The Effect of Economic and Social Infrastructure on Household Food Security in Indonesia

Dyah Wulan Sari[a,*], Putri Candra Anggi Yudha[a], & Wenny Restikasari[a]

[a]*Faculty of Economics and Business, Airlangga University, Surabaya, Indonesia*

Abstract

Food is a basic requirement for living things. This study aims to analyze the effects of economic infrastructure, social infrastructure and household characteristics on food security in Indonesia using the Johnsson and Toole (1991) methods. There were 285,908 households studied originating from the 2015 SUSENAS data. The model used in this study was the general ordered logistics model. Based on the results of the study there were 29.51% of food security, 25.12% of vulnerable food, 23.14% of food shortages and 22.33% of households at food insecurity. The results of this study also revealed that ownership of transportation modes, electricity use, fuel use, education of household heads and household health insurance significantly affected food security. The government program in the form of giving poor rice (RASKIN) provides poor results reducing the chance of food security by 11% and increasing the chances of food insecurity by 6%.

Keywords: food security; infrastructure; *general ordered logit*
JEL Classification: I28; O18; Q18

[*]Corresponding Author: Faculty of Economics and Business, Airlangga University. Airlangga St. No. 4, Surabaya 60286, Indonesia. Phone: +62-31-5033642; 5036584, Fax: +62-31-5026288. E-mail: dyah-wulansari@feb.unair.ac.id; wlnsari@yahoo.com.

1. Introduction

Food needs are a challenge for island nations such as Indonesia with a population of 258,162,113 million in 2015 (World Bank, 2019). Food needs in Indonesia are estimated to continue to increase along with the increase in population. Malthus theory once predicted that population growth follows a series of measures while the growth of available food resources follows a series of calculations. Food security is one of the goals in the Sustainable Development Goals (SDGs). Food security is one of the world's goals but many developing countries in Africa and Asia are experiencing food insecurity including Indonesia (Frayne & McCordic, 2015). Thirty percent of households stated that their food consumption was less than what they needed. More than a quarter of children under 5 years old are underweight and 8% suffer greatly. Forty-two percent of children under 5 years experience stunting before a crisis occurs. Poor nutrition inhibits child development, threatens maternal health and reduces labor productivity which traps people in poor health and poverty (World Bank, 2005). Food security in Indonesia is one of the national development priorities listed in the National Medium-Term Development Plan (RPJMN) 2015–2019. Achieving food sovereignty is the reason for the importance of adequate infrastructure. Infrastructure inequality can be a reason for household food insecurity (Tacoli, 2013). The World Bank (1994) divides infrastructure into two categories: economic infrastructure and social infrastructure. Economic infrastructure plays an important role in increasing economic growth, for example, telecommunication, sanitation, road construction, transportation and so on. In contrast, social infrastructure does not support direct economic growth such as education and health. Therefore, the provision must be carried out by the government.

This research uses economic infrastructure in the form of ownership of modes of transportation and electricity use. The social infrastructure in this study is in the form of household head education and household health insurance, while the household characteristics used are the use of cooking fuel (LPG), poor rice receipt status, gender and location of household residence. The transportation facilities used in this study are motorbikes, motorboats, and boats. These facilities are used by the community to mobilize daily activities including food-getting activities. Measuring opportunities for household food security in this study uses measurements from Johnsson and Toole (1991) that use cross-classification of two indicators of food security: food expenditure and energy sufficiency which are classified into 4 categories: food security, vulnerable food, food shortages, and food insecurity.

2. Literature Review

The concept of food security is achieved when quantity, quality, and food security are achieved, available and accessible and optimally utilized by all individuals at all times for healthy living (Food and Agriculture Organization, 2000). The

concept of food security is applied at the global, national and household levels. The definition shows that the concept of food security does not only focus on meeting food needs but also accesses to get food and the use of food for a healthy and productive life. Clay et al. (1988) divided food security into two dimensions, namely national food security and individual food security. National food security occurs when national food availability is following national food needs and overtime food stocks can be imported. Individual food security is a condition when all people can meet their food needs by buying or producing food as needed.

