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Population vs. Poverty Level in the Future in Indonesia: Holt's Linear Trend Method

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ABSTRACT

Poverty is one of the major issues in the field of economics and a serious focus for finding effective solutions. Population size is also a key factor that can influence the poverty rate. This research aims to evaluate the conditions of poverty and the population of Indonesia in the next five years, from 2023 to 2027. Forecasting methods are used, specifically Exponential Smoothing and Holt's method, due to the presence of trends in the data. With the assistance of machine learning technology, particularly using the R, poverty rates and population figures can be projected. The results of the projections indicate that the population of Indonesia is expected to continue increasing each year from 2023 to 2027 or have a positive trend. On the other hand, the poverty rate in Indonesia is projected to decrease each year or have a negative trend during the same period, from 2023 to 2027. This research has important implications for policymakers, as it underscores the significance of data-driven decision-making and informed policy development. The positive demographic trend suggests the necessity of preparing for the associated challenges and requirements of a growing population. Meanwhile, the declining poverty rate presents an opportunity for socio-economic development, necessitating sustained efforts to maintain this trajectory. The study underscores the importance of data analysis and forecasting in addressing critical issues like population growth and poverty reduction, ultimately contributing to the well-being and advancement of Indonesian society.

1. INTRODUCTION

In terms of etymology, the term "poverty" originates from the word "poor," which means lacking wealth and everything necessary. According to the definition provided by the Central Statistics Agency (BPS), poverty refers to the inability of someone to fulfill the minimum basic needs for a decent life [1]. Poverty becomes a fundamental problem because it can hinder the fulfillment of basic living needs and is also a global issue that occurs in many countries [2]. In Indonesia, poverty is one of the biggest problems. This occurs when basic needs such as shelter, food, clothing, education, and health cannot be fulfilled. Poverty is a multidimensional phenomenon that can be studied from both economic and social dimensions.

Poverty can be caused by several factors, such as population growth, high unemployment, low levels of education, limited resources, and limited work opportunities. Additionally, the life expectancy of the population also has a significant influence on the number of people living in poverty [3]. The common problems associated with poverty have a negative impact on society, including an increase in crime, high mortality rates, limited educational opportunities, and high unemployment rates. The problem of poverty cannot be effectively managed and can become a stumbling block in a country [4].

Poverty can be resolved through the utilization of socially-based business initiatives, particularly for mothers receiving PKH benefits. Considering the very high poverty levels, a forecast (prediction) is carried out regarding the poverty level in Indonesia. Projection is a function that predicts or estimates a variable based on known values from other related variables. One of the factors related to poverty discussed in this research is the population. As the population grows, the number of people living in poverty will also increase. The relevant population includes people who live and reside in certain areas. Population growth is influenced by births, deaths, and migration. Due to population growth, the number of workers increases. The number of residents living in poverty is high, and in developing countries, the larger the population, the higher the number of people living in poverty. Economic growth alone does not guarantee individual well-being. However, economic growth, in and of itself, may not directly help the public to escape poverty. High economic growth, even in regions with a large population, does not guarantee that the public will prosper and move out of poverty [5].

Reducing poverty and inequality in income distribution is the core of all development problems and is the main goal of development policies in many countries [6]. Many poverty alleviation programs have been carried out, such as cash assistance for communities "top-down" to empowerment programs in other communities [7].

To address issues related to population and poverty, we can make predictions using time series data. The results of the suitable time series model are expected to minimize the outlier

of the data fluctuation so that the model building will approach the actual data [8].

Forecasting is the activity of using relevant data from the past to predict what will happen in the future and projecting it into the future using a number of mathematical modeling forms [9]. Forecasts can serve as the basis for planning in the short, medium, or long term. Time series analysis is a modeling or predictive technique used in various fields such as engineering, agriculture, medicine, economics, and geophysics. In addition to forecasting, the goal of time series modeling is to study and identify systematic patterns of behavior. Forecasting the population and poverty levels is necessary to understand whether the population and poverty levels will increase or decrease in the coming year. Anticipating poverty levels is essential because poverty can influence various aspects of life and have a detrimental impact on the future of society and the state.

