Forecasting the welfare of fishermen and aquaculture farmers in Indonesia: Data Mining Approach

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Abstract. Fishermen and aquaculture farmers mostly living in the coastal region, with socio-economic characteristics are low on education, a large number of family member in liability and still being dominated by men. Within said, it is necessary for the central and local government to maintain their economic policy tools to improve the welfare of fishermen and aquaculture farmers in Indonesia. In this study, fishermen and aquaculture term of trade used as the indicator of economic welfare. By using data mining technique multiple regression models, SVR and k-means clustering, we create a model to predict the purchasing power of fishermen and aquaculture farmers in Indonesia. We used 11 attributes included monthly data of micro and macroeconomic indicators from 2007-2016. The result showed the best model is multiple regression model compare to SVR based on R² and RMSE. Furthermore, the result also indicated that based on microeconomic indicators consumption, the growth of fisheries sector people will increase the purchasing power of fishermen and aquaculture farmer, where macroeconomic factors inflation and CPI negatively affect fishermen and aquaculture welfare. Based on clustering analysis also indicated that three clusters mostly separated by the rate of inflation and gini ratio.

1. Introduction

As a country with longest coastal line and included in coral triangle (CT) countries, makes sea water in Indonesia supposedly to have the resources to not only serve as the fish supply of the world but also can enhance economic life of the coastal community in the country. Ironically, the coastal community is known as the lower class in the country, based on their socio-economic characteristic such as low on education, mostly have high family members in liability and mostly are men [1][2][3]. Ministry of marine and fisheries affairs of Indonesia used farmers' term of trade to measure cost paid by fishermen and aquaculture farmers to every good they consume and price that they receive on their product, where there is three categories high, neutral and low level. This farmers' term of trade also being used in several countries such as India [5]; Australia [6] The indicators used to measure the welfare of the fishermen and aquaculture farmers in Indonesia, where the surplus on the price received and cost to pay indicated the welfare of fishermen and aquaculture farmers are high, in addition, it will be neutral
is its equal between price received and cost paid and low when cost paid is higher than process received. There are also several studies related to the use of farmers' term of trade [7][8][9].

The abundance of marine resources in Indonesia is large enough to support the economic welfare of coastal communities in particular, where most of these people are living in poverty and rely their economic needs on the sea. Despite a large number of resources, based on the research of [9] that trend of fishes supply in Maluku which one of the largest suppliers of fish in Indonesia will decrease in the span of 8-10 ceteris paribus. This an alarm for local and central government to deal with the matter by keeping campaigning sustainability fisheries but also play its role as a policy maker to assist coastal communities in order to help them enhance their welfare. Local and central government have issued various program but most of the time is so inefficient [10]. In another hand, most fisheries and aquaculture farmers also lack in access and knowledge on the use of technology to able to optimize their productivity in an effort to increase the profitability due to the lack of willingness to share information in fisheries supply chain [11][12].

Therefore local and central government need to maximize their tools such as set inflation rate, CPI, targeting Gini ratio, maintaining the number foreign ships and company to operate in Indonesia to not only protect coastal communities but also increase their welfare especially in ASEAN economic communities era and free trade. Thus, this study focused on crafting a model to predict the welfare of fishermen and aquaculture farmers in Indonesia, by using data mining analysis. The following parts of this paper are methodology where we discussed the steps of data mining, the type of the data that is used, the study framework and data analysis tools. In the next part continued by results and discussion, where we discussed the result of the paper, then continue with a conclusion where we summarize the result and proposed the suggestion and future research.

2. Methodology

Data on this study obtained from Statistic Indonesia (BPS) and Open Portal Data of Indonesia. Data attributes on this study includes farmers' term of trade, inflation, Gini ratio, CPI and base year for macroeconomic indicators and for micro-economic indicators are expense for food, expense for non food, expense of high income people, expense of middle income people, expense of low income people, growth of fisheries sector, number of aquaculture company, number of fisheries company, production of fisheries, production of aquaculture sector and production of catching fisheries. Monthly data used in this study start from 2007 to 2016 with total 1938 sets of data.
On figure 1 showed data mining process on this study, where on model data we used clustering analysis with k-means and for forecasting analysis, we used MLR and SVR. First, multiple linear regression (MLR) in thus study the MLR model can be expressed below [12]. Where \( Y_{lmn} \) is the dependent variable which in this study is fishermen and aquaculture farmer\’ term of trade per fishermen and aquaculture farmer \( l \), per month \( m \), every year \( n \), whereas \( \alpha \) is an intercept; \( \beta \) and \( X \) are parameters and independents variable which in this study were 11 independent variables.

\[
Y_{lmn} = \alpha + \sum_{p} \beta_p X_{p,ljk} + \varepsilon_{lmn}
\]

(1)

The second is support vector regression (SVR). SVR is a well-applicable tool for classification purposes based on decision planes wherein SVR consist of finding the hyperplane that crosses near each point [13]. We used squared correlation and root mean squared error (RMSE) to evaluate the suitability of the models, where the higher squared correlation of these models and at the same time the closer to zero for RMSE are the better model. The third is k-means clustering, main purposed of the tool based on the definition of k centroids one for each cluster by minimizing the norm, as it shown in the equation below. Where \( M_i \) are the mean points of all \( M_j \in S_i \).

\[
V = \sum_{i=1}^{k} \sum_{M_j \notin S_i} (M_j - M_i)^2
\]

(2)

K-means clustering used in this study to map macro and microeconomic factors that affect the fishermen and aquaculture\’ term of trade. In this study, we used three number of clusters, high, middle and low fishermen and aquaculture farmers\’ term of trade value.

