

## Poverty viewed from the perspective of domestic production in Yogyakarta: the Solow growth model approach

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**Abstract:** This aim of this study was to determine the impact of human capital variables on the probability of poor families. The research was conducted based on the data collected in SUSENAS in province of special region of Yogyakarta, analysed using logit model and estimated using maximum likelihood estimator (MLE) method. The number of data was 3,606 families. The result showed that the cost variable of disease prevention (BPP), scholarships (BP), food security (JP), health insurance (AK), average length of schooling (RLS), and cost for non-formal education (BPN) affect and is statistically significant to poverty status in 2013 at 5% significance. Also, Calorie consumption per capita (KK) and protein consumption per capita (KP) affect on poverty status at 10% significance in 2013.

**Keywords:** Solow growth model; poverty line; poverty size; logit models; human capital variables.

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## **1 Introduction**

The effort to reduce poverty can be done by improving human resources (HR) as investment capital to increase the income of the poor. Bhaunik and dan Arindam (2009) identified that human resources development (HRD) has a strong relationship with the resilience of the poor to earn their permanent living. In its implementation, HRD could be developed through formal education; so that, poor people might possess skills and sensitivities to external changes that might affect their income (Kabanankye et al., (2004). Gounder and Xing (2012) and Geda et al. (2005) claimed that poor people with a formal education could anticipate the changes in the price of the primary input and output.

In term of poverty, special region of Yogyakarta (DIY) is a province that its poverty rate is relatively high, 15.5% of the people are poor (ranked 25th nationally); in fact, its level is good (ranks 4th nationally) (BPS, 2015). It is suspected that the effort to improve HR by conducting human capital is still low resulting in a low quality of the poor. Therefore, this study explores the extent to which HR and human capital stock affect poverty status at the family level in the special province of Yogyakarta (DIY).

## **2 Theory**

In this research, Solow's production function is chosen to generate a model that can explain the influence of the human capital variable on the probability of a family to be poor. It is assumed that a family in province of special region of Yogyakarta is the smallest unit of production of goods and services and uses capital as production factors. In the Solow model, technology is denoted by  $A$ , which is assumed to be exogenous, and technological improvements are constant during the production process (Barro and Sala-i-Martin, 1995a, 1995b; Barro, 2007). Solow production function with technology is denoted by:

$$Y = K^\alpha AL^{1-\alpha} \quad (1)$$

when the level of technology is  $A > 0$ , and  $y = AK^\alpha$ ; however, if the output per capita  $y = \frac{Y}{L}$  and the capital per labour  $L$   $k = \frac{K}{L}$ , the function of the production is:

$$y = k^\alpha A^{1-\alpha} \quad (2)$$

Human capital as a production factor can be obtained through education (Barro, 2003), and the result of education is used to produce consumer goods and selected capital goods (Basseti, 2008, Basseti, 2012). Therefore, the equation of unskilled workers who learn to acquire a particular ability is:

$$H = e^{\omega t} L \quad (3)$$

where  $H$  is the total of unskilled workforces and  $\omega$  has a positive value that determines the individual productivity as a result of the human capitalised.

The equation of the output level per worker is:

$$Y = Ak^\alpha (h)^{1-\alpha} \quad (4)$$

In Solow production function, if physical capital is assumed to be immediate and the value of human capital is  $H$ , then, the production function depends on  $H$  and  $A$  (Basseti, 2012). Therefore, the equation of the function of the production will be:

$$y = \frac{Y}{L} = f(H; AL_Y) \text{ and } l = \frac{AL_Y}{L_Y} = A \quad (5)$$

If  $\hat{y}$  is the change of the output because of the change of the labour influenced by  $H$  and  $A$ , then the equation of the change of the output is:

$$\hat{y} = \frac{d \ln f}{dt} = \frac{fH}{f} \frac{dH}{dt} + \frac{fA}{f} \frac{dA}{dt} \quad (6)$$