Based on the concept of FAO food security in 2000 there are four main aspects of food security, which means that in any situation food must be available in terms of quantity and quality. First, food availability serves to ensure the food needs of all residents are safe in quantity, quality, and diversity including nutrient-rich foods in the area concerned through domestic production and imports from abroad and food aid. Secondly, accessibility is related to the ability of households to obtain adequate, safe and nutritious food physically in an area, but cannot be accessed by certain households because of limited physical access, economic access, and social access. Third, food utilization refers to the use of food by households that have access and the ability of individuals to absorb nutrients efficiently by the body so that they are healthy and productive. Fourth, food stability refers to food consistency in meeting the needs of the entire population despite disasters or fluctuations in food prices.

Frayne and McCordic (2015) stated that food security is influenced by economic infrastructure and social infrastructure. Economic infrastructure and social infrastructure are reflected in access to clean water, access to electricity, health insurance, and fuel for cooking. The results of the study state that social infrastructure and economic infrastructure have a large impact. But the influence caused by access to electricity for household food security is smaller because the cost of electricity supply in a region is relatively high. Apart from in terms of infrastructure, household characteristics also determine opportunities for household food security. The characteristics of the household in the form of the residence location of the household and the sex of the head of the household significantly influence the chances of household food security (Obayelu, 2012; Esturk & Oren, 2014).

3. Method

3.1. Logistic Regression

Logistic regression is used to analyze the relationship between the dependent variable nominal or ordinal scale which consists of two categories with one or more independent variables. There are several types of logistic regression, first binary logistic regression is used to determine the occurrence of an event where depending on this model there are two categories. Second, multinomial logistic regression is the same as binary logistic regression, but the dependence on this

Table 1: Variables and Determinants of Household Food Security

Variable	Information	Notation	
Dependent Variable (*Food secure*):	**Categories**		
- Food insecurity	- 0= Food insecurity	Y	Y0
- Food shortages	- 1= Food shortages		Y1
- Vulnerable food	- 2= Vulnerable food		Y2
- Food secure	- 3= Food secure		Y3
Independent Dependent:	**Dummy Variable**		
- Ownership modes of transport	1 = Has a mode, another 0	X_1	$x_{1.1}$ = TRP
- Status of electricity usage	1 = Has electricity, 0 others		$x_{1.2}$ = ELC
- Education of household head	1 = Attending school, 0 other	X_2	$x_{2.1}$ = EDU
- Household health insurance	1 = Has a guarantee, another 0		$x_{2.2}$ = HEALTH
- Status of LPG use (3 kg/5 kg)	1 = Using LPG, the other 0	X_3	$x_{3.1}$ = FUEL
- RASKIN status	1 = Receive Raskin, 0 others		$x_{3.2}$ = RASKIN
- Location of residence	1 = Low in the city, 0 others		$x_{3.3}$ = LOC
- The sex of the head of the household	1 = Female, 0 others		$x_{3.4}$ = GEN

Table 2: Food Security Criteria Johnsson and Toole Method

Consumption Level Food Energy	The Proportion of Food Expenditures	
	Low (<60% of total expenditure)	High (≥60% of total expenditure)
Enough (>80% sufficiency food energy)	Food Secure (Y3)	Vulnerable Food (Y2)
Less (≤80% sufficiency food energy)	Food Shortages (Y1)	Food Insecurity (Y0)

Source: Maxwell and Smith (1992)

model consists of more than two variables. Third, ordinal logistic regression is the same as multinomial logistic regression but the category in this model has a sequence in which category one is better than the other categories.

3.2. Ordinal Logistic Regression Model

In the ordinal logistic model, there is an important assumption that must be fulfilled, namely proportional odds assumption which states that the relationship between two variables in the dependent variable category is the same, therefore the slope coefficient does not vary except the cutoff. To consider the proportional odds assumptions accepted or rejected, a Brant test was carried out. This test is used to compare predictors of independent variables at different levels of endurance. The Brant test compares the slope of the $(j-1)$ ordinal logistic regression model (Sasidharan & Menendez, 2014).

