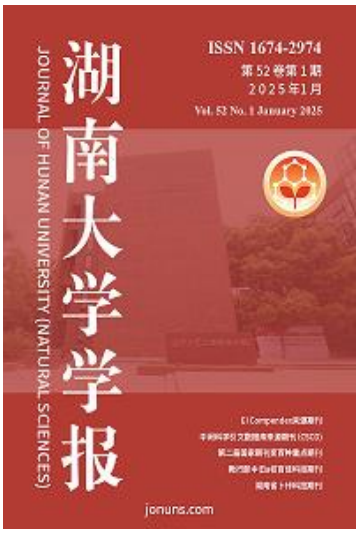

Journal of Hunan University

(Natural Sciences)

Vol. 52 No. 1

January 2025

Available online at

https://jonuns.com

Original research article

https://doi.org/10.55463/issn.1674-2974.52.1.8

Assessing Fishery Households Welfare in Indonesia: Panel Spatial Durbin Model Approach

Iwan Harsono[1*], Ketut Sukiyono[2], Lalu Yuriade Mulana[3]

[1]Faculty of Economics and Business, University of Mataram, Nusa Tenggara Barat, Indonesia

[2]Department Agricultural Socio-Economic, Faculty of Agriculture University of Bengkulu, Bengkulu, Indonesia

[3]Statistics of Nusa Tenggara Barat Province, Nusa Tenggara Barat, Indonesia

* Corresponding author: iwanharsono@unram.ac.id

Article History:

Received: November 25, 2024
Reviewed: December 30, 2024
Revised: January 22, 2025
Accepted: January 27, 2025
Published: February 28, 2025

Abstract: The welfare of fishermen, as indicated by the value of NTN, is the government's focus in supporting economic growth and national development. The NTN, or Nilai Tukar Nelayan (Fihermen Exchange Rate), is estimated based on the prices of goods and services in terms of production, costs, and household consumption. However, the government needs to recognize how macroeconomic assumptions affect the welfare of fishermen in Indonesia as a basis for budget planning and national development programs. Therefore, this study aims to comprehensively analyze the welfare of fishermen in Indonesia using a spatial Durbin panel model approach. Provincial (spatial) secondary data from 2020 to 2022 involved variables of fishermen's Exchange Rates, Human Development, Population Density, inflation, agricultural sector labor, and average daily wages. It is new and interesting to include regional influences in determining the right policies to alleviate poverty in fishermen in Indonesia, considering the geographical conditions of Indonesia, which consists of islands. This study found that the Durbin spatial panel model is the best model for the data used and that the human development index (HDI) and inflation variables had a significant and positive effect on the welfare of fishing households in Indonesia.

Therefore, it is important for the Indonesian government to reduce the poverty rate of fishermen by improving the skills and innovation of fishermen, development gaps, and controlling inflation.

Keywords: Fishermen Welfare, HDI, Inflation, human capital, Spasial Durbin Model

评估印度尼西亚渔业家庭福利：面板空间杜宾模型方法

摘要：渔民福利以 NTN 值表示，是政府支持经济增长和国家发展的重点。NTN 或 Nilai Tukar Nelayan（渔民汇率）是根据商品和服务的生产、成本和家庭消费价格估算的。另一方面，政府需要认识到宏观经济假设如何影响印度尼西亚渔民的福利，以此作为预算规划和国家发展计划的基础。因此，本研究旨在使用空间 Durbin 面板模型方法全面分析印度尼西亚渔民的福利。本研究使用了 2020 年至 2022 年省级（空间）二级数据，涉及渔民汇率、人类发展、人口密度、通货膨胀、农业部门劳动力和平均日工资等变量。考虑到印度尼西亚由岛屿组成的地理条件，将区域影响纳入确定减轻印度尼西亚渔民贫困的正确政策是新颖而有趣的。从最佳模型选择结果来看，本研究得出杜宾空间面板模型为最佳模型。研究结果发现，人类发展指数（HDI）和通货膨胀变量对印度尼西亚渔业家庭的福利有显著的正向影响。该研究结果很有意思，需要印度尼西亚政府进一步考虑，通过提高渔民的技能和创新、发展差距和控制通货膨胀来降低渔民的贫困率

关键词：渔民福利、人类发展指数、通货膨胀、人力资本、空间杜宾模型

1. Introduction

Indonesia is one of the largest maritime countries in the world, and almost two-thirds of Indonesia's territory is sea. Indonesia, with a sea area of 5.8 million km2 and a coast length of 95,181 km, has fishery potential and a vast abundance of marine resources. This condition has immense potential for use in fisheries and marine resources. As mandated by law, this enormous potential must be pursued for the prosperity of people. Optimum utilization of fisheries and marine resources will improve the welfare of fishermen as the main actors in economic activities directly related to these resources.

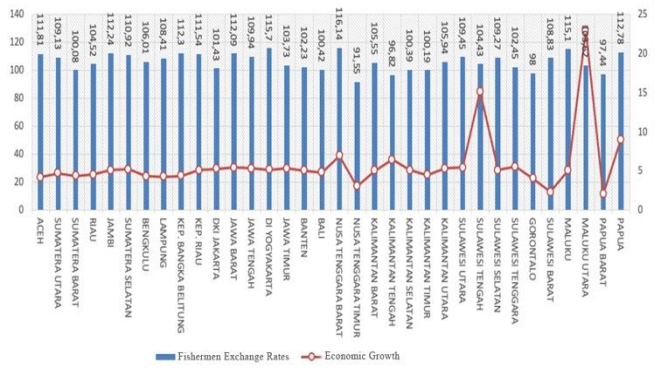

Fig 1. Fishermen Exchange Rates and Economic Growth by Indonesian Provinces in 2022
Source: Central Bureau of Statistics (processed)

The welfare of farmers in the fisheries and fishermen sectors is now receiving increasing attention from the government. This is proven in 2023, in article 53 point e of Law no. 28 of 2022 concerning the government in implementing the State Budget for Fiscal Year 2023 seeks quality development targets to increase Farmer Exchange Rates and Fishermen Exchange Rates (NTN). Increasing NTN is a goal of national development and economic growth. This shows the amount of government attention paid to the fishermen in Indonesia. The fishermen's exchange rate determines the values of macroeconomic assumptions, which will influence the design of the government's budget in improving people's welfare, especially in coastal areas.

