? Effects of the industrial cluster may not base on the distance itself but other factors such as suppliers' network. In that case, we ought to turn back to conventional discussions as Weber and his followers have discussed.

Vernon proposed that there is a relation between market maturity and factory location (Vernon, 1966). As the market becomes mature, the company’s product becomes a
commodity. As a result, to save production cost, the company will transfer its factory to overseas where production cost is cheaper. The cost-oriented perspective is similar to Weber’s controversy shown above. His original viewpoint is that cost constrains the company’s production and enhances foreign expansion. In this process, the company cannot but realize maximum production amount.

Dunning provides an insightful approach, called the eclectic paradigm (Dunning, 1979, 1988, 1999, 2001). According to his articles, a company trying to expand its production base or overseas subsidiary to a foreign country considers three aspects: Ownership-specific effect, location, and internalization. Ownership-specific effect stands for the company's resources which it cannot afford to bring from the origin to its destination. Location stands for resources which the company can afford to acquire only if it expands overseas. Lower labor cost, special natural resources, and rich and use meets the intention. Internalization stands for a situation when the company regards it better than it sells or transfers its production system toward a company.

Dunning’s theory has been revised by himself and his followers repeatedly. Nowadays, the theory is important to consider in foreign expansion. Regarding location, he stated the following factors are important: spatial distribution of inputs and markets; input prices, quality and productivity; transport and communication cost, government intervention, control on imports (including tariff barriers), tax rates, incentives, climate for investment, political stability etc.; infrastructure; psychic distance (language, cultural business, customs etc. differences); economies of R&D production and marketing (e.g. extent to which scale economies calls for centralization of production).

These theories propose the factors affecting industrial location comprehensively. The theories, however, sounds static. Transportation cost is one of the most vital factors to discuss on factory locations. It, however, changes day by day. Other factors have similar static
characteristics. We should treat factory location to be more dynamic. In addition, we cannot estimate and explore the possibility to do FDI due to lack of theoretical framework. Each of the content of the theory does not include endpoints to evaluate its accomplishment. Many prior researches set values which are likely to express the three values and test its effectiveness statistically.

To examine such a movement of company, logistic growth model is useful. Originally, the model, r/K selection theory, was invented by an Ecologist to explain population movement in a country. Nowadays many disciplines have applied the theory to their own field. Particularly Ecology has integrated their theories with their observation-based knowledge and generated the concept of carrying capacity. Carrying capacity is the maximum number or amount resource which a species can afford to survive in a space. According to the model, a species can increase its number or amount until they will reach carrying capacity. The number or amount cannot be increase unlimitedly. In many disciplines, the concept has been applied (Harris, 1999; Hui, 2006; Meyer and Ausubel, 1999; Seldi and Tisdell, 1999). In fact, the model is favorable for social scientists as well. For example, researches discussing technology diffusion have employed the s-shaped model since Rogers has applied it to explain the technology diffusion process (Alcota, 1999; Andersen,, 1999; Davies, 1979; Frank, 2004; Guidolin, 2010; Lekvall, 1973; Mahajan, 1994; Naicenovic, 1986; Rogers,1962; Russel, 1977).

Through the increasing process of the carrying capacity model, as time goes by, the number or amount increase along with S-shaped curve (Figure 1). At an initial stage, the number or amount increase slowly. Once the number or amount will excess the first point, they will increase dramatically until they are about to reach the second turning point. Then they will grow up slowly until the number will reach the carrying capacity, the maximum amount. After reaching the carrying capacity, the number will not elevate any more. Also, the curve is
symmetric about the midpoint. In detail of characteristics of the logistic curve, refer to some articles (Lekvall and Wahlbin, 1973; Maharajan and Perterson, 1985).

Considering the reason why we employed r/K selection theory to understand the movement of expanding agribusiness companies in Thailand, it is necessary for us to review the history of introducing the theory to management studies. For the details of the mathematical procedure of this model, please refer to Appendix A.

It is not unfamiliar that management scientists apply the theory to companies, workers, and organization. One of the most familiar case is so-called Population Dynamics approach in organization studies. Hannan and Freeman have introduced two theory, r/K selection theory and Lotka-Volterra model (Freeman and Audia, 2006; Hannan, 1988, 1997, 2005). The former model has been developed in Ecology to estimate resource amount, which works to decide the number of organism species. The latter model has been developed to express survival competition among organism individuals. This model has been enlarged from the former model to consider the competitive relation between two or more species.

