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Determinant factors on farmers household food security in greater Malang

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Abstract

This study aims to analyze the determinants as to what affects the household food security of farmers. The study was comparative by comparing the results of model calculations in 3 regions in Greater Malang, including Batu City, Malang City, and Malang Regency. The results showed that the chance of a food-insecure (Y0) household is high for households that do not have a mode of transportation. In conclusion, the similarity of points is evidenced by the form of output, which has the same significance level and coefficient in each of these regions.

Keywords: Food security, General ordered logit.

Factores determinantes en la seguridad alimentaria familiar de los agricultores en el gran Malang

Resumen

Este estudio tiene como objetivo analizar los determinantes de lo que afecta la seguridad alimentaria de los hogares de los agricultores. El estudio fue comparativo al comparar los resultados de los cálculos del modelo en 3 regiones en Greater Malang, incluidas Batu City, Malang City y Malang Regency. Los resultados mostraron que la posibilidad de un hogar con inseguridad alimentaria (Y0) es alta para los hogares que no tienen un modo de transporte. En conclusión, la similitud de puntos se evidencia por la forma de salida, que tiene el mismo nivel de significancia y coeficiente en cada una de estas regiones.

Palabras clave: Seguridad alimentaria, Logit ordenado en general.

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1. INTRODUCTION

Previous research shows that studies of food security issues are closely related to population growth, natural climate, poverty, inequality, conflict/war, and other similar problems. In this phenomenon, when there is a global crisis there will usually be adjustments to various policy transmissions, but unfortunately, the phenomenon of food security will always occur. Meanwhile, FAO and UNICEF claim that a population explosion that continues to grow will be an obstacle to achieving food security in the next 30 years. That is, the problem of food security becomes an exciting topic to study solutions and coping strategies.

The problem of food security remains a particular challenge in developing countries such as Africa, most of Asia. The collaboration between The Economist and Cortera announces the results of their study of the Global Food Security Index (GFSI) or the index of global resilience. Indonesia's position is still considered unsafe from food insecurity because it even claims that 5 ASEAN countries such as Singapore, Malaysia, Thailand, Vietnam, and the Philippines. Last year, Indonesia was ranked 65 out of 113 countries surveyed. This means that Indonesia still has food security problems.

Based on the phenomenon that occurred and the tracking of previous studies. This research plan will focus on exploring the factors that are determinants of food security in Greater Malang, including Batu City, Malang City, and Malang District. There are farmers'

households. This is different from previous studies. First, because it contains a comparative study of food security in the three regions. Second, food security indicators are adapted from ACHEAMPONG, SAYER & MACGREGOR (2018) measurements that classify food security indicators in levels: Food Security, Food Vulnerability, Food Deficiency, and Food Insecurity which will form the basis of the general ordered logit model in this study. Third, the use of determinants of economic and social factors such as ownership of electricity, use of power, type of education, health insurance, type of work, property of LPG gas, status of rice recipient, home location, head sex household, land ownership, and other similar factors (BRÜCK & D'ERRICO, 2019).

2. METHODOLOGY

The food security model in this study uses qualitative response regressions because the dependent variable in the form of probability for household food security divides into four categories: Food Insecure (Y0), Food Less secure (Y1), Food Vulnerable (Y3), and Food Secure (Y4). While the independent variables used in this study were ownership of household transportation (TRANS) is a dummy, 1 is used for households that have one type of vehicle and value 0 is used for households that do not have transportation. Electricity use (ELEC) is a dummy variable, where 1 is used in households that use electricity and number 0 is used in households that do not use electricity. Education of the head of the household (EDUC) explains about the education of

the head of an educated household given 1 or given the number 0 for the other. Household health insurance (HH) is a dummy variable that shows if 1 is intended for households that have health insurance and 0 is intended for households that do not have health insurance (DIAZ-BONILLA, THOMAS, ROBINSON & CATTANEO, 2000).

