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THE SPATIAL DISTRIBUTION OF INDONESIA'S MANUFACTURING INDUSTRIES: AN EXPLORATORY SPATIAL DATA ANALYSIS

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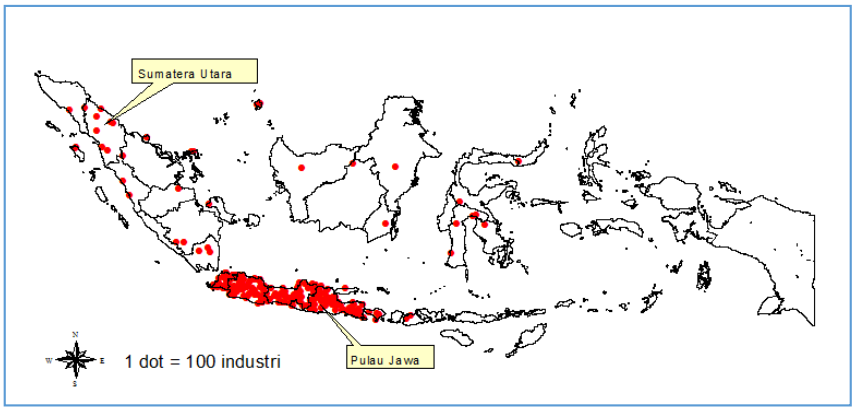
Abstract

The issues of spatial distribution of manufacturing industries are important to economic policy. In this paper we contribute to the empirical literature on the spatial distribution of manufacturing sector by taking spatial dependence among region units explicitly into account. The main objective of this paper is to analyze the space-time dynamics of spatial distribution of manufacturing industries in Indonesia. For the methodology, Exploratory Spatial Data Analysis (ESDA) Global Moran's *I* was used to determine the general level of spatial autocorrelation in the data based on the province level of manufacturing industries establishments data for the year 2006 to 2015. The results show strong evidences of global spatial autocorrelation in the distribution of manufacturing industries in Indonesia. The result shows that the distribution of Indonesia's manufacturing industries are unevenly distributed. The Moran's I statistic analysis, indicates a strong positive spatial autocorrelation in research area and discribes the phenomenon pattern expressed is clustered. A high concentration of manufacturing industries is seen in the several provinces only, as well as in Java island. The moran's I are tend to decrease along the periode of study. From the LISA, we can ascertain that there was statistically significant high clustering. Only some provinces really show significant clustering and these provinces are West Java, Banten, DKI Jakarta, Central Java, and East Java.

Keyword: Spatial Distribution, Manufacturing Industries, ESDA, Spatial Autocorrelation, LISA

INTRODUCTION

The main feature of geographically economic activity is concentration and unevenness. The concentration of spatial economic activity indicates that industrialization is a selective process and occurs only in certain cases when viewed in geographical terms. For example, in the United States, the majority of the manufacturing industry is concentrated in a Northeast and Upper Midwest location known as manufacturing belt. Then the manufacturing industry in the United States moved from the northern region to other country and certain areas of the southern region have become very specialized in manufacturing and referred to as the new manufacturing belt [1]. Similar industrial spatial concentrations are also found Axial Belt industrial estate in UK and Ruhr manufacturing belts in Germany [2].



Source: Calculated from BPS, Industrial Survey

Figure 1. Distribution of Indonesia's Manufacturing Industry, 2015

The same phenomena can also be found in Indonesia, industrial development and economic activities in Indonesia for more than the last three decades is unevenly distributed. Indonesia's manufacturing industry has tended to be spatially concentrated in Java since the 1970 [3, 4]. According to [5], the manufacturing industry was spatially concentrated in Java since the 1970, although in the late 1980 it shifted to Sumatra and Bali. Spatially concentrated industries, especially for large and medium manufacturing industries. This was due to a series of deregulation and liberalization in mid-1980. In addition, this spatial concentrated was also caused by the infrastructure and labor accumulated in some certain areas, especially Java [6]. Spatial concentrations also can be found in most developing countries where population and industrial distribution are concentrated in large cities such as Bangkok, New Delhi, Sao paulo and Jakarta which mark a spatial system based on capital and labor accumulation in urban agglomeration [7].

