Analysis of aquaculture leading commodities in Central Java using Location Quotient and Shift Share methods

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Abstract. The condition of capture fisheries is currently stagnating, even tended to decline, which is indicated by the decrease of production in some fishery development areas in Indonesia. Aquaculture is one solution that can be done. Central Java Province is a province that has a large aquaculture potential, therefore of course Central Java province has leading commodities that become the sector of regional economic development. This research discusses about the potential location for the development of each leading commodities in Central Java Province as a recommendation related to the center of fisheries production. Analytical methods in this research are Location Quotient (LQ) and Shift share. It used to see how big these locations have a potential in the development of aquaculture production and to identify spatial autocorrelation in the amount of aquaculture production using Moran’s index. The analysis of LQ and shift share shows that each district has a different potential in the development of leading commodities production. The value of the Moran’s index obtained equal to -0.1381, that is in the range of -1 <I ≤ 0, indicating that the presence of spatial autocorrelation is negative but small because of near to zero. It can be concluded that there is no similarity of the values between the districts or indicate that amount of aquaculture production among the districts in Central Java is not correlated.

1. Introduction
The condition of the present capture fisheries has been stagnant; it even tends to decrease regarding the production in some areas in Indonesia. The degradation of water environment is caused by global climate change. In addition, it is also caused by uncontrolled massive fish exploitation. Continuous fish catching with no control can damage the environment ecosystem and its sustainability. Meanwhile, the fish consumption rate tends to increase along with the rising population each year. Certainly, the said matter needs a solution as an attempt to fulfill the fish consumption demand which tends to increase along with the fish production which tends to decrease. Aquaculture is one of many solutions which can be done with a note that its production can be controlled by technology innovation and its capacity.

Central Java is a province which has great potential aquaculture; it can escalate the public welfare. Leading commodities are the commodities which have become the dominant or outstanding commodities in every area. By understanding the leading aquaculture commodities in each regency/city, the Fisheries Office at Central Java and the community can keep developing it so that they can strive and support the commodities to be better.
This research provides the analysis of leading commodities in Central Java regarding the leading commodities characteristics in each regency. The methods applied in this research are Location Quotient (LQ), Shift Share, and Moran’s Index.

2. Literature review

The data applied in this research is a secondary data which is obtained from the statistic report. The report was made by Fisheries Office of Central Java regarding the number of production on each leading aquaculture commodities from 2013 until 2016 in every regency or city [1, 2, 3, 4].

According to [5], there are nine outstanding commodities in aquaculture sector and it is expected to increase the national income of Central Java: milkfish (*Chanos chanos*), gourami (*Osphronemus goramy*), carp (*Cyprinus carpio*), walking catfish (*Clarias*), nile tilapia (*Oreochromis niloticus*), pangasius (*Pangasius*), java barb (*Barbonymus gonionotus*), whiteleg shrimp (*Litopenaeus vannamei*), dan Asian tiger prawn (*Peneaus monodon*).

The leading commodity has a better prospect to be developed. In addition, it is expected to boost other commodities to grow. The methods which can be applied in analyzing which regency/city that has an important role in developing the said nine leading aquaculture commodities are Location Quotient (LQ) dan Shift Share. In this research, the writer also identifies the autocorrelation by utilizing Moran’s Index.

2.1 Location Quotient (LQ) method

According to [6], LQ analysis has an aim to compare the role of a sector or industry in an area towards its role in a reference area (a larger area). This method has once used by [7] with the title “Producing alternative concept to develop the Trans-Sumatera toll road project by applying location quotient method.” This research results in a more efficient alternative route than the 797.29 km one by utilizing the north Trans-Sumatera toll road. It is done by considering Gross Regional Domestic Product and the population density which includes Banda Aceh, Sigli, Bireuen, Lhokseumawe, Idirayeuk, Stabat, Medan, Lubukpakam, Limapuluh, dan Raya. The superior commodities in Nanggroe Aceh Darussalam (NAD) include mining in North Aceh and East Aceh, industries in Lhokseumawe. Meanwhile, the leading commodities in North Sumatera are mining and agriculture in Langkat and industry in Batubar.

