overdispersion problems, hence this study continued using the BZIPIGR model.

D. Regression Modeling of the Number of HIV and AIDS Cases in Trenggalek and Ponorogo Districts using the BZIPIG method.

The number of HIV and AIDS cases in Trenggalek and Ponorogo Districts is count data with overdispersion problems. Therefore, this research modeling using BZIPIGR. Simultaneous testing of parameters is carried out to determine whether the significant $\boldsymbol{\beta}_1, \boldsymbol{\beta}_2$ parameter jointly affects the response. Simultaneous testing of the parameters of the BZIPIGR model with a hypothesis

$H_0 : \beta_{1k} = \beta_{2k} = 0$ with $k = 1,2,\ldots,5$

H_1 : at least one of β_{hk} =0 with $h = 1,2$ and $k = 1,2,\ldots,5$

The value of test statistics G (73.18336) is greater than $\chi^2_{(0.05;10)} = 18.30704$, hence rejecting H_0. The conclusion is predictor variables together affect the response.

After testing simultaneously, the next step is testing the parameters BZIPIGR model partially. The hypothesis for this testing is:

i) For β

$H_0 : \beta_{hk} = 0$; $h = 1,2;\ k = 1,2,3,4,5$

$H_1 : \beta_{hk} \neq 0$

ii) For θ

$H_0 : \theta_h = 0$; $h = 1,2$

$H_1 : \theta_h \neq 0$

iii) For τ

$H_0 : \tau = 0$

$H_1 : \tau \neq 0$

The partial hypothesis testing on the parameters of the BZIPIGR model can be seen in Table 2.

TABLE II
PARAMETER ESTIMATION OF BZIPIGR MODEL

Parameter	Estimate	Se	Z
$\beta_{1.0}$	-1.117	0.001417051	-788.257
$\beta_{1.1}$	-0.097	0.001422267	-68.201
$\beta_{1.2}$	0.064	0.001409661	45.401
$\beta_{1.3}$	-0.042	0.001405293	-29.887
$\beta_{1.4}$	-0.27	0.001415502	-190.745
$\beta_{1.5}$	-0.015	0.001417234	-10.584
$\beta_{2.0}$	-1.963	0.001515899	-1294.941
$\beta_{2.1}$	-0.019	0.001539334	-12.343
$\beta_{2.2}$	0.056	0.001515931	36.941
$\beta_{2.3}$	-0.014	0.001507484	-9.287
$\beta_{2.4}$	-0.01	0.001469292	-6.806
$\beta_{2.5}$	-0.022	0.001510367	-14.566
θ_1	0.05	1.3956E-07	358267.700
θ_1	0.057	2.59258E-07	219858.600
τ	0.006	9.81499E-05	61.131

$P-value$ of the all parameters are less than the $\alpha = 0.05$ (*P-Value* < 0.05), hence H_0 is rejecting. Therefore, all the predictor variables partially influence the number of HIV and AIDS cases in Trenggalek and Ponorogo Districts. They are the percentage of the age group 25-29 years, the percentage of the lowest level of education is the senior high school variables, the percentage of couples of reproductive ages using condoms, the percentage of health education activities, and the percentage of public health insurance.

The equation of the BZIPIGR model according to table 2 for the number of HIV cases is divided into 2 models, such as the model for Poisson state and the model for zero state. The Poisson state regression model for HIV as follows.

$$\log\left(\hat{\lambda}_{1i}\right) = -1.1169 - 0.0966X_{1i} + 0.0643X_{2i} - 0.0423X_{3i} + \\ -0.2703X_{4i} - 0.0150X_{5i}$$

The estimation of parameters in the equation above can be interpreted based on the independent variables' coefficient and coefficient sign. For instance, every 1% increase of the population aged 25-29 years (X_1) will reduce the average number of HIV cases in each sub-district in Trenggalek and Ponorogo districts equal to $\exp(0.0966) = 1.1011$ times, assuming the other variables are constant. The interpretation of the other independent variables can carry out in the same way. The Poisson state regression model for AIDS as follows.