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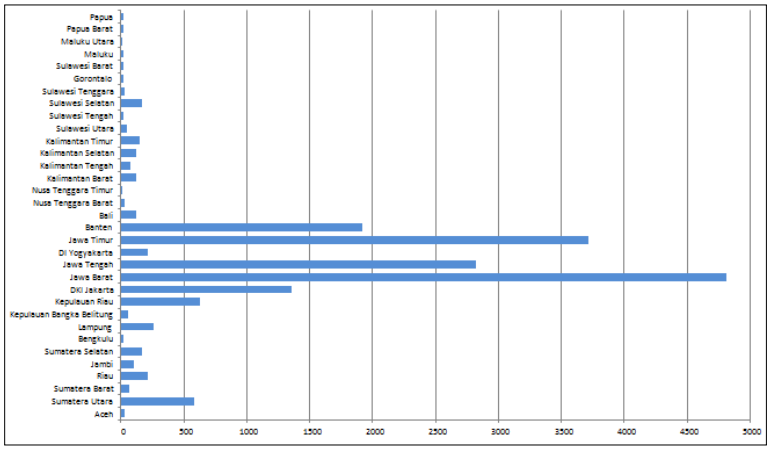


Source: Calculated from BPS, Industrial Survey

Figure 2. Labor Growth of Manufacturing Industry by Province (000 people), 2011-2014

Figure 2 shows that an interregional disparities associated with manufacturing industry for the growth of manufacturing labor for the year 2011-2014. The largest labor growth of manufacturing industry is dominated by the provinces that became the center of manufacturing industry in Indonesia, mostly found in Java. These provinces are Banten Province, East Java, Central Java, West Java, and DKI Jakarta. For the province outer of Java Island, there are North Sumatra Province and Riau Islands Province. Hence, it can be concluded that the growth of labor of manufacturing industry in Indonesia is linear with spatial concentration of manufacturing industry. This means that high labor growth occurs in provinces that do have a high concentration of manufacturing industry activity (see figure 1).

The concentration of spatial economic activity, especially in the manufacturing industry, has become an interesting phenomenon to be analyzed. For the manufacturing industry, spatial concentrations are determined by wage costs, transportation costs and market access and the externalities of spatial concentration associated with saving localization and saving urbanization. Uneven distribution of resources leads to disparities in spatial industrial concentrations between regions. The inequality of this resource is reflected in the concentration of economic activity occurring in certain areas only. A region where the concentration of economic activity occurs benefits (a so-called agglomeration economies). As a result the industry will move and be spatially concentrated in areas that can benefit from the geographic proximity of economic activity. Instead the industry will leave areas that are no longer able to provide benefits from the geographic proximity of economic activity.

The concentration of spatial economic activity can be understood by the location theory approach. The purpose of the location theory is to determine the reasons and explain why certain factors are important for one industry but not for other industries [8]. It also involves the principle of substitution, in which the industry chooses a location from some alternative location, which in economic theory, is similar to the problem of how to replace labor production factors with capital or land and vice versa. Many factors are considered in relation to the determination of the appropriate location for the industry. These factors vary depending on the peculiarities of an industry [9]. Generally speaking location theory is broadly divided into three theoretical schools [10], which include: Neo-classical theory, New trade theory, and New Economic Geography (NEG). Neo-Classical theory is characterized by perfect competition, homogenous products and non-increasing returns to scale [10]. This theory indicates that the location of an industry is determined exogenously, by the so called *first nature* (term used by [11] and [12], which indicates a given spatial distribution of natural endowments, climate, technology, and factors of production. Conversely, in the NEG theory, location is determined endogenously, by *second nature* where spatial distribution of economic activities is independent from natural advantage. The concept of *second nature* is characterized by mobility of production factors and/or firms, pecuniary and technical externalities, and input-output linkages [10].

The present study focuses on spatial exploratory analysis of Indonesia's manufacturing industries. Spatial exploratory analysis of industry location will aid in capturing important intangible aspects concerning spatial dependence and heterogeneity, which was not acknowledged by most of the previous studies. This spatial analysis can also identify some of manfacturing industries that may clustered or randomly distributed. Analyzing these spatial concepts and location factors will aid state and local economic development agencies in designing strategies to better retain and attract manufacturing industries and their clusters, which in turn will boost their economy and provide employment opportunities for local residents. The primary objective of this paper is to evaluate the presence and extent of manufacturing industries spatial correlation for province level data. This objective is achieved by utilizing Global Moran's I Statistic and Local Indicators of Spatial Association (LISA) statistics.