In this research, LQ is used to find out the location of each commodity and the regency/city specialty in regard to the superior commodities. According to [6], the formula to measure LQ can be explained as below:

$$LQ = \frac{E_{i,r}}{E_{r}} \cdot \frac{E_{i,N}}{E_{N}}$$

Remarks:
- $E_{i,r}$ = the production amount of leading fish commodities (i) in region (r)
- $E_{r}$ = the total production of the entire leading commodities in region (r)
- $E_{i,N}$ = the production amount of leading commodities in reference area (i)
- $E_{N}$ = the total production of the entire leading commodities in reference area

The criteria:
- $LQ > 1$, $i$ fish, in $r$ regency is leading commodities
- $LQ \leq 1$, $i$ fish in $r$ regency is not leading commodities

In this research, a commodity is considered as dominant in certain regency if the value has $LQ$ mean $> 1$ and $LQ$ deviation standard $< LQ$ mean.
2.2 Shift Share method

According to Markusen et al. (1991) in [6], the fast and relatively inexpensive technique to analyze the growth and regional decrease overtime is Shift-Share analysis. In this final project, the shift share analysis aims to examine the production growth rate on fish commodities in each regency/city by comparing it with Central Java Province. According to Dunn (1960) in [6], shift share analysis uses three basic information which related to one another that is:

- Economic growth references show impact of fish production growth in the reference region towards the study region or national share
- Proportional shift shows relative performance changes of a commodity in the study region towards the same commodity in the reference region.
- Regional shift shows how far the competitiveness of a commodity is in the study region to the economy in the reference region.

As for equation formula from the Shift Share analysis based on Perloff et al (1960) in [6] are as follows:

\[
G_{i,j} = y_{i,j,t} - y_{i,j,0} = NS_{i,j} + IM_{i,j} + RS_{i,j}
\]

1. National Shift obtained from:

\[
NS_{i,j} = y_{i,j,t} \cdot \left( \frac{Y_{t}}{Y_{0}} - 1 \right)
\]

2. Proportional Shift obtained from:

\[
IM_{i,j} = y_{i,j,t} \cdot \left( \frac{Y_{t}}{Y_{0}} - \frac{Y_{i,j,t}}{Y_{i,j,0}} \right)
\]

3. Differential Shift obtained from:

\[
RS_{i,j} = y_{i,j,t} \cdot \left( \frac{y_{i,j,t}}{y_{i,j,0}} - \frac{Y_{i,t}}{Y_{i,0}} \right)
\]

Remarks:

- \(G_{i,j}\) = real impact of \(i\) fish production growth in \(j\) study region
- \(y_{i,j,t}\) = amount of \(i\) fish production in \(j\) study region on the end of a period
- \(y_{i,j,0}\) = amount of \(i\) fish production in \(j\) study region on the beginning of a period
- \(NS_{i,j}\) = impact of \(i\) fish production growth in reference region towards \(i\) sector in \(j\) study region
- \(IM_{i,j}\) = proportional shift (growth rate) \(i\) fish in study region \(j\)
- \(RS_{i,j}\) = level of competitive advantage (differential shift) \(i\) fish in study region \(j\)
- \(Y_{t}\) = total production every commodity in reference region on the end of a period
- \(Y_{0}\) = total production every \(i\) commodity in reference region on the beginning of a period
- \(Y_{i,t}\) = total production \(i\) fish in reference region on the end of a period
- \(Y_{i,0}\) = total production \(i\) fish in reference region on the beginning of a period

There are two indicators from the equation of shift share sector analysis or leading commodity of a region, are as follows:

1. If value of a proportional shifts component from a commodity (\(IM_{i,j}\)) > 0, then \(i\) commodity on the region undergo rapid growth and gives positive impact on the growth of reference region and vice versa.
2. If value of differential shift (\(RS_{i,j}\)) > 0, then \(i\) commodity on \(j\) region has a higher competitive advantage towards reference region, vice versa.