The population refers to individuals living in the geographical area of the Republic of Indonesia for a minimum of 6 months or those who stay for less than 6 months but intend to settle [1]. A resident is formed through demographic processes such as birth, death, and migration. It refers to a group living in a specific area or country for at least one year during data collection or a census. Three main factors influence population growth: the number of births, deaths, and migration or population mobility.

The distribution of the Indonesian population is not even, with nearly 60% of Indonesia's total population living on the islands of Java and Madura. The population is very important in economic activities, including workers, energy experts, entrepreneurs, and those involved in economic activities. Population growth has three contributing factors: fertility, mortality, and migration. Confucius Adioetomo believes there is an ideal relationship between land area and the number of residents, and he suggests a solution to address population density issues by relocating inhabitants to areas with a lower population.

Society consists of all individuals who have lived in the geographical area of the Republic of Indonesia for more than six months or those who have stayed for less than six months but intend to live there [10]. The size of the population is an indicator of economic activity and is an important component. Society is a potential source of power that can be optimally utilized. However, this population can become a "burden" for development if the increase is not accompanied by an adequate enhancement in the quality of the community in the respective area or region. The World Bank defines poverty in terms of purchasing power, which is $1 or $2 per person per day. BPS defines poverty using the poverty line. The poverty line is used to define poverty and refers to the minimum requirements necessary for an individual, which is 2,100 calories per person per day. Minimum requirements include housing, clothing, education, transportation, and basic household needs. Friedman's view is that poverty is defined as the lack of opportunities to gain a social power base. This social power base includes:

1) Production capital, such as land, tools production, space life, health
2) Source funding
3) Organization social and political can utilized for interest together, like cooperatives, parties politics, organizations society
4) Networking Social
5) Knowledge and Skills
6) Useful information throughout life.

There are several indicators used to measure poverty and as theoretical concepts. In measuring poverty, BPS (Central Bureau of Statistics) uses two approaches, namely the HCI-P0 approach and the basic needs approach. In the concept of the ability to fulfill basic needs, poverty is understood as the financial inability to meet basic needs and other needs that are measured from the expenditure side. The poor are the population whose average expenditure per person per month falls below the poverty line. This is temporary, meaning that the Head Count Index represents the percentage below the poverty line. The Head Count Index is used in calculating poverty and is widely used in Indonesia.

In the academic realm, understanding population and poverty trends provides critical insights that can enrich the literature on socio-economic dynamics, helping to identify patterns, causal factors, and impacts of demographic and economic change. This research is also important for testing and developing theories that can explain the complex interactions between population growth and poverty. From a practical perspective, information on these trends is valuable for planning and policy-making. Governments, non-governmental organizations, and international agencies need accurate data to design and implement programs that can reduce poverty and manage population growth sustainably. Given that Indonesia is one of the most populous countries in the world, challenges such as urbanization, economic inequality, and environmental sustainability are issues that must be addressed with strategies based on in-depth data and analysis. Therefore, studying population and poverty trends is not only important for the development of scientific knowledge but also essential for improving the social and economic welfare of Indonesians in the future.

Prediction is based on all types of designs when applied to an unstable environment. Forecasting is an important and significant part of every decision-making process for every company or organization. Forecasts serve as the basis for long-term planning. In economic activities, forecasts are used for budgeting and cost estimation [11]. Forecasting is also a method for measuring or estimating the future conditions of a business, which can be done quantitatively and qualitatively. It involves predicting future conditions in business by analyzing past data.

Projection is a function that projects or estimates a variable's value based on known values from related variables. There are two types of methods: qualitative and quantitative. The qualitative method relies on intuition without mathematical or statistical approaches. Situations, conditions, and experiences significantly influence the forecasting results. The quantitative method can be divided into two types: causal methods and time series methods [12]. For setting a standard design, preventive action is necessary. Planning is not possible without a reference point. Sales forecasts are needed to determine what products and services will be produced. Predictions can be made both quantitatively and qualitatively. Quantitative measurements use statistical methods, while qualitative measurements are based on opinions. Based on this explanation, prophecy is referred to as forecasting and prediction.