One of the key assumptions of the ordered probability models is that they must meet the proportional odds assumption, then the relationship between any two pairs in the dependent variable group is the same. This forces the coefficients for independent variables in the model to remain constant for all levels of the dependent variable. However, we know that some covariates might increase the probability of occurrence of some crash severity level(s); whereas they might reduce the probability of occurrence of some other severity level(s). Savolainen and Mannering and Peterson and Harrell suggest that ordered logit/probit models cannot account for this. AHMADI & MELGAR-QUIÑONEZ (2019) reported that the violation of proportional odds assumption in ordered logit models may lead to incorrect, incomplete or misleading results (Omoruyi, 2015).

Ordered logit models can be derived based on the level of an unobserved variable (AHMED, YING, BASHIR, ABID & ZULFIQAR, 2017). A vital assumption of these models is that the data meet the proportional odds assumption, i.e., the relationship between any two levels in the dependent variable group is the same and therefore the slope coefficients do not vary over different alternatives except the cut-off points. Based on the assumption the proportional

odds effect of the independent variables is the same for all categories on the dependent variable (BRÜCK, D'ERRICO & PIETRELLI, 2018).

This implies that the probability for Food Insecure (Y0)+Food Less secure (Y1)+Food Vulnerable (Y2) vs Food Secure (Y3), is similar to Food Secure (Y3), vs. Insecure (Y0)+Food Less secure (Y1)+Food Vulnerable (Y3). However, in the analysis of the probabilities for food security, it is not logical to assume that the different levels of food insecurity are the same. To consider the proportional odds assumptions accepted or rejected, a Brant test was performed. This test is used to compare predictors of independent variables at different levels of endurance (CLAY, 2002). The Brant test compares the slope of the (j-1) 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 the two variables in the dependent variable category is the same, therefore the slope coefficient does not vary except the cutoff. Yi is an observation of the level of food security in households, Yi* is a latent variable that is not measurable whose value determines what the Yi variable observes, x is the independent variable, j is the level of Food Insecure (0 = Food Less secure, 1 = Food Vulnerable, 2 = food shortages, and 3 = Food Secure) and j the number of levels of food security (in this study j = 4). The size of Yi* latent food security can be written as follows:

$$Yi^{*} = x_i\beta + \varepsilon \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where β is the regression coefficient x, ε is the error distribution. μk is the cutoff for food security, k = 0, 1. . . , j-1. The following is the difference in the Y value:

Table 1: Criteria for Food Security Using the Johnsson and Toole Method

Energy Consumption Level	The proportion of Food Expenditures: Low (<60% of total expenditure)	High (≥60% of total expenditure)
Enough (> 80% energy sufficiency)	Food Secure (Y3)	Vulnerable Food (Y2)
Less (≤80% energy sufficiency)	Food Less secure (Y1)	Food Insecure (Y0)

Source: Johnsson, U., and Toole

Y = 0 Food Insecure if Y* ≤ μ1

Y = 1 Food Less secure if μ1 ≤ Y* ≤ μ2

Y = 2 Vulnerable Food if μ2 ≤ Y* ≤ μ3

Y = 3 food secure if Y* > μ3

j is the number of levels of food security, the probability for household food security can be written as follows (WILLIAMS, 2006):

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

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. The ordinal logistics 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 probability of food security entirely. The partial proportional odds model is a model that bridges the boundary between ordinal logistics and multinomial logistics models. The most relevant thing about this partial proportional odds model is that it allows certain individuals on independent variables to affect each category differently, while other independent variables assume the proportional odds assumption. The probability of household food security can be written as follows.

$$P(Y_i > j) = \frac{e(\alpha_j + X_i\beta_j)}{1+e(\alpha_j + X_i\beta_j)}; j = 1, 2 \dots j-1 \text{.....(3)}$$

The partial proportional odds 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, the X_3 variable violates the proportional odds assumption that β on X_3 (β_{3j}) is free for each category in the variable dependent.

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

The partial proportional odds model in this study used the generally ordered logit as an analysis tool (DAUD, OMOTAYO, AREMU & OMOTOSO, 2018). Interpretation of the partial proportional odds model must be carried out carefully because the category sign does not always determine the direction of the effect. So that the marginal effect is used to interpret the results (DICKIN, DAGERSKOG, JIMÉNEZ, ANDERSSON & SAVADOGO, 2018).

