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APPLICATION OF THE PRAIS WINSTEN METHOD IN OVERCOMING AUTOCORRELATION ON LIFE EXPECTATION FACTORS

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ABSTRACT

One of the error conditions that are required to be met is the absence of autocorrelation problems. Autocorrelation is a correlation of errors between observations, the existence of an error correlation between observations will cause deviations from the actual statistical value. One of the statistical methods for overcoming autocorrelation is the Prais Winsten method. This study aims to explain the Prais Winsten method in overcoming the problem of autocorrelation on factors that affect the life expectancy of East Java Province in 2018. This research is a secondary data analysis, data obtained from the East Java Province's health profile in 2018 with the dependent variable, namely life expectancy, and independent variables, namely prevalence of diarrhea, clean and healthy living behavior, and mean years of school. The results of this research indicated the finding of autocorrelation problems in the factors that affected the life expectancy of East Java Province in 2018. Improvements with the Prais Winsten method showed that the Durbin Watson value was at the critical point limit, Mean Square Error and coefficient of determination (R2) value was decreasing. This research concludes that the Prais Winsten method can overcome autocorrelation.

Kata kunci:
autokorelasi,
angka harapan hidup,
Prais Winsten

ABSTRAK

Salah satu syarat error yang harus dipenuhi adalah tidak ada permasalahan autokorelasi. Autokorelasi merupakan hubungan atau korelasi error antar anggota observasi, adanya hubungan error antar observasi akan menyebabkan terjadi penyimpangan nilai statistik yang sebenarnya. Salah satu metode statistik dalam mengatasi autokorelasi adalah metode Prais Winsten. Penelitian ini bertujuan untuk menjelaskan metode Prais Winsten dalam mengatasi masalah autokorelasi pada faktor yang memengaruhi Angka Harapan Hidup Provinsi Jawa Timur tahun 2018. Penelitian ini adalah analisis data sekunder dari laporan tahunan berupa profil kesehatan Provinsi Jawa Timur 2018 dengan variabel terikat, yaitu Angka Harapan Hidup dan variabel bebas, yaitu prevalensi diare, perilaku hidup bersih dan sehat, serta rata-rata lama sekolah. Hasil dari penelitian ini menunjukkan bahwa ditemukannya masalah autokorelasi pada faktor yang memengaruhi Angka Harapan Hidup Provinsi Jawa Timur tahun 2018. Perbaikan menggunakan metode Prais Winsten menunjukkan bahwa nilai Durbin Watson berada pada batas titik kritis, nilai koefisien determinasi (R2) yang menjadi turun serta nilai Mean Square Error yang semakin kecil. Kesimpulan dari penelitian ini adalah metode Prais Winsten mampu mengatasi masalah autokorelasi.

INTRODUCTION

The analysis of the regression model contains the assumption that the error must be fulfilled, that is, there is no autocorrelation symptom. The symptom of autocorrelation is the correlation error between observations. The problem of autocorrelation of errors in regression can cause incorrect decision-making due to large errors; therefore, it is necessary to improve it by transforming it to eliminate the problem of autocorrelation of errors in regression. The problem of autocorrelation in linear regression analysis causes the estimation of the parameters of the regression model obtained to be not good because it does not have a minimum variance. The variance value that is not minimum will cause the error to become larger so it will affect the statistical test results. If you continue to use the results of linear regression with autocorrelation problems, it will cause the conclusions drawn to be incorrect (1).

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Autocorrelation that occurs in regression should not be ignored because it can result in the estimation of the standard error and variance of the regression coefficient being too high (overestimated) or too low (underestimated) so that there will be deviations from the true value in the population. Error autocorrelation can be detected using the Durbin-Watson test which is often used to detect error autocorrelation problems because when carrying out a linear regression test, the error value can be known. The basis for decision-making is based on the lower Durbin and upper Durbin limit values which can be adjusted according to the Durbin-Watson table (2).