Viewed from the development of NTN and economic growth in various provinces in Indonesia, based on Figure 1 below, shows that regions with a fisherman exchange rate index below 100 are in line with the low regional economic growth compared to other provinces with NTN above 100. For example, the East Nusa Tenggara and West Papua Provinces with the lowest NTN, namely 91.55 and 97.44, respectively, had low economic growth for the two provinces. This also shows that economic progress in a region improves the welfare of its people. Regions with high economic growth can be stimulated through well-implemented and sustainable economic development processes and output

growth, which the entire community can enjoy. Among the high-income minority group or from the low-income majority group, the delivery of economic development obligations, if delegated to high-income population groups, will be able to spur economic growth properly. However, suppose that the majority of the low-income population is selected. In this case, the development results must be shared equally, making it less likely to achieve a higher Gross National Product(Todaro dan Smith, 2009).

Since ancient times, fishermen have been the most traditional and significant source of income for people living along the coast(Rahaman et al., 2022). The Fishermen's Exchange Rate (NTN) is a component of the farmers ' exchange rate (NTP), which is obtained by comparing the price index received by fishermen (IT) and the price index paid by fishermen (IB) multiplied by 100. If NTN in an area exceeds 100, fishermen in that region experience a surplus. In other words, the increase in production prices is faster than the increase in consumer prices, or fishermen's income increases faster than their expenditure. The higher the value of the NTN index in a region, the more prosperous the life of fishermen in that region and vice versa. The Fishermen's Exchange Rate is calculated periodically every month based on the prices of goods and services in terms of production, costs, and household consumption to examine the actual welfare of fishermen. According to Law No. 23 of 2022, based on the government's target, the fishermen's exchange rate must be at a vulnerable value of 107 – 108. However, Figure 1 shows that more than half of the provinces in Indonesia have NTN below the government's target of 18 (eighteen) provinces. Various government programs and strategies have been implemented year to year to improve this NTN, and some of the things that have always been obstacles to the government are the equitable distribution of regional development in Indonesia, which consists of an archipelago.

The spatial dependency factor is an important factor that must be considered when assessing the economy and welfare of a region. This is based on the view that a region cannot be treated as a stand-alone unit; of course, regions, especially provinces within a country, must have socio-economic interactions, including trade, capital flows, migration, technological diffusion, and information exchange. Socioeconomic interactions between these regions will certainly emerge with spatial dependence on the economy in each region. V Tselios (2009) added that the spatial dependence between these regions would have a stronger influence on the economy and welfare of neighboring areas. Th is is due to the relatively unhindered socioeconomic interactions between neighboring regions. Grouping within a region can occur because of economic concentration in certain areas. The new geographic economic theory focuses on circular causality mechanisms that explain the economic concentration within a region(Fujita et al., 2001).

The welfare of fishers using the fisherman exchange rate approach includes an index of quantity elements in the form of a monthly production index and consumption index, which is still constrained by issues of collective agreement, data availability, and analysis and has not yet included spatial dependency factors. This prompted researchers to link and build the NTN model with various influencing factors, especially the indicators that make up macroeconomic assumptions that lead to policy simulations for development planning.

Yunianto (2015) stated that in his research, what is expected to improve the welfare of fishermen is strengthening the value of the rupiah against the USD, maintaining the stability of prices for consumer goods, and falling world oil prices.Yapanto (2022), in his research results, stated that fishermen who get easy access to education and support from government assistance through free schools and scholarships have an impact on increasing their level of welfare. Beneficiary fishermen or those with low levels of welfare state their readiness to increase their business if assistance with fishing gear facilities, infrastructure, and increased income increases the welfare of farmers(Kembar et al. 2022). Other studies related to NTN have not been carried out, especially concerning the geographical conditions of the region or spatial neighbors. Research conducted by Long W (2022) suggests that increasing the welfare of farmers will be more effective through the sustainable development of natural and human resources.

Bathe (2022) also revealed that the adaptation of fishermen to increase their income or welfare is influenced by several variables, including asset ownership, level of education, experience savings, and distance from the fishing ground. The conditions of tides

and seasons also significantly affect the profits and losses of fishermen in Indonesia(Radjab et al., 2022). The results of a study Alpiani (2022)considering the income and expenses of fishing labor households found that many fishermen still need help to meet their basic needs. Therefore, in addition to the limited research related to fishermen's welfare, a comprehensive study of fishermen's welfare involving macroeconomic variables is important and wise to conduct. These macroeconomic variables include inflation, human capital, level of labor in the agricultural sector, and population density.

According to Elhorst (2014), there are several spatial models of panel data, including spatial autoregressive (SAR), spatial error (SEM), and Spatial Durbin Models (SDM). However, as a result of the literature survey, the application of the Spatial Durbin Models model to analyze fishermen's welfare involving macroeconomic variables is very difficult to find. The spatial model of Durbin is widely applied in the banking sector, including in the tourism aspect(De Siano & Canale, 2024), unemployment in Iran (Rafiee et al., 2024), and the growth factor of the productivity of the fisheries sector in China (Shen Weiteng et al., 2023), among others. Therefore, the application of this model is one of the research gaps that should be closed to enrich scientific research.

The problem of poverty levels in Indonesia in the agricultural sector, including the welfare of fishermen, needs to be resolved. Various poverty alleviation programs implemented by the Indonesian government have not been sufficient to reduce poverty or improve the welfare of fishermen. The geographical factor of the archipelago region is also an obstacle to equalizing development to improve welfare. Therefore, it is interesting for researchers to study the welfare of fishermen in Indonesia using an analytical model approach that considers regional factors. Research on farmer welfare with the NTN approach will use the development of a spatial panel model, namely the Spatial Durbin Model (SDM), which is expected to provide the best model for the welfare of fishermen in Indonesia.

Furthermore, the purpose of this study is to conduct research/analysis of the welfare of fishermen through the factors that affect the exchange rate of fishermen in Indonesia by considering the influence of spatial neighborliness using the Spatial Durbin Model (SDM) approach. The results of this study are expected to be used by the government as a reference to improve the welfare of Indonesian farmers. This study hypothesizes that there is a spatial effect on fisherman exchange rates in Indonesia, and that the independent variables used significantly affect the dependent variable.

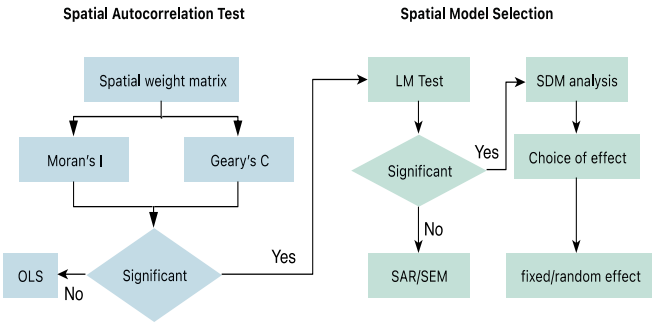

Fig 2. Work Flow of the research method

2.Methodology

2.1. Data Collection Method

This study used secondary data from the Central Bureau of Statistics (BPS) secondary data. The time period used in this study was from 2020 to 2022, with 34 research objects covering all provinces in Indonesia. So that the observations in this research were 102 observations. The variables used include NTN (index), Agricultural Sector Labor (percent), HDI (index), Population Density (people/km2), and inflation (percent).