Y_i is an observation of the level of food security in households, Y_i^* is a latent variable that is not measurable whose value determines what the Y_i variable observes, x is the independent variable, j is the level of food security (0 = food insecurity, 1 = food shortages, 2 = vulnerable food and 3 = food secure) and j the number of levels of food security (in this study $j = 4$). The measure of latent Y_i

food security * can be written as follows:

$$Y_i^* = x_i\beta + \varepsilon \quad (1)$$

Where β is the regression coefficient x, ε is the error distribution. μk is the cutoff for food security, $k = 0, 1, \ldots, j-1$. The following is the difference in the Y value:
$Y = 0$ food insecurity if $Y^* \leq \mu 1$
$Y = 1$ food shortages if $\mu 1 \leq Y^* \leq \mu 2$
$Y = 2$ vulnerable food if $\mu 2 \leq Y^* \leq \mu 3$
$Y = 3$ food secure if $Y^* > \mu 3$
j is the number of levels of food security, the opportunity for household food security can be written as follows:

$$P(Y_i > j) = P_{ij} = \frac{e^{(\alpha_j + X_i\beta)}}{1 + e^{(\alpha_j + X_i\beta)}}; j = 1, 2, \ldots j-1 \quad (2)$$

The value of β for all levels of food security j is the same. However, the parallel lines of assumption can be violated in many ways. Then a Brant test is needed to find out whether the model violates these assumptions or not.

3.3. General Ordered Logit Model

The ordinal logistic model requires data to comply with the proportional odds assumptions between different levels of food security. On the other hand, the multinomial model ignores the opportunity for overall food security. The general ordered logit model is a model that bridges the boundary between ordinal logistic and multinomial logistics models. The most relevant thing about this general ordered logit model is that it allows certain individuals on independent variables to affect each category differently (violating the proportional odds assumption), while other independent variables assume the proportional odds assumption. The opportunity for household food security can be written as follows (Williams, 2006).

$$P(Y_i > j) = \frac{e^{(\alpha_j + X_i\beta_j)}}{1 + e^{(\alpha_j + X_i\beta_j)}}; j = 1, 2, \ldots j-1 \quad (3)$$

The general ordered logit model in the above equation follows an illustration where the variables X_1 and X_2 accept this proportional odds assumption why the variables X_1 and X_2 (β_1 and β_2) are the same for all categories of variable dependencies. On the other hand X_3 variable which violates the proportional odds assumption that β on X_3 (β_{3j}) is free in each category in the variable dependent.

$$P_{ij} = \frac{e^{(\alpha_j + X_{1i}\beta_1 + X_{2i}\beta_2 + X_{3i}\beta_{3j})}}{1 + e^{(\alpha_j + X_{1i}\beta_1 + X_{2i}\beta_2 + X_{3i}\beta_{3j})}} \quad (4)$$

The partial proportional odds model in this study used the generally ordered

logit as an analysis tool (Williams, 2006). Interpretation of the partial proportional odds model must be done carefully because the category mark does not always determine the direction of the effect so that the marginal effect is used to interpret results (Sasidharan & Menendez, 2014).

4. Result

The results of the calculation and analysis of food security in Indonesia in 2015 used the Johnsson and Toole calculation method (1991). There were 29.51% of food security, 25.12% of food shortages, 23.14% of vulnerable food and 22.23% of households' insecurity. As explained in the research methodology for calculating food security using two indicators, namely the portion of food expenditure and household energy consumption. The number and percentage of the calculation results can be seen in the table.

Table 3: Result of Calculation of Percentage of Household Food Security in Indonesia 2015

Food Security	Frequency	Percentages (%)
Food insecurity	63,558	22.23
Food shortages	66,160	23.14
Vulnerable food	71,830	25.12
Food secure	84,360	29.51
Total	285,908	100

Source: Badan Pusat Statistik (2015)

The assumption of proportional odds is important in the ordinal logistic model. The implications of the violated proportional odds assumption are shown in Table 3. Figures 1, 2, 3, and 4 are the categories analyzed in the study. This table contains information in the form of coefficients in cumulative logistic regression (1 vs 2,3,4; 1,2 vs 3,4; and 1,2,3 vs 4). The Brant test results show that the proportional odds assumption has been violated by eight variables. To be accepted by the proportional odds assumption, all β must be the same (theoretically) or at least close. Because the ordinal logistic model rejects the parallel lines assumption, the right model used is the general ordered logit.