Future predictions are a very important element in the decision-making and retrieval process. The quality of estimations varies depending on the situation and various factors that influence it. While they may not always achieve absolute accuracy, this does not reduce the utility of

forecasting. Forecasting is often used and proves to be very helpful in various situations. An example of applications for forecasting include:

1. Period Short (Short Term) Determine quantity and time than usual nature daily or weekly.
2. Period Medium (Medium Term) Determine basic quantity and time nature monthly or quarter.
3. Long Term (Long Term) Planning usual quantity and time nature annual, 5 years, 10 years, or 20 years.

Exponential smoothing is an effective forecasting technique for predicting medium and long-term periods, especially at the operational level of a company. The foundation of exponential smoothing is mathematical, and it has become a highly practical method, particularly in supply forecasting. Exponential smoothing is a method used to obtain forecasted data for future years from a time series data. It involves a continuous improvement process based on the most recent observations. This method gives higher priority to recent observations in an exponential manner, meaning that when forecasting, the most recent observations are prioritized over older ones. This is done to ensure that any changes or influences on the decision-making process can be addressed.

The main advantage of the exponential smoothing method is that by considering the relative value, it provides a more accurate result than methods based solely on intuition or quantitative systems like the Quantitative System (QS) or the interesting decomposition method. However, in situations where hundreds of forecasts are required, this method may be more suitable.

Forecasting involves estimating the future values of variables of interest using past and current information. Given the complexity of forecasting, this field attracted attention from several researchers [13].

2. METHODOLOGY

This study utilizes secondary data, specifically, the quantitative data on the population and the number of Indonesians living in poverty from 2000 to 2022. The secondary data in this study is a time series that has been processed using R. The research method employed in this study is exponential smoothing or exponential smoothing. The exponential smoothing method places a significant emphasis on continuous improvement based on the most recent observations. This method prioritizes recent observations in an exponential manner, giving more weight to the latest observations when making predictions compared to older ones or observations with different time spans of interest [14]. This approach provides historical information that stands out, resulting in estimations that are more accurate.

Exponential smoothing is a method used to obtain forecasts for data in the upcoming year from a time series dataset [15]. This method involves continuous improvement based on the most recent observations available. Several general methods are used in this category, including the Single Exponential Smoothing method, which is employed for time series data following a stationary model. The principles applied in this study are derived [15].

$$\hat{Y}_{t+1} = \alpha Y_t + (1-\alpha)\hat{Y}_t \quad (1)$$

where,

$\hat{Y}_{t+1}$: value forecast for period next
α : constant smoothing
Y_t : new data or actual value in period t
$\hat{Y}_t$: value long smoothing or average smoothing until period t-1

The data used in this study are derived from the population figures and the numbers of people living in poverty in Indonesia, and these data exhibit trends over time. In this case, exponential smoothing with Holt's method was employed for predictions. Holt's method extends simple exponential smoothing to take into account the data's trend in forecasting. This method involves two equations for smoothing (one for level and one for trend). The study aims to estimate the population and poverty levels until the year 2027. Holt's linear exponential smoothing method is essentially similar to Brown's method, with the difference that Holt does not use multiple smoothing formulas directly. Instead, Holt refines the trend using different parameters than those used in the original series. Holt's Exponential Smoothing prediction is obtained by using two smoothing constants (which fall between 0 and 1) [16].

In forecasting modeling, we need the best model. If the model has been selected, the selection of the best model is based on the AIC, AICC and BIC values. Systematically, the equations for AIC and BIC can be written as follows:

$$AIC = nln\left(\widehat{\sigma_\varepsilon}^2\right) + 2k$$

$$AICC = AIC + \frac{n-k-1}{2k(k+1)}$$

$$BIC = nln\left(\widehat{\sigma_\varepsilon}^2\right) + kln(n)$$

where, n is the number of observations, $\widehat{\sigma_\varepsilon}^2$ is the maximum likelihood estimator of $\widehat{\sigma_\varepsilon}^2$, and k is the number of parameters estimated. The best model is the model that has the smallest value of AIC, AICC and BIC.

