

DETERMINANTS OF OFF-FARM HOUSEHOLD INCOME: EVIDENCE FROM RICE FARMERS IN INDONESIA

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ABSTRACT

Most small-scale rice farming households in Indonesia face land ownership constraints that result in low on-farm income levels, often falling below the national poverty line. In such circumstances, off-farm income serves as a vital alternative source to meet household needs. This study aims to identify the key determinants of off-farm income among rice farming households in Indonesia using the two-step Heckman selection model to address potential sample selection bias. The analysis is based on household survey data collected in 2016 by the Ministry of Agriculture of the Republic of Indonesia, comprising 321 farming households across 14 major rice-producing districts. The estimation results indicate that off-farm income is significantly influenced by macro-level factors, such as the proportion of non-agricultural labor in the district and geographical proximity to economic centers. At the micro level, the number of working household members and the educational attainment of the household head are positively associated with off-farm income. Conversely, limited access to land and low levels of non-labor income serve as push factors driving participation in low-productivity off-farm activities. The findings suggest that policy interventions should focus on promoting the development of non-agricultural industries in rural areas and improving farmers' access to education and vocational training in order to enhance income diversification and strengthen the economic resilience of farming households.

Keywords: off-farm income, rural development, small farming household, two-step Heckman selection model

ABSTRAK

Sebagian besar rumah tangga petani padi skala kecil di Indonesia menghadapi keterbatasan penguasaan lahan yang berdampak pada rendahnya pendapatan usahatani, bahkan berada di bawah garis kemiskinan. Dalam kondisi tersebut, pendapatan dari luar usahatani (off-farm) menjadi sumber pendapatan alternatif dan menjadi andalan dalam memenuhi kebutuhan rumah tangga petani. Penelitian ini bertujuan untuk mengidentifikasi faktor-faktor determinan pendapatan off-farm rumah tangga petani padi di Indonesia dengan menggunakan pendekatan two-step Heckman selection model untuk mengatasi bias seleksi sampel. Data yang digunakan bersumber dari survei rumah tangga petani tahun 2016 dari Kementerian Pertanian Republik Indonesia, dengan total sampel sebanyak 321 rumah tangga petani dari 14 kabupaten sentra produksi padi. Hasil estimasi menunjukkan bahwa pendapatan off-farm dipengaruhi secara signifikan oleh faktor makro seperti proporsi tenaga kerja non-pertanian di wilayah kabupaten dan kedekatan geografis dengan pusat aktivitas ekonomi. Pada level mikro, jumlah anggota rumah tangga yang bekerja dan tingkat pendidikan kepala rumah tangga berpengaruh positif terhadap pendapatan off-farm. Sebaliknya, keterbatasan lahan dan rendahnya pendapatan non-tenaga kerja menjadi faktor pendorong keterlibatan dalam aktivitas off-farm dengan produktivitas rendah. Implikasi kebijakan yang disarankan mencakup pengembangan industri berbasis non-pertanian di wilayah pedesaan serta peningkatan akses petani terhadap pendidikan dan pelatihan kejuruan untuk memperkuat diversifikasi pendapatan rumah tangga petani.

Kata kunci: pembangunan perdesaan, pendapatan dari luar usahatani, rumah tangga petani skala kecil, two-step Heckman selection model

INTRODUCTION

Rice is a strategic commodity for Indonesia, not only because it is the staple food for most Indonesians, but also because it is an important source of household income for food crop farmers. Based on the 2018 intercensus agricultural survey, conducted by the Statistics Indonesia (BPS), it can be seen that of the 27.68 million farming households in Indonesia, 36.64% have rice farming as their main crop. Rice farmers control an average of only 0.18 hectares of rice fields (Statistics Indonesia, 2018).

With such a narrow paddy field (0.18 hectares of rice fields), farming households earn on-farm incomes equivalent to below the poverty line, according to the BPS definition. To obtain an equivalent rice farming income above the poverty line, farmer households need a minimum of 0.65 hectares of rice fields (Susilowati & Maulana, 2012). This phenomenon suggests that income from activities outside of farming, or off-farm income, is an unavoidable necessity and becomes a way for farm households with small landholdings to escape poverty.

Many previous studies have stated that off-farm income, especially from non-agricultural activities, is important for farming households and rural development. Among them, it can increase the food security of farming households (Mishra & Khanal, 2017; Tadesse, 2022), and can reduce poverty in rural areas (Huang, Zheng, & Wang, 2022; Imai, Gaiha, & Thapa, 2015). Considering the importance of off-farm income for farming households and rural development, it is necessary to analyze the determining factors that can increase the off-farm income of farming households.