Since the models have been developed, the models have played a principal role in Ecology. In the 1960s' a Demographist has introduced the models and applied it to Human Demography. In Demography, the models have been working as a principal model to understand the dynamics of human population as well. In the 1970s' Hannan and Freeman introduced the models from Demography. Since then, many followers and critics have emerged (Kearney, 2003; Lomi, 1995; Ng and Goldsmith, 2010; Nickerson and Zur, 2006; Nunez-Nickel and Moyano, 2006; Ruef, 2000; Scholz and Teydon, 2010; Sorensen, 2004; Zhou and Li, 2008). Young's critique has valuable content. His opinion can be expressed in short phrases (Young, 1988:23).

A better direction for future effort would be to build the intriguing empirical work into the general sociological literature, with which up to now it has
had little contact, and in doing so to follow rigorous methodological standards of procedure"

Summarizing his critical conclusion, we can wrap up Young’s conclusion above as follows. First, it does not show the method to count the number of organization. It tries to introduce the models from Population Ecology while regarding organization as an organism individual. At a glance, the view seems true. We often compare an organization to an individual. However, who can count the number of organizations precisely? The number of worker or company is quite easy to count without fail. Organization, however, it is difficult to count, since its border is vague and opaque. Originally the r/K selection theory has been invented to estimate time-series trend of the NUMBER of individual in a population. Unless an organizational scientist can count the number of organization, they are not able to apply the theory for organization. Second, they might not understand the meaning of intrinsic rate of natural increase. The rate is a core point of the r/K selection theory. Namely, thanks to the rate, the theory is able to express the limit of the number of individual naturally and reasonably. This implies that the number of individuals is determined by carrying capacity. We, however, do not know whether they understood the implication. They might simply apply the theory. They and their followers regard the theory that an organization's competitiveness can be determined by the surrounding business environment. But the truly-important meaning of existence of K is not environment-determined survival but existence of the maximum number of individual itself. Both organism species and mankind can transform its environment for better living and activation. Sometimes they try to increase K by themselves. We do not have to regard K as an evidence of environment-dependent behavior.
The characteristics of the model meet our intention, since the model can deal with the dynamic topic, including the concept of carrying capacity, and have confidence based on frequent use. As Vernon’s argument discussed and our instinct on scenery from the airplane, we should consider the maximum amount of the number of company. By employing the model, we can discuss a dynamic movement of the number of expanding companies while considering its maximum.

We would like to turn our view to the specific situation of foreign direct investment in Thailand. Regarding company location, researches have focused on industrial cluster or location of electronics and automobile assembly, regarded as prosperous industries of Thailand. Lecler suggested to attract support industry, since the Thai government has failed to enhance linkages with industries (Lecler, 2002).

Figure 1 Characteristics of logistic curve
Kittiprapas and McCann investigated company's location behavior (Kittiprapas and MacCann, 1999). The research concluded that product-cycle arguments are supported. Originally, the arguments was set up by Hymer (Hymer, 1976). According to Hymer's conclusion, a MNE locates its headquarters at the country's capital when it is about to expand its factory or subsidiaries because the capital is a convenient location to sell its product and gather information. Such a company, however, seeks low-wage workers and tend to locate its factory at a place apart from the capital. As a result, by function, location will be differentiated.

In Thailand, Atthirawong and MacCarthly identified the factors affecting international locations (Atthirawong and McCarthy, 2001). According to their research result, macro-economic condition, supplemental policies and internal facility are crucial for an expanding company. It concluded that attractive and coherent decision making process should be introduced by region.

Their views are, however, also static and difficult to help understand the current situation. Moreover, their argument does not consider government policy for promoting FDI such as BOI promotion system, even though most expanding companies consider whether it is possible for them to make use of the promotion. Of course, some of them do not, since issuing and obtaining the promotion require that the company deals with huge amount of preparation and document work. When a company uses another promotion such as the one by Industrial Estate Authority of Thailand (IEAT), a company can achieve sufficient incentive. Nevertheless, the company can obtain more advantages if it will apply for BOI promotion at a time. We should consider BOI promotion to discuss factory location of Thailand.
Object

This study mainly deals with companies expanding to Thailand that avail of the Board of Investment (BOI) promotion. Especially, we focus on agro industry. Evidently situation, production technology, and historical path of the industry are different from each other. Nobody can imagine that automobile assembly and agroindustry can belong to a same group. We should treat the industries separately. The industry has remained for some decades a leading industry of Thailand. Similarly in Thailand, as in many countries, agro industry can be considered a ‘kick-off’ industry. So we chose to understand the long-term movement of MNEs' foreign expansion in agro industry.