Prais Winsten is a method that can be used to overcome the problem of autocorrelation *error*. The Prais Winsten method performs a transformation based on consideration of the rho value (ρ) or the error correlation coefficient to overcome autocorrelation and considers the first observation with certain calculations in estimating the regression so that an overall observation of the sample is obtained (3). The advantage of the Prais Winsten method is to get complete data transformation results for all observations. Complete data will minimize errors in statistical analysis. One of the results of the study showed that the Durbin Watson value before correction showed that there were symptoms of autocorrelation and after correction with the Prais Winsten method, there was an increase in the Durbin Watson value so that it could be concluded that the Prais Winsten method could overcome the problem of autocorrelation (4).

The Human Development Index or *Index Perkembangan Manusia* (IPM) is an important measure in determining the success of achieving the development of the quality of human life. Human development indicators are divided into three measures, namely the life expectancy measure which represents life span and health, the second measure is the average length of schooling which represents the level of knowledge, and the third measure is spending per capita which represents a decent standard of living. The measure in the formation of the human development index, especially in the health sector, is life expectancy (5). The level of health is directly proportional to the life expectancy: if the level of health increases, the life expectancy also increases. Conversely, if the level of health is low, life expectancy will also be low.

Life expectancy for East Java Province in 2018 was 70.97 years where this value was at the bottom and still relatively small when compared to other provinces on Java Island such as the Special Capital City Region or *Daerah Khusus Ibukota* (DKI) Jakarta 72.21 years, West Java 72.69 years, Central Java 74.84 years and the Special Region of Yogyakarta or *Daerah Istimewa Yogyakarta* (DIY) 74.84 years (5). This also means that the health status in East Java Province is still low compared to other provinces in Java. The Theorem of Hendrik L. Blum explained that four factors can affect the degree or level of health, including the environment, behavior, medical services, and genetics. Environmental factors affect the degree of health, including the physical and social environment. The prevalence of diarrhea is an example of physical environmental factors that affect health status (6). The results of research in East Java stated that one of the causes that could affect life expectancy was the incidence of diarrhea, this would also have an impact on health status (7).

The increasing health status is also influenced by Clean and Healthy Living Behavior or *Perilaku Hidup Bersih dan Sehat* (PHBS), thus affecting the Life Expectancy Rate. According to one study in Jember districts, it was found that PHBS had an impact on life expectancy in Jember districts (8). The degree of health can be influenced by a person's level of education where the level of education can be measured based on the average length of time in school. The higher average length of time in school can increase life expectancy. The results of other studies in Central Java also state that the length of schooling can affect life expectancy (9).

High or low life expectancy depends on the factors that influence it, so it needs to be analyzed statistically to get a good mathematical model. A good model must meet the assumptions or conditions, namely identical, independent, and normal errors in the regression analysis so that the model can explain factors that can have an impact on East Java's life expectancy. According to data in East Java, some regencies/cities have almost the same or similar life expectancy values, such as in Trenggalek districts 73.35 and Tulungagung 73.34, Situbondo districts 68.73 and Jember 68.74(5). This creates an opportunity for autocorrelation errors to occur in the regression model, so this study aims to explain Prais

Winsten's method of dealing with autocorrelation problems in the analysis of factors that affect life expectancy in East Java Province in 2018.

METHODS

This research was made using secondary data. The data for this study were taken from the East Java Provincial Health Office in the form of the 2018 East Java Health Annual Report and from The Central Bureau of Statistics for East Java province in the form of a 2018 population survey.

The population and research samples are all regencies or cities in East Java Province which consists of 38 regencies or cities. Life expectancy in East Java Province is the dependent variable, while the influencing factors are the prevalence of diarrhea, PHBS, and the average length of schooling, which describes the level of education, as the independent variable which is then analyzed using IBM SPSS software statistics.

Statistical analysis performed multiple linear regression. Testing the assumptions on linear regression errors consists of testing for normality, heteroscedasticity, multicollinearity, and autocorrelation. If it is indicated to contain autocorrelation, then it is continued with repairing the data using the Prais Winsten method and then re-analyzing it until the autocorrelation problem can be solved and a model made.

RESULT

The life expectancy for East Java Province in 2018 is influenced by several factors which will be analyzed statistically. Furthermore, improvements are made if, in the follow-up test in the regression model, there are assumptions that are not fulfilled so that a good model will be obtained.