Forecasts made using Holt's linear method exhibit a sustainable trend (up or down) indefinitely into the future. Empirical findings suggest that this method can lead to high overestimation, especially for longer-term estimates. In light of these findings, introduced parameters in 1985 that "softened" the flat trend from time to time [17]. The combination of smoothed trend methods has proven to be very successful and is possibly the most popular method when individual moment forecasting is required for automated network planning.

The Holt Linear Trend Method was chosen to predict future population and poverty rates because of its strong ability to capture linear trend patterns in historical data. This method is particularly suitable for this study because it can cope with data fluctuations by continuously updating the trend and level estimates. The use of historical data from recent years allows this method to provide more accurate and reliable predictions, helping to identify significant changes in population and poverty rates. By capturing long-term trends, the Holt Linear Trend Method allows researchers and policymakers to make more realistic and informative projections, which is crucial for strategic planning. In addition, the method is relatively simple to implement and interpret, making it more accessible to a wide range of stakeholders who need this data to make high-impact decisions.

The Holt Linear Trend Method not only provides a powerful analytical tool to answer this research question but also provides a solid foundation for data-driven decision-making in an effort to manage population growth and reduce poverty in Indonesia.

The present study discusses Holt's forecasting method or the double exponential smoothing model. The double exponential smoothing model is a reasonable method for in-sample forecasts. However, this method should not be used for long-term forecasts. This method may produce a good forecast in a short lead time only, such as one or two periods ahead [18].

In this study, the Holt Linear Trend Method is used to predict the future population and poverty rate in Indonesia. The steps in data processing and analysis are carried out systematically to ensure accurate and reliable results. First, historical data on population and poverty rates were collected from official sources such as Indonesia's Central Bureau of Statistics (BPS), which provides comprehensive and verified annual data. The time period chosen covers at least the last 20 years to ensure there is sufficient data to detect long-term trends. Secondly, the collected data is then cleaned to address issues such as missing data, inconsistencies, or anomalies. The data is organized in a time series format for each variable (population and poverty rate) so that it is ready for further analysis. Third, the Holt Linear Trend Method is applied to the processed time series data. This procedure involves several steps: estimation of levels and trends from historical data, updating of parameters whenever new data is available using an exponential formula that gives more weight to the most recent data, and prediction of the future using the updated parameters. Fourth, the prediction results are tested for validity by comparing them against the actual data available.

Evaluation is done using error metrics such as Mean Absolute Error (MAE) or Mean Squared Error (MSE) to ensure model accuracy. Fifth, once the predictions are verified, the results are analyzed to understand the implications of the identified trends. These findings can then be used by policymakers to plan appropriate interventions and formulate long-term policies aimed at managing population growth and reducing poverty. By following these steps, this research provides a clear and structured framework for using the Holt Linear Trend Method to predict population and poverty rates in Indonesia and provides a solid foundation for data-driven decision-making.

Holt's model is based on estimating smoothed versions of the level and the trend of the time series. The level plus the trend is then extrapolated forward to obtain the forecast. The formulas governed level and trend are given by Brooks [19].

The selection process for the recommended method is the same (Damped Holts). However, different accuracy measures may sometimes recommend different forecasting methods. Therefore, a decision must be made about which forecasting method is best to use. Since forecasting tasks can vary in various dimensions (forecasting horizon length, test set size, forecasting error size, data frequency, etc.), no single method can be better than others in all forecasting scenarios. From the perspective of forecasting, we need consistent and reliable forecasting, which often requires a balance with existing tasks.

3. RESULTS AND DISCUSSION

This study is essential for understanding the dynamics of population and poverty levels in Indonesia. Raw data collection is a fundamental step in the research process, and in this case, data from the Central Bureau of Statistics (BPS) spanning from 2000 to 2022 has been utilized. The focus of this study has been on two key aspects: the population trends and poverty levels within the country.

The primary objective of this research is to make forecasts for the years 2023-2027. To achieve this, Holt's Exponential Smoothing method has been employed. This method is particularly suitable when dealing with data that exhibits a consistent trend over time. Moreover, the application of machine learning, specifically through the use of R, further enhances the accuracy and efficiency of the forecasting process.