Growth characteristics could simplify determine by joined analysis between LQ method and Shift Share. According to [8], a commodity is leading when its value \(LQ \geq 1\) and value \((IM_{i,j} + RS_{i,j})\) on Shift Share \(\geq 0\), and potential commodity is marked having \(LQ \geq 1\) and value \((IM_{i,j} + RS_{i,j})\) on Shift Share < 0.

These LQ and Shift share methods have been used by [9] on their research, titled “Analysis on leading sub-sector on base sector towards the region’s income on Siak Regency, Riau Province.” The research shows that according to the LQ analysis using Gross Regional Domestic Product (PDRB)
from the year 2009 – 2013 excluding mining and excavation sector, farming sector become the base sector with plantation and forestry as the leading subsectors. In the mining sector, oil and gas are the leading subsectors. However, from the Shift Share analysis shows that the plantation sector with its leading subsector has the positive value, while in the mining sector with oil and gas as the leading subsectors have a negative value.

2.3 Identification of spatial autocorrelation
Spatial autocorrelation is the correlation between observations in connected variables with the location. In other words, it is a point distribution analysis that differentiates the location with its attribute. Spatial data is a data that contains the location or geographical information from a region. According to [10], spatial analysis is a variation of operation and concept including simple calculation, classification, arrangement, geometric overlay, and cartographic modeling.

The most important thing in spatial analysis is the weight or commonly mentioned as spatial weight matrix. It is used to determine the weight between observed locations according to the neighbor relationship of said locations. According to [11], neighbor could be defined in several ways, which are: Rook Contiguity, Bishop Contiguity, and Queen Contiguity. In this research, the weight matrix that will be used is the standardize contiguity matrix $W$. In order to identify the spatial autocorrelation, Moran’s Index will be used.

According to [11], the calculation of spatial autocorrelation could be done in two ways, which are:

1. Moran’s Index with non standardized spatial weight matrix $W^*$

$$I = \frac{n \sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij}^* (x_i - \bar{x})(x_j - \bar{x})}{S_0 \sum_{i=1}^{n} (x_i - \bar{x})}$$  \hspace{1cm} (6)

with $S_0 = \sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij}^*$

2. Moran’s Index with standardized spatial weight matrix $W$

$$I = \frac{n \sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij} (x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^{n} (x_i - \bar{x})^2}$$  \hspace{1cm} (7)

Remarks:
- $I$ = Moran index
- $n$ = number of locations of the incident
- $x_i$ = value on location i
- $x_j$ = value on location j
- $\bar{x}$ = average of total value from all research location
- $w_{ij}^*$ = elements on unstandardized weighting between i region and j region

Value range from Moran Index in case of standardized spatial weighting matrix is $-1 \leq I \leq 1$. Value $-1 \leq I < 0$ shows the existence of negative spatial autocorrelation, while value $0 < I \leq 1$ shows the existence of positive spatial autocorrelation. If Moran Index Value is zero ($I = 0$), indicates there is no spatial autocorrelation.

According to [12], to identifies the existence of autocorrelation, Moran Index significance test was run.

Hypotheses:

$H_0$: $I = 0$ (No spatial autocorrelation between locations)

$H_1$: $I \neq 0$ (There is spatial autocorrelation between locations)
Significance level: $\alpha$
Statistics Test:

$$Z_{count} = \frac{I - E(I)}{\sqrt{\text{var}(I)}}$$

with:

$$I = \sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij} (x_i - \bar{x})(x_j - \bar{x})$$

$$E(I) = I_0 = -\frac{1}{n-1}$$

$$\text{var}(I) = \frac{n^2S_1 - nS_2 + 3S_0^2}{(n^2 - 1)S_0^2} - [E(I)]^2$$

$$S_0 = \sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij}$$

$$S_1 = \frac{1}{2} \sum_{i \neq j} (w_{ij} + w_{ji})^2$$

$$S_2 = \sum_{i \neq j} (w_{ij} + w_{ji})^2$$

$$w_{to} = \sum_{j=1}^{n} w_{tj}$$

$$w_{ot} = \sum_{j=1}^{n} w_{oj}$$

directory:

$x_i$ = Data number-$i$ ($i = 1, 2, ..., n$)