BOI was a department of the Ministry of Industry of Thai government until 2014. From 2014, the office has been transferred to the Office of the Prime Minister according to the National Council for Peace and Order announcement No. 100. Its headquarters is located in Bangkok Metropolis and organizes promotions in foreign countries expanding to the country. Moreover, BOI have 13 overseas offices in Beijing, Frankfurt, Guangzhou, Los Angeles, Mumbai, Osaka, New York, Paris, Sydney, Seoul, Shanghai, Stockholm, Tokyo, and Taipei.

Most foreign companies are likely to apply for BOI promotion. So for foreign companies, BOI and its promotion policy is a curious matter. According to our previous survey, the manager of a parts processing company had this to say in 2012.

"We acquire a certification of ISO to obtain BOI promotion. We develop workers’ capacity to obtain more advantageous BOI promotion".

The BOI provides useful documents to understand its objective, background, promotion system, and others. Using the documents, we are able to understand the whole picture of the promotion system. The documents are available in Thai, English, Japanese and other
languages. Contents of the documents are the same for all languages. To understand BOI promotion system, we referred to documents by BOI. Fortunately, we can check the documents via internet.

To understand the long-term trend, BOI directory is very useful. The directory lists approved project by industry: Agriculture & Agricultural Products; Mining, Ceramics & Basic Metals; Light Industry; Metal Products, Machinery & Transport Equipment; Electronic Industry & Electrical Appliance; Chemicals, Paper & Plastics; Services & Public Utilities. In the directory, activities, name, office address, zip code, phone number, email address, website URL, and product of the companies are shown. At library of BOI headquarter in Bangkok Metropolis, we can purchase the data with directory book for 800THB. From 2014, we can access the data using CD-ROM. Thanks to the media, we do not have to input the data by hand.

The data looks so useful and helpful. However, we must pay attention to its preciseness. First, the list is made by project, not company. Permission of BOI promotion is provided per project. In accordance with application procedure of the promotion, a company is supposed to apply by product and service. If a company would like to make products A and B, the company has to apply to BOI by product. As a result, two projects are supposed to be permitted by product and listed. In the list, sometimes we can find the same company producing different products. To use the list as a dataset, we have to pay attention to duplication.

Second, the address indicated is that of the headquarter and not the factory. Some factories locate somewhere with its headquarter and others do not. To know the address of a company, we should find it in different ways such as other directory, internet, and other media. To confirm factory location, we referred to “Factory directory in Thailand 2014-2015”. Referring to the directory, we can make clear the factory’s location. If not, we are able to find their
address via internet. At last, 513 of completed data could be gathered. Also, there are some typos. If we treat the company's name, we should check it before use.

**Method**

To express factory location, we draw choropleth maps (Jenks and Caspall, 1971). Using the map, we can visualize factories' location and understand with ease. In this paper, we draw maps demonstrating provinces of Thailand and district of specific provinces. On the map, each of the region is painted based on characteristics such as the number of factory, headquarter, and others. When we paint by province or district, we apply k-means clustering method. Using the method, we are able to paint by the regions appropriately.

To estimate long-term trend of the number of agro-industrial companies, we employed nonlinear regression method while applying logistic curve. As we discussed before, the models are applicable to what we would like to understand. When we estimate the curve, we ought to estimate three values: K, r, and midpoint. K is maximum number of the function, which is the same as values entitled Carrying capacity. r is slope of the function. Midpoint is midpoint of the Logistic curve. This time, the point stands for a turning point of the number of factory, namely, an year when the number begin to decrease. To estimate the values, we use R (Ver. 3.1.0), a comprehensive statistical analysis environment.

**Results**

**Overview of BOI promotion system and validity of BOI directory data**

BOI's promotion consists of two parts; tax exemption and other services. First, we would like to consider the tax exemption. The tax exemption is based on some criteria, ZONE, promotion by industry, and others. ZONE is major criterion reflecting the Thai government policy to overcome regional disparity.
From 1960s’ the Thai government introduced import substitution industrialization. Then, from 1970s’ the government transformed its policy to export-oriented industrialization. BOI, established in 1954, have played an important role in the Thailand’s industrialization.

As a part of the policy transition, ZONE system has been implemented since 1977. Until 2014, Thailand is separated into 3 regions; ZONE1, ZONE 2, and ZONE3.

