DETERMINING POVERTY MAP USING SMALL AREA ESTIMATION METHOD

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Abstract. Poverty is a phenomenon that always occurs in every country especially in the developing country such as Indonesia. Poverty is defined as a condition where someone has not capability to fulfill their basic needs (food and non food). The difference of geographic condition and the unequal of demography always become some problems in the geographic targeting of the poor in the poverty reduction program. One of method that is accurately effective and sensitive with poverty in the small area is Small Area Estimation method by Elbers et al. It is known as Elbers, Lanjouw, Lanjouw method (ELL method). The objective of this method is to map the incidence of poverty in every county or city using the steps in ELL method. In this study, we use Central Java as our case study. The results of this study are the model consumption of Central Java, poverty indicators for each city in Central Java and the poverty maps so that can give information and facilitate the government for making priority in poverty reduction programs.
Keywords: Poverty map, ELL Method

1. INTRODUCTION

Poverty is a phenomenon that always occurs in every country especially in the developing country. Every country has the difference of geographic condition, poverty levels, the tools to measure and handling the poverty. Poverty is defined as a condition where someone has not capability to fulfill their basic needs (food and non food). Someone is called as a poor people if his or her expenditure or income below poverty line. Poverty line is the minimum incomes that have to fulfill his or her minimum living standard. If poverty line is high, then there are so many people that are poor.

Indonesia, a country that is very large in size of population and has the difference of geographic condition in every province, always has some problems in the geographic targeting of the poor in the poverty reduction program. Obviously, in order to make poverty reduction programs, we need an instrument that is accurately effective and sensitive with poverty, which in turn the objective of poverty reduction can be exactly attained.

SMERU [7] stated that, ideally, geographic targeting should be based on a description of poverty incidence and other indicators of economic welfare in small area or

at low administrative levels. In Indonesia, the administrative levels start from the national level, and descend to the provincial, county or city, sub district, and village levels.

There is one way to obtain village level information on the distribution of economic welfare that is to carry out a household survey representative at the village level. However, this is very difficult to be done because a household survey is too large and expensive to carry out.

Fortunately, as a result of recent methodological advances in this study, the World Bank has developed a new method to estimate small area distribution of economic welfare from statistical data collections that is normally available in a country. The result of this method will be pointed out in a geographic map, known as a poverty map.

A poverty map is a visual representation of the spatial incidence of poverty that can facilitate the focused pro poor interventions and guide the allocation of public spending to reduce poverty. It will help the government to reduce poverty exactly. Moreover, it can reduce the risk of poor households being missed by poverty reduction programs.

One of the methods for producing small area estimation of the spatial description of economic welfare is small area estimation method by Elbers, Lanjouw, Lanjouw. It is known as Elbers, Lanjouw, Lanjouw (ELL) Method. This method was introduced by Chris Elbers, J. O. Lanjouw, and Peter Lanjouw and is based on regression models of income or expenditure with random effects at the level of survey clusters. This method has been done successfully in other countries, especially in South Africa and Ecuador. In the first application, this method would be done if the sources of data needed are available. This method has been applied in Indonesia to map the poverty in East Kalimantan, East Java and Jakarta. But no one has mapped the poverty in Central Java.

In this study, we use the application of small area estimation method that is described by Elbers, Lanjouw, Lanjouw (or ELL method) to estimate the small area of poverty in county or city levels, to calculate the poverty indicators, to make a poverty map of Central Java and to interpret it.

2. THEORETICAL AND METHODOLOGY

2.1 The definition of poverty

According to the World Bank [2], poverty is concerned with absolute standard living part of the poor society in the equality refers to relative living standards across the whole society.

United Nations Development Program (UNDP) [2] defines poverty as hunger; poor of haven; incapacity to go to a doctor when getting sick; have not any access to go to school and illiteracy; jobless; afraid of the future; incapacity to get pure water; powerless; has no representative and freedom.

According to Government's Law No. 42 1981 [2], the poor is the people who have not any job and have not any capability to fill their basic commodities of humanity or people who have a job but they cannot fill the basic commodities of humanity. In addition, by the Asian Development Banks' point of view [2], poverty is a deprivation of essential assets and opportunities that every human is entitled.

2.2 The indicators of poverty

In this study, we use poverty indicators from BPS. To measure poverty, BPS calculates a number of summary statistics describing the incidence, depth and severity of poverty. These include the headcount index (which measures the incidence of poverty), the poverty gap (which measures the depth of poverty) and the poverty severity (which measures the severity of poverty).