There are four categories in this study and therefore there are three models in the estimation of the general ordered logit. In Table 5 the dependent variable is re-categorized where Model I is food insecure compared to less, vulnerable and food resistant, Model II is prone and less food than vulnerable and food resistant and so on. Because the model rejects the parallel lines assumption so the model that is suitable for use in this study is the general ordered logit model.

As explained earlier in the methodology of the independent variable that violates the assumptions of parallel lines interpreted using the marginal effect. Table 6 illustrates the marginal effect and standard error of the model of partial proportional odds on the opportunities for food security. The output of Pseudo R2 in this research model is 0.098. This value explains that 9.8% of the variation

Table 4: Proportional Odds Assumption Result Using the Brant Test

Variable	0 vs 1,2,3	0,1 vs 2,3	0,1,2 vs 3	χ^2	*P-value*
TRP	0.551	0.011	0.509	695.77	0.000***
FUEL	0.308	0.208	0.367	420.57	0.000***
ELC	0.743	0.673	0.389	153.67	0.000***
RASKIN	-0.469	-0.216	-0.697	3,538.49	0.000***
EDU	-0.117	-0.406	0.117	3,070.76	0.000***
HEALTH	0.139	0.075	0.201	320.39	0.000***
LOC	0.449	-0.155	0.265	6,244.72	0.000***
GEN	-1.751	-1.618	-1.302	573.72	0.000***

Note: Coefficient *: Significance at α 1% level
0, 1, 2, 3: Differences in the level of food security in the research model

Table 5: Results of Estimating Food Security Using General Ordered Logit 2015

Variable	Model I		Model II		Model III	
	Coef	SE	Coef	SE	Coef	SE
TRP	0.514***	0.011	0.021***	0.009	0.512***	0.011
FUEL	0.297***	0.010	0.224***	0.009	0.362***	0.009
ELC	0.710***	0.017	0.686***	0.017	1.042***	0.028
RASKIN	-0.443***	0.009	-0.230***	0.008	-0.697***	0.010
EDU	-0.144***	0.011	-0.385***	0.010	0.122***	0.011
HEALTH	0.123***	0.009	0.062***	0.008	0.202***	0.008
LOC	0.435***	0.011	-0.150***	0.008	0.277***	0.009
GEN	-1.686***	0.019	-1.604***	0.0142	-1.321***	0.012
Constant	1.668	0.022	1.205	0.021	-1.471	0.029

Note: *** : S is significant at the level of α 1%
Observation : 285,908
Prob>chi2 : 0.000
Pseudo R^2 : 0.098
AIC : 719,096.834
BIC : 719,382.047

of the dependent variable can be explained by the model. The R-squared test results using Mc Fadden R2 of 0.070. Although the results of the Pseudo R2 and Mc Fadden R2 test in a small logit model do not mean the model is considered not good.

Gujarati and Poter (2012) argue that small values are not a problem in logit regression. The main part that must be considered in logistic regression is the model significance indicator, significance on the independent variable and the positive or negative nature of the coefficient on the independent variables and following the economic theory of the model classified as still statistically feasible.

The results of the study showed that the chances of the occurrence of food insecurity households (Y0) were high for households that did not have transportation modes. Households that have transportation modes (TRP) have the opportunity to increase food security (Y3) by 9%, reduce vulnerable food by 9%, increase food shortages by 8% and reduce food insecurity opportunities (Y0) by 9%. These results are following the theory put forward by Selepe et al. (2014) and