The zones are decided based on their location; distance from Bangkok Metropolis is a major reason of the separation. The further the zone is from Bangkok Metropolis, a company can gain additional promotions. For details of the promotion by Zone, please refer to appendix A. By introducing the ZONE separation, the government tried to generate regional employment and economic prosperity. At first, the government has failed to achieve the objective. Different from its perception, many of expanding companies have located its production base around Bangkok Metropolis, such as Samut Prakan, Samut Sakhorn, and Pathum Thani province, which all belong to ZONE 1. Too many companies locating in these provinces cause social problems such as traffic jam, lack of land and environment pollution.

As a result, from the 1980s’, the government has partly allowed factories to penetrate other regions and established industrial estates. Especially, industrial estates in Chon buri and Rayong province are known as crucial projects of Thailand (Pansuwan, 2013).

BOI promotions do not apply to all industries. In total, just 146 industries are listed up as promoted industry. Depending on the industry, degree of promotion differs. For any industries which are not listed, the government does not provide any promotions. The government has targeted industries to meet its objectives. When a company would like to gain the promotions, the company should apply at the BOI office. In most cases, a company apply under a consultant's support. Application procedure to gain the promotion is complicated which is difficult to comprehend for a company expanding to Thailand. Fortunately, a number of consultants exists to support such a company. Also, the promotion is permitted only if the
company exports its products. When the company sells its products inside of Thailand, the tax exemption is canceled.

With the economic situation has gone by, to enhance expansion of promising industries, additional promotions have been added to enhance foreign direct investments. The following criteria are the major additional privileges.

1. Priority activities
   - Exemption from import duties on machinery for all zones
   - Eight-year corporate income tax exemption for all zones (subject to the corporate income tax exemption cap)
   - Other relevant location-based incentives

2. Activities of Special Importance and Benefits to the Country.
   - Exemption from import duties on machinery for all zones
   - Eight-year corporate income tax exemption for all zones (NOT subject to the corporate income tax exemption cap)
   - Other relevant location-based incentives.

3. Additional Incentives under the Skill, Technology and Innovation (STI)

Until 2014, as a result, BOI promotion system has been so complicated. For details of the number of project by type of promotion above, please refer to Table 1 and Table 2.

Using the additional promotions, depending on industry, a company using the three special additional promotions indicated above can avail of the best promotion in urban area. In ZONE 1, 3,082 out of 6,272 (49.1%) companies availed of the special promotions (Table 3). Based on the special promotion, a company does not always have to consider its location. ZONE
system partly loses its substance. Number of promoted company by province. Until 2013, in total, 12,435 projects have been approved as promoted projects by BOI.

The proportion of project by province differs by province. In Bangkok Metropolis, 4,049 (32.92%) projects exist. The number shows that Bangkok Metropolis is the dominant location for overseas subsidiaries. The second province with the highest accumulation is Chon Buri with 1,510 (12.28%) of approved projects.

Table 1  Summary of the number of approved project by industry

<table>
<thead>
<tr>
<th>Industry</th>
<th>Agriculture and Agricultural Products</th>
<th>Mining, Ceramics and Basic Metals</th>
<th>Light Industry</th>
<th>Metal Products, Machinery and Transport Equipment</th>
<th>Electronic Industry and Electrical Appliance</th>
<th>Chemicals, Paper and Plastics</th>
<th>Services and Public Utilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>1,773</td>
<td>522</td>
<td>1,160</td>
<td>2,727</td>
<td>1,828</td>
<td>1,598</td>
<td>2,827</td>
</tr>
<tr>
<td>Min.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Median</td>
<td>7</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Mean</td>
<td>23</td>
<td>7</td>
<td>15</td>
<td>36</td>
<td>24</td>
<td>21</td>
<td>37</td>
</tr>
<tr>
<td>Max.</td>
<td>515</td>
<td>160</td>
<td>401</td>
<td>682</td>
<td>655</td>
<td>538</td>
<td>1,575</td>
</tr>
<tr>
<td>SD</td>
<td>62.14</td>
<td>21.67</td>
<td>48.91</td>
<td>108.74</td>
<td>84.16</td>
<td>71.97</td>
<td>181.56</td>
</tr>
<tr>
<td>SE</td>
<td>7.13</td>
<td>2.49</td>
<td>5.61</td>
<td>12.47</td>
<td>9.65</td>
<td>8.26</td>
<td>20.83</td>
</tr>
</tbody>
</table>