3. RESULTS AND DISCUSSION

The first measurement in the partial proportional odds model is the multicollinearity measurement. The results of multicollinearity measurements in the model are shown in table 2. The table shows that there are no variables that have a VIF value> 10. This means that there is no strong correlation between the independent variables so that it can be concluded that there is no multicollinearity variable in the model used in this study. So that research can proceed to the next stage

Table 2: Multicollinearity Measurement Results

Variables	VIF	1/VIF
	Malang Regency	
TRANS	1,21	0,962
LPG	1,23	0,932
ELEC	1,14	0,821

RAS	1,08	0,988
EDUC	1,09	0,887
HH	1,05	0,920
CITY	1,11	0,982
GENDER	1,05	0,923
Mean VIF	1,16	
	Malang City	
TRANS	1,22	0,812
LPG	1,21	0,801
ELEC	1,17	0,876
RAS	1,01	0,928
EDUC	1,18	0,853
HH	1,06	0,998
CITY	1,13	0,840
GENDER	1,03	0,917
Mean VIF	1,12	
	Batu City	
TRANS	1,20	0,809
LPG	1,29	0,800
ELEC	1,15	0,889
RAS	1,09	0,930
EDUC	1,13	0,854
HH	1,09	0,995
CITY	1,10	0,846
GENDER	1,11	0,913
Mean VIF	1,15	

Source: own calculations used Stata. 12.0

Brant test results in this study indicate that there are eight variables that reject parallel lines assumption/ proportional odds assumption. All variables (TRANS, LPG, ELEC, RAS, EDUC, HH, CITY, and GENDER) in this study reject the assumption of parallel

lines/ proportional odds assumption. Where indicated by the p-value on all independent variables in a significant model at a confidence level of 99% or α 1%. Table 3 explains the variables that reject this assumption. Because the ordinal logistic model rejects parallel lines assumption, the suitable model used in this study is partial proportional odds/general ordered logit (BLACK, WALKER, FERNALD, ANDERSEN, DIGIROLAMO, LU & DEVERCELLI, 2017).

Table 3: Results of Parallel Assumptions Using Brant Test

Variables	0 vs 1,2,3	0,1 vs 2,3	0,1,2 vs 3	χ^2	P-value
		Malang Regency			
TRANS	0,457	0,343	0,2321	5 456,87	0,000***
LPG	0,434	0,353	0,214	574,04	0,000***
ELEC	0,575	0,345	0,875	754.37	0,000***
RAS	-0,878	-0,13	-0,343	475.18	0,000***
EDUC	-0,244	-0,123	0,646	57.81	0,000***
HH	0,658	0,253	0,474	532.19	0,000***
CITY	0,436	-0,866	0,124	4262.72	0,000***
GENDER	-1,466	-1,123	-1,435	464.72	0,000***
		Malang City			
TRANS	0,361	0,231	0,499	5 837,87	0,000***
LPG	0,309	0,393	0,397	390,29	0,000***
ELEC	0,827	0,298	0,284	282.67	0,000***
RAS	-9,292	-0,838	-0,983	3838.02	0,000***
EDUC	-0,293	-0,838	0,932	382.83	0,000***
HH	-0,381	-0,732	0,023	294.92	0,000***
CITY	0,864	-0,848	0,823	983.91	0,000***
GENDER	-1,943	-1,982	-1,092	732.92	0,000***
		Batu City			
TRANS	0,743	0,918	0,384	6 873,87	0,000***
LPG	0,392	0,383	0,843	832,04	0,000***

ELEC	0,910	0,873	0,933	173.37	0,000***
RAS	-0,762	-0,833	-0,939	884.18	0,000***
EDUC	-0,124	-0,932	0,927	171.81	0,000***
HH	0,932	0,093	0,873	828.19	0,000***
CITY	0,349	-0,345	0,235	3434.72	0,000***
GENDER	-1,341	-1,458	-1,142	343.72	0,000***