For example,  $w_t = \frac{wL_Y}{wA}$  is the labour wages earned as a result of the use of their knowledge and experiences (Bourguignon, 2004; Tarabini and Jacovkis, 2012).  $w_t$  is the ratio between wages and a certain cost. If a company maximises profits by adjusting the amount of  $wL_Y$  and  $w$ , the equation will be:

$$h^* w(t), A_t = A^* \frac{FL_Y}{FA} = w_t \quad \text{or} \quad (7)$$

By combining equations (5) and (4), the new one will be:

$$\hat{y} = \frac{f_h h^*}{f} \quad (8)$$

Meanwhile, the equation of the impact of the improved knowledge compiled (A) to produce the output is:

$$\hat{y} = s\phi\hat{w} + s\frac{\partial \ln h^*}{\partial A}\hat{A} + \frac{\partial \ln f^*}{\partial \ln}\hat{A} \quad (9)$$

$s\phi\hat{w}$  illustrates the magnitude of the change in the output growth due to the change of  $w$ . Therefore, equation (9) can be interpreted that  $s\frac{\partial \ln h^*}{\partial A}\hat{A}$  is the impact of the exogenously human capital; meanwhile,  $\frac{\partial \ln f^*}{\partial \ln}\hat{A}$  illustrates the effect of the change of the workforces' knowledge as a result of the improved knowledge accumulated. Therefore, the equation of the function of the production is:

$$\hat{y} = s\phi\hat{w} + s\delta\hat{B} + \frac{\partial \ln f}{\partial \ln A}\hat{A} \quad (10)$$

In this research, as the physical capital of the household is limited, the physical capital is assumed to be constant. The model of the household production in DIY based on the equation (10) is:

$$\hat{y} = f\left(s\delta\hat{w}, s\delta\hat{B}, \frac{\partial \ln f}{\partial \ln A}\hat{A}\right) \quad (11)$$

### 3 Research methodology

In this research, secondary data were taken from the raw data of Susenas in province of special region of Yogyakarta in 2013. The supporting data including GRDP, poverty, public welfare indicator, and HDI were taken from Central Bureau of Statistics of Yogyakarta special province (BPS) and the Provincial Government of Province of special region of Yogyakarta.

As the main model derived from the model 9 has the dependent variable as the dummy variable of poor household and non-poor household, the (cumulative) logistic distribution function used is:

$$P_i = F\left(\beta_0 + \beta_j \sum_{j=1}^n X_{ji}\right) = \frac{1}{1 + e^{-Z_i}} = \frac{1}{1 + e^{-\beta_0 + \beta_j \sum_{j=1}^n X_{ji}}} \quad (12)$$

Meanwhile, the logit of the poor household in DIY is as follows:

$$Ly_i = \ln\left(\frac{p_i}{1 - p_i}\right) = A_i + \beta_1 BPP_i + \beta_2 BP_i + \beta_3 JP_i + \beta_4 AK_i + \beta_5 RLS_i + \beta_6 BPN_i + \beta_7 KP_i + \beta_8 KK_i + \varepsilon_i \quad (13)$$

The value of the dependent variable  $Ly_i$  is 1 if the household is in the category of poor and 0 if the household is in the category of not poor. The independent variable comprises of:

- 1 Cost of disease prevention per capita per month is the cost incurred to prevent all household members in one month divided by the number of household members, which is symbolised by BPP.
- 2 Protein consumption per day is the amount of protein in food consumed per person per day, symbolised by the KP. The foodstuffs consist of 180 commodities of raw food consumed by the member of the household.
- 3 Educational scholarship variable. The educational scholarship is an assistant fund for education given to exceptional students from a household member, which is symbolised by BP.
- 4 Food security variable is an assurance to obtain staple food given as the aid of the rice for the poor, symbolised by JP.
- 5 Health insurance variables is a social assistance program for health services, which cover Jamkesnas, Jamkesda, delivery insurance (Jampersal), JPK, JPK Social Security, private health insurance, and health fund. Health insurance variables is a dummy variable of which its value is equal to 1 if a household member possesses health insurance, and zero if a household member does not have health insurance, denoted by AK.
- 6 Education is measured by the average duration to be in the formal school of a household member scored by the highest education level attained, denoted by RLS
- 7 Non-formal education cost variable is the cost incurred for a non-formal education to improve skills by joining tutoring, test, and others, symbolised by BPN.
- 8 Calories consumption per day is the amount of fat of foods consumed per person per day, symbolised by KK.