East Java Province Life Expectancy Figures in 2018

Data for 2018 East Java's life expectancy is 70.97 years. This means that the average length of life for a person to die in East Java is 70.97 years. Table 1 describes the life expectancy for the province of East Java in 2018.

Table 1. East Java Province Life Expectancy

Discticts/City	AHH 2018
Districts Pacitan	71.52
Districts Ponorogo	72.43
Districts Trenggalek	73.35
Districts Tulungagung	73.34
…	…
Batu City	72.37

Several districts/cities in East Java still have life expectancy below 70.97 years, those districts were Bondowoso districts, Probolinggo districts, Pamekasan districts, Sampang districts, Situbondo districts, Jember districts, Lumajang districts, Bangkalan districts, Pasuruan districts, Sumenep districts, Banyuwangi districts and Probolinggo City.

Simultaneous Test (F test)

Simultaneous tests in multiple linear regression were used to detect the independent variables consisting of the prevalence of diarrhea, PHBS, and the average length of time at school which together influence the dependent variable, namely life expectancy. The F-test shows a value of 22,306 with an F table value of 2,882 so Fhit > Ftab produces a statistical value of 0.000. Based on these results, it can be concluded that the prevalence of diarrhea, PHBS, and the average length of time at school have an impact on the life expectancy of East Java in 2018 where the p value is less than alpha (α=0.05).

Partial Test z (T-test)

Partial test with T-test in multiple linear regression functions in knowing the impact of the variable independent of the dependent variable, namely life expectancy with an alpha of 0.05. The results of the T-test showed significance with a statistical value of 0.047 for the diarrhea prevalence variable, 0.011 for the PHBS variable, and an average length of schooling with a value of 0.000. The conclusion from these results is the prevalence of diarrhea, PHBS and the average length of time at school can have an impact on life expectancy with a statistical value of less than 0.05.

Regression Assumption Test

Normality test

Normality test in multiple linear regression is used to test the variance of the residual or error. The normality test aims to examine errors in normally distributed regression models. The Kolmogrov Smirnof normality test was performed. The test results show a significance value of 0.200, meaning that the errors are normally distributed as indicated by the statistical value greater than alpha (α=0.05). The histogram of the normality test for multiple linear regression errors in Figure 1 shows that the errors in the regression model are normally distributed.

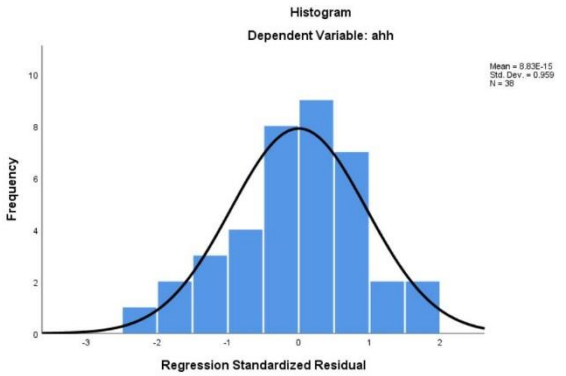

Figure 1. Histogram of Multiple Linear Regression Error Normality Test

Heteroscedasticity Test

Heteroscedasticity testing in multiple linear regression is used to find out whether the residual variance or error is the same or not in all observations. If the errors in the regression model are not the same it will cause the regression model to be incorrect; this can be said to have symptoms of heteroscedasticity so that the model cannot be used.

The heteroscedasticity test that is often used is the Spearman rho test; the statistical test results are said to be significant if the value is greater than alpha (α = 0.05) for the independent variable, the prevalence of diarrhea (p = 0.545), PHBS (p = 0.825) and the average length of school (p=0.918). Based on these results, there are no symptoms of heteroscedasticity between the independent variables.

Multicollinearity Test

The regression model requires a multicollinearity test where this test aims to find out whether there is a strong relationship between the independent variables. The conclusions are based on *Variance Inflation Factor* (VIF) and Tolerance. If the VIF is less than 10 and the tolerance is greater than 0.10, it can be said that there is no multicollinearity problem in the regression model.