2.2. Analysis Method

The analysis method used in this research was spatial panel regression. The neighborhood scale is used to determine which districts are neighbors, weighing queen order 1. Thus, the area that becomes a neighbor is directly adjacent to other sites. The steps of the analysis in this study are as follows:

1. Set the spatial weighting matrix (W)
2. Determine the selected model based on the model's goodness.
3. Estimate the model parameters with spatially fixed and random effects according to the selected model.
4. Testing the residual normality assumption, identical, independent, and no multicollinearity existed in the model. Countermeasures are performed if the assumptions are not met.

5. Interpret the results obtained and create a policy simulation.

2.3 Panel Data Regression

The panel data regression model can be performed with the common effect, fixed effect, and random effect models. The Common Effect Model is the simplest because it ignores the influence of the cross-section and time series. The CEM model is as follows:

$$y_{it} = X_{it}\beta + u_i + u_{it}$$

The fixed effects model is the simplest because, in this model, the influence of the cross-section and time series is ignored. The CEM model is as follows*:*

$$y_{it} = X_{it}\beta + u_i + u_{it}$$

The Random Effects Model (REM), also known as the Error Component Model (ECM), is expressed as follows:

$$y_{it} = X_{it}\beta + u_i + u_{it}$$

In this model, u_i was considered a random variable with an average of u_0. Therefore, the intercept can be written as $u_i = u_0 + \boldsymbol{\varepsilon_0}$ where $\boldsymbol{\varepsilon_0}$ is the error with a zero mean and variance $\boldsymbol{\sigma_\varepsilon^2}$. This equation can then be written as follows:

$$\boldsymbol{y_{it} = u_0 + X_{it}\beta + u_{it} + \varepsilon_i}$$

$$\boldsymbol{y_{it} = u_0 + X_{it}\beta + u_i + w_{it}}$$

With $\boldsymbol{w}_{it} = u_{\boldsymbol{it}} + \boldsymbol{\varepsilon}_i$

2.4. Spatial Weights Matrix

It is necessary to add weights to the model to explain the presence of spatial effects(Anselin, 1988). LeSage (1999) also explained that several methods could be used to determine the spatial weighting matrix, one of which is the Queen Contiguity method, which was used in this study. The Queen Contiguity method defines $w_{ij} = 1$ if the location is tangential to the sides or corners with other sites and $w_{ij} = 0$ if it is not tangential. The spatial weighting matrix is essential for measuring the spatial effects in different areas(Zhong et al., 2023).

In addition, spatial autocorrelation analysis was carried out to test the spatiality of the model. The spatial autocorrelation test aims to verify whether similar variables exist in neighboring areas or form regional spatial agglomerations. If the indicators are identical, this is called a positive spatial correlation; otherwise, it is called a negative spatial correlation. If the test results are randomly distributed, the spatiality between them is absent or weak(Nan & Luo, 2023). In recent years, Moran's I, Geary's C, and Getis-ord G indices have been proposed to measure the degree of spatial autocorrelation status. Based on the summary and analysis of existing research results, Moran'sI index approach was chosen to test and verify spatial autocorrelation. The Moran's I calculation method is shown in the following equation:

$$Moran's\ I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{s_0^2 \sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}}$$

$$s_0^2 = \frac{\sum_{i=1}^{n}(x_i - \bar{x})}{n},\ \bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

In the above equation, w_{ij} represents the spatial weight between elements *i* and *j*, x_i is the observed value of the i-th element, and n is the total number of factors. According to the equation, Moran's I values are generally -1 and 1; If the Moran's I value is greater than 0, there is a positive correlation, and the higher the Moran's I value, the higher the spatial correlation value. If Moran's I value is less than 0, there is a negative correlation; the smaller the Moran's I value, the higher the spatial correlation. Moran's value equals zero, meaning that the variable has no spatial correlation.

2.5. Spatial Panel Model

When determining the interactions between spatial units, the model may have a spatial lag in the dependent variable or spatial autoregressive error processes, commonly called spatial lag and spatial error models(Elhorst, 2014). Generally, the spatial panel model is expressed as follows:

$$y_{it} = \alpha + \tau y_{it-1} + \rho \sum_{j=1}^{n} w_{ij} y_{jt} + \sum_{k=1}^{K} X_{\boldsymbol{itk}}\beta_k + \sum_{k=1}^{K}\sum_{j=1}^{n} W_{\boldsymbol{it}}\theta_k + u_i + \boldsymbol{\gamma}_t + v_{it}$$

$$v_{it} = \lambda \sum_{j=1}^{n} m_{\boldsymbol{ij}} v_{it} + \epsilon_{it},\quad i = 1, \ldots . n,\ t = 1, \ldots . T$$

where ρ is the autoregressive spatial coefficient and W_{ij} is a spatial weighting matrix W component. For the static model, $\tau = 0$; and for the dynamic model, $\tau \neq 0$ (Yu et al., 2008). Based on the above modelling formula,

where the researchers used a static model, the spatial panel model equations used in this study were formed as follows:

$$NTN_{it} = \rho \sum_{j=1}^{n} w_{ij} NTN_{jt} + \beta_1 IPM_{it} + \beta_2 TkP_{it} + \beta_3 Upah_{it} + \beta_4 Pop_{it} + \beta_5 INF_{it} + u_i + \lambda \sum_{j=1}^{n} w_{ij} v_{it} + \epsilon_{it}$$

with NTN_{it} is the i-th province Farmer's Exchange Rate in the t-period; IPM_{it} is the Human Development Index of the i-th province in the t-period; TkP_{it} is the Percentage of Labor in the Agriculture Sector of the i-th province in the t-period; $Upah_{it}$ is the average hourly wage of the agricultural sector in the i-th province in the t-period; Pop_{it} is the population density of province i in period t; INF_{it} is the inflation of the ith province in the tth period; λ is the spatial error coefficient; β_k is the spatial coefficient of the k-th variable regression; u_i is the i-th region spatial specific effect; ϵ_{it} is the error of the i-th region in the t-period.

3. DISCUSSION

3.4. Overview of Fishermen Exchange Rates

The Fishermen's Exchange Rate (NTN) is one of the benchmarks for the welfare of farmers in Indonesia; the development of fishermen's exchange rates by the province in Indonesia is illustrated in Figure 3.