METHODS

[13] noted that traditionally, each of economies is assumed as independent unit, and has ignored the possibility of space interactions across regions. [14] stated that everything is related to everything else, but near things are more related than distant things. Since, data obtained from points in space are generally associated with spatial dependence and heterogeneity [15, 16]. Spatial dependence indicates that observations at a particular location depend on observations at other locations. This spatial dependence in some instances is also expressed as spatial autocorrelation [15]. Conversely, spatial heterogeneity refers to variations in spatial structure in the form of non-constant error variance or model estimates [15]. Many economists have been interested in the use of spatial econometrics in a regional economic studies. One of the advantages of this method is its ablity to capture the spatial effect or spatial relationship in a geographical economies. Spatial effects are important in explaining spatial distribution of economic activities, however it has been largely ignored in the traditional economic literature that pool data for large samples of countries or regions. This study analyse an exploratory spatial data associated with spatial distribution of Indonesia's manufacturing industries, which examines whether a phenomenon pattern expressed is clustered, dispersed, or random. Using manufacturing industries establishments for periode 2007-2014. To achieve the objectives, we were used Global Moran's I Statistic and Local Indicators of Spatial Association (LISA) statistics. The brief explanation for each method as follows:

1. Global Moran's I

The spatial association of data collected from points in space is tested using a Global Moran's I, which measures similarities and dissimilarities in observations across space [15]. Moran's I is a test for spatial autocorrelation, which examines whether a phenomenon pattern expressed is clustered, dispersed, or random (Stieve, 2012). For the number of establishments *y*, Moran's I is:

$$I = \left(\frac{n}{\sum_i \sum_j w_{ij}} \right) \text{X} \left(\frac{\sum_i \sum_j (y_i - \mu)(y_j - \mu)}{\sum_i (y_i - \mu)^2} \right) \quad \text{.......} \quad (1)$$

where w_{ij} indicates elements of the spatial weight matrix ***W*** (distance/contiguity weight matrix) between two points (i and j), μ the mean of all *y* observations, and i, j = 1,…,n. In general, a Moran's Index value near +1.0 indicates clustering while an index value near -1.0 indicates dispersion. A positive and significant value for Moran's I indicate positive spatial correlation, showing that provinces have a high or low number of establishments similar to their neighbouring province. Conversely, a negative and significant value for Moran's I indicates negative spatial correlation, showing that provinces have high or low number of establishments unlike neighbouring provinces [17]. The study calculate's Moran's I for the number of manufacturing industries across 33 province in Indonesia for the year 2006-2015, by employing GeoDa, a spatial data analysis software.

2. Local Indicators of Spatial Association (LISA)

In the case of uneven spatial clustering, global spatial indicators such as Moran's I are found to be less useful. This resulted in a new general class of local spatial indicators such as Local Indicators of Spatial Association (LISA, also known as Local Moran) statistics developed by [15] are designed to test individual sites for membership in clusters, which measures the contribution of individual provinces to the global Moran's I statistic [15]. Local Moran's I is useful for showing places where significant spatial autocorrelation exists and designed to test individual sites for membership in clusters. The LISA statistic is calculated for the *i*th province as:

$$I_i = z_i \sum_j w_{ij} z_j \quad \text{.......} \quad (2)$$

where w_{ij} indicates elements of the spatial weight matrix ***W*** (distance/contiguity weight matrix) between two points (i and j), z_i and z_j indicates the standardized number of establishments for province *i* and *j*, respectively. The sum of LISA ($\sum_i I_i$) for all observations is proportional to global Moran's I, implying that LISA statistic can be interpreted as indicators of local spatial clusters and as diagnostics for local instability (spatial outliers) [15].

The LISA cluster map indicates the locations with a significant Local Moran statistic classified by type of spatial correlation: (a) high-high association (HH), a province with many manufacturing industries has neighboring province with many manufacturing industries; (b) low-low association (LL), a province with few manufacturing industries has neighboring province with few manufacturing industries; (c) low-high association (LH), a province with few manufacturing industries has neighboring province with many manufacturing industries; and (d) high-low association (HL), a province with many manufacturing industries has neighboring province with few

manufacturing industries. The HH and LL locations suggests clustering of similar values (positive spatial correlation), whereas the HL and LH locations indicate spatial outliers (negative spatial correlation) [15].