Source: own calculations used Stata. 12.0

Notes:
Coefficient ***: Significance at the level α 1%
0,1,2,3: Differences in the level of food security in the research model
(0 vs 1,2,3): Regression coefficient cumulative logistic food insecure vs food less secure, vulnerable food, food secure
(0,1 vs 2,3): Regression coefficient cumulative logistic food insecure, food less secure vs vulnerable food, food secure
(0,1,2 vs,3): Regression coefficient cumulative logistic food insecure, food less secure, vulnerable food vs food secure

This section provides the results of food security using ordinal logistics. Table 4 is the result of estimating food security opportunities using ordinal logistics including the coefficient of the independent variable, the cutoff in each category on the dependent variable, the odds ratio and the significance of each independent variable (p-value). In the ordinal logistic model, a positive coefficient indicates that an increase in the value of the independent variables (TRANS, LPG, ELEC, RAS, EDUC, HH, CITY, and GENDER) will increase the chances of food security of farm households.

Table 4: Results of Food Security in Indonesia Ordinal Logistics Model

Variable	Coefficient	SE	**Odds ratio**

	Malang Regency		
TRANS	0,212***	0,006	1,274
LPG	0,280***	0,006	1,345
ELEC	0,725***	0,018	2,234
RAS	-0,350***	0,008	0,455
EDUC	-0,184***	0,009	0,562
HH	0,187***	0,009	1,232
CITY	0,192***	0,009	1,233
GENDER	-1,345***	0,012	0,232
Cut1	-1,345		
Cut2	-0,832		
Cut2	0,923		
	Malang City		
TRANS	0,317***	0,009	1,121
LPG	0,270***	0,005	1,323
ELEC	0,534***	0,013	2,178
RAS	-0,560***	0,009	0,523
EDUC	-0,124***	0,007	0,890
HH	0,123***	0,007	1,353
CITY	0,173***	0,008	1,171
GENDER	-1,364***	0,009	0,630
Cut1	-1,743		
Cut2	-0,732		
Cut2	0,743		
	Batu City		
TRANS	0,323***	0,003	1,272
LPG	0,780***	0,074	1,852
ELEC	0,323***	0,893	2,832
RAS	-0,872***	0,007	0,322
EDUC	-0,922***	0,008	0,028
HH	0,103**	0,003	1,093
CITY	0,1893**	0,094	1,732
GENDER	-1,032***	0,08	0,983
Cut1	-1,832		
Cut2	-0,022		

Cut2	0,323

Source: own calculations used Stata. 12.0

Conversely, an increase in the independent variable with a negative value will reduce household food security opportunities. The odds ratio is used to see the results for each independent variable. The Cut1, Cut2 and Cut3 values in table 5 are the threshold values that separate each category on food security opportunities. Cut1 is an estimate of the variable Y used to distinguish opportunities for food security in the form of food insecurity (Y0) with lack of food (Y1), food insecurity (Y2) and food security (Y3) when the independent variable is 0. Meanwhile, Cut2 is an estimated limitation that distinguishes food insecurity (Y0) and lack of food (Y1) with food insecurity (Y2) and food insecurity (Y3). Cut3 is a limiting estimate that distinguishes food resistance (Y3) from the others.

Bearing in mind that there are no differences in the determinants of factors affecting the food security of farm households in the Malang area, this study provides results that can be compared to more differences in the conditions of food security that is happening.

This research will ultimately combine all survey elements into one data that covers the area of Malang Regency, Malang City, and Batu City. Based on this explanation of the results of research using generally ordered logistics will also be adjusted so that the language will focus on the condition of Greater Malang.