On the one hand, land tenure by farmers is getting smaller (Statistics Indonesia, 2018); on the other hand, it has long been known that technological advances cause the use of labor to be replaced by capital (Wadley, 2021), so that farmers have an excess of productive labor that is not absorbed in on-farm activities. Off-farm employment among members of

farm households is often viewed as part of the labor transition from full engagement in agriculture to participation in non-agricultural sectors. As noted by Lewis (1954), this labor transition reflects a structural economic transformation marked by the shift of the workforce from agriculture to more productive, higher-income non-agricultural sectors. In several developed and developing countries, off-farm employment has been encouraged as part of the structural transformation of economic development (Ngo, 2018; Sheng et al., 2022).

The structural transformation in Indonesia did not occur in a balanced manner, where the decline in the share of agriculture in GDP was not followed at the same pace by the decline in the share of the agricultural sector in employment. Based on data published by the Statistics Indonesia, it appears that there is an imbalance between the share of the agricultural sector in GDP and its share in employment, which in 2021 will be 13.28% and 29.96% respectively. As a result of the imbalance in structural transformation, land tenure per worker is getting smaller, and poverty alleviation is becoming increasingly difficult in the agricultural sector and rural areas. Thus, the development mode that can increase the access of farming households to increasing job opportunities outside the agricultural sector, both off-farm and non-farm, needs to be continuously promoted.

Many studies have been conducted on the determinants of the off-farm income of farming households (Anang & Yeboah, 2019; Iqbal et al., 2021; Mebrate et al., 2019). Various studies on the factors that affect the off-farm income of farmer households have emphasized the internal conditions of farmers and farmer households, such as age, education, number of household members, asset ownership, and the distance of the farmer's house to the market or city center.

The main objective of this study is to investigate the factors that affect off-farm income of rice farmers' households. In contrast to previous studies on the determinants of farmers' household off-farm income, this stu-

dy was an improvement from previous research on off-farm income, which relies entirely on micro aspects at the household level. In addition to micro variables at the household level of rice farmers, this study also employed macro variables to capture the effect of labor market conditions on the off-farm income of farmers' households. In addition, this study also included aspects of farmers' incomes that were not from labor, such as income transfers from outside the nuclear family, rental of assets or agricultural equipment, and government assistance, which previous studies had not taken into account.

The results of this study are expected to be useful as basic information for the formulation of various policies in the agricultural and rural sectors, particularly those aimed at improving farmers' welfare and economic transformation in rural areas. Increasing the involvement of farm household workers outside of their farm and in non-agriculture activities certainly has an influence that cannot be ignored on agricultural and rural development (Haile, Seyoum, & Azmeraw, 2021; Sauer, Gorton, & Davidova, 2015; Yang et al., 2016).

METHOD

DATA

The types of data used in this study include micro data at the farmer household level and macro data at district and provincial levels. The macro data for 2015 comes from the Statistics Indonesian, namely, the percentage of non-agricultural sector workers at the regency level, distance to the nearest shopping areas, distance from the village to the district capital, distance from the village to the provincial capital, and land area of rice fields in the district.

Meanwhile, micro data at the rice farmer household level employed data from the survey results of the Center for Socio-Economic and Agricultural Policy of the Ministry of Agriculture Republic Indonesia, which was held in 2016. Fourteen districts in Indonesia's

rice production centers were selected as the survey sample. From each sample district, one village of irrigated rice fields was selected, and from each sample village, approximately 25 farming households were randomly selected. Considering the completeness of the data, the total sample that can be used in this study was 321 farmer households.

MODEL ANALYSIS

From a total sample of 321 farming households, it turned out that there were 27.7% who did not work in off-farm activities, so their off-farm income was zero. Estimating off-farm income only on the dataset of farm households with non-zero off-farm income will cause sample selection bias. The two-step Heckman selection model approach can overcome the problem of sample selection bias (Greene, 2012; Heckman, 1979).

The two-step Heckman selection model was expressed using two equations (Greene, 2012). In this study First, the selection equation (D_j , decision of the j^{th} farmer household to work or not to work in off-farm activities) is expressed as

$$D_j = \beta_1' x_{1j} + \varepsilon_{1j} \dots \dots \dots (1)$$

Second, the outcome equation (I_j , off-farm income of the j^{th} farmer household) is expressed as:

$$I_j = \beta_2' x_{2j} + \varepsilon_{2j} \dots \dots \dots (2)$$

Where, x_1 and x_2 are vectors of explanatory variables for farmers' household decisions to work or not to work in off-farm activities and off-farm income, respectively. β_1 and β_2 are vectors of model parameters, and ε_1 and ε_2 are error components representing other unobserved factors. Component ε_{2j} was affected by component ε_{1j} .