$$\log\left(\hat{\lambda}_{2i}\right) = -1.9625 - 0.0187X_{1i} + 0.0560X_{2i} - 0.0141X_{3i} + \\ -0.0103X_{4i} - 0.0221X_{5i}$$

Like the the first model above, can interpret every 1% increase of population aged 25-29 years (X_1) will reduce the average number of AIDS cases in each sub-district in Trenggalek and Ponorogo districts equal to $\exp(-0.187) = 0.9815$ times, which assuming the other variables are constant. The interpretation of the other independent variables can carry out in the same way.

There are differences influence of variables by Wijaya, where in Wijaya's research there are 3 variables that have a positive effect on the number of HIV and AIDS, namely the percentage of age group 25-29 years, The percentage of couples of reproductive age using condoms, and The percentage of community health insurance (Jamkesmas), while the other 2 variables have a negative effect. In this study only the percentage of population with senior high school level has a positive effect (it can increase the number of HIV and AIDS as the percentage of this variable increases), while other variables have a negative effect.

The second model of BZIPIGR is zero state regression model for HIV and AIDS. The zero-state regression model for HIV is as follows:

$$\begin{aligned} \operatorname{logit}\left(\hat{p}_{1i}\right) &= -0.05\left(-1.1169 - 0.0966X_{1i} + 0.0643X_{2i} - 0.0423X_{3i} + \right. \\ &\quad \left. -0.2703X_{4i} - 0.0150X_{5i}\right) \\ &= 0.0558 + 0.0048X_{1i} - 0.0032X_{2i} + 0.0021X_{3i} + 0.0135X_{4i} + \\ &\quad 0.0008X_{5i} \end{aligned}$$

The logit model equation above can interpret the Opportunities in every district in Trenggalek and Ponorogo did not have HIV cases increased equal to exp (0,0048)=1.0048 times if there is an increase of 1% of the population aged 25-29 years (X_1), assuming other variables constant. Similarly, to the variable X_3, X_4, and X_5. However, if there is an increase of 1% of percentage of the population with senior high school level X2 with the assumption that the other variables are constant, then the chance of not having an HIV case will decrease by exp (0.0032)= 1.0032 times. This is related with the Poisson state regression model, which can increase the number of HIV is variable X_2.

The zero-state regression model for AIDS cases is as follows.

$$\begin{aligned}\text{logit}\left(\hat{p}_{2i}\right) &= -0.057\left(-1.9625-0.0187X_{1i}+0.0560X_{2i}-0.0141X_{3i}+\right.\\&\quad\left.-0.0103X_{4i}-0.0221X_{5i}\right)\\&= 0.1119+0.0011X_{1i}-0.0032X_{2i}+0.0008X_{3i}+0.0006X_{4i}\\&\quad+0.0013X_{5i}\end{aligned}$$

The logit model equation above can interpret the chance that each sub-district in Trenggalek and Ponorogo districts does not have AIDS cases increases by $\exp(0.0011)=1.0011$ times if there is an increase of 1% of the population aged 25-29 years, assuming the other variables are constant. Similarly, to the variable X_3, X_4, and X_5. However, if there is an increase of 1% of percentage of the population with senior high school level X_2 with the assumption that the other variables are constant, then the chance of not having an AIDS case will decrease by exp (0.0032)= 1.0032 times. This is related to the Poisson state regression model, which can increase the number of AIDS variables X_2. Based on these two regression models (Poisson state and zero state), an increase in the number of HIV and AIDS can be caused by an increase in the percentage of the population aged 25-29 years (X_2).

According to Akaike Information Criterion Corrected (AICc) value. The AICc value uses if the objective of regression modeling is to identify the influencing factors. The AICc value using the BZIPIGR model obtained is 317.96. Previous research with the same data using the BZIPR method on the number of HIV and AIDS cases got an AICc value of 340.6977. Therefore, the data on the number of HIV and AIDS cases in Trenggalek and Ponorogo Districts is better using the BZIPIGR model.