The results of the multicollinearity test found that the tolerance value was > 0.1 and VIF < 10 for the three independent variables, so it was concluded that there was no multicollinearity in the three variables to be used.

Table 2. Multicollinearity Test

Model	*Collinearity Statistics*	
	tolerance	**VIF**
Prevalence of diarrhea	0.991	1.009
PHBS	0.989	1,011
The average length of the school	0.982	1.019

Autocorrelation Test

The function of the autocorrelation test is to find out the error relationship between observations; the autocorrelation test in the analytical method can use Durbin Watson values. In decision-making there is no autocorrelation if the value of d is between du and (4-dU) and there is autocorrelation if the value of d < dl.

Calculations from Durbin Watson get a value of 1,107 with observations (n) 38 and the number of independent variables is three (k = 3), where in the Durbin table, the lower Durbin limit is 1,318 and the upper Durbin is 1,656, so based on this it can be concluded that there is an autocorrelation problem.

Prais Winsten method

The Prais Winsten method is a method for dealing with autocorrelation symptoms, based on the Durbin Watson assumption test that there is an autocorrelation problem so it needs to be repaired. The first thing that needs to be done is to determine the magnitude of the error in the regression model based on the estimation of *Ordinary Least Squares* (OLS). The results of calculating the error for each observation are displayed in the following table.

After obtaining the error value in the 1st to 38th observation, a calculation is carried out to obtain the rho value (ρ), the resulting value

(ρ) is 0.462; then the value (ρ) is transformed with the initial data so that it will form new data. The new data will be re-analyzed and tested for autocorrelation to ensure that no signs of autocorrelation occur.

Table 3. Error Value

No	Error Value
1	0.731
2	0.985
3	2.448
…	…
38	0.460

Simultaneous Test after Repair

Simultaneous test results can be seen in the value of the F test. The results of the F test after repairs show a value of 16.295 with an F table value of 2.901 so that Fhit > Ftab and produces a p value of 0.000 less than alpha (α = 0.05) so that it can be interpreted that the model obtained is fit.

Partial Test after Repair

The partial test after the improvement showed that the statistical value of the prevalence of diarrhea variable was 0.078, the PHBS variable was 0.013, and 0.000 for the average length of schooling variable. The conclusion from the partial test after the improvement was that the PHBS variable and length of schooling had an impact on the dependent variable, namely, life expectancy, where the p value < (α=0.05) while the prevalence of diarrhea has no impact on life expectancy where the p value is more than (α=0.05).

Autocorrelation Test after Repair

The results of the autocorrelation test after repairs obtained a Durbin value of 2.001 with n=38 observations and the number of independent variables was three (k = 3) so that the dU value in the Durbin Watson table was 1.656 and (4-dU) 2.344. These results show that the Durbin value is at the dU and 4-dU limits, which means there is non autocorrelation problem, so the model obtained is good.

Regression Model Equations

The results of the simultaneous test, partial test, and regression assumption showed that the PHBS variable and the average length of time at school had an impact on the dependent variable while the prevalence of diarrhea had no impact.

Based on this, it was found that the coefficient of determination (R2) was 0.600 or 60% which means that life expectancy can be explained by the prevalence of diarrhea, PHBS, and the average length of schooling by 60%, the remaining 40% are independent variables that were not examined in this study. Here is the mathematical model equation.

AHH (Y) = 63.995 - 0.024 (diarrhea prevalence) + 0.032 (PHBS) + 0.802 (average length of schooling)

The coefficient value for the independent variable, namely PHBS and the average length of schooling shows a positive value, which means that there is a relationship between the independent variables and the dependent variable in a direct proportion; if PHBS increases it will increase AHH and if the average length of schooling increases it will also increase the life expectancy.

Comparison before Repair and after Repair with Prais Winsten Method

Based on the results of the repair, there is a change in the statistical value between before the repair and after the repair, there are three indicators that are considered, namely Durbin Watson, coefficient of determination, and Mean Square Error (MSE). There is an increase in value in the Durbin Watson test after repairs are made so that the autocorrelation problem can be solved; in the coefficient of determination (R2) there is a decrease between before and after the repair while in MSE there is a decrease after the repair.

