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AUTOREGRESSIVE MOVING AVERAGE (ARMA) MODEL FOR DETECTING SPATIAL DEPENDENCE IN INDONESIAN INFANT MORTALITY DATA

Ray Sastri[1], Khairil Anwar Notodiputro[2], Indahwati[3]

[1]Master Student of Bogor Agricu ltural University
[2,3]Lecturer of Bogor Agricultural University
E-mail : raysastree@gmail.com[1]

ABSTRACT

Infant mortality is an important indicator that must to be monitored seriously. The infant mortality is associated with several determinants, such as the infant's characteristics, maternal and fertility factors, housing condition, geographical area, and policy. It can also be influenced by the presence of spatial dependence between regency in Indonesia. This is due to the social and economic activity in one regency depend on social and economic activity in other regency, especially with neighboring area. Infant mortality data obtained from Indonesian Demographic and Health Survey (IDHS) published by Statistic Indonesia (BPS). In BPS's publication, data is always sorted by regency code from the smallest to the largest. Therefore, the closeness of the regency code refers to the closeness of the regency itself. the infant mortality data by regency could be analogized as time series data. So that, the relationship between regency can be seen using Autoregressive Moving Average (ARMA) model. If the parameter at ARMA is significant, we can conclude that there is a spatial dependence on the infant mortality in Indonesia. This paper will focus on discussing whether there is a spatial dependenc in Indonesia's Infant Mortality Data using ARMA approach. The result is the Autocorrelation Function (ACF) showed a significant effect until lag 3, and Partial Autocorrelation Function (PACF) showed a significant effect until lag 1. Based on Bayesian Information Criterion (BIC), the AR(1) fitted the model well. It shows that the probability of infant mortality in one regency is affected by probability of infant mortality in neighboring regency.

Key words : ARMA, spatial dependence, infant mortality, IDHS

INTRODUCTION

Infant mortality is the death of children before they reach one year of age. Information on infant mortality could be obtained from the Indonesian Demographic and Health Survey (2012) which conducted by Statistics Indonesia (BPS) every five years.

Infant mortality is multidimensionally case because it relates to many things such as infant's characteristics, maternal and fertility factors, housing condition, geographical area, and policy. It also influenced by the presence of spatial dependence between regency in Indonesia. This is due to the social and economic activity in one regency depend on social and economic activity in other regency, especially with neighboring area.

Usually, we use Moran I Index and Grey G Index for testing the spatial dependence. The calculation of both Moran I index and Crey G

index are involve spatial weighted matrix that takes more effort to create.

A simple way to determine the presence of spatial dependence without involving weighted matriks is using time series approach. In time series data, the sequence of observations show sequence of time. In cross section data, if we could arrange regions based on their proximity of the geographical location, we could use time series model approach for identify the relationship between one area with the neighboring geographically area.

In conducting the survey, BPS has made a unique code for each regency. code 01, 02, and so on for district and code 71, 72, 73, and so on for city. In the infant mortality data by regency, regency are sorted based on this code, ranging from the smallest to the largest. Here is the illustration of regency code sequence.

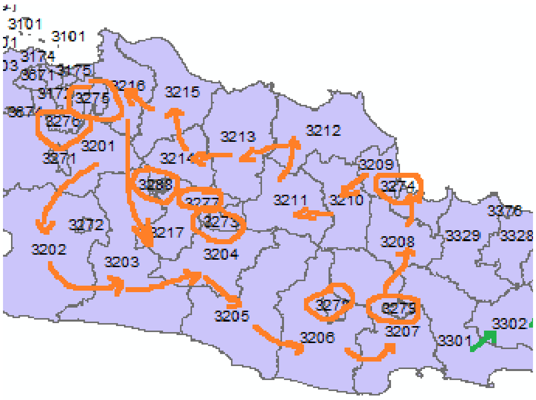

Figure 1. Illustration of Sequence of Regency Code Which Used by BPS

The closeness of regency code illustrates the closeness of the geographical location of regency itself on map. For example, code 01 is close to 02, code 13 is close to code14. It means, regency 01 is neighboring area of regency 02 and regency 13 is neighboring area of regency 14.

Unfortunately, there are many lack of this sequence. Some of the closeness of regency code doesn't show the closeness of the regency itself. this case occurs in the code for city area because they always written in the end part even if they close to district area. This case also occur when switching from one provinces to others province.

However, 80 percent of closeness of the regency code show the closeness of geographical location. so that, the infant mortality data by regency could be analogized as time series data. Spatial dependence could be seen using ARMA model. If the parameter is significant, there is a spatial dependence on the data.

The aim of this research is to develope an ARMA models for identify spatial dependence in Infant mortality data.

RESEARCH METHODOLOGY

Data

This study uses data from Demographic and Health Survey Indonesia Year 2012 (SDKI 2012) conducted by the Central Statistics Agency (BPS). The survey was conducted 466 regency throughout Indonesia. Information included 83.650 children. The probability of infant mortality in one regency was calculated by the number of infants who died before reach one year of age divided by the total number of children.