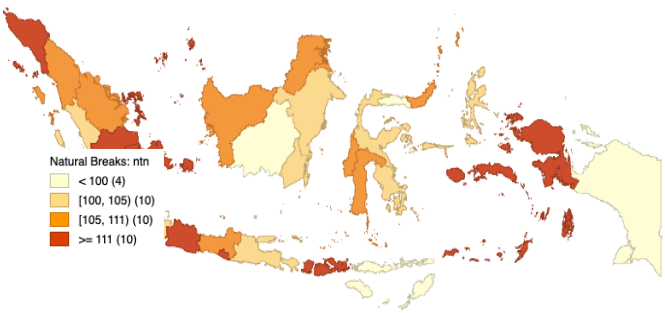

Fig 3. Fishermen Exchange Rate by Province Indonesia in 2022
Source: Badan Pusat Statistik (processed)

The NTN in 2022 shows that there are still four provinces under 100, namely the provinces of East Nusa Tenggara, Central Kalimantan, West Papua, and Gorontalo. The welfare of fishermen in these four provinces is still low. It is important for the central government to pay special attention to these four areas.

Figure 3 also shows ten provinces in the second cluster, namely NTN, at rank intervals of 100 – 105. At this rank, in theory, NTN provinces are above 100 but still below the government's target according to Law No. 23 of 2023 in Article 53 point e, stating that the target for NTN is 107-108. Therefore, those in Clusters 1 and 2 are the government's main targets for implementing policy programs to increase NTN in Indonesia.

3.5. Fishermen Welfare Modeling Analysis

Before further analysis with Spatial Panel modelling, a test is required to determine the presence of spatial dependence on panel data. To test the spatial support, the researcher tested it using Pesaran's test. Pesaran's test examines cross-sectional independence, where the test results using Stata 14 obtained a value of 5.451 with a probability of 0.000. Based on these results, because the likelihood is smaller than 0.05, H0 is rejected, which means there is a spatial dependency on the panel data studied and can be continued in panel data modelling.

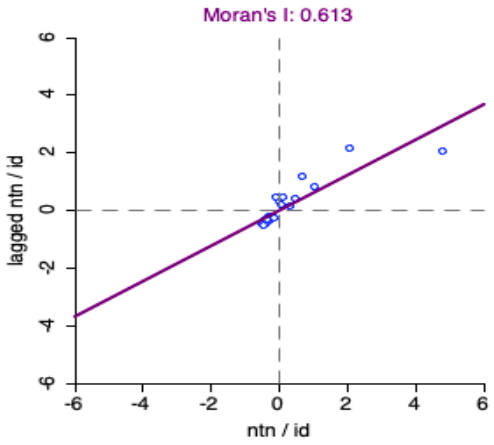

Fig 4. Moran Scatter Plot of Fishermen's Exchange Rates 2022

Next, to conduct a spatial analysis, Moran's I test was performed to determine whether there was a correlation between regions globally. From the test results, with a significance level of five per cent, it can be concluded that there was spatial autocorrelation or an element of neighborliness in the NTN-dependent variable. Based on this test, the value of the autocorrelation Moran has a positive value of 0.613. A

positive Moran's value indicates spatial autocorrelation with grouping patterns in an area(Harmes et al., 2017).

In the next stage, a model-selection test was conducted. In this case, the Hausman test determined the best model between the fixed- and random-effect models. The results of this test show a value of 0.00 <p-value (0.05), so with a significance level of 5 per cent, the fixed effects model is better to use than the random effects model. Then, by comparing the AIC and BIC values, the best model was selected, namely the Spatial Durbin Model (SDM) model with AIC values of 405.2145 and BIC 416.7141, which had the smallest value(Trisila, 2011; Yu Edward et al., 2019).

Table 1. Spatial Autocorrelation Test Variable Farmer Exchange Rates

Spatial Weight Matrix	Moran's I	
	I	p-value*
2020	0.598	0.0023
2021	0.674	0.0011
2022	0.613	0.0018

Notes: *) Significant at $\alpha = 5\%$

After the model is formed, it is necessary to test the classical assumptions to determine whether the constructed model can be used and included in a reliable model to explain the dependent variable. Based on the Kolmogorov-Smirnov test, the statistical value of the normality test was obtained with a p-value of 0.0843. Thus, the residual model followed a normal distribution. A multicollinearity test was carried out by examining the variance inflation factor (VIF) value. If the VIF value was less than 10, there was no multicollinearity.

Based on the test results, the VIF value of each independent variable was less than ten, so multicollinearity did not occur. The heteroscedastic Glejser test was used.

From the test, it was found that the independent variables were not significant, with values greater than 5 per cent. Thus, the assumptions were met and the model formed could be used.

Based on the results of calculations and testing of the spatial interaction of panel data and model testing that has been carried out, the Spatial Durbin Model is obtained with the tabulation summary results as follows:

Table 2. Estimation Results of Fishermen's Welfare Spatial Panel Durbin Modeling

Variabel	Coefficient	Standar Error	Z	P-Value
IPM	9.489646	4.838838	1.96	0.049*
TkP	0.1422883	0.1960701	0.73	0.468
lnUpah	0.0589115	6.893126	0.01	0.476
Pop	-0.6118395	1.292111	-0.47	0.636
Inf	-0.2919552	0.3024707	-4.97	0.000*
Constanta	3.866281	0.5789208	6.68	0.000*
Spasial (Rho)	0.2735384	0.0675476	4.05	0.000*
R-Square	0.8918			

Notes: *) Significant at $\alpha = 5\%$

In the form of a spatial panel model equation, using the Spatial Durbin Model (SDM) approach, it can be written as follows:

$$\widehat{NTN_{it}} = 3{,}866281 + 9{,}489646 IPM_{it} + 0{,}1422883 TkP_{it} + 0{,}0589115 Upah_{it} - 0{,}6118395 Pop_{it} - 0{,}2919552 INF_{it} + \epsilon_{it}$$

Based on the results of the output table above, it can be seen that the fishermen's welfare model in Indonesia, which considers aspects of spatial dependence, produces better estimates than the conventional fishermen's welfare models (non-spatial models). This is shown from the Spatial Rho results, which show the rejection of H_0 with H_0: Non-Spatial Model for spatial models that use a spatial weight matrix based on contiguity, and for spatial models that use a spatial weight matrix based on distance. This shows that spatial dependence is essential in explaining the level of fishermen's welfare using the provincial fisherman exchange rate approach in Indonesia. This means that reliance on social neighborliness among provinces in Indonesia significantly influences the value of NTN in neighboring provinces in Indonesia. Increasing bilateral relations and inter-regional trade, as well as inter-provincial economic relations, are major priorities for improving the welfare of fishermen in Indonesia. The government should improve the equitable distribution of development between regions and maximize each province according to its potential and geographical conditions to enhance the welfare of the community, especially fishermen,

because there are still differences in NTN development between regions. This increase can be supported by infrastructure, especially in coastal areas that connect parts, accompanied by creating jobs in regions with low wage levels to increase purchasing power.