IV. Conclusion

Based on the results and discussion above, it can conclude that: The estimation parameters of the BZIPIGR model using the MLE method has obtained that the first derivative does not yield closed form. Therefore, it is followed by numerical iteration using the Berndt Hall Hall Hausman (BHHH) algorithm. For Simultaneous hypothesis testing of the BZIPIGR model using the MLRT method has obtained test statistics that follow Chi-square distribution. Based on the AICc value were obtained from the BZIPIGR model, it has shown that the model is feasible to apply for data on the number of HIV and AIDS cases. All predictor variables significantly affected the number of HIV and AIDS cases.

Based on the Poisson state regression model, the variable whose effect is to increase the number of HIV and AIDS cases is the percentage of the population with low education (SMA). The variables that can reduce the number of HIV and AIDS cases are the percentage of the population aged 25-29 years, the percentage of reproductive-age couples (PUS) using condoms, the percentage of health education activities, and the percentage of community health insurance (Jamkesmas). Based on the Zero state regression model,

References

[1] R. Fitriani, L. N. Chrisdiana, and A. Efendi, "Simulation on the Zero Inflated Negative Binomial (ZINB) to Model Overdispersed, Poisson Distributed Data," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 546, no. 5, 2019, doi: 10.1088/1757-899X/546/5/052025.

[2] R. D. Kusuma and Y. Purwono, "Zero-Inflated Poisson Regression Analysis On Frequency Of Health Insurance Claim PT. XYZ," in *Proceedings of the 12th International Conference on Business and Management Research (ICBMR 2018)*, 2019, vol. 72, no. Icbmr 2018, pp. 321–325, doi: 10.2991/icbmr-18.2019.52.

[3] D. Karlis and E. Xekalaki, "Mixed Poisson distributions," *Int. Stat. Rev.*, vol. 73, no. 1, pp. 35–58, 2005, doi: 10.1111/j.1751-5823.2005.tb00250.x.

[4] Purhadi, Sutikno, S. M. Berliana, and D. I. Setiawan, "Geographically weighted bivariate generalized Poisson regression: application to infant and maternal mortality data," *Lett. Spat. Resour. Sci.*, vol. 14, no. 1, pp. 79–99, 2021, doi: 10.1007/s12076-021-00266-5.

[5] L. Amaliana, U. Sa'Adah, and N. W. Surya Wardhani, "Modeling Tetanus Neonatorum case using the regression of negative binomial and zero-inflated negative binomial," *J. Phys. Conf. Ser.*, vol. 943, no. 1, 2018, doi: 10.1088/1742-6596/943/1/012051.

[6] S. Mardalena, Purhadi, J. T. D. Purnomo, and D. D. Prastyo, "Bivariate Poisson Inverse Gaussian Regression Model with Exposure Variable: Infant and Maternal Death Case Study," *J. Phys. Conf. Ser.*, vol. 1752, no. 1, 2021, doi: 10.1088/1742-6596/1752/1/012016.

[7] X. F. Huang, G. L. Tian, C. Zhang, and X. Jiang, "Type I multivariate zero-inflated generalized Poisson distribution with applications," *Stat. Interface*, vol. 10, no. 2, pp. 291–311, 2017, doi: 10.4310/SII.2017.v10.n2.a12.

[8] M. S. Nur, Purhadi, and A. Choiruddin, "Parameter Estimation and Hypothesis Testing of Geographically Weighted Bivariate Zero Inflated Poisson Inverse Gaussian Regression Models," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 1115, no. 1, p. 012043, 2021, doi: 10.1088/1757-899x/1115/1/012043.

[9] J. M. Hilbe, *Cambridge Books Online*, vol. 48, no. 04. 2010.