Table 4. Multiple Linear Regression Model Life Expectancy

Model	*Unstandardized coefficients*		*Standardized coefficients*	t	Sig
	B	***St. Error***	**Betas**		
Constant	63.995	1.277		50.112	0.000
Diarrhea prevalence	-0.024	0.013	-0.021	-1.817	0.078
PHBS	0.032	0.012	0.289	2.614	0.013
The average length of the school	0.802	0.139	0.641	5.772	0.000

Table 5. Comparison before Repair and after Repair with Prais Winsten Method

Condition	DW	R2	MSE
Before Prais Winsten	1.107	66.3	1.503
After Prais Winsten	2001	60	1.228

DISCUSSION

Error autocorrelation is an error relationship between members of the observation, based on the results of detecting autocorrelation symptoms in the factors that affect the life expectancy of East Java Province in 2018 there is an autocorrelation problem. Autocorrelation problems can be caused due to time or region autocorrelation. The autocorrelation found in regional data is due to the similarity of the data. Area data that are close to each other have almost similar regional characteristics.

The problem of autocorrelation of errors in multiple linear regression can cause incorrect evaluation results, this is due to errors that are not free. The consequence is that if the error is not free, the error variance value is not minimum, causing the error value to be large. The impact of a larger error value will affect the results of the hypothesis test based on the F-test and T-test so the results cannot be trusted for evaluating regression results (1).

The Prais Winsten method is a method for overcoming the autocorrelation problem using a transformation, namely considering the rho value (ρ) as the error correlation coefficient. The Prais Winsten method begins by forming a new value based on the difference between the original value (i) and the rho value (ρ) and the lag value or previous value (i-1). The different results will form a new value that is free from autocorrelation problems (3).

Durbin Watson is one of the tests in detecting error autocorrelation problems and is based on the error correlation coefficient between observations so that if the error correlation coefficient is not equal to zero then it can be said that there is an autocorrelation problem (10). Evaluation of the Durbin Watson value after the repair has changed, which is at the dU and 4-dU critical points, showed that after testing there are no autocorrelation problems. The Durbin Watson test calculates the value in the error where, after data correction, the error will be smaller, so that it will increase the Durbin Watson value.

The coefficient of determination shows the diversity of the independent variables which can explain the dependent variable and can describe the accuracy of the model; the greater the value of the coefficient of determination, the better the model. The results of the coefficient of determination after repair using the Prais Winsten method decreased when compared to before the repair was carried out. This was because after the repair there was one independent variable that did not have a significant effect on the dependent variable. The more independent variables that do not have a statistically significant effect on the dependent variable, the more it will affect the coefficient of determination, namely by decreasing the value. The smaller the coefficient of determination, the less accurate the independent variable will be in explaining the dependent variable (11).

Mean Square Error is the difference between the observed value and the estimated value. The smaller the error value, the better the estimated value. The Mean Square Error after the repair is smaller, which means that

after the improvement with the Prais Winsten method the model obtained is getting better. The decrease in the error value after the correction was made was due to the Prais Winsten method forming a new value with a transformation based on the difference between the original value and the rho and lag values. The difference will reduce the value of the error. Other studies mention that rho value(ρ) describes the strength of the error relationship between observations. The greater the rho (ρ) value, the greater the error relationship between observations so by using the transformation, the Prais Winsten method which considers the rho (ρ) value, will be able to make the model error smaller (12).

Life expectancy is the extent of life from birth to reaching a certain age. Life expectancy is one measure of human development in the health sector which describes the degree of public health. If the degree of health in the community increases, the life expectancy also increases, conversely, if the degree of health decreases, the life expectancy also decreases (13). Low life expectancy needs to be increased through health development programs including environmental health, nutrition, and poverty reduction(14).

Based on the research results, the prevalence of diarrhea is inversely related to life expectancy. This can be seen by the magnitude of the regression coefficient -0.023, which means that if there is a decrease in the prevalence of diarrhea by one case per 1,000 population, it can increase life expectancy by 0.023 years. However, based on the results of statistical tests on the prevalence of diarrhea, the effect was not significant (p-value > 0.05) on life expectancy. This study gave different results from others which stated that the incidence of diarrhea had a significant effect on East Java's life expectancy in 2014 (7).