#### 4 Data analysis

Logit model using Susenas data 2013 was used to determine variables of the poverty status of the households in province of special region of Yogyakarta. Meanwhile, MLE was used to determine the result of the estimation model of logit determinants of poverty in 2013. The result is as follows:

**Table 1** Parameter estimation of MLE method for logit model test of poverty status in 2013

<i>Variable</i>	<i>Coefficient</i>	<i>Std. error</i>	<i>z-statistic</i>	<i>Prob.</i>
C	-0.952631	0.353174	-2.697344	0.007
BPP*	0.441959	0.034665	12.74959	0
BP*	0.753755	0.119332	6.316471	0
JP*	0.53226	0.145371	3.661383	0.0003
AK*	-0.404787	0.120646	-3.355162	0.0008
RLS*	-0.293816	0.024127	-12.17796	0
BPN*	-0.048922	0.019954	-2.45175	0.0142
KK**	-0.371064	0.210009	-1.766893	0.0772
KP**	-0.006894	0.004059	-1.698613	0.0894

Note: \*, \*\*, significance at 5% and 10%.

Table 1 of the determinant model of poverty in province of special region of Yogyakarta in 2013 shows that the cost of disease prevention, educational scholarships, and food security positively influenced the household poverty status. Meanwhile, the variables of health insurance, average duration to be in the formal school of the household members, non-formal education cost, calorie consumption per capita, and protein consumption per capita negatively affected household poverty status.

#### 4.1 Partial test of the model

Table 1 shows the individual test of the poverty determinant coefficient in province of special region of Yogyakarta. By comparing the statistical value of Z to Z table at 0.05 or 0.10 significance level ( $\alpha$ ) the results were 1.64 and 1.28 respectively. These value indicated that the poverty status was influenced and statistically significant at 5% by the variable of cost of disease prevention (BPP), scholarships (BP), food security (JP), health insurance (AK), the average duration to be in formal school (RLS), and the cost of non-formal education (BPN) in 2013. Moreover, the poverty status was also influenced by calorie consumption per capita (KK) and the protein consumption per capita (KP) at 10% significance in 2013.

#### 4.2 Simultaneous test of the model

Table 1 also shows the simultaneous test to the result of the logit regression model estimated by MLE method that its statistical LR value is 718.5542. The comparison between the value of LR and the value of  $hGH\chi^2(8)$  showed that the count value of the LR was much greater than that of JGU table, which was 15.5 at 0.05 significance. This value meant that the null hypothesis was rejected; therefore, all independent variables statistically could explain the model.

#### 4.3 The goodness of fit test

Table 2 shows the goodness of fit test consisting of

- 1 As the coefficient of determination of  $R_{McF}^c$  is 0.223584, approximately 22.36% variation of the poverty status in 2013 could be explained by the variables in the model; while, the 77.64% could be explained by other variables outside the model. According to Kabanankye et al. (2004, p.35), the  $R_{McF}^c$  value is good enough for cross-section data.
- 2 The count R-square of 84.86% means that there were 3,060 out of 3,606 observations fit to the predictions.
- 3 The statistical value of HL based on Andrews and Hosmer-Lemeshow goodness-of-fit tests was  $> 0.05$ , while the statistical value of Andrews was  $< 0.05$ . Although the result of the two tests to the models was different, the logistic regression model was still suitable to be used as an analysis tool. In binary regressand model, the goodness of fit became the second priority, and the one that had to be considered was the sign and statistical significance of the regression coefficients [Gujarati, (2004), p.605].
- 4 Economic analysis

Table 3 shows that the estimated value of the coefficient variable of disease prevention costs per capita in DIY in 2013 significantly affected the household poverty status; although, the cost of disease prevention negatively affected the household poverty status.