Table 2  Summary of the number of approved project by promotion criteria

<table>
<thead>
<tr>
<th>Promotion criteria</th>
<th>Announce ment No. 4/2543</th>
<th>Act 36</th>
<th>Priority activity</th>
<th>Priority activity of special importance and benefits to the country</th>
<th>Promotion policy for electronics and electrical appliance industry</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>76</td>
<td>76</td>
<td>76</td>
<td>76</td>
<td>76</td>
<td>76</td>
</tr>
<tr>
<td>Min.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Median</td>
<td>6.5</td>
<td>0</td>
<td>8.5</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mean</td>
<td>64.26</td>
<td>5.93</td>
<td>50.96</td>
<td>25.13</td>
<td>4.82</td>
<td>10.74</td>
</tr>
<tr>
<td>Max.</td>
<td>1369</td>
<td>244</td>
<td>1060</td>
<td>768</td>
<td>85</td>
<td>556</td>
</tr>
<tr>
<td>SD</td>
<td>190.46</td>
<td>29.27</td>
<td>140.07</td>
<td>93.44</td>
<td>14.62</td>
<td>64.16</td>
</tr>
<tr>
<td>SE</td>
<td>21.85</td>
<td>3.36</td>
<td>16.07</td>
<td>10.72</td>
<td>1.68</td>
<td>7.36</td>
</tr>
</tbody>
</table>
Table 3  Number of approved project by ZONE and promotion criteria

<table>
<thead>
<tr>
<th>ZONE 1</th>
<th>2,189</th>
<th>316</th>
<th>1,765</th>
<th>1,167</th>
<th>148</th>
<th>685</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZONE 2</td>
<td>1,792</td>
<td>127</td>
<td>1,183</td>
<td>482</td>
<td>187</td>
<td>118</td>
</tr>
<tr>
<td>ZONE 3</td>
<td>903</td>
<td>8</td>
<td>923</td>
<td>261</td>
<td>31</td>
<td>33</td>
</tr>
</tbody>
</table>

On the other hand, in some provinces such as Amnat Charoen, and Naratiwat province, no promoted project exists. The promotion policy appears not to solve regional disparity. It is important that "important" projects locate in specific provinces. The important projects mostly locate in Bangkok Metropolis. There are 1,880 (30.57%) projects in Bangkok Metropolis. Chon Burin province comes in second with 684 (11.12%) projects. Two thirds of the overseas subsidiaries projects locate in these two provinces.

Turning to the proportion of special project by province, the situation is different. In Bangkok Metropolis, the proportion is merely 46.43%. Depending on province, the proportion is higher than Bangkok Metropolis. In Mae Hong Song province, all of the project (merely one project) belongs to the group. Between the zone in both headquarters and factories, regarding the number of company, there are statistically difference at 1% level (Kruskal-Wallis rank sum test. Headquarters: Chi square statistics = 16.77, df = 2, p =0.00028; Factory: Chi square statistics = 17.22, df = 2, p = 0.0001816).

Factory location and its relation to location of headquarters

Headquarters locate in various provinces of Thailand. We cannot say that there is an accumulation of the headquarters in Bangkok Metropolis. Considering the number of HQ and one factory, we found a statistically significant correlation at 1% level (Kendall’s rank correlations, tau = 0.82, Z statistics = 9.30, p < 2.2e-16). This means that a company do not
always locate its headquarter in Bangkok Metropolis. In other words, they locate their own
headquarters at the same place as their factories. The fact means that provinces with more
head headquarters have more factories. If a headquarter locates in a province, the factory is
also likely to locate its factory in the same province.

Using kmeans method, depending on the number of headquarter and factory, we can
separate the provinces into 4 groups shown in figure 2. We would like to turn our viewpoint
to a different aspect to check the location while using choropleth maps (Figure. 3).
Particularly, we would like to look at three provinces; Samut Prakan, Samut Prakan, and
Songkhla, all belonging to the group with the most-accumulated provinces as shown in
Figure 4. Accumulated areas of headquarters and factory differ. Headquarters accumulate in
Bangkok Metropolis. Meanwhile, their factories locate in vicinity of Bangkok metropolis
such as Samut Prakan, Samut Sakhorn, Chon buri, Prachin buri, Nakhorn Ratchasima, and
Lop buri provinces.

When companies decide to locate their production bases in the provinces because of the tax
exemption, there were some options. The companies, however, locate them in the provinces.
We expect that they locate themselves for the reason that materials can be obtained easily. For
example, Songkhla province is famous for rubber production internationally. Samut Prakan
province has been the "Kitchen" or "Fisherman's wharf" of Bangkok Metropolis. Markets in
the province have supplied fish and seafood to Bangkok Metropolis citizens. A certain
amount of fish and seafood is brought into and gathered Samut Prakan and the factories are
able to make use of the accumulation.