$x_j$ = Data number-$j$ ($j = 1, 2, ..., n$)

$\bar{x}$ = Data average

$\text{var}(I)$ = Moran’s variant I

$E(I)$ = Expected value Moran’s I

Decision: $H_0$ rejected if $|Z_{count}| \geq Z_{\alpha/2}$

3. Results and Discussion

The Location Quotient analysis is used to acknowledge which regencies are the growth areas of each leading aquaculture commodities in Central Java Province. If the mean of LQ > 1 and the standard deviation of LQ < the mean of LQ, then the commodities is more dominant in said regency. According to the analysis, milkfish is more dominant in Pemalang Regency with the mean of LQ = 3,11790 and the standard deviation of LQ = 0,233922, gourami fish is more dominant in Banyumas Regency with the mean of LQ = 11,252023 and the standard deviation of LQ = 2,163283, carp fish is more dominant in Temanggung Regency with the mean of LQ = 13,724865 and the standard deviation of LQ = 3,745627. Walking catfish and nile tilapia are commodities that being farmed in every regency in Central Java Province, however, from the analysis result, it is shown that walking catfish is more dominant in Blora Regency with the mean of LQ = 2,979573 and the standard deviation of LQ = 0,391870. While nile tilapia is more dominant in Wonogiri Regency with the mean of LQ = 3,889201 and the standard deviation of LQ = 0,568736. On the other hand, pangasius fish is more dominant in Purbalingga Regency with the mean of LQ = 8.168610 and standard deviation of LQ = 6,204588, and java barb is more dominant in Banyumas Regency with the mean of LQ = 14,029287 and standard deviation of LQ = 5,498703. Besides fish, whiteleg shrimp and Asian tiger shrimp are also leading aquaculture commodities in Central Java Province. According to the Location Quotient analysis, whiteleg shrimp is more dominant in Purworejo Regency with the mean of LQ = 11,670500 and standard deviation of LQ = 8,319955, and Asian tiger shrimp is more dominant in Rembang Regency with the mean of LQ = 6,147305 and standard deviation of LQ = 2,575621.

Shift Share analysis is used to identify the growth rate and competitive rate in each commodity from each regency in Central Java Province. According to the analysis, each regency has different
growth rate and competitive rate. Identification of the leading growth commodity characteristic can be simply obtained from LQ analysis and Shift Share. A commodity could be called as superior or leading in a regency if it has the mean of $LQ \geq 1$ and the number of $(IM_{i,j} + RS_{i,j})$ in Shift share $\geq 0$. If a commodity has the mean of $LQ \geq 1$ and the number of $(IM_{i,j} + RS_{i,j})$ in Shift share $< 0$, then said commodity is a potential commodity. The result of the analysis that combines the two types of analysis can be seen in table 1 below:

| Regency/City | Leading Commodity | Potential Commodity |
|--------------|-------------------|---------------------|
| Cilacap Regency | Carp, Pangasius | Gourami, Java Barb, Asian Tiger Shrimp |
| Banyumas Regency | Gourami | Carp, Java Barb |
| Purbalingga Regency | Gourami, Walking Catfish, Pangasius, Java Barb |
| Banjarnegara Regency | Gourami, Walking Catfish | Carp, Pangasius, Java Barb |
| Kebumen Regency | Gourami, Walking Catfish | |
| Purworejo Regency | Whiteleg Shrimp | Gourami, Java Barb |
| Wonosobo Regency | | Nile Tilapia |
| Magelang Regency | Carp, Walking Catfish, Nile Tilapia | Walking Catfish |
| Boyolali Regency | Gourami | Nile Tilapia |
| Klaten Regency | Walking Catfish, Pangasius | Nile Tilapia |
| Sukoharjo Regency | Pangasius | Nile Tilapia |
| Wonogiri Regency | Walking Catfish, Pangasius | Nile Tilapia |
| Karanganyar Regency | Walking Catfish, Pangasius | Nile Tilapia |
| Grobogan Regency | Gourami, Walking Catfish, Java Barb | |
| Blora Regency | Walking Catfish | |
| Rembang Regency | Whiteleg Shrimp, Asian Tiger Shrimp | |
| Pati Regency | Walking Catfish | Milkfish, Asian Tiger Shrimp |
| Kudus Regency | Milkfish, Asian Tiger Shrimp | Milkfish, Walking Catfish |
| Jepara Regency | Walking Catfish | Carp |
| Demak Regency | Walking Catfish | Milkfish, Walking Catfish |
| Temanggung Regency | Carp, Nile Tilapia | |
| Kendal Regency | Milkfish, Whiteleg Shrimp | Milkfish, Walking Catfish |
| Batang Regency | Milkfish | |
| Pekalongan Regency | Milkfish, Walking Catfish | |
| Pemalang Regency | Milkfish, Whiteleg Shrimp | |
| Tegal Regency | Milkfish, Walking Catfish | |
| Brebes Regency | Whiteleg Shrimp | Milkfish, Asian Tiger Shrimp |
| Magelang City | Nail Tilapia | Carp, Walking Catfish |
| Surakarta City | Walking Catfish | Walking Catfish |
| Salatiga City | Milkfish | |
| Semarang City | Milkfish | |
| Pekalongan City | Whiteleg Shrimp | Milkfish, Asian Tiger Shrimp |
| Tegal City | Milkfish | |