The two-step Heckman selection model makes the following two assumptions (Greene, 2012). First, ε_1 is normally distributed with a mean equal to 0 and variance equal to 1, ε_2 is normally distributed with mean 0 and variance equal $\sigma_{\varepsilon_2}^2$, and the error term of both equations corresponds to the

Table 1. Description of Research Variables

Variable	Description
<i>I</i>	Total farmer household income from off-farm activities (IDR. 000)
<i>D</i>	Dummy farmer household who earned off-farm income (=1 if there is, =0 if otherwise)
x (vector of explanatory variables):	
<i>X1</i>	Share of non-agricultural sector workforce in the district (%)
<i>X2</i>	Distant to nearest shopping area (Km)
<i>X3</i>	Distant to district capital (Km)
<i>X4</i>	Distant to province capital (Km)
<i>X5</i>	Area of rice fields in the district (Hectares)
<i>X6</i>	Age of head of farmer household (Years)
<i>X7</i>	Farmer household head education (Years)
<i>X8</i>	Number of farm household workers (Person)
<i>X9</i>	Area of agricultural land cultivated by farmer households (Hectares)
<i>X10</i>	Farmer household non-labor income (IDR 000)

correlation level of $Corr(\varepsilon_1, \varepsilon_2) = \rho$. Consequently, the error term $(\varepsilon_1, \varepsilon_2)$ has a bivariate normal distribution

(NBV) with a mean of 0 and covariance Σ . In other words, $(\varepsilon_1, \varepsilon_2) \sim NBV(0, \Sigma)$, where $\Sigma = \begin{pmatrix} 1 & \rho\sigma_{\varepsilon_2} \\ \rho\sigma_{\varepsilon_2} & \sigma_{\varepsilon_2}^2 \end{pmatrix}$. Second, D_j is a latent variable that is expressed as a probit model, with dummy variable $D_j^* = 1$ for farmer households who work in the off-farm labor market (or off-farm participants) and $D_j^* = 0$ for farmer households who do not work in the off-farm. Therefore, $D_j^* = 1$, if $D_j > 0$, and $D_j^* = 0$ otherwise. Based on these assumptions, the off-farm income equation for farmers participating in off-farm households can be stated as follows,

$$I_j|_{D_j^*=1} = \beta_2'x_{2j} + \delta\left(\frac{\phi(\beta_1'x_{1j})}{\Phi(\beta_1'x_{1j})}\right) + e_j, \dots\dots\dots(3)$$

where ϕ and Φ represent the standard normal and cumulative distribution function, respectively. Meanwhile $\frac{\phi(\beta_1'x_{1j})}{\Phi(\beta_1'x_{1j})} = \hat{\lambda}(\beta_1'x_{1j})$ can be referred to as *Inverse Mills Ratio* (IMR) or *Heckman lambda* variable.

The IMR variable in (3) acts as a bias controller. If the coefficient $\delta \neq 0$, then there is a sample selection bias problem, meaning that ignoring the effect of $\lambda(\beta_1'x_{1j})$ on the estimated off-farm income in general will result in an inconsistent estimated coefficient β_2 (Greene, 2012).

By only employing the data set of farmer households with non-zero off-farm income, and by including the *Heckman lambda* ($\hat{\lambda}(\beta_1'x_{1j})$), then the final equation of the off-farm income of the farmer's household is obtained, which is called the two-step Heckman selection model, as stated by equation (3). The error component (e_j) in equation (3) is random; therefore, the estimation of equation (3) using the ordinary least squares (OLS) method produces an unbiased model coefficient (Greene, 2012).

Equation (3) then becomes an analysis model for the determinants of farmer households' off-farm income in this study. In this study, the explanatory variable vector for the selection equation (x_1) is the same as that for off-farm income equation (x_2). To explain the off-farm income of farmer households, this study uses macro variables at the district level (X1-X5) and micro variables at the rice farmer household level (X6-X10). The definitions of the research variables are shown in Table 1.