The companies export their products overseas. We can consider that the factories mainly
export their products because of BOI regulations. To obtain customs and import duty
exemption of their material, they are supposed to export their products. If they sell them in
Thailand, the companies can not avail of the tax exemption.
Figure 2  Relation between the number of headquarters and one of factory by province (2013, Log translated)

Figure 3  The number of factory by province (2013, aggregate Thailand: Left: Headquarters; Right: Factory)
Figure 4  The number of factory by province (2013, upper left: Samut Prakan; upper right: Samut Sakhorn; lower left: Songkhla)

Agglomeration Process

For more than six decades (1950 to 2013), depending on the period, the number of agroindustry companies has risen along an S-shaped curve. From 1950 to the midst of the 1970s', the number has gone up gradually. Then after the midst of 1970s', the number has escalated dramatically until the first half of 2000. We can regard that at the midst of 1970's and the beginning of 2000’s are turning points of the industry. From the first turning point, the number has increased until the second point would come. Prosperity of the number has remained for approximately 25 years. The first period has come in the same period as the ZONE system started operation. Looking at the trend, a logistic curve fit well (Fig. 5).
Until the 2000’s the expansion boom has finished. We can regard that the number is about to reach a carrying capacity. In terms of characteristics of the curve, it is thought that the boom will not come again. The trend shows that the number of enterprise will not increase so dramatically from now on.

Turning to the situation of each district, we can observe almost the same trends. In Samut Sakhorn province, the number has started increasing since the midst of the 1970s' as the aggregate trend had been. Comparing the real trend and estimated curve, there is a gap. This means that there is an allowance and some more factories are able to locate there. Especially after the beginning of 1990s', the gap has become wider and wider. In Samut Prakan province, the number has started increasing since the beginning of the 1970's, faster than the aggregate trend. Until the end of 1990s', the number has stopped escalating. The shape of the curve is more modest, since the first turning point has been faster than other provinces the gap, however, is smaller than other provinces. Now the number come to reach its carrying capacity. In Songkhla province, the number has started increasing since the beginning of 1980s', later than the aggregate trend. Until the end of 2000s', the number has stopped escalating.

The first turning point has been also the same as the period when industrial cluster developed in 100km-Eastern area of Bangkok Metropolis. From that period, Thai government started developing huge industrial estates in Chon Buri and Rayong province, locating the area. Not only newly expanding factories but also other factories located around Bangkok Metropolis and its vicinity. Gaps between the real trend and estimated curve has become larger and larger since the midst of the 1980s'. In Samut Sakhorn and Songkhla province, different from other provinces, the number is not likely to reach its carrying capacity.
Figure 5  Trend of the number of factory by province (1950-2013, upper left: Samut Prakan; upper right: Samut Sakhorn; lower left: Songkhla; lower right: aggregate Thailand)

Table 4  Estimation results of nonlinear regression applying logistic curve

<table>
<thead>
<tr>
<th>Province</th>
<th>Value</th>
<th>Estimate</th>
<th>SD</th>
<th>t value</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate</td>
<td>Carrying Capacity (K)</td>
<td>553.87</td>
<td>4.79</td>
<td>111.36</td>
<td>2.2e-16</td>
</tr>
<tr>
<td></td>
<td>Midpoint (Year)</td>
<td>CY1991</td>
<td>0.23</td>
<td>176.46</td>
<td>2.2e-16</td>
</tr>
<tr>
<td></td>
<td>Slope (r)</td>
<td>8.57</td>
<td>0.15</td>
<td>57.29</td>
<td>2.2e-16</td>
</tr>
<tr>
<td>Samut Prakan</td>
<td>Carrying Capacity (K)</td>
<td>59.04</td>
<td>0.65</td>
<td>90.73</td>
<td>2.2e-16</td>
</tr>
<tr>
<td></td>
<td>Midpoint (Year)</td>
<td>CY1988</td>
<td>0.29</td>
<td>131.73</td>
<td>2.2e-16</td>
</tr>
<tr>
<td></td>
<td>Slope (r)</td>
<td>8.19</td>
<td>0.20</td>
<td>40.10</td>
<td>2.2e-16</td>
</tr>
<tr>
<td>Samut Sakhorn</td>
<td>Carrying Capacity (K)</td>
<td>50.21</td>
<td>0.70</td>
<td>71.79</td>
<td>2.2e-16</td>
</tr>
<tr>
<td></td>
<td>Midpoint (Year)</td>
<td>CY1990</td>
<td>0.32</td>
<td>126.75</td>
<td>2.2e-16</td>
</tr>
<tr>
<td></td>
<td>Slope (r)</td>
<td>5.84</td>
<td>0.25</td>
<td>23.67</td>
<td>2.2e-16</td>
</tr>
<tr>
<td>Songkhla</td>
<td>Carrying Capacity (K)</td>
<td>47.19</td>
<td>1.66</td>
<td>28.16</td>
<td>2.2e-16</td>
</tr>
<tr>
<td></td>
<td>Midpoint (Year)</td>
<td>CY1996</td>
<td>0.95</td>
<td>48.68</td>
<td>2.2e-16</td>
</tr>
<tr>
<td></td>
<td>Slope (r)</td>
<td>10.42</td>
<td>0.46</td>
<td>22.59</td>
<td>2.2e-16</td>
</tr>
</tbody>
</table>
Discussion