Table 6: Result Margin Effect Using General Ordered Logit 2015

Variable	Food Security							
	Y0		Y1		Y2		Y3	
	ME	SE	ME	SE	ME	SE	ME	SE
TRP	-0.090***	0.002	0.082***	0.002	-0.090***	0.002	0.092***	0.001
FUEL	-0.050***	0.002	-0.004***	0.002	-0.016***	0.002	0.067***	0.002
ELC	-0.130***	0.003	-0.030***	0.002	0.003***	0.004	0.160***	0.003
RASKIN	0.072***	0.001	-0.020***	0.001	0.074***	0.002	-0.130***	0.002
EDU	0.022***	0.001	0.066***	0.002	-0.111***	0.002	0.023***	0.002
HEALTH	-0.019***	0.001	0.005***	0.001	-0.023***	0.001	0.040***	0.001
LOC	-0.070***	0.002	0.102***	0.002	-0.090***	0.001	0.052***	0.002
GEN	0.189***	0.001	0.141***	0.002	-0.051***	0.002	-0.280***	0.002

Note: *** : Significant at the level of α 1%
ME : Marginal Effect (dy/dx)
SE : Standard Error
Y0 : Food insecurity
Y1 : Food shortage
Y2 : Vulnerable food
Y3 : Food secure

Frayne (2004) which states that transportation affects the opportunities for household food security. This is because transportation modes play an important role in the mobilization of raw materials between producers and consumers through the market. The mode of transportation makes it easier for households to access food needs so that households become more food-resistant. Also, transportation modes play an important role as household support jobs. This is reflected in the rise of online transportation in Indonesia as a household livelihood. This shows how important the role of transportation is for food security and its relationship with the source of household income.

Based on the results of the study, it was shown that there was a high probability of food insecurity households (Y0) for households that did not have access to household fuel in the form of LPG. Households that have access to household fuels have the opportunity to increase food security (Y3) by 7%, reduce vulnerable food opportunities by 1%, reduce the chance of food shortages by 0.4% and reduce the opportunity for food insecurity (Y0) by 5%. The relationship between food security and cooking fuel is following the theory put forward by Frayne and McCordic (2015) which states that household cooking fuels are positively associated with household food security opportunities. Household fuel is important in maintaining household food so that it can be used properly and used at certain times. LPG fuel and food are related to food processing and storing food to make it more durable. Also, the use of household LPG shows that households have financial adequacy compared to households that still use alternative fuels such as fuelwood and charcoal. So it is appropriate for the 3 kg LPG tube program to be given to underprivileged households to be able to increase the chances of household security.

Households that use electricity (ELC) have an opportunity to food secure

(Y0) at 16%, reduce the chances of vulnerable food by 0.3%, increase the chances of food shortages by 3% and reduce the chances of food insecurity by 13%. This result is following Frayne and McCordic (2015) study which states that households that have access to electricity have a greater impact on household food security opportunities compared to households that do not have access to electricity. This is because electricity is a major requirement in communication, one of which is communication in the need for food supplies. This communication helps producers to meet the food needs of consumer households in various regions. This shows that electricity is one indicator that shows that the majority of households that are electrified can meet their living needs, including in terms of food needs.

Based on the results of the study, households that received poor rice had the opportunity to reduce the chances of food secure by 13%, increase the chances of vulnerable food by 7%, reduce the chances of food shortages by 2% and increase the chances of food insecurity by 7%. The poor rice program (RASKIN) is one of the subsidy programs carried out by the government by providing subsidies in the form of rice to poor households that aim to help poor households to more easily reach their basic needs. This program is quite good unfortunately not good enough in alleviating household food insecurity. The results in table 4.6 show that government programs in the form of poor rice subsidies (RASKIN) are not effective enough to reduce household food insecurity. The existence of this poor rice program, in turn, makes households less productive. This is due to the dependence of households to rely on poor rice as their food staple. Therefore, it is better if the government replaces this program with a program that is more effective in increasing household productivity.

5. Conclusion

The results of the study and analysis of the discussion can be concluded that based on food security calculations and analysis using the Johnsson and Toole method (1991) there were 29.51% of food secure households, 25.12% of vulnerable food households, 23.14% of food shortages and 22.23% of food insecurity. And there is the influence of economic infrastructure (ownership of modes of transportation and electricity use) social infrastructure (ownership of health insurance, education of the head of the household) and household characteristics (use of cooking fuel, use of LPG, household sex, and residential area) of opportunities for food security. The limitations of this study do not include distance as a variable that influences food security opportunities. Future research is expected to be able to provide more detailed variables to provide more complete and better results. This study has not been able to see the extent to which the relationships built in this study can be distributed spatially. Future research is expected to be able to apply the model built in research in life. Poor quality of RASKIN has an impact on people's buying appetite for low Raskin. Seeing this, the government should be able to improve the quality of existing RASKIN or utilize other materials such

as tubers to be used as a staple food.