**Table 2** Goodness-of-fit test

<i>No.</i>	<i>Types of test</i>	<i>Value</i>	<i>P value</i>
1	$R_{McF}^c$	0.223584	
2	Count-R squared	84.86	
3	H-L statistic	9.0921	0.3346
	Andrews statistic	310.6525	0.0000

**Table 3** The results of the determinant estimation model of poverty

<i>Variable</i>	<i>2013 (n = 3,606)</i>				
	<i>Estimate</i>	<i>Zi</i>	<i>Prob</i>	<i>Odds rasio</i>	<i>Marginal effect</i>
C*	-0.9526	-2.697344	0.0070	0.3857	-0.0722
BPP*	0.4420	12.74959	0.0000	1.5558	0.0335
KP**	-0.0069	-1.6986	0.0894	0.9931	-0.0005
BP*	0.7538	6.316471	0.0000	2.1250	0.0571
JP*	0.5323	3.661383	0.0003	1.7028	0.0403
KK**	-0.3711	-1.7668	0.0772	0.6900	-0.0281
BPN*	-0.0489	-2.45175	0.0142	0.9523	-0.0037
RLS*	-0.2938	-12.17796	0.0000	0.7454	-0.0223
AK*	-0.4048	-3.355162	0.0008	0.6671	-0.0307

Note: \*, \*\*, significance at 5% and 10%.

The important variable affecting a family to be poor was the level of education as this variable was considered to be the human capital. The variable representing the level of education was the cost of non-formal education (BPN) and the average duration of schooling of all household members (RLS). In 2013, the estimated value of this variable negatively influenced and was statistically significant at 5% against the poverty status.

Meanwhile, the cost of disease prevention had a positive and significant effect on the poverty status of households in 2013. Consequently, every additional of 1 member to households, the possibility the households to be poor was 1.5558 times higher than households with fewer members. Therefore, the more the cost of disease prevention to be spent, the greater the possibility the household was categorised as poor.

Judging from the value of marginal effect, in 2013, the cost of disease prevention gave a positive value and relatively high to marginal effect, which was 0.0335. If the mean of the sample of the households member increased by one, the chance of the households fell into the poor category was 3.35% higher.

Table 3 also exhibits that the coefficient of the protein consumption variable per capita in 2013 is -0.006894 with an odds ratio of 0.9931. If the protein consumption of a household increased by 1 gram per capita, the probability the household fell into poor category declined by 0.99 times. The result could be interpreted that the higher the protein consumption of a household, the risk the household fell into the poor category was getting smaller. This interpretation was not different from the side of marginal effect.

Every increase in the protein consumption of the mean sample by 1 gram per capita, the possibility the households belonged to the poor category decreased by 0.05% in 2013.

Moreover, Table 3 reveals that the estimation of the educational scholarships coefficient variable is 0.753755 with an odds ratio of 2.1250. This value could be interpreted that the households having health insurance had the probability to be in the category of poor 2.1250 times lower than the households having no health insurance. In other words, the households with no scholarship were potentially poorer than the households holding a given educational scholarship. Also, the marginal effect of the scholarship variable in the agricultural sector, in 2013, was 0.0571. This number meant that without getting the educational scholarship, the possibility the agriculture-based households fell into the poor category was 5.71%.

Moreover, food security is related to the availability of food for the fulfilment of energy for human activities. The estimation result of the logit model revealed that the estimation coefficient of food security (JP) was 0.532260 with an odds ratio of 1.7028. The result implied that the households without having food security had a probability of 1.7028 times higher to be in the poor category than the households having food security. Meanwhile, from the perspective of marginal effect, the value of the food security variable was 0.0403. This value meant that the opportunity of the households without food security fell into poor category increased by 4.03 per cent.

Also, variables that can describe poverty characteristics in DIY is the calorie consumption per capita (KK). The logit estimation calculated that the estimation of KK coefficient was -0.371064 with the odds ratio of 0.6900. The estimation meant that every additional of 1 kcal of calorie consumption per capita, the possibility the households to be included into the category of the poor would be 0.6900 times lower than the households with lower calorie consumption per capita. Therefore, the greater the consumption of calories per capita the smaller the chances of the households would be getting poor. The marginal effect variable of KK in 2013 was -0.0281, which meant the chances of the households fell into the category of poor would be reduced by 2.81% if the calorie consumption per capita increased by 1 kcal per person. The higher the calorie consumption per capita, the lower the chance of the household fell into the poor category.