The use of Holt's Exponential Smoothing method in conjunction with machine learning has proven to be a powerful combination for this study. It has enabled the development of forecasts that are essential for informed decision-making, particularly for policymakers, government institutions, and organizations working to address issues related to population growth and poverty reduction in Indonesia.

The research underscores the importance of utilizing advanced techniques and tools to analyze and forecast critical socio-economic factors like population and poverty. These forecasts provide valuable insights for policymakers and aid in the formulation of effective strategies to address the challenges and opportunities associated with Indonesia's changing demographics and socio-economic landscape.

As seen in Figure 1, the population of Indonesia has been steadily increasing from 2000 to 2022. The graph illustrates a consistent upward trend each year. The largest population in Indonesia was recorded in 2022, with a total of 275.8 million people.

As depicted in Figure 2, the poverty level in Indonesia from 2000 to 2022 shows a decreasing trend each year. However, in 2006, there was an increase in the poverty level in Indonesia due to the global economic crisis. Similarly, in 2020, Indonesia experienced an increase in poverty levels caused by the COVID-19 pandemic.

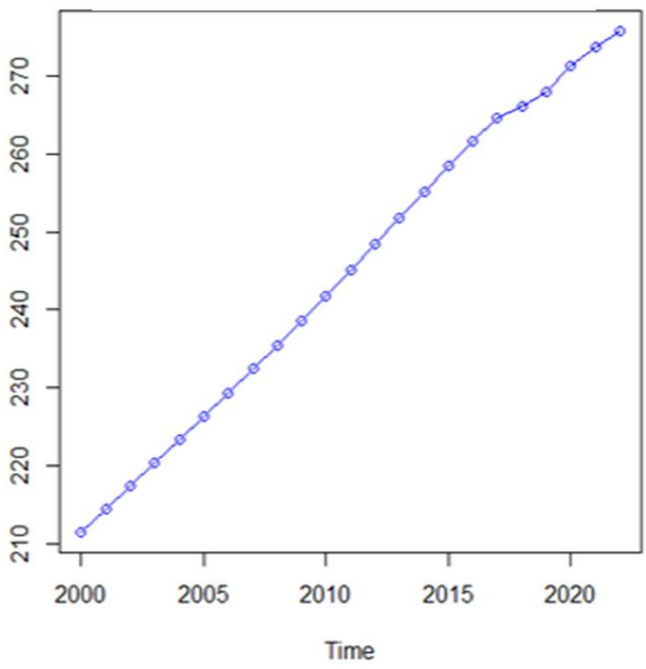

Figure 1. Time series graph of numbers Indonesia's population

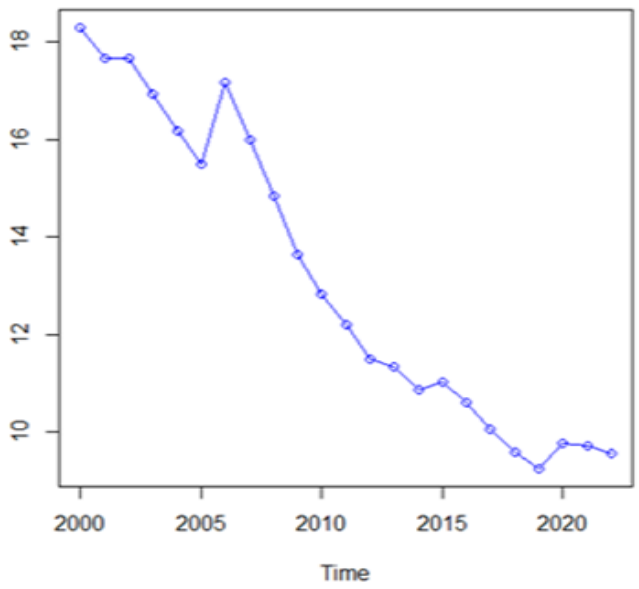

Figure 2. Time series graph of Indonesia's poverty level

In this research, Holt's Exponential Smoothing method will be utilized to predict the population and poverty level in Indonesia until 2027, covering a period of five years ahead. Holt's method is employed for smoothing data that exhibits trends within it [20].