Based on the R-Square or termination coefficient of 89.18 per cent, this means that the diversity of fishermen's Exchange Rates (NTN) in provinces in Indonesia can be explained by the variables of human capital (IPM), agricultural workforce, average daily wages, population density, and inflation. The table above also shows the partial relationship between the research variables, where the five variables examined for the Human Development Index (IPM) and inflation (INF) have a significant relationship. When examined as an important variable, HDI has a positive and meaningful connection to the fishermen's Exchange Rate, which was recorded at 9.489646. This means that an increase in HDI by one point will encourage growth in NTN by 9.489646 points in Indonesia. Increasing the HDI in a region will undoubtedly increase productivity, impact regional output, and promote prosperity. In line with what was conveyed byTrianggara (2016), the importance of human development as a measure of overall development performance, where the dimensions of development are formed through a three-dimensional approach, namely, age, health, knowledge, and a decent livelihood. Similar to the results of Rahaman (2022) this research, the quality of fishermen's education needs to be addressed to target and improve the work lifestyle of fishermen, which will undoubtedly encourage the welfare of fishermen in Indonesia. Therefore, an increase in policy programs to push the HDI indicator is considered significant in increasing the value of NTN for better fisherman welfare. This also aligns with Baihaqi (2017) dan Savitri (2017) research where increasing human capital or HDI can reduce poverty levels in an area.

The human capital dimension, or the human development index, is the basic foundation for improving welfare. Improvements in the three dimensions that make up the HDI, such as longevity and healthy living, increased knowledge, and living standards, deserve the government's mandatory attention to improve people's welfare(Zulgani et al., 2022). Enhancing fishermen's welfare through HDI is a strategic breakthrough for provincial and central governments. An increase in the HDI in each province will affect the HDI in the neighboring provinces. This is in line with the results of Sartibi (2023) this study, where an increase in human capital or HDI has a spatial correlation, which means that an increase in the HDI of a province will have direct or indirect impacts on its neighboring provinces. As an example, increasing knowledge of the use of information technology by fishermen in an area will encourage neighboring regions to adopt similar technology if it significantly impacts their welfare.

There needs to be a central and regional government policy in the form of job training programs and quality improvement of human capital to improve the quality of human resources from fishermen in each region. Various programs to foster and strengthen fishermen's infrastructure support, both in terms of information technology and innovation in increasing fishermen's output, will significantly impact the welfare of fishermen in Indonesia. Investment in capital and knowledge related to information technology use certainly significantly impacts HDI(Suprapto et al., 2022). Raising human capital is a fundamental investment in improving people's welfare, starting from investment programs from both the regions and the central government towards HDI to priority programs that need to be implemented(Jaroslav Gonos et al., 2023; Schamberger et al., 2023; SM Hassan, 2022).

The results of the Durbin spatial panel modelling also show that price-level growth or inflation (INF) has a negative impact on NTN. This means that an increase in prices or inflation of 1 per cent will reduce the welfare level of farmers through NTN of 0.2919552 points. The welfare of fishermen undoubtedly decreases if there is an increase in the price of consumer goods (inflation). It has been proven that the rise in the inflation rate in various countries, both related to various socio-economic issues and price instability, has been proven to increase the poverty level in multiple countries. A price increase or inflation is a difficult blow for vulnerable residents around the poverty line(M Buheji, 2022). Meanwhile, an increase in welfare will always be achieved if prices decrease by more than or equal to two per cent. The more significant the decline in the price of consumer goods and the stronger the value of the rupiah, the further the welfare of fishermen will improve(Yunianto et al., 2015). Inflation control is a

critical policy of provincial governments in Indonesia to enhance the welfare of its population, especially in fishing communities. Reasonable price levels for the consumption or production of goods will undoubtedly increase the community's purchasing power, especially among Indonesian fishermen (Kasem et al., 2022). To meet basic needs, clothing and food will be more affordable for fishermen and for obtaining production factors. Therefore, the policies of the central and regional governments to support inflation control in their regions are a fixed price to increase the welfare of the community, especially fishermen.

The inflation control program must be continuously encouraged by central and regional governments to maintain the purchasing power of people, especially fishermen. A decrease in consumer prices in an area will improve the quality of life of the people in that region. Therefore, a holistic framework is needed to mitigate the impact of the dangers of inflation on people experiencing poverty (M Buheji, 2022). Controlling inflation is important because it also affects regional income inequality (Zandi et al., 2022). Controlling inflation through monetary policies, such as controlling interest rates and the amount of money circulating in the community, is also the government's choice to maintain the purchasing power of people, especially fishermen (Flaccadoro & Landi, 2022).

Interesting findings from this study include the fact that regional factors cannot be ignored in policymaking by the Indonesian government to improve the welfare of fishermen in Indonesia. It has been proven that a model of fishermen's welfare in Indonesia that considers the aspect of spatial dependence produces better estimates than the conventional fishermen's welfare model. Another interesting finding is that quality of human life and price level control are important factors that must be considered by the Indonesian government to improve the welfare of fishermen in Indonesia. The quality of human life represented by the human development index (HDI) variable can be derived through various policies in the fields of education, health, and increasing community income in the region. Furthermore, controlling price levels is also important where the role of the government is to maintain price stability so that the purchasing power of the fishing community can be maintained and the supply of various types of raw materials and consumption goods is available in every region in Indonesia.

4. Conclusions

Based on the results of the research and discussion of the above analysis, the following conclusions can be drawn:

1. Because the fishermen's Exchange Rate (NTN) is clustered and there is spatial dependence between regions, the most appropriate modeling to use is panel spatial modeling. Based on the results of the model test, the best model was found, namely the panel spatial model with the Spatial Durbin Model (SDM) approach, which is proven by the smallest AIC and BIC values.
2. From the model analysis, it was found that the variables that have a significant effect on the welfare of fishermen through the fishermen's Exchange Rate (NTN) level variable in provinces in Indonesia include the Human Development Index (HDI) and Price Increase (HDI).
3. Then, for the level of employment opportunities in the agricultural sector (TkP), Population Density (Pop) and Average Wage Level (lnWage) do not have a significant effect on the welfare of fishermen or NTN.

Based on these conclusions, it is interesting to find that to improve the welfare of farmers in Indonesia, a policy or program is needed to improve the quality of human resources, especially fishermen in Indonesia. This can be achieved by improving various government programs, such as improving the quality of life, access to education, and increasing income, as a basis for encouraging improvements in the quality of human capital. In addition, price control programs or inflation control in these regions are considered significant in maintaining the purchasing power of the community, especially fishermen in Indonesia. Therefore, the neighborhood relationship of the exchange rate of fishermen between regions is quite strong, which is a challenge for local and central governments to implement regional development evenly and sustainably in coastal areas to improve the welfare of fishermen in Indonesia.