The purpose of this study is to estimate the trend in the number of factories, confirm location of the factory, and address the role of BOI (Board of Investment) in. The main target of this study are companies belonging to agro industry, which produces products that use primary commodities from agriculture, fishery, and forestry. Data were obtained both from the BOI and Thailand factory directory. To estimate time-series trend of the number of factory, we employed a nonlinear regression with logistic curve. Moreover, by referring to BOI documents, we are able to understand its promotion system for companies that are expanding to Thailand.

From our study, we found three facts. First, as for the BOI promotion, we confirmed that BOI has implemented so-called ZONE system together with some special promotions. The special promotions provide special treatment to a company engaging in producing important products for Thailand. Using the special promotion, a company can obtain advantageous privileges without locating in ZONE 3. In some industries, more than half of companies can use the special promotion. As a result, the zoning system has lost its effectiveness. BOI promotion has contributed merely to promoting foreign direct investment, not to solving regional disparity.

Second, regarding factories' location, we confirmed that factories mostly accumulate in the three provinces; Samut Prakan, Samut Sakhorn, and Songkhla province. Also, their headquarters locate mainly in Bangkok Metropolis. However, we also confirmed that some companies locate their headquarters in other provinces other than Bangkok Metropolis. Probably in the province, factories locate in the area because of material procurement.

Finally, the factories have increased since the midst of the 1970s' and begun to decrease from the beginning of 2000s'. Their prosperity has remained approximately 25 years in terms of the number of factory.
Depending on the region, turning points differ. In Samut Prakan province, the prosperity has come since the beginning of 1970s’ and remained up to the end of 1990s’. It should be noted that the number of factory is not likely to increase from now on.

Conclusion

We concluded that carrying capacity of Thailand especially the agglomerated provinces appear to be occupied. A company may not be able to locate any more in specific areas of Thailand even if the company would like to locate its production base there.

If the company would try to expand by force, all companies locating in the area would compete with one another to obtain resources such as workers, electric power, and infrastructure use. In that case, not only the company but also existing companies will not be able to operate in the area due to their overconsumption of the limited resources.

Policy transition in 1990s’ might have contributed to avoid such catastrophe. By guiding an expanding foreign company to vacant regions, the company and the region could have avoided the catastrophe.

Many of HQ certainly locate in Bangkok Metropolis. Considering other provinces' situation, however, we conclude that there are also certain number of HQ in other provinces together with their factories.

The r/K selection theory can contribute to reinforce the OLI approach in terms of location. Using the theory, we are able to describe and analyze situation of human resource in a company theoretically. Moreover, results of the analysis can be testable, different from the previous studies using readily available data.

Finally, we would like to state our further research. First, we would like to discuss on determinants of factory location more precisely. Second, we would like to compare the trend and determinants of the agglomeration by industry. According to BOI criteria, there are some
other industries and we can compare with each other. Third, we would like to consider locational influence toward human resource management practices. Some prior researches have focused on a relation between location and human capital (Scott, 1988; Simpson, 1992). However, with regard to the relation between location and human resource management have not considered so deeply.
References


Cruz, S. C. S. & Teixeira, A. A. C. 2010. The evolution of the cluster literature: Shedding


Goss, J. & Burch, D. 2001. From agricultural modernisation to agri-food globalisation: the


Appendix A  Intrinsic rate of natural increase

Time variability of the number of individual in a population is called as "Population Dynamics" in Ecology. The dynamics is determined the number of born infant and dead individuals when no transportation inside / outside of a spatial area.