Table 1. Results of Holt's exponential smoothing model number Indonesian population 2023-2027

Smoothing Parameters	
alpha	0.9999
beta	0.3745
Initial States	
l	208.5468
b	2.9565
sigma	0.5168
AIC	47.35651
AICC	50.88592
BIC	53.03398

The obtained values for the smoothing parameters from table 1 are as follows: the alpha value is 0.9999, and the beta value is 0.3745. The initial states have the following values: the l value is 208.5468, the b value is 2.9565, and the sigma value is 0.5168. Additionally, in the table above, you can find information about the Information Criteria (IC) in Holt's Exponential Smoothing model. The AIC value is 47.35651, the AICC value is 50.88592, and the BIC value is 53.03398. These values meet the fit criteria in Holt's Exponential Smoothing model and are considered suitable for use.

The use of information criteria such as AIC, AICC, and BIC is a common way to evaluate how well a forecasting model fits the observed data. Lower values of the information criteria indicate a better fit of the model to the data. Therefore, values that meet the fit criteria suggest that Holt's Exponential Smoothing model is a good model for forecasting the population and poverty levels in Indonesia from 2023 to 2027.

A good model will produce forecasts that closely resemble the actual data, and the use of information criteria helps ensure that the model meets the quality standards in forecasting analysis.

In Table 2 and Figure 3, it is evident that the forecasting values using Holt's method for the Indonesian population from 2023 to 2027 indicate an increasing trend each year. In Holt's Method forecasting graph, it can be observed that there are two methods used: Holt's method and Damped Holt's method. In Holt's Method, the chart shows a less steep increase, while in Damped Holt's method, the chart exhibits a steeper incline. This suggests that Damped Holt's method introduces an element that results in a steeper slope compared to Holt's method.

Table 2. Forecasting value amount Indonesian population in 2023-2027

Year	Amount Indonesian Population (Million People)
2023	278.1310
2024	280.4919
2025	282.8528
2026	285.2137
2027	287.5746

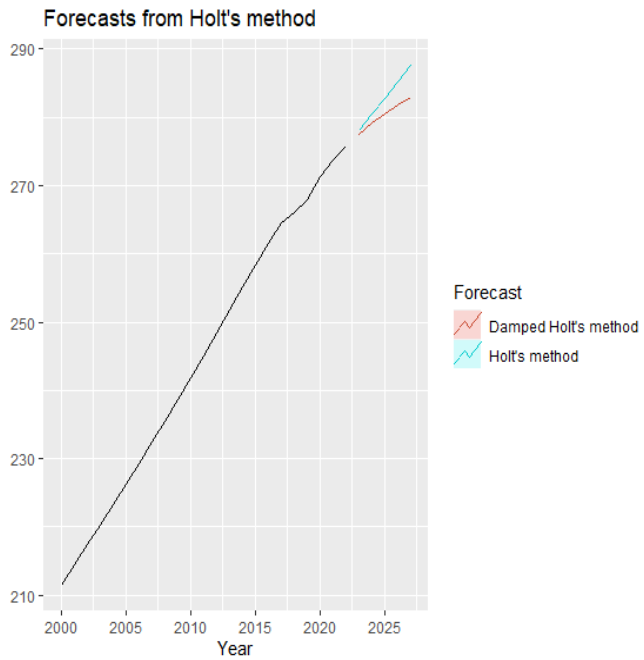

Figure 3. Number forecasts graph the Indonesian population from Holt's method

In the next five years, by 2027, Indonesia is projected to have a population of approximately 287.5746 million people. This number is significantly large, and Indonesia is entering a demographic bonus status, which can bring positive impacts to the country if effectively utilized. However, if the demographic bonus is not harnessed properly, it can have adverse effects on Indonesia.

The values of the smoothing parameters obtained from Table 3 are as follows: the alpha value is 0.9883, and the beta value is 0.1111. The initial states have the following values: the l value is 18.6923, the b value is -0.3991, and the sigma value is 0.665. Additionally, in Table 3, you can find information about the Information Criteria (IC) in Holt's Exponential Smoothing model. The AIC value is 58.95683, the AICC value is 62.48624, and the BIC value is 64.63430. These values meet the fit criteria in Holt's Exponential Smoothing model and are considered suitable for use.