Based on the logit model exhibited in Table 3, the cost of non-formal education negatively and significantly influences the status of the poor households with the estimated value of -0.048922 and odds ratio of 0.9523. Every increasing of the education cost of the household members by one thousand rupiahs, the probability of the households fell into the poor category would be 0.9523 times lower than the household spending lower expenditure for education. In other words, the higher the cost incurred for non-formal education, the smaller the probability the household belonged to the poor category. The marginal effect of the variable of non-formal education cost in 2013 was -0.0037, meaning that the chances of the household fell into the category of poor reduced by 0.37% if the cost of non-formal education was one thousand rupiahs higher.

In this research, the important variable of HR is the variable of the average duration to be in the school of the household members (RLS). The result of the estimation of the coefficient showed that the average length of schooling of the members of the household could explain the risk of the household member to be poor. The coefficient of the RLS variable was -0.293816 with odds ratios of 0.7454. This result meant that any increase in the average length of schooling for the members of the household by one year, the chances of the household fell into the poor category was 0.293816 times lower compared to the household with a lower average of being in school. The marginal effect of this

variable indicated that the probability of the household to be poor reduced by 2.23% in 2013. Human resources are at the core of solving the problem of poverty, improving human resources will raise the income of low-income families permanently (Lam, 2005; Bulte et al., 2005).

The interpretation of the logit model proved that education to develop HR had a strong relationship with the risk of households to be categorised as poor. The higher the person's level of education, the higher the knowledge and expertise a person had, the higher the productivity a person performed. The result would be higher output quality that resulted in higher wages s/he would get.

Understanding the relationship between education and poverty was very important as the education affect the level of poverty a household might became. A person whose education and income were higher was likely to have a lower chance of being poor (Kabanankye et al., 2004). The educational characteristics that had been described were in the percentage of the head of poor and non-poor households about the duration of education they got (Sumarto and De Silva, 2014; Silva, 2008).

Also, in Table 3, the estimated value of the dummy variable of health insurance coverage (AK) was significant at 5% with the parameter value of  $-0.404787$ , and the value of odds ratio was 0.6671. These numbers meant that the probability of households with no health insurance coverage was 0.6671 times higher to be poor than that of households with health insurance coverage. This finding indicated that families without health insurance had a higher risk of poverty than families with health insurance coverage. Hamid et al. (2011) states that health insurance will have an impact on the belief of people not to worry about health costs so as not to impact on working hours and work productivity. Meanwhile, based on the value of the marginal effect, the household without health insurance in 2013 had a greater risk of being poor with the marginal effect value was  $-0.0307$ . This value meant that the opportunity of households with health insurance coverage fell into poor category decreased by 3.07.

## **5 Closing remark**

The determinants model of poverty of province of special region of Yogyakarta in 2013 suggested that the cost of disease prevention, educational scholarships, and food security positively influence the poverty status of a household. Meanwhile, the variables of the health insurance, the duration to be in a school of the household members, the cost of non-formal education, the consumption of calorie per capita, and protein consumption per capita negatively affect the household poverty status. Also, the result of the logit regression model estimated by MLE simultaneously method proved that the null hypothesis is rejected; therefore, all independent variables statistically could explain the model.

In conclusion, why the development of HR in poor countries has no impact on poverty in developing countries, because developing countries depend and are made powerless by globalisation. Globalisation has a negative impact on improving the welfare of poor countries. There is no guarantee between the improvement of technological improvements and globalisation towards improving the welfare of the rural population. Rising agricultural products can not increase the income of the poor as demand for agricultural products in developed countries is low. Globalisation offers an opportunity for developing countries to create wealth through growth through the export of primary

agricultural products in developed countries. Globalisation can not reduce poverty in poor countries because poor countries depend on technology controlled by developed countries. The well-being of poor countries depends on agricultural products and is dependent on modern technology controlled by large multinational corporations whose primary interest is to generate profits for developed countries, not the welfare of the people of poor countries. Poor countries have an abundance of unskilled labour and developed countries have technological crises that are capital-intensive so that the use of labour is diminishing and resulting in cheaper labour and no impact on the welfare of poor people does not reduce poverty (Bhensdadia and Dana, 2004).

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