We can describe the number of individual in a population in the following.

\[ N_t = N_{t-1} - B + D \]

Where \( N_t \) is the number of individual at a date \( t \), \( N_{t-1} \) is one at a date \( t-1 \), \( B \) is the number of live births, and \( D \) is death numbers. Then we can express the time variation of the number with differential type formula.

\[ \frac{dN}{dx} = (b - d)N \]

Where \( b \) is fertility rate and \( d \) is mortality rate. Difference of \( b \) and \( d \) is called as intrinsic rate of natural increase (\( r \)).

\[ \frac{dN}{dx} = rN \]

Integrating the formula above, the number can be described as follows:

\[ N_t = N_0 e^{rt} \]
This formula means that the number will increase exponentially. This conclusion is beyond reality because the amount of resource which the individual can use will decline as the number increase (density effect).

So reflecting the fact, we can revise the formula while supposing the r decrease as N increase. In this case, r becomes maximum when N is 0 and becomes when the Number becomes a certain point K, called carrying capacity. K also stands for a maximum number of N. K is determined by the amount of resources what the individual depends on.

Then, the rate per individual is expressed in the following.

\[
\frac{1}{N} \frac{dN}{dx} = r \left(1 - \frac{N}{K}\right)
\]

Deforming,

\[
\frac{dN}{dx} = r \left(\frac{K - N}{K}\right) N
\]

Using the formula, N transit while showing S-shaped curve, called as logistic curve.

Introducing the r/K selection model into our research.
### Appendix A Summary of Basic Tax Incentives

<table>
<thead>
<tr>
<th>Zone 1</th>
<th>Zone 2</th>
<th>Zone 3</th>
<th>Zone 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inside industrial estates / promoted industrial zones</td>
<td>Outside industrial estates / promoted industrial zones</td>
<td>Outside industrial estates / promoted industrial zones (Excluding Laem Chabang industrial estates / promoted industrial zones in Rayong Province)</td>
<td>Outside industrial estates / promoted industrial zones</td>
</tr>
<tr>
<td>Outside industrial estates / promoted industrial zones (Excluding Laem Chabang industrial estates / promoted industrial zones in Rayong Province)</td>
<td>Outside industrial estates / promoted industrial zones</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outside industrial estates / promoted industrial zones</td>
<td>Outside industrial estates / promoted industrial zones</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Import duties on machinery</th>
<th>50% reduction</th>
<th>50% reduction</th>
<th>Exemption</th>
<th>50% reduction</th>
<th>Exemption</th>
<th>Exemption</th>
<th>Exemption</th>
<th>Exemption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corporate income tax exemption</td>
<td>3 years</td>
<td>---</td>
<td>7 years</td>
<td>3 years</td>
<td>8 years</td>
<td>8 years</td>
<td>8 years</td>
<td>8 years</td>
</tr>
<tr>
<td>50 percent reduction of corporate income tax</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>5 years after the exemption period</td>
<td>---</td>
<td>5 years after the exemption period</td>
<td>---</td>
</tr>
<tr>
<td>Import duties on raw and essential materials used in manufacturing of export products</td>
<td>Exemption</td>
<td>Exemption</td>
<td>Exemption</td>
<td>Exemption</td>
<td>Exemption</td>
<td>Exemption</td>
<td>Exemption</td>
<td></td>
</tr>
<tr>
<td>Deduction of transportation, electricity and water costs</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>Double deduction for 10 years</td>
<td>---</td>
<td>Double deduction for 10 years</td>
<td>Double deduction for 10 years</td>
</tr>
<tr>
<td>Deduction of the project infrastructure installation construction costs</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>25% deduction from net profit</td>
<td>25% deduction from net profit</td>
<td>25% deduction from net profit</td>
<td>25% deduction from net profit</td>
</tr>
<tr>
<td>Import duties on raw or essential materials used in manufacturing products for domestic sale</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>75% deduction for 5 years with yearly approval (Excluding Laem Chabang industrial estates / promoted industrial zones in Rayong Province)</td>
<td>---</td>
<td>75% deduction for 5 years with yearly approval</td>
<td>---</td>
</tr>
</tbody>
</table>

* For projects in Laem Chabang Industrial Estate and Industrial estates or promote industrial zones in Rayong Province, applications must be submitted by December 31, 2014.

** Applications must be submitted by December 31, 2014

Source: BOI "A guide to the Board of Investment (http://www.boi.go.th/upload/content/AW_BOI-A_guide.BOI2014_69740.pdf, viewed on 1st June 2015)"