RESULT AND DISCUSSION

Table 2 presents descriptive statistics on research variables and sources of farmer household income, based on the research sample data. It can be seen that in general, the control of farmer households over production factors was very limited. This situation was visible from three things. First, the education

Table 2. Descriptive Statistic Research Variables and Sources of Farmer Household Income

Variable	Mean	StDev.	Min.	Max.
Share of non-agricultural sector workforce in the district (%)	62.7	12.4	34.6	83.7
Distant to nearest shopping area (km)	6	8	0	35
Distant to district capital (km)	63	76	4	281
Distant to province capital (km)	142	91	12	410
Area of rice fields in the district (hectares)	61,527	27,480	16,673	11,5913
Age of head of farmer household (years)	54	10	27	78
Farmer household head education (years)	7	4	0	18
Number of farm household workers (person)	3	1	0	7
Area of agricultural land cultivated by farmer households (hectares)	1.01	0.95	0.01	5.19
<i>Sources of farmer household income:</i>				
Household non-labor income (IDR 000)	2,662	11,697	0	155,000
Household off-farm income (IDR 000)	15,872	30,098	0	360,000
Household on-farm income (IDR 000)	31,633	37,523	-2,348	249,930
Total household income (IDR 000)	50,166	54,040	2,275	572,797
Average share of off-farm income to total farmer household income	= 32 %			
Average share of non-labor income to total farmer household income	= 5 %			
Percentage of farmer households with off-farm income	= 72 %			

level of the head of a farmer's household, on average, was only equivalent to graduating from elementary school (7 years). With such a low level of education, farmers tend to have difficulty accessing jobs outside the agricultural sector, which generally require relatively high educational qualifications.

Second, in Table 2 appears that, in general, the non-labor household income of the sample farmers is relatively low. The average non-labor income of the sample farmer households is around IDR 2.662 million per year or equivalent to IDR 0.22 million per month. Sources of non-labor income are referred to, among others, from the rental of agricultural equipment assets, bank interest, assistance, or transfers from relatives or the government. Evidence from Aggarwal et al. (2024) supports the importance of such transfers, showing that cash transfers can enhance food security and increase agricultural productivity by encouraging farm investments and reducing reliance on casual off-farm labor.

Rural areas in developing countries generally have indigenous arrangements for mutual assistance and risk-sharing (Beegle et al., 2018; Nengah et al., 2016). This mutual assistance system can be categorized as an informal safety net that can help farmers when

they do not have a source of income to meet their household needs. Crop failure and the inability to access jobs outside of farming can cause farming households to fall into poverty. However, these informal safety net systems in rural areas are often insufficient to fully relieve households from poverty or the risk of failure to generate income (Grimm et al., 2020); therefore, government policies and assistance are still needed.

Third, the average area of agricultural land cultivated by farmer households was around 1.01 hectares, with the area of rice fields controlled by farmer households on average only about 0.64 hectares. The limited land that can be cultivated by farmers has implications for the low income obtained from farming activities, which was only around IDR 31.63 million per year or equivalent to IDR 2.64 million per month (see Table 2).

The description above generally shows that the non-labor household income and the average area of agricultural land cultivated by farmer households are relatively low. This indicates that the limited control of farmers on farming production factors, especially non-labor income and the area of agricultural land and rice fields, will be a push factor to earn income outside their farms (off-farm income).

Based on the sample data, it appears that there were 72% of farming households that had off-farm sources of income, with an average off-farm income of only around IDR 15.87 million per year, or equivalent to IDR 1.32 million per month, or equal to 32% of the total household income of farmers (see Table 2). Furthermore, to analyze the determinants of off-farm income of farmer households, this research uses a two-step Heckman selection model approach which is stated in equation (3). The model estimation results are presented in Table 3. Based on the results of the Wald Chi2 test, it appears that the Heckman selection of the predicted model obtained was statistically significant. This was indicated by the Wald Chi2 (10) statistic, which was greater than the table value $\chi^2_{10(1\%)} (23.2)$, and the probability $> \chi^2$ less than 0.1 %. Thus, the estimated Heckman selection model presented in Table 3 can be used to explain the determinants of farmers' household off-farm income.

In terms of the influence of spatial and socio-economic factors on the off-farm income of farmer households, Table 3 shows that there are 3 macro variables have a significant effect on the off-farm income of farmer households. First, the distance from the village to the district and province has a negative and significant effect on the off-farm income of farmer households. This shows that the closer the distance to the regency/province, the cheaper the transportation costs to the labor market outside the agricultural sector in the district or province. The cheaper transportation costs will increase the real wages received by farming households. An increase in real wages increases the off-farm income of farming households. This finding is in line with the results of Anang & Yeboah (2019), and Iqbal et al. (2021).