FINDINGS AND ARGUMENT

Uneven distribution of resources can lead to disparities in the economic development between regions. The inequality of this resource is reflected on concentration of economic activities occurring on certain region. A region with a concentration of manufacturing industry would be growing faster than a region with no a concentration of manufacturing industry. The figure 1 illustrates that the spatial distribution of manufacturing industries in Indonesia for the year 2015 is unevenly distributed, which is some provinces becoming central to this distribution of industries. Provinces with high concentrations of industries are dominated by provinces in Java Island such as Banten, West Java, DKI Jakarta, Central Java, and East Java. Some provinces outside of Java island also have a high concentration of industries, these provinces are North Sumatra and Riau Islands. Hence, it can be concluded that the distribution of manufacturing industry in Indonesia is unequally distributed and still concentrated in Java Island.

Spatial Exploratory Analysis

The spatial distribution of manufacturing industries for the year 2015 is presented in figure 3. The figure illustrates that the distribution of Indonesia's manufacturing industries is unevenly distributed for all 33 provinces. Mostly, the manufacturing industries are located in Province of Banten, West Java, DKI Jakarta, Central Java, East Java, and North Sumatra, where most of these provinces are located in Java Island. As a result, a high concentration of manufacturing industries is seen in the Java Island. This implies that the Indonesia's manufacturing industries shows a spatial pattern and it is not independently distributed over space.

Source: Calculated from BPS, Industrial Survey

Figure 3. The Spatial Distribution of Indonesia's Manufacturing Industries, 2015

To prove that the Indonesia's manufacturing industries are not independently distributed over space. we could use the Global Moran's I. This index analyze spatial dependence (autocorrelation) of manufacturing industries establishments acrooss regions (provinces).

Global Moran's I

The spatial association of manufacturing industries is tested using a global Moran's I, which measures similarities and dissimilarities in manufacturing industries across neighbouring counties [19]. A positive and significant value for Moran's I indicate positive spatial correlation, showing that province with a high or low numbers of manufacturing industries are similar to their neighbouring province. Conversely, a negative and significant value for Moran's I indicates negative spatial correlation, showing that province with a high or low number of manufacturing industries are unlike their neighbouring province. We calculate Moran's I for the number of manufacturing industries establishments across all contiguous Indonesia's provinces for the year 2015, by employing GeoDa, spatial data analysis software. The Moran's I statistic is equal to 0.581859, indicating a strong positive spatial relationship (autocorrelation) in my research area and shows that the phenomenon pattern expressed is clustered. But, it is significant?. Use pseudo p-value in the randomization for reporting p-value, we get ρ = 0.002, so it's definitely significant.

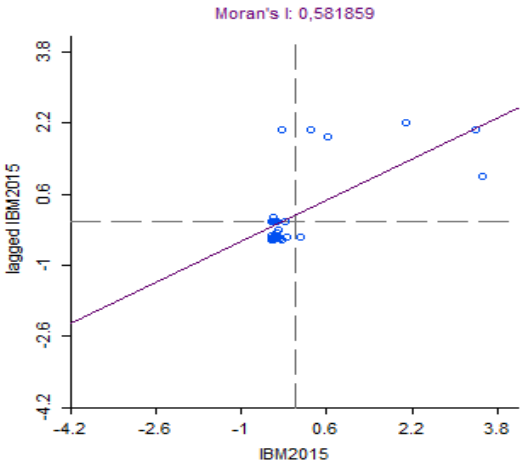
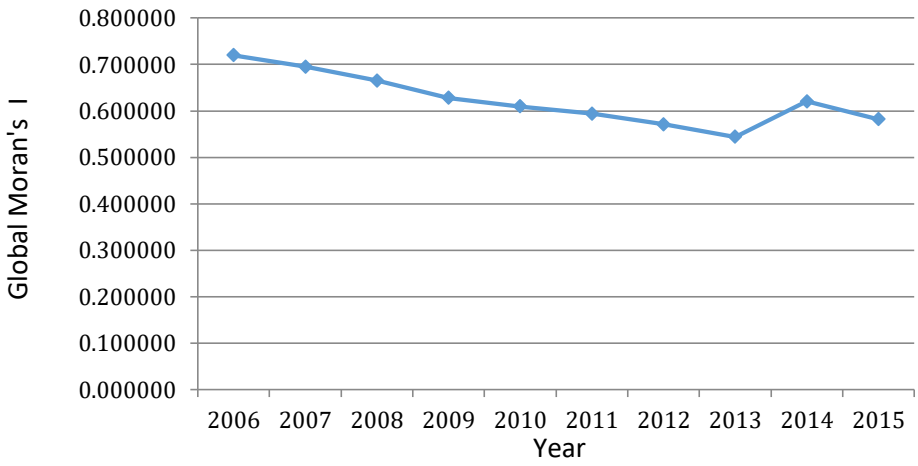