Table 5: Estimation Results of Farmers Household Food Security in Malang Using General Ordered Logit

Variables	Model 1		Model II		Model III	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
TRANS	0,545***	0,032	0,928***	0,002	0,983***	0,023
LPG	0,844***	0,002	0,982***	0,022	0,374***	0,033
ELEC	0,393***	0,092	0,827***	0,045	1,373***	0,034
RAS	-0,343***	0,082	-0,827***	0,043	-0,933***	0,052
EDUC	-0,232***	0,082	-0,029***	0,043	0,433***	0,545
HH	0,232***	0,082	0,022***	0,843	0,921***	0,454
CITY	0,242***	0,028	-0,192***	0,832	0,042***	0,543
GENDER	-1,292***	0,029	-1,332***	,0023	-1,021***	0,462
Constant	1,282	0,029	1,343	0,329	-1.232	0,263

Source: own calculations used Stata. 12.0

Notes
***: Significance at the level α 1%
Observasi: 600
Prob>chi2: 0,000
Pseudo R2: 0.098
AIC: 78234324.834
BIC: 79238212.047

As explained earlier in the methodology the independent variable that violates the proportional odds assumption is explained using marginal effect because the direction of the independent variable that violates the proportional odds assumption does not always determine the course of the impact. Table 6 illustrates the negligible effect and the standard error in the partial proportional odds model in each category of household food security. Table 6 shows that the chance of a food-insecure (Y0) household is high for families that receive poor rice (RAS) and female heads of household (GENDER).

The chance of a food-insecure (Y0) household is low for heads of households that have a mode of transportation (TRANS).

Table 7: Results of Marginal Effects and Standards of Error in Food Security of Farmers Households in Greater Malang Using General Ordered Logit

Variables	Food Security							
	Y0		Y1		Y2		Y3	
	ME	SE	ME	SE	ME	SE	ME	SE
TRANS	-0,020***	0,043	0,024***	0,001	-0,043***	0,003	0,074***	0,013
LPG	-0,232***	0,032	-0,023***	0,001	-0,033***	0,006	0,042***	0,042
ELEC	-0,239***	0,006	-0,023***	0,003	0,013***	0,002	0,342***	0,043
RAS	0,943***	0,008	-0,045***	0,004	0,034***	0,001	-0,132***	0,031
EDUC	0,034***	0,002	0,052***	0,005	-0,011***	0,008	0,433***	0,012
HH	-0,923***	0,002	0,045***	0,001	-0,033***	0,004	0,340***	0,011
CITY	-0,021***	0,001	0,032***	0,003	-0,010***	0,004	0,342***	0,023
GEN	0,145***	0,007	0,023***	0,005	-0,011***	0,004	-0,380***	0,002

Source: own calculations used Stata. 12.0

Notes
***: Significance at the level α 1%
ME: Marginal Effect (dy/dx)
SE: Standart Error
Y0: food insecure
Y1: food less secure
Y2: vulnerable food
Y3: food secure

The results showed that the chance of a food-insecure (Y0) household is high for households that do not have a mode of transportation. Households that have a way of transportation (TRANS)

have an opportunity to increase food security (Y3) by 9%, reduce the chance of food vulnerability by 9%, increase food shortage opportunities by 8% and reduce the chance of food insecurity (Y0) by 9%. This is because the mode of transport plays a vital role in the mobilization of raw materials between producers and consumers through the market. The method of transportation makes it easier for households to access their need for food, making them more food-resistant. Also, the mode of transportation also plays a vital role in supporting household work. This is reflected in the rise of online traffic in Indonesia as a livelihood for households. This shows how vital the part of transportation is for food security and its relationship with household income sources.

4. CONCLUSIONS

Based on the results of the study and analysis of the discussion, it can be concluded that, based on calculations and review of food security using the Johnsson and Toole methods, there is a profile characteristic level of resilience. Based on this issue, the similarity of points is also evidenced by the form of output, which has the same significance level and coefficient in each of these regions. Upon these forms of similarity, all respondents were then combined as materials to form a model that was expected to represent conditions in each area.

The merging of data carried out provides results including the effects of economic infrastructure, social infrastructure and household

characteristics on food security opportunities in Indonesia. Ownership of modes of transportation, electricity usage, education of household heads, health insurance, use of LPG and household residence locations positively influence food security opportunities, whereas the status of poor people's rice reception and household gender negatively affects food security. Limitations in this study do not include distance as a variable that affects food security opportunities. Future studies are expected to be able to provide more detailed variables, so that they provide more complete and better results. Then, this research has not been able to see the extent to which the relationships built in this study can be spatially distributed. Future studies are expected to be able to apply models that consider many aspects.

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