Table 3. Results of Holt's exponential smoothing model of poverty levels in Indonesia 2023-2027

Smoothing Parameters	
alpha	0.9883
beta	0.1111
Initial States	
l	18.6923
b	-0.3991
sigma	0.665
AIC	58.95683
AICC	62.48624
BIC	64.63430

The use of information criteria such as AIC, AICC, and BIC is a common practice in evaluating the goodness of fit for forecasting models. Lower values of the information criteria indicate a better fit of the model to the data. In this case, the values suggest that Holt's Exponential Smoothing model is a good fit for forecasting the population and poverty levels in Indonesia from 2023 to 2027. A well-fitting model is important in forecasting to ensure that the forecasts generated are reliable and accurate, and the information criteria help in assessing the model's quality in this regard.

Table 4. Forecasting value of Indonesia's poverty level for 2023-2027

Year	Poverty Level Indonesia (Percent)
2023	9.167810
2024	8.768696
2025	8.369581
2026	7.970467
2027	7.571353

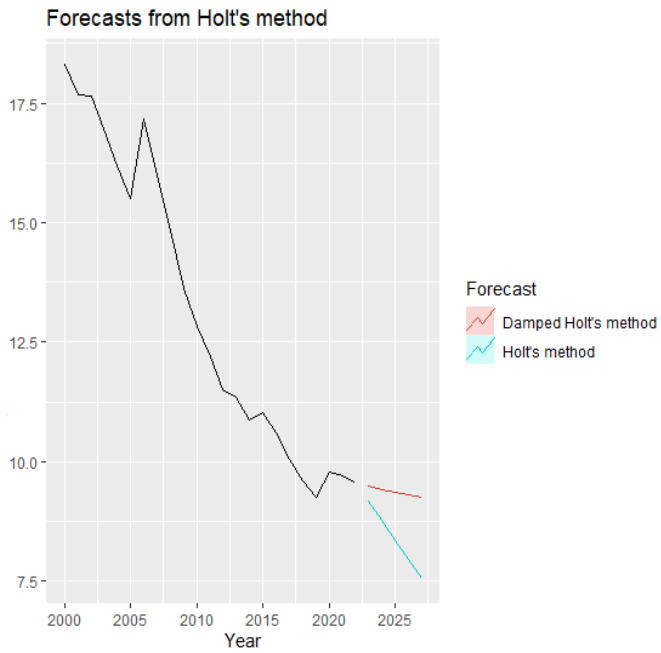

Figure 4. Forecasts of Indonesia's poverty level from Holt's method

Table 4 and Figure 4 above present the forecasted values for Indonesian poverty using Holt's level method for the period from 2023 to 2027. These forecasts indicate a consistent downward trend, with a decrease in the poverty level each year. This trend is essential because it suggests a positive trajectory in terms of reducing poverty in Indonesia. The graph showcases two methods, Holt's method and Damped Holt's method, used for these forecasts. The key difference between the two methods lies in the slope of the trend line. In Holt's Method, the decline is less steep, suggesting a gradual reduction in poverty. In contrast, Damped Holt's method displays a steeper decline, indicating a faster reduction in poverty levels. The forecasted poverty rate for 2027 is estimated to be at 7.57%. This figure is relatively positive for Indonesia, signifying a lower poverty rate. However, it is crucial to emphasize that maintaining this level of poverty reduction is essential. Policies and interventions that have contributed to this positive trend should be continued and possibly enhanced to ensure that poverty in Indonesia continues to decrease.

A declining poverty rate is a significant socio-economic achievement and contributes to an improved standard of living and well-being for the population. It can lead to better access to education, healthcare, and economic opportunities for those previously living in poverty. Therefore, sustaining and even accelerating this positive trend is of paramount importance for the country's development.

The results from applying Holt's Linear Trend Method to data on population and poverty rates in Indonesia provide important insights directly related to the research question: how will the population and poverty rates in Indonesia change in the future? Predictions show that Indonesia's population is expected to continue to increase, following historical trends with a steady growth rate. This population increase could have major implications on various aspects of social and economic life, including the demand for health services, education, and infrastructure.