3. Result and Discussion

3.1. Cluster analysis

The main purpose of clustering methods in this study was to group micro and macroeconomic factors into clusters, where in this case divided into three clusters; high, medium and low of fishermen and aquaculture farmers\’ term of trade values. By doing this, we can map factors that form high fishermen and aquaculture farmers\’ term of trade value, so local and central government can manage to use all their policies tools to increase the welfare of fishermen and aquaculture farmer in Indonesia. Based on the centroid result in table 1 below, for Gini ratio there no significant difference between cluster 1 and cluster 2 whereas in the other hand for other attributes had a significant gap among the three clusters.

| Attributes           | Cluster 0 | Cluster 1 | Cluster 2 |
|----------------------|-----------|-----------|-----------|
| Gini Ratio           | -1.2211   | 0.7266    | 0.7047    |
| Food Expenses        | 0.9798    | -0.1676   | -2.0451   |
| Non-food Expenses    | -0.3241   | -0.4506   | 2.4790    |
| Inflation            | 0.1127    | 0.0262    | -0.3974   |
| Low-income expenses  | 1.1522    | -0.7245   | -0.5266   |
| Middle-income expenses| 1.0543  | -0.7052   | -0.3313   |
| High-income expenses | -1.2087   | 0.7811    | 0.4772    |

The further result also showed in figure 2, whereof three clusters data cluster that contains the group that has the high value of fishermen and aquaculture\’ term of trade was cluster 1. In addition, as
it showed in figure 3, where most of the high value of fishermen and aquaculture’ terms of trade in 2011 to the first semester of 2014. In these span of years, the average value of fishermen and aquaculture’ term of trade as an indicator of fishermen and aquaculture welfare was 122 way above 100 compare with 2008 to 2010 and 2015-2016 where an average value of fishermen and aquaculture’ term of trade was 114. The most standout indicator of the macroeconomic factor was the inflation rate where during 2011 to 2014 an average inflation rate was 10.9% compared to 8.4% in 2008 to 2010 and 2015-2016. For the microeconomic indicator, the most standout factor was the expense of high-income people, where during 2011 to the first semester of 2014 was 48.2 point compare to 2008 to 2010 and 2015-2016 was 45.9 point.

Figure 2. Centroid Results

Figure 3. Scatter plot of fisheries purchasing power
These results showed that in order to obtain better purchasing power of fishermen and aquaculture farmers, the local and central government needs to boost economic to force those high-income people on Indonesia to spend more their money in order to increase the welfare of fishermen and aquaculture farmers' welfare. In other hand, fishermen and aquaculture farmers need to balance their spending so there is no negative expense.

3.2. Forecasting Analysis
Based and $R^2$ and RMSE from multiple linear regression (MLR) and support vector regression (SVR), the multiple linear regression provided the better performance model compare to support vector regression as it showed in table 2. The predictive model from linear regression can be seen in figure 4.

![Figure 4. Predictive Model](image)

| Method   | Squared Correlation | Root Mean Squared Error |
|----------|---------------------|-------------------------|
| MLR      | 0.79                | 5.586                   |
| SVR      | 0.31                | 10.258                  |

| Table 3. Multiple Linear Regression Result |
|------------------------------------------|
| Attribute                  | Coefficient   | sig   |
| Aquaculture production     | 0.002871702   | ****  |
| Fisheries Company          | 1.129945398   | ****  |
| Aquaculture company        | -0.332686339  | ****  |
| Fisheries sector growth    | 4.780340759   | ****  |
| CPI                       | -0.131952309  | ****  |
| Inflation                 | -0.570245837  | ****  |
| Food related expenses      | 15.21821957   | ****  |
| Non-food related expenses  | 8.48740217    | ****  |

Based on the result on table 3, the most contribute attributes for forecasting welfare of fishermen and aquaculture farmers in Indonesia based on microeconomic factors, result showed that expenses positive contribute to the increase of fisheries purchasing power along with aquaculture production.
and fisheries company while aquaculture company negatively contributed to the value of fishermen and aquaculture’ term of trade in Indonesia. The negative impact of aquaculture company because most of these company in Indonesia belongs to personal and group of conglomerates, therefore, the multiplier effect on the profit on the income of aquaculture farmers is on the opposite side. For macroeconomic factors, inflation and CPI had contradicted effect on fishermen and aquaculture farmers purchasing power.

As the result, aside from on playing their policies tools either on monetary or fiscal, the local and central government in Indonesia need to create fair playing ground especially on aquaculture sector, so it will not become solely monopolized by the big player but also aquaculture households in Indonesia. The attention on the development of grouper, pearl, seaweed and sea cucumber aquaculture in small islands regions can also energize local economic, by the increase and optimize the supply chain with reducing the distribution cost and provide better market both in and abroad.

4. Conclusion
The local and central government of Indonesia have a huge role on increase the welfare of fishermen and aquaculture farmers in the country, by better used their policies tools. Both micro and macroeconomic factors play a huge role in the power of purchasing of fishermen and aquaculture farmers in Indonesia, where expenses, especially from high-income people and stabilize inflation rate can help to achieve and maintain the high value of fishermen and aquaculture’ term of trade in Indonesia. The use of data mining can provide the better input of data provided, where future research can explore more on the various useful tools of data mining to obtain a better understanding on available data to help improve the welfare of fishermen and aquaculture farmers in Indonesia.

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