Spatial autocorrelation analysis is used to identify if the aquaculture production between regencies in Central Java Province is correlated or not. The analysis method that can be used to analyze the spatial autocorrelation is Moran’s Index. The following is the result of Moran’s Index’s calculation:
Hypothesis:

\( H_0 : I = 0 \) (There is no spatial autocorrelation between locations)

\( H_1 : I \neq 0 \) (There is a spatial autocorrelation between locations)

Significance level: \( \alpha = 5\% \)

Statistical test:

\[
Z_{hitung} = \frac{I - E(I)}{\sqrt{Var(I)}}
\]

where:

\( I = -0.1381 \)

\( I_0 = E(I) = -0.0294 \)

\( Sd = 0.1184 \) maka \( Var(I) = 0.01402 \)

Therefore:

\[
Z_{count} = \frac{-0.1381 - (-0.0294)}{\sqrt{0.01402}} = -0.918
\]

Criteria testing:

\( H_0 \) is refused if \( |Z_{hitung}| \geq Z_{\alpha/2} \) or p-value \( \leq \alpha \)

Conclusion:

\( |Z_{hitung}| < Z_{\alpha/2} = 0.918 < 1.96 \) and p-value > \( \alpha = 0.1870 > 0.05 \) therefore \( H_0 \) is accepted. From the calculation result, it can be said that in significance level of 5\% there is no spatial autocorrelation towards the production of aquaculture in Central Java during 2016. The Moran’s Index value of -0.1381 falls on \(-1 \leq I \leq 0\) range and \( I \leq I_0 = -0.1381 < -0.0294 \) shows the availability of negative autocorrelation, however the correlation could be classified as weak because it is close to zero. Therefore, it can be concluded that there is no similar value between regencies or there is indication on that the value of aquaculture production between Central Java Provinces is not correlated into one another.
4. Conclusion

According to the analysis, there are several things can be concluded. There are various regions that are becoming the growth center of each leading aquaculture commodity in Central Java Province. Cilacap Regency has become the most potential regency, out of the other 34 regions, in the production of leading aquaculture commodity. According to the spatial autocorrelation analysis, it gives the result as follows:

a. The calculation, Moran’s Index value of $I = -0.1381$. The Moran’s Index value falls in the $-1 < I \leq 0$ range, therefore, it shows that there is negative spatial autocorrelation, but the correlation could be classified as weak because it is close to zero, therefore there is no spatial correlation in Moran’s Index’s significance testing.

b. Significance testing of Moran’s Index with the significance level of 5% resulted in $|Z_{count}| < Z_{a/2} = 0.918 < 1.96$ and $p$-value $> \alpha = 0.1870 > 0.05$, therefore it can be concluded that there is no similar value between regencies or there is indication that the value of aquaculture production between Central Java Provinces is not correlated into one another.

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