Declarations

Availability of data and materials

The datasets used and analyzed during the current study are available from the author upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

IH: conceptualizing the idea and writing; LYM: data analysis and writing; KS: handled the literature section; IH: responsible for proofreading and manuscript editing. All authors have read and approved the final manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this manuscript. In addition, ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies, have been completely observed by the authors.

Acknowledgments

The authors are grateful to my colleague, Ade Paranata PhD (cand) at the University of Pécs, Hungary, for his correction.

References

[1] Alpiani, A., Nur, A., Massiseng, A., & Ummung, A. (2022). The Exchange Rate of Bagan Rambo Fishermen in Barru District. Barru Regency, South Sulawesi. *International Journal of Applied Bioloy*, *6*(1), 104–1012.

[2] Anselin, L. (1988). Model Validation in Spatial Econometrics: A Review and Evaluation of Alternative Approaches. *International Regional Science Review*, *11*(3), 279–316. https://doi.org/10.1177/016001768801100307

[3] Baihaqi, A., Publicuho, P. P.-J., & 2020, undefined. (n.d.). Analisis dampak pengangguran, Indeks Pembangunan Manusia, zakat dan PDRB terhadap kemiskinan di Provinsi Aceh. *Core.Ac.Uk*, *3*(2), 177–192. https://doi.org/10.35817/jpu.v3i2.12272

[4] Bathe, P., Bathe, P. N., Kale, G. B., & Tayade, S. A. (2022). Adaptation of Coastal Fishermen in Pacitan Regency Due to Climate Change Through the Sustainable Livelihood Framework Approach. *International Journal of Economics, Business and Management Research*, *6*(7), 206–223.

[5] De Siano, R., & Canale, R. R. (2024). The role of tourism in European regions' economic recovery: A spatial perspective. *Tourism Economics*. https://doi.org/10.1177/13548166241248679

[6] Elhorst, J. P. (2014). *Spatial Panel Data Models* (pp. 37–93). https://doi.org/10.1007/978-3-642-40340-8_3

[7] Flaccadoro, M., & Landi, V. (2022). Foreign monetary policy and domestic inflation in emerging markets. *Bank of Italy, Directorate General for Economics, Statistics and Research*. https://doi.org/10.2139/ssrn.4109533

[8] Fujita, M., Krugman, P., & Venables, A. (2001). *The spatial economy: Cities, regions, and international trade*.

[9] Harmes, H., Juanda, B., … E. R.-… P. W., & 2017, undefined. (n.d.). Pemetaan efek spasial pada data kemiskinan Kota Bengkulu. *Jurnal.Ipb.Ac.Id*, *2017*(2), 192–201.

[10] Jaroslav Gonos, Anna Tomkova, Katarina culkova, & Julius Lisuch. (2023). Influence of Human Development Index to the State Economy in V4 Region. *Montenegrin Journal of Economics*, *19*(1).

[11] Kasem J, & Al-Gasaymeh A. (2022). a Cointegration Analysis for the Validity of Purchasing Power Parity: Evidence from Middle East Countries. *International Journal of Technology, Innovation and Management*, *2*(1), 54–67. https://doi.org/10.54489/ijtim.v2i1.60

[12] Kembar, M., Budhi, S., Nyoman, N., Suasih, R., Putu, N., & Lestari, N. E. (2022). Improving The Welfare of Fishermen Entrepreneurs In New Normal Era With Inclusive Financing Model Through Village. *Managementjournal. Usamv. Ro*, *22*, 15. https://managementjournal.usamv.ro/pdf/vol.22_4/Art14.pdf

[13] LeSage. (1999). The theory and practice of spatial econometrics. *University of Toledo*.

[14] Long, W., Chen, J., Yuan, Y., Xu, G., Shen, N., Nie, Z., Li, H., Zhang, L., Gong, Y., He, Y., Ma, X., Zhang, H., Zhu, J., Duan, J., & Xu, P. (2022). Valuation of Ecosystem Services for the Sustainable Development of Hani Terraces: A Rice–Fish–Duck Integrated Farming Model. *Mdpi.Com*. https://doi.org/10.3390/ijerph19148549

[15] M Buheji. (2022). Impact of post-pandemic inflation on global POVERTY–A holistic perspective.

Researchgate.Net; International Journla of Management, *13*(5), 11–23. https://doi.org/10.34218/IJM.13.5.2022.002

[16] Nan, S., & Luo, X. (2023). *Assessing the Role of the Digital Economy on Carbon Emissions: New Evidence Based on the Spatial Durbin Model*. https://doi.org/10.36689/uhk/hed/2023-01-046

[17] Radjab, M., Munizu, M., School, A. M.-J. of P., & 2022, undefined. (n.d.). Local Labor Market Conditions and The Jobless Poor: Indonesian Social Policy Employment Strategy. *Journalppw.Com*, *2022*(5), 2971–2987. Retrieved May 31, 2023, from https://www.journalppw.com/index.php/jpsp/article/view/6594

[18] Rafiee, E., Shabani, Z. D., & Hadian, E. (2024). Driving factors on unemployment in Iran's provinces: Do temporal and spatial dynamics matter? *Regional Science Policy and Practice*, *16*(2). https://doi.org/10.1111/RSP3.12715

[19] Rahaman, S. N., Pal, A., Samanta, S., Banerjee, J., Das, S., Mukhopadhyay, R., Kumar Dash, S., & Ali, K. M. (2022). Evaluation Of Socio-Economic Status And Demographic Characteristics Of Fishermen At Coastal Areas Of West Bengal, India. *IJFANS International Journal Of Food and Nutritional Sciences*, *11*(8). https://www.ijfans.org/uploads/paper/b680e30cb05fb0dcc1135fe4b2db3e44.pdf

[20] Sartibi, A., Tohidfam, M., Ardestani, A., & Amini, A. (2023). The Position of Good Governance in Iran from the Perspective of Human Development Indicators during the Years 2000-2010. *International Journal of Political Science*, *12*. https://doi.org/10.3390/ijerph20010818

[21] Savitri, N. (2017). Pemodelan Indeks Pembangunan Manusia (Ipm) Kabupaten/Kota Provinsi Jawa Timur Tahun 2012-2015 Menggunakan Regresi Panel Spasial. *Jurnal Sosial Ekonomi*.