Figure 4. Global Moran's I Scatter Plots of Indonesia's Manufacturing Industries, 2015

How about the patern of the Moran's I for Indonesia's manufacturing industri?. Figure 5 shows the global Moran's ***I*** statistic for spatial distribution of manufacturing industries in Indonesia for the year 2006 to 2015 using the spatial weight matrix. The values of global Moran's ***I*** statistic show a downward trend from 2006 to 2015 and significant positive spatial autocorrelation. The results suggest that the locations of province with high or low the number of manufacturing industries are clustered, and the spatial pattern has a developing trend of decrease spatial autocorrelation.



Source: Calculated from BPS, Industrial Survey

Figure 5. The chart of Moran's I statistics for Indonesia's Manufacturing Industries, 2006-2015

The Moran's I is a global statistic. Hence, we know there is clustering going on in the research area, but we do not know exactly where clustering exist. To investigate further, we would do a Local Indicators of Spatial Association (LISA). This test not only tests for regional clustering, it can also show the presence of significant spatial clusters or outlier.

Local Indicators of Spatial Association (LISA)

Moran's ***I*** gives us a global statistic, and a single result to assess the spatial association pattern for the entire study area. Therefore, it cannot identify the regions contributing more to the results of global spatial autocorrelation, and detect the hot spot or a typical localization. In order to solve these problems, the Moran scatter plot and Local Indicators of Spatial Association (LISA, also known as Local Moran) are adopted. LISA statistics was developed by [19], which measures the contribution of individual province to the global Moran's I statistic. Local Moran's I useful for showing places where significant spatial autocorrelation exists.

The figure 3 shows a high concentration of manufacturing industries is seen in the several provinces, as well as in java island. This implies that, the Indonesia's manufacturing industries exhibits a spatial pattern and it is not independently distributed over space.