References

[1] Badan Pusat Statistik. (2015). *Survei Sosial Ekonomi Nasional Tahun 2015*. Jakarta: Badan Pusat Statistik.

[2] Clay et al. (1998). Introduction. In *Food strategies in Bangladesh: Medium and long term perspectives*. University Press Limited, Dhaka.

[3] Esturk, O., & Oren, M. N. (2014). Impact of household socio-economic factors on food security: case of Adana. *Pakistan Journal of Nutrition, 13*(1), 1-6. doi: http://dx.doi.org/10.3923/pjn.2014.1.6.

[4] Food and Agriculture Organization. (2000). *Food insecurity: when people live with hunger and fear starvation* (The state of food insecurity in the world 2000). Italy: Food and Agriculture Organization of the United Nations. http://www.fao.org/3/x8200e/x8200e00.pdf.

[5] Frayne, B. (2004). Migration and urban survival strategies in Windhoek, Namibia. *Geoforum, 35*(4), 489-505. doi: https://doi.org/10.1016/j.geoforum.2004.01.003.

[6] Frayne, B., & McCordic, C. (2015). Planning for food secure cities: Measuring the influence of infrastructure and income on household food security in Southern African cities. *Geoforum, 65*, 1-11. doi: https://doi.org/10.1016/j.geoforum.2015.06.025.

[7] Gujarati, D. N., & Porter, D. C. (2012). *Dasar-dasar ekonometrika*. Jakarta: Salemba Empat.

[8] Johnson, U., & Toole, D. (1991). *Household food security and nutrition: A conceptual analysis [Mimeo]*. New York: UNICEF.

[9] Maxwell, S., & Smith, M. (1992). Household food security: a conceptual review. In S. Maxwell & T. R. Frankenberger, *Household food security: Concepts, indicators, measurements*, Part 1, (pp. 1-72), UNICEF.

[10] Obayelu, A. E. (2012). Households' food security status and its determinants in the North-Central Nigeria. *Food Economics, 9*(4), 241-256. doi: https://doi.org/10.1080/2164828X.2013.845559.

[11] Sasidharan, L., & Menendez, M. (2014). Partial proportional odds model—An alternate choice for analyzing pedestrian crash injury severities. *Accident Analysis & Prevention, 72*, 330-340. doi: https://doi.org/10.1016/j.aap.2014.07.025.

[12] Selepe, M., Sabela, T., & Masuku, M. (2014). The effect of infrastructural challenges on food security in Ntambanana, Kwazulu-Natal, South Africa. *African Journal of Hospitality, Tourism and Leisure, 3*, 1-12.

[13] Tacoli, C. (2013). Urban poverty, food security and climate change. *IIED Briefing Paper, 17149*. International Institute for Environment and Development. https://pubs.iied.org/17149IIED/.

[14] Williams, R. (2006). Generalized ordered logit/partial proportional odds models for ordinal dependent variables. *The Stata Journal, 6*(1), 58-82. doi: https://doi.org/10.1177%2F1536867X0600600104.

[15] World Bank. (1994). *World Development Report 1994: infrastructure for development - executive summary (English)*. World Development Report; World Development Indicators. Washington, DC: World Bank Group. http://documents.worldbank.org/curated/en/687361468340136928/World-Development-Report-1994-infrastructure-for-development-executive-summary.

[16] World Bank. (2005). *Feeding Indonesia*. http://siteresources.worldbank.

org/INTINDONESIA/Resources/Publication/280016-1106130305439/617331-1110769011447/810296-1110769045002/Feeding.pdf.
[17] World Bank. (2019). *DataBank: World Development Indicators*.https://databank.worldbank.org/source/world-development-indicators.

this page intentionally left blank