[22] Schamberger, T., Schuberth, F., & Henseler, J. (2023). Confirmatory composite analysis in human development research. *International Journal of Behavioral Development*, *47*(1), 89–100. https://doi.org/10.1177/01650254221117506

[23] Shen Weiteng, Ge Haoran, & Bao Junyao. (2023). Green total factor productivity growth and its driving forces in China's fisheries sector. *Frontiers in Sustainable Food Systems*, *7*. https://doi.org/10.3389/FSUFS.2023.1281366/FULL

[24] SM Hassan. (2022). Historical Evolution and Calculation of the Human Development Index. *Daha International University, Academic Journal*. https://diuaj.com/index.php/pub/article/view/17

[25] Suprapto, H., Sumaryoto, & Sugiyanto Saleh. (2022). The Effect Of Investment On Economic Growth And Human Development Index And Community Welfare (Case Study In Bekasi Regency). *International Journal of Economics, Business and Accounting Research*, *6*, 195–205. https://jurnal.stie-aas.ac.id/index.php/IJEBAR/article/view/4705

[26] Todaro dan Smith. (2009). *Economic Development*. University of California.

[27] Trianggara, N., Rahmawati, R., & Yasin, H. (2016). Pemodelan Indeks Pembangunan Manusia Menggunakan Spatial Panel Fixed Effect (Studi Kasus: Indeks Pembangunan Manusia Propinsi Jawa Tengah 2008-2013). *Jurnal Gaussian*, *5*(1), 173–182. http://ejournal-s1.undip.ac.id/index.php/gaussian

[28] Trisila, M. (2011). *Analisis data panel spasial dengan General Spatial Models (GSM)*. http://repository.ub.ac.id/id/eprint/152766

[29] V Tselios. (2009). Growth and convergence in income per capita and income inequality in the regions of the EU. *Taylor & Francis*. https://www.tandfonline.com/doi/abs/10.1080/17421770903114711

[30] Yapanto, L., & 2022, undefined. (2022). Analysis of Income and Impact on the Welfare of Fisherman's Household Boalemo District. *European Journal Of Business*, *2*(11), 2795–9228. http://www.inovatus.es/index.php/ejbsos/article/view/1477

[31] Yu Edward, Sharma, B. P., Koç, A. A., Yu, T. E., Kıymaz, T., & Sharma, B. P. (2019). Effects of government supports and credits on Turkish agriculture: A spatial panel analysis. *Journal of Agribusiness in Developing and Emerging Economies*, *6*, 391–401. https://doi.org/10.1108/JADEE-11-2018-0164

[32] Yu, J., Jong, R. De, Econometrics, L. L.-J. of, & 2008, undefined. (2008). Quasi-maximum likelihood estimators for spatial dynamic panel data with fixed effects when both n and T are large. *Elsevier*, *146*, 118–134. https://doi.org/10.1016/j.jeconom.2008.08.002

[33] Yunianto, W., Sumertajaya, I., & Wibowo, S. (2015). Simultaneous Equations Modelling Using 2sls And 3sls Methods For Fishermen Term Of Trade Of Indonesia. *Academia.Edu*.

[34] Zandi, G., Rehan, R., Muhammad, Q., Hye, A., Mubeen, S., & Abbas, S. (2022). Do Corruption, Inflation and Unemployment Influence the Income Inequality of Developing Asian Countries? *International Journal of Applied Economics, Finance and Accounting*, *14*(2), 118–128. https://doi.org/10.33094/ijaefa.v14i2.688

[35] Zhong, H., Zhang, J., & Song, W. (2023). The relationship between rural information consumption and regional economic development with spatial Durbin model—A case study of Zhejiang, China. *PLoS ONE*, *18*(2 February). https://doi.org/10.1371/JOURNAL.PONE.0281405

[36] Zulgani, B., Zevaya, F., Yuriade Mulana, L., & Rhogib Asfahani, F. (2022). Simultaneous Modeling Analysis of Poverty Panel Data in Jambi Province from 2011 to 2019. *Resmilitaris. Net ; Social Science Journal*, *12*(4), 1008–1020. https://resmilitaris.net/menu-script/index.php/resmilitaris/article/view/1919

参考文:

[1] Alpiani，A.，Nur，A.，Massiseng，A.，＆Ummung，A.（2022）。 巴鲁区蒲甘兰博渔民的汇率。 巴鲁摄政,南苏拉威西岛. 国际应用 Bioloy 杂志，6（1），104-1012。

[2] Anselin，L.（1988）。 空间计量经济学模型验证：替代方法的回顾和评估。 国际区域科学评论，11（3），279-316。 https://doi.org/10.1177/016001768801100307

[3] Baihaqi,A.,Publicuho,P.P.-J.,&2020,undefined.（n.d.）。 Analisis dampak pengangguran，Indeks Pembangunan Manusia，zakat dan PDRB terhadap kemiskinan di Provinsi Aceh。 Core.Ac.Uk，3（2），177-192。 https://doi.org/10.35817/jpu.v3i2.12272

[4] Bathe，P.，Bathe，P.N.，Kale，G.B.，＆Tayade，S.A.（2022）。 通过可持续生计框架方法适应 Pacitan Regency 的沿海渔民应对气候变化。 国际经济学，商业和管理研究杂志，6（7），206-223。

[5] De Siano，R.，＆Canale，R.R.（2024）。 旅游业在欧洲地区经济复苏中的作用：空间视角。 旅游经济学。 https://doi.org/10.1177/13548166241248679

[6] Elhorst，J.P.（2014）。 空间面板数据模型（第37-93 页）。 https://doi.org/10.1007/978-3-642-40340-8_3

[7] Flaccadoro，M.，＆Landi，V.（2022）。 新兴市场的外国货币政策和国内通胀。 意大利银行，经济、统计和研究总局。 https://doi.org/10.2139/ssrn.4109533

[8] Fujita，M.，Krugman，P.，＆Venables，A.（2001）。 空间经济：城市、地区和国际贸易。

[9] Harmes，H.，Juanda，B.，...E.R.-...P.W.，＆2017，未定义。（n.d.）。 Pemetaan efek spasial pada 数据 kemiskinan Kota Bengkulu. Jurnal.Ipb.Ac.Id，2017（2），192-201。

[10] Jaroslav Gonos，Anna Tomkova，Katarina culkova 和 Julius Lisuch。 (2023). 人类发展指数对 V4 地区国家经济的影响。 黑山经济学杂志，19（1）

[11] Kasem J，＆Al-Gasaymeh A.（2022）。 购买力平价有效性的协整分析：中东国家的证据。 国际技术，创新与管理杂志，2（1），54-67。 https://doi.org/10.54489/ijtim.v2i1.60

[12] Kembar，M.，Budhi，S.，Nyoman，N.，Suasih，R.，Putu，N.，＆Lestari，N.E.（2022）。 以村村普惠融资模式改善新常态下渔民企业家的福利。 Managementjournal.Usamv.Ro，22，15. https://managementjournal.usamv.ro/pdf/vol.22_4/Art14.pdf