The health problem in the community is diarrhea. Diarrhea can attack infants and toddlers, if not treated immediately it will result in dehydration which leads to death, so if more and more people suffer from diarrheal disease in an area, it will directly impact their health status. The higher the child mortality caused by diarrhea, the worse the quality of health services; this cannot be separated from the child mortality rate which is one measure to assess the degree of health (15). The higher the incidence of diarrhea in the community can reduce life expectancy, and the lower the incidence of diarrhea can increase life expectancy.

The diarrheal disease control program aims to reduce the morbidity and mortality caused by diarrhea. The measure of targeting accuracy of diarrheal disease control can be seen from the program's performance achievements, namely the coverage of diarrhea services for toddlers. Based on existing data, in East Java from 2014 to 2018, the achievement of diarrhea service coverage decreased and was lowest, namely in 2018 with a coverage achievement of 77.85% (16). This means that the diarrhea disease control program in East Java Province in the 2014-2018 period has not been effective yet, so improvements are needed so that in the following year the coverage of diarrheal disease services can increase.

Statistically clean and healthy living behavior shows significant results so it can be interpreted that there is an influence of PHBS on life expectancy. PHBS has a coefficient with a value of 0.036; a positive coefficient means PHBS is directly proportional to life expectancy so that every 1% increase in PHBS can increase life expectancy by 0.036 years. This research shows the same results as other studies in Jember districts which state PHBS can have an impact on life expectancy (8). Other studies also state that in Central Java PHBS has an impact on life expectancy (17).

PHBS in the smallest scope is that households aims to empower household members in carrying out clean and healthy living behaviors and be able to participate in healthy community life (18). PHBS in the household will create a healthy family that can reduce health problems so that family members can adopt a healthy lifestyle and a healthy family will have a healthy attitude and mentality so that other members, such as children, can grow healthy and have their nutrition fulfilled. PHBS in households is increasing, so it can be said that self-awareness, family, and community about the importance of health is also increasing. The higher the percentage of households implementing PHBS, the higher their health status so that they can increase life expectancy.

Statistically, the average length of schooling is significant with a p value of less than 0.05, so it can be concluded that the

average length of schooling can affect life expectancy. The average length of schooling has a regression coefficient of 0.852, meaning that if there is an increase in one year of schooling, one's life expectancy can increase by 0.852. This study shows the same results as other studies which state that in 2018 in Sumatra the average length of schooling has an impact on life expectancy (19). Other research also mentions that school travel time impacts on East Java life expectancy(20).

The educational travel time needed by individuals is an illustration of the average length of schooling, if the average length of schooling is higher, the longer the education taken by the individual. The higher the education a person goes through, it can be interpreted that the quality of that person is also getting higher, both in his mindset and actions (20). In a small scope, namely in families, the average length of schooling for parents is needed to improve the quality of life and improve the health status of their children.

Parents who have high school years have the opportunity to gain knowledge and understanding of the importance of health to be taught to future generations. A high average length of schooling can increase education so that it can increase income, which will have an impact on increasing a person's ability to maintain health by applying healthy behaviors in life and being able to improve nutritional health.

CONCLUSIONS AND SUGGESTIONS

Conclusion

Results analysis shows there is an autocorrelation problem in East Java Province 2018 on factors that influence life expectancy. The Prais Winsten method can overcome the autocorrelation problem where before the Durbin Watson value was repaired at 1.107 after the Prais Winsten method was repaired it became 2.001, not only that, the Mean Square Error (MSE) value was also getting smaller so that the autocorrelation problem could be solved. Life expectancy figures in 2018 East Java are influenced by PHBS and the average length of the schooling.

Suggestions

Before doing the modeling, further analysis is needed, namely testing the assumption of errors so that a good model and the correct statistical information will be obtained. If one of the assumption tests, namely autocorrelation, is not fulfilled, it is necessary to make improvements. The Prais Winsten method should be used to overcome autocorrelation problems if the data used are data according to time or region. The government can make strategic steps to increase life expectancy by increasing PHBS and education so that the quality of life in the community will also be good.

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