Model

The Autoregressive model for lag p denoted by AR(*p*) is written as :

$$X_t = c + \sum_{i=1}^{p} \varphi_i X_{t-1} + \varepsilon_t \qquad (1)$$

where X_t is probability of infant mortality in regency t, $\varphi_1 \ldots\ldots \varphi_p$ are parameters, *c* is a constant, and the random variable ε_t is white noise. Some constraints are necessary on the values of the parameters so that the model remains stationary. For example, processes in the AR(1) model with $|\varphi_1| \geq 1$ are not stationary.

The moving average model of order q denoted by MA(q) is witten as:

$$X_t = \mu + \varepsilon_t + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i} \qquad (2)$$

where the $\theta_1, \ldots, \theta_q$ are the parameters of the model, μ is the expectation of X_t (often assumed to equal 0), and the $\varepsilon_t, \varepsilon_{t-1} \ldots \ldots \varepsilon_t - q$, are white noise error terms.

The notation ARMA(*p*, *q*) refers to the model with *p* autoregressive terms and *q* moving-average terms. This model contains the AR(*p*) and MA(*q*) models.

$$X_t = c + \varepsilon_t + \sum_{i=1}^{p} \varphi_i X_{t-1} + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i} \qquad (3)$$

RESULT

Autocorrelation Function (ACF) of probability of infant mortality showed a significant effect until lag 3 and Partial Autocorrelation Function (PACF) showed the significant effect in lag 1. Based on ACF and PACF, the data could be modeled by AR (1), AR (2), AR (3), MA (1), ARMA (1,1), ARMA (2,1) ARMA (3,1).

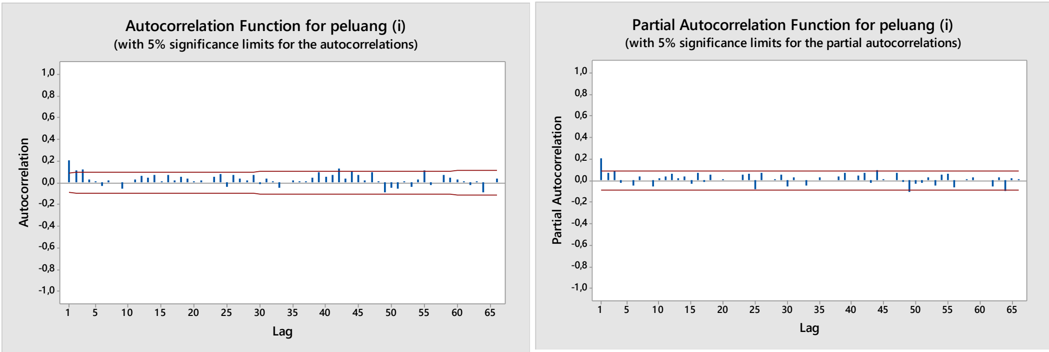

Figure 2. ***Autocorrelation Function*** **(ACF) dan** ***Partial Autocorrelation Function*** **(PACF) of Probability of Infant Mortality in Indonesia**

Bayesian Information Criterion

Lags	**MA 0**	**MA 1**	**MA 2**	**MA 3**	**MA 4**	**MA 5**
AR 0	-6.57711	-6.59706	-6.59323	-6.59824	-6.58564	-6.57284
AR 1	-6.60765	-6.60221	-6.58944	-6.58559	-6.57268	-6.55966
AR 2	-6.60086	-6.58922	-6.58098	-6.57249	-6.55949	-6.54708
AR 3	-6.59711	-6.58448	-6.5713	-6.56100	-6.54936	-6.53667
AR 4	-6.58482	-6.57178	-6.56018	-6.5492	-6.53618	-6.5264
AR 5	-6.57177	-6.56069	-6.54935	-6.53617	-6.52667	-6.52641

The best model was Selected with Bayesian Information Criterion (BIC). The minimum BIC value obtained from the AR (1) model. It shows that the AR (1) fit the model well.

Here is the parameters estimation of AR (1) model. parameters are significant with p-value of 0.000.

Type	**Coef**	**SE Coef**	**T**	**P**
AR1	0,2108	0,0454	4,64	0,000
Constant	0,044049	0,001708	25,79	0,000
Mean	0,055816	0,002164		

The model is :

$$X_t = 0{,}044 + 0{,}2108X_{t-1} \qquad (4)$$

Because of parameter in AR(1) model is significant we can say that there is a spatial dependency in Indonesian infant mortality data in 2012. The probability of infant mortality in one regency is affected by probability of infant mortality in its nearest regency.

CONCLUSION

There is a spatial dependency in Indonesia infant mortality data in 2012. in the decision making about the reduction in infant mortality rate, the government needs to noticed the spatial dependence.

REFERENCES

Anselin L. 1988. *Spatial Econometrics: Methods and Models (Studies in Operational Regional Science)*. New York (USA): Springer Publishing.

Gujarati D. 2015. *Econometrics by Examples*. London (UK): Palgrave.

Statistics Indonesia (Badan Pusat Statistik—BPS), National Population and Family Planning Board (BKKBN), and Kementerian Kesehatan (Kemenkes—MOH), and ICF International. 2013. *Indonesia Demographic and Health Survey 2012*. Jakarta: BPS, BKKBN, Kemenkes, and ICF International.

Wei WWS. 2006. *Time Series Anlysis : Univariate and Multivariate Methods*. New York (USA): Pearson Education, Inc.