Foster, et al in Avenzora [1] show that the three poverty measures may all be calculated using the following formula:

$$P_\alpha = \frac{1}{N}\sum_{h=1}^{M}\left(\frac{z - y_{ch}}{z}\right)^\alpha \text{, where } \alpha = 0,1,2 \tag{2.1}$$

where:

z = poverty line

y_{ch} = per capita consumption of household in location c

N = the number of people in the sample population

M = the number of poor people (household)

i. the headcount index. When $\alpha = 0$, then

$$P_0 = \frac{1}{N}\sum_{h=1}^{M}\left(\frac{z - y_{ch}}{z}\right)^0 = \frac{1}{N}\sum_{h=1}^{M}1 = \frac{M}{N}. \tag{2.2}$$

Commonly, it is denoted as the headcount ratio or when turned into a percentage, the headcount index (proportion of person whose expenditure level is under the poverty line). Although it is to interpret the incidence of poverty, the headcount index is not sensitive to estimate how far below the poverty line poor people is.

ii. the poverty gap index. When $\alpha = 1$, then

$$P_1 = \frac{1}{N}\sum_{h=1}^{M}\left(\frac{z - y_{ch}}{z}\right)^1 = \frac{1}{N}\sum_{h=1}^{M}\left(\frac{z - y_{ch}}{z}\right). \tag{2.3}$$

It is denoted as the poverty gap index which is simply the sum of all the poverty gaps in the population can be used as an indicator of the minimum cost of eliminating poverty using perfectly targeted transfers.

iii. the poverty severity index. When $\alpha = 2$, then

$$P_2 = \frac{1}{N}\sum_{h=1}^{M}\left(\frac{z - y_{ch}}{z}\right)^2. \tag{2.4}$$

This is poverty severity index which is sensitive to the distribution of living standards among the poor. The poverty severity index measures the severity (or intensity) of poverty. This is the other relevant poverty indicator that is inequality in the distribution of expenditures among poor people (it is also referred to as severity).

To determine whether poverty has changed over time or varies over some geographic or demographic characteristic, estimation of the sampling variance for the indexes are required. According to Kakwani in Jollife [4], there are two formulas to estimate the variance of the index class of poverty indexes that are easy to calculate the frequent used. Those are

a. variance of P_0

$$\text{var}\left(P_0\right) = \frac{P_0\left(1 - P_0\right)}{\left(n - 1\right)}, \tag{2.5}$$

where n is sample size.

b. Variance of $P_\alpha, \alpha = 1, 2$

$$\text{var}\left(P_\alpha\right) = \frac{\left(P_{2\alpha} - P_\alpha^2\right)}{\left(n-1\right)} \quad . \tag{2.6}$$

2.3 The poverty mapping

Poverty map is a visual presentation of the spatial incidence of poverty able to facilitate a better or a better focused pro poor interventions and guide the allocation of public spending to reduce poverty. This poverty map will help the government in reducing poverty precisely. Moreover, it can reduce the risk of poor households being missed by poverty reduction programs.

According to Peter Lanjouw [5], there are three basic steps of poverty mapping. Those are

Steps 1: identifying variables at the household level that is defined in the household survey.

Steps 2: estimating model of consumption. The parameter estimates the model of consumption and it will be applied to the census data, the expenditure is predicted and the poverty statistics are derived.

Steps 3: inputting the model of consumption into census data at the household level, and the estimation of poverty and inequality measure at a variety of levels of spatial disaggregating.

2.4 Small Area Estimation

Small Area Estimation (SAE) [6] is a statistical technique that models the living standard information available in small household survey data to establish comparability of other non comparable household surveys with population census and generate estimation of living standards of household in population census. SAE provides an opportunity to obtain high resolution poverty maps through the integration of census data.

One of the methods for producing small area estimation of the spatial description of economic welfare is small area estimation method by Elbers, Lanjouw, Lanjouw. It is known as Elbers, Lanjouw, Lanjouw (ELL) method.

2.5 ELL method

ELL method [3] is a new method in the construction of poverty map that has been introduced by the World Bank. This methodology is introduced by Chris Elbers, J. O. Lanjouw, and Peter Lanjouw. It involves a household survey and a population census as

data sources. This method has capability to estimate the poverty level and the poverty indicators until the lowest levels. The systematic procedures for Poverty Mapping is