Second, the percentage of non-agricultural workers in the district has a positive and significant effect on the off-farm income of

Table 3. Equation Results for Determinant of Off-Farm Household Income in Indonesia

Variable		Coef.	Std. Err.	P>z
<i>Dependent variables: Ln(off-farm income)</i>				
<i>Ln(I)</i>				
<i>Explanatory variables (Z):</i>				
Share of non-agricultural sector workforce in the district	X1	0.0181**	0.0089	0.041
Distant to nearest shopping area	X2	-0.0161	0.0165	0.332
Ln(Distant to district capital)	Ln(X3)	-0.2260**	0.1052	0.032
Ln(Distant to province capital)	Ln(X4)	-0.4286***	0.1464	0.003
Ln(Area of rice fields in the district)	Ln(X5)	-0.3194	0.2908	0.272
Age of head of farmer household	X6	-0.0119	0.0203	0.556
Education of household head	X7	0.0740***	0.0263	0.005
Number of farm household workers	X8	0.5249***	0.1872	0.005
Area of agricultural land cultivated by farmer households	X9	-0.2392	0.2772	0.388
Ln(non-labor income of farmer household)	Ln(X10)	-0.0046	0.0076	0.547
Constanta		12.532***	3.4400	0.000
Inverse Mills Ratio (IMR)		1.4517	1.3057	0.266
Sigma		1.4799		
Rho		0.9810		
Number of observation		321		
Censored observation		89		
Uncensored observation		232		
Wald chi2 (10)		41.15***		
Probability > chi2		0.0000		

Note: Ln = Natural log.

***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

farming households. This phenomenon shows that more available employment opportunities outside the agricultural sector will increase the opportunities for members of farming households to work and earn income outside the agricultural sector. These job opportunities are determined by developments outside the agricultural sector (Rantšo, 2016). Economic development outside the agricultural sector, especially in rural areas, can be a pull factor for obtaining income from activities outside the farm.

The findings described above show that all policy interventions that can bring non-agricultural jobs closer to the countryside and increase non-agricultural employment opportunities in the countryside and its surroundings will make it easier for farmers to work and earn additional income in off-farm activities. The policy in question is a rural economic development policy that can create nonagricultural employment in rural areas. Among them are agro-industry development policies in rural areas (Shavkat Hasanov, 2018), especially those that are compatible with local commodity competitiveness.

Furthermore, in terms of the influence of micro factors on the off-farm income of farmer households, Table 3 shows that there are two explanatory variables that have a significant effect on the off-farm income of farmer households, namely the number of farm household workers, and the education level of the head of the farmer's household. With the area of rice fields controlled by farmer households sample on average only about 0.64 hectare, the need for labor for their farming is also relatively low. The increasing number of farm household workers (with the relatively low need for labor for their farming business) will allow household members to seek additional income outside their farming business (off-farm income).

The education level of the household head was positively and significantly related to the off-farm income of the farmer's household (Table 3). Work productivity increases with an increase in education level. With relatively high work productivity, they tend to be able

to work in types of work outside the agricultural sector, which generally provides relatively high wages, so that off-farm income increases. The results of this study are in line with the results of research by Anang & Yeboah (2019); Iqbal et al. (2021); Mebrate et al. (2019).

If we look again at Table 2, it can be seen that in general, the education level of the head of a farmer's household is, on average, only graduating from elementary school (seven years). With such a low level of education, farmers tend to have difficulty accessing jobs outside the agricultural sector, which generally require relatively high educational qualifications. From these findings, it appears that all government policy interventions that can encourage increased access of farmer households, especially smallholding farmers, to education and skills are needed. The improvement of farmers' education and skills is primarily related to vocational education, which is in line with the development of superior commodities in the local area (Kirui & Kozicka, 2018). The increase in vocational education will encourage an increase in the off-farm income of farmer households, which in turn will also encourage an increase in labor productivity in rural areas.

CONCLUSION

The increase in the off-farm income of farmer households is determined by macro-economic factors, namely, the closer location and increase in the non-agricultural sector job market at the district and regional levels. Job opportunities outside the agricultural sector are a pull factor for obtaining off-farm income. In addition, the increase in the off-farm income of farmers' households is determined by micro factors at the farm household level, namely by the higher level of education of farmers. The limited control of farmers on farming production factors, especially land and agricultural assets, is a push factor in obtaining off-farm income. Government policy interventions are needed that can create jobs outside the agricultural sector in rural

areas, such as agro-industry development policies in rural areas, and encourage the improvement of farmers' education.

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