[13] LeSage。 (1999). 空间计量经济学的理论与实践。 托莱多大学

[14] Long,W.,Chen,J.,Yuan,Y.,Xu,G.,Shen,N.,Nie,Z.,Li,H.,Zhang,L.,Gong,Y.,He,Y.,Ma,X.,Zhang,H.,Zhu,J.,Duan,J.,&Xu,P.(2022). 哈尼梯田可持续发展生态系统服务评估：稻鱼鸭综合养殖模式。 Mdpi.Com...https://doi.org/10.3390/ijerph19148549

[15] M 布和吉. (2022). 大流行后通货膨胀对全球贫困的影响--一个整体的观点. Researchgate.Net;国际管理学杂志，13（5），11-23。 https://doi.org/10.34218/IJM.13.5.2022.002

[16] Nan，S.，＆Luo，X.（2023）。 评估数字经济对碳排放的作用：基于空间德宾模型的新证据。 https://doi.org/10.36689/uhk/hed/2023-01-046

[17] Radjab，M.，Munizu，M.，School，A.M.-J.of P.，＆2022，undefined。（n.d.）。 当地劳动力市场条件和失业穷人：印度尼西亚社会政策就业战略。 Journalppw.Com，2022（5），2971-2987。 检索到 2023 年 5 月 31 日，从 https://www.journalppw.com/index.php/jpsp/article/view/6594

[18] Rafiee，E.，Shabani，Z.D.，＆Hadian，E.（2024）。 伊朗各省失业的驱动因素：时空动态重要吗？ 区域科学政策与实践，16（2）。 https://doi.org/10.1111/RSP3.12715

[19] Rahaman，S.N.，Pal，A.，Samanta，S.，Banerjee，J.，Das，S.，Mukhopadhyay，R.，Kumar Dash，S.，＆Ali，K.M.（2022）。 评估印度西孟加拉邦沿海地区渔民的社会经济状况和人口特征。 IJFANS 国际食品和营养科学杂志，11（8） https://www.ijfans.org/uploads/paper/b680e30cb05fb0dcc1135fe4b2db3e44.pdf

[20] Sartibi，A.，Tohidfam，M.，Ardestani，A.，＆Amini，A.（2023）。从2000-2010年人类发展指标的角度看，伊朗的善政地位。国际政治学杂志，12。https://doi.org/10.3390/ijerph20010818
[21] Savitri，N.（2017）。Pemodelan Indeks Pembangunan Manusia(Ipm)Kabupaten/Kota Provinsi Jawa Timur Tahun2012-2015Menggunakan Regrsi Panel Spasial. Jurnal Sosial Ekonomi。
[22] Schamberger，T.，Schuberth，F.，＆Henseler，J.（2023）。人类发展研究中的证实性复合分析。国际行为发展杂志，47（1），89-100。https://doi.org/10.1177/01650254221117506
[23] 沈伟腾、葛浩然、鲍君尧。(2023). 绿色全要素生产率增长及其在中国渔业部门的驱动力。可持续粮食系统的前沿，7。https://doi.org/10.3389/FSUFS.2023.1281366/FULL
[24] SM 哈桑. (2022). 人类发展指数的历史演变和计算．大哈国际大学，学术期刊。https://diuaj.com/index.php/pub/article/view/17
[25] Suprapto，H.，Sumaryoto，＆Sugiyanto Saleh。(2022). 投资对经济增长和人类发展指数和社区福利的影响（Bekasi Regency 的案例研究）。国际经济学，商业和会计研究杂志，6，195-205。https://jurnal.stie-aas.ac.id/index.php/IJEBAR/article/view/4705
[26] 托达罗*丹*史密斯。(2009). 经济发展。加州大学。
[27] Trianggara，N.，Rahmawati，R.，＆Yasin，H.（2016）。Pemodelan Indeks Pembangunan Manusia Menggunakan 空间面板固定效果（Studi Kasus：Indeks Pembangunan Manusia Propinsi Jawa Tengah2008-2013）。Jurnal Gaussian，5（1），173-182。http://ejournal-s1.undip.ac.id/index.php/gaussian
[28] Trisila，M.（2011）。Analisis 数据面板 spasial dengan 通用空间模型（GSM）。http://repository.ub.ac.id/id/eprint/152766
[29] V Tselios. (2009). 欧盟地区人均收入和收入不平等的增长和趋同。泰勒和弗朗西斯。https://www.tandfonline.com/doi/abs/10.1080/17421770903114711
[30] Yapanto，L.，＆2022，未定义。(2022). 收入分析及对渔民家庭福利的影响 Boalemo 区. 欧洲商业杂志，2（11），2795-9228。http://www.inovatus.es/index.php/ejbsos/article/view/1477
[31] Yu Edward，Sharma，B.P.，Koç，A.A.，Yu，T.E.，Kıymaz，T.，＆Sharma，B.P.（2019）。政府支持和信贷对土耳其农业的影响：空间小组分析。发展中和新兴经济体的农业综合企业杂志，6，391-401。https://doi.org/10.1108/JADEE-11-2018-0164
[32] Yu，J.，Jong，R.De，Econometrics，L.L.-J.of，＆2008，undefined。(2008). 当 n 和 T 都很大时，具有固定效应的空间动态面板数据的准最大似然估计量。Elsevier，146，118-134。https://doi.org/10.1016/j.jeconom.2008.08.002
[33] Yunianto，W.，Sumertajaya，I.，＆Wibowo，S.（2015）。使用 2sls 和 3sls 方法对印度尼西亚渔民贸易术语进行联立方程建模。Academia.Edu...
[34] Zandi，G.，Rehan，R.，Muhammad，Q.，Hye，A.，Mubeen，S.，＆Abbas，S.（2022）。腐败、通货膨胀和失业是否会影响亚洲发展中国家的收入不平等？国际应用经济学，金融和会计杂志，14（2），118-128。https://doi.org/10.33094/ijaefa.v14i2.688
[35] Zhong,H.,Zhang,J.,&Song,W.(2023). 以空间德宾模型研究农村信息消费与区域经济发展的关系--以浙江为例。PLoS ONE，18（2 二月）。https://doi.org/10.1371/JOURNAL.PONE.0281405
[36] Zulgani，B.，Zevaya，F.，Yuriade Mulana，L.，＆Rhogib Asfahani，F.（2022）。2011-2019年占碑省贫困面板数据同步建模分析。Resmilitaris.Net；社会科学杂志，12（4），1008-1020。https://resmilitaris.net/menu-script/index.php/resmilitaris/article/view/1919

Word count: 6,995 words, excluding references.

Peer review information:
The reviewer reports submitted in first round: 3 reports
The reviewer reports submitted in 2nd round: 1 report
The revision rounds stages: 2 rounds
Final revised version submitted: January 22, 2025.