On the other hand, poverty rate predictions show a more complex pattern. While there has been a decline in the poverty rate over the past few decades, the model indicates that the rate of decline may be slowing down. This suggests that poverty alleviation efforts require more innovative and sustainable strategies to address the remaining determinants of poverty.

Another important finding is that there is significant regional variation in the pattern of population growth and poverty. Regions with high urbanization rates tend to show faster population growth, while less developed rural areas may face different challenges in terms of poverty alleviation.

Indonesia is the world's fourth most populous country, with a population exceeding 270 million people as of my knowledge cutoff date in 2022. This high population size has significant implications for the country's economic, social, and environmental dynamics, including the poverty rate. Indonesia's large population presents both challenges and opportunities. On one hand, a large labor force can be a source of economic growth and innovation. On the other hand, rapid population growth can strain resources, infrastructure, and public services. Indonesia has been experiencing a demographic dividend, where the working-age population exceeds the dependent population. This has the potential to boost economic growth if the labor force is well-educated, healthy, and productively employed.

Indonesia has made significant progress in reducing poverty over the years. However, poverty remains a critical issue, especially in rural and less developed areas. The poverty rate measures the percentage of the population living below the national poverty line. Poverty is more prevalent in rural areas compared to urban centers. Access to education, healthcare,

and employment opportunities tends to be better in urban areas, contributing to lower poverty rates.

The Indonesian government has implemented various social programs to alleviate poverty, including conditional cash transfers, food assistance, and healthcare subsidies. Efforts to spur economic growth, promote entrepreneurship, and create job opportunities are crucial in addressing poverty. Infrastructure development and investments in human capital are also key components of these efforts.

This study demonstrates the effectiveness of Holt's Linear Trend Method in predicting long-term trends in population and poverty, which is an important contribution to methodology in demographic and economic studies. Second, by emphasizing regional variations in population growth and poverty, this study enriches the existing literature by offering a more nuanced perspective on socio-economic dynamics in Indonesia. Third, the findings on the slowing pace of poverty reduction underscore the need for more innovative and sustainable poverty alleviation strategies, offering new directions for social policy research. Fourth, the use of verified historical data from BPS as the basis for predictions provides a strong foundation for future research to follow a similar data-driven approach. By highlighting these contributions more clearly, this study not only enhances academic understanding of population and poverty trends but also provides a strong empirical basis for policymakers and practitioners to design more effective interventions.

4. CONCLUSIONS

In conclusion, this study utilizes Holt's Exponential Smoothing method to forecast population and poverty levels in Indonesia for the period from 2023 to 2027. The findings suggest that the Indonesian population is expected to increase each year, demonstrating a positive demographic trend for the country. Simultaneously, the forecasted poverty level, also based on Holt's method, shows a consistent annual decrease. These results have been generated with the aid of R and the application of Holt's Exponential Smoothing method, emphasizing the value of data-driven forecasting for informed decision-making.

This study opens up several specific areas for future research. One is further exploration of the factors that influence regional variations in population growth and poverty rates. In-depth studies using qualitative approaches can help identify the underlying causes of these differences, such as access to education, health, and infrastructure. In addition, future research could explore the impact of government policies and intervention programs on population and poverty trends, which could provide insights into the effectiveness of different poverty alleviation strategies.

To improve the current study, several improvements can be made. First, expanding the data coverage by including additional variables such as education level, health access, and employment can provide a more comprehensive picture of the factors affecting population and poverty. Second, the use of more sophisticated forecasting methods such as the Holt Linear Trend Method to see which one provides more accurate predictions. Finally, validating the model by using data from independent sources or conducting a longitudinal study could improve the reliability of the results. By making these improvements, future research can provide deeper insights and more effective solutions to manage population growth and reduce poverty in Indonesia.

These projections have significant implications for policymakers and stakeholders in Indonesia. The expected population growth highlights the importance of planning for the associated needs and challenges that come with a larger population. On the other hand, the declining poverty rate is a positive sign for socio-economic development, but it necessitates ongoing efforts to ensure that this trend continues. The findings emphasize the importance of data analysis and forecasting in addressing critical issues like population growth and poverty reduction, ultimately contributing to the well-being and progress of Indonesian society.

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