[10] Q. Aini, Purhadi, and Irhamah, "Bivariate zero inflated generalized Poisson regression model in the number of pregnant maternal mortality and the number of postpartum maternal mortality in the Central Java Province in 2017," *J. Phys. Conf. Ser.*, vol. 1511, no. 1, 2020, doi: 10.1088/1742-6596/1511/1/012055.

[11] Dinas kesehatan Provinsi Jawa Timur, *Profil Kesehatan Provinsi Jawa Timur Tahun 2018*. Jawa Timur, Indonesia: Dinas Kesehatan Provinsi Jawa Timur, 2019.

[12] Kementerian Kesehatan Republik Indonesia, "Infodatin (Situasi HIV dan AIDS di Indonesia)," *Pusdatin*, 2020, [Online]. Available: https://pusdatin.kemkes.go.id/resources/download/pusdatin/infodatin/infodatin-2020-HIV.pdf.

[13] I. Purnamasari and I. N. Latra, "Parameter Estimation and Statistical Test in Modeling Geographically Weighted Poisson Inverse Gaussian Regression," in *International Conference Research:Implementation and Education of Mathematics and Science*, 2016, no. May, pp. 16–17.

[14] S. Mardalena, P. Purhadi, J. D. T. Purnomo, and D. D. Prastyo, "Parameter Estimation and Hypothesis Testing of Multivariate Poisson Inverse Gaussian Regression," *Symmetry (Basel).*, vol. 12, no. 10, p. 1738, Oct. 2020, doi: 10.3390/sym12101738.

[15] J. Amalia, Purhadi, and B. W. Otok, "Application of geographically weighted bivariate poisson inverse Gaussian regression," *AIP Conf. Proc.*, vol. 2268, no. September 2020, doi: 10.1063/5.0017393.

[16] J. Pangulimang, "Parameter Estimation and Hypothesis Testing Geographically Weighted Bivariate Zero-Inflated Poisson," in *International Conference Research:Implementation and Education of Mathematics and Science*, 2016, no. May, pp. 16–17, [Online]. Available: http://seminar.uny.ac.id/icriems/sites/seminar.uny.ac.id.icriems/files/prosiding/M-12.pdf.

[17] S. M. Berliana, Purhadi, Sutikno, and S. P. Rahayu, "Parameter estimation and hypothesis testing of geographically weighted multivariate generalized poisson regression," *Mathematics*, vol. 8, no. 9, pp. 1–14, 2020, doi: 10.3390/math8091523.
[18] J. N. Gonçalves and W. Barreto-Souza, "Flexible regression models for counts with high-inflation of zeros," *Metron*, vol. 78, no. 1, pp. 71–95, 2020, doi: 10.1007/s40300-020-00163-9.
[19] H. Cho, T. Porras, D. Baik, M. Beauchemin, and R. Schnall, "Understanding the predisposing, enabling, and reinforcing factors influencing the use of a mobile-based HIV management app: A real-world usability evaluation," *Int. J. Med. Inform.*, vol. 117, pp. 88–95, 2018, doi: 10.1016/j.ijmedinf.2018.06.007.
[20] S. U. Wijaya, *Pendugaan Parameter dan Pengujian Hipotesis pada Bivariate Poisson Inverse Gaussian Regression (Studi Kasus: Jumlah Kasus Baru HIV dan AIDS di Kabupaten Trenggalek dan Ponorogo Tahun 2012)*. Indonesia: Repository ITS, 2017.
[21] S. M. Berliana, Purhadi, Sutikno, and S. P. Rahayu, "Multivariate generalized Poisson regression model with exposure and correlation as a function of covariates: Parameter estimation and hypothesis testing," *AIP Conf. Proc.*, vol. 2192, 2019, doi: 10.1063/1.5139171.
[22] N. Shrestha, "Detecting Multicollinearity in Regression Analysis," *Am. J. Appl. Math. Stat.*, vol. 8, no. 2, pp. 39–42, 2020, doi: 10.12691/ajams-8-2-1.