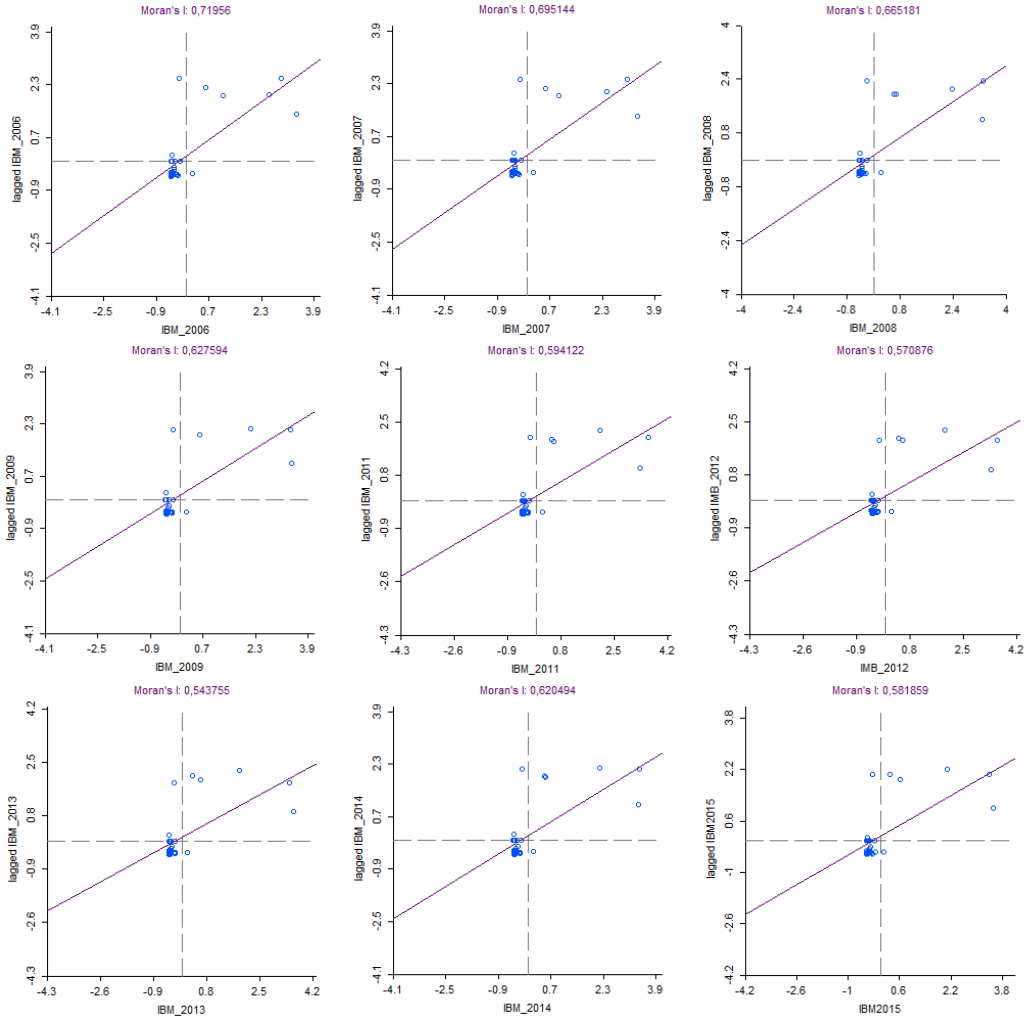


Figure 6. Local Moran's I scatter plot for Indonesia's Manufacturing Industries, 2006-2015

The HH and LL locations suggests clustering of similar values (positive spatial correlation), whereas the HL and LH locations indicate spatial outliers (negative spatial correlation) [19]. A positive and high autocorrelation is found in some provinces really show significant clustering. Figure 6 indicates locations with a significant Local Moran statistic for the year 2006 to 2015. It illustrates that no significant changes for HH location for along research period. Provinces of West Java, Banten, DKI Jakarta, Central Java, and East Java still have the most significant manufacturing industrial clusters among all Indonesia Provinces. So, it can be concluded that along the periode of study, the provinces which is have significant manufacturing industrial clusters are the same, these provinces are West Java, Banten, DKI Jakarta, Central Java, and East Java. although, the moran's I tend to decrease along the year 2006-2015.

Source: Calculated from BPS, Industrial Survey

Figure 7. Local Indicator of Spatial Association (LISA) Cluster Map for Manufacturing Industries, 2006

The LISA Cluster Map shows that how the attribute industries clusters. The red color show the tracts where high rate cluster with high rates, and blue shows where low rates cluster with low rates. Figure 7 and figure 8, we could see there is a cluster of high industries cluster and cluster of lower industries. For the year of 2006 and 2015, A high cluster (HH) industries occurs in five provinces, these provinces are West Java, Banten, DKI Jakarta, Central Java, and East Java. For outer java, there is no high cluster (HH) industries for any province.

Source: Calculated from BPS, Industrial Survey

Figure 8. Local Indicator of Spatial Association (LISA) Cluster Map for Manufacturing Industries, 2015

CONCLUSION

This study analysis an exploratory spatial data associated with spatial distribution of Indonesia's manufacturing industries, which examines whether a phenomenon pattern expressed is clustered, dispersed, or random. In this paper we contribute to the empirical literature on the spatial distribution of manufacturing sector by taking spatial dependence among region units explicitly into account. We apply an approach that considers simultaneously geographical concentration and spatial dependence to characterize the spatial distribution of manufacturing industries. The result from the Moran's I statistic analysis, indicating a strong positive spatial relationship (autocorrelation) in research area and shows that the phenomenon pattern for the distribution of manufacturing industries expressed is clustered, and a high concentration of manufacturing industries based is seen in the several provinces, as well as in java island. Report at least the moran's I are tend to decrease along the periode of study. From the LISA, we can ascertain that there was statistically significant high clustering in Indonesia. Only some provinces really show significant industrial clustering and these provinces are West Java, Banten, DKI Jakarta, Central Java, and East Java.

The findings are not only strengthened the regional economic theory especially the economic geography theory, but also important to develop a policy recommendation due to industrial development planning. As a policy implication, the analyse showed that spatial dependence across regions was matter and in other side will be beneficial for the economic growth of the regions. It implied that all regions need to cooperate due to economic integration.

For future research, it might be interesting to develop model take into account some variables which influence to spatial distribution of manufacturing industries. Hence, the model can be able to explain the spatial distribution of manufacturing industries process.

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