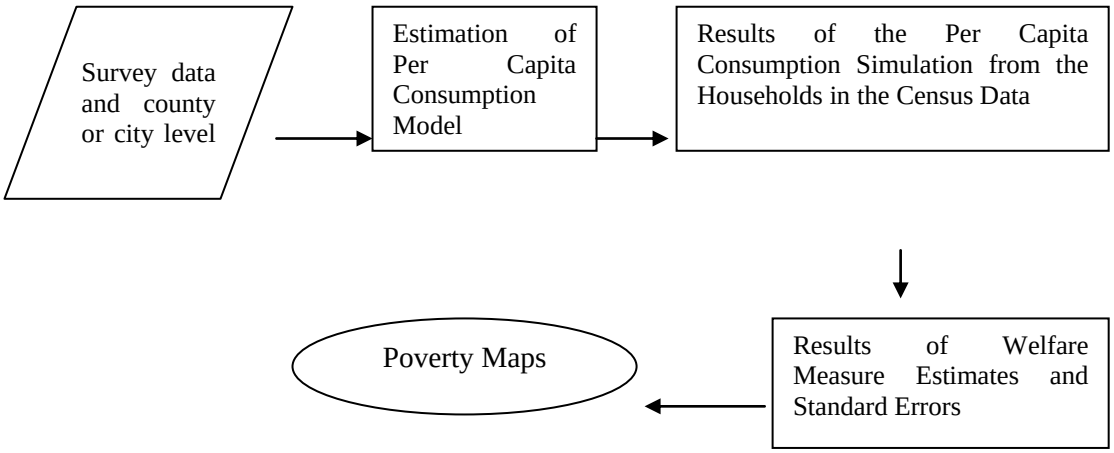

Figure 1. Systematic Procedurs for Poverty mapping

2.6 The consumption model

According to Elbers *et al* [3], the first stage begins with an accurate empirical model of y_{ch}, per capita expenditure of household h in location c, is defined as:

$$\ln y_{ch} = x_{ch}\beta + u_{ch}. \tag{2.7}$$

Where $\ln y_{ch}$ is the logarithm of per capita consumption of household h in location c, x_{ch} is a vector of characteristics of this household, and u_{ch} is the error term which is distributed $N(0,\Sigma)$.

Because survey data is just a sub sample of whole population, the location information is not available for all regions in the census data. Thus, we cannot include the location variable in the survey model. Therefore, the residual of (2.7) must contain the location variance and u_{ch} can be decomposed into uncorrelated terms:

$$u_{ch} = \eta_c + \varepsilon_{ch}. \tag{2.8}$$

Where η_c is a location error term common to all household within the location and ε_{ch} is a household specific error term. It is further assumed that the η_c is uncorrelated across location and the ε_{ch} is uncorrelated across households. With these assumptions, equation (2.7) is reduced to

$$\ln y_{ch} = x_{ch}\beta + \eta_c + \varepsilon_{ch} \tag{2.9}$$

3. THE RESULT

3.1 Description Data

In this study, we use three sources of data: (i) SUSENAS 2006, (ii) Central Java in Figure 2006, and (iii) data and information of poverty 2005-2006. To estimate the consumption model, we use the data on household consumption obtained from SUSENAS 2006, the data on household characteristics is obtained from Central Java in Figure 2006 and to calculate the poverty measures, we use data and information of poverty 2005-2006.

3.2 Selecting Variables.

The procedure in selecting the explanatory variables of equation (2.9) refers to the research of SMERU and available in SUSENAS data. The explanatory variables are only selected and will be used in estimating the consumption model if they contribute significantly to the explanation of (log) per capita consumption. The explanatory variables that are selected by stepwise method are occupation sector of household head (agriculture and mining), household size and working status of household head (seeking).

3.3 Estimating the Consumption Model.

The result of 3.2 can give us information that explanatory variables will be used to estimate the consumption model. First step to estimate the consumption model is to use Ordinary Least Squares (OLS) and save the residuals as a variable $\hat{u}_{ch}$. We find the consumption model as

$$\ln y_{ch} = 14.127 - 0.4a + (3.555\times10^{-6})b - (1.728\times10^{-6})c - (1.888\times10^{-5})d \qquad (3.1)$$

where

a = Household size

b = Working status of household head (seeking)

c = Occupation sector of household head (agriculture)

d = Occupation sector of household head (mining)

3.4 Calculating the Poverty Indicators.

There are three measurements of poverty indicators. These are the headcount index which measures the incidence poverty, the poverty gap index which measures the depth of poverty, and the poverty severity index which measures the severity of poverty.

Commonly, those poverty indicators are known as FGT family of poverty measures. Using PovMap 2.0 [8], we find those poverty indicators for each location,

Table 3.1 The poverty indicators and standard errors of each poverty indicators for each location

County or City	Headcount Index	Standard error of Headcount Index	Poverty Gap Index	Standard error of Poverty Gap Index	Poverty Severity Index	Standard error of Poverty Severity Index
Cilacap	0.62	0.00038	0.5853	0.000374	0.5689	0.000447
Banyumas	0.54	0.00041	0.5051	0.000396	0.4885	0.0004
Purbalingga	0.7	0.00051	0.6765	0.000504	0.6653	0.000736
Banjarnegara	0.52	0.00054	0.4742	0.000521	0.4583	0.000494
Kebumen	0.61	0.00044	0.5904	0.000437	0.5781	0.000527
Purworejo	0.67	0.00056	0.6449	0.000546	0.6297	0.000743
Wonosobo	0.55	0.00057	0.5073	0.000552	0.4866	0.000561
Magelang	0.58	0.00046	0.5556	0.000448	0.5405	0.000503
Boyolali	0.6	0.00051	0.542	0.000484	0.5114	0.000531
Klaten	0.58	0.00047	0.5566	0.000452	0.5403	0.000509
Sukoharjo	0.51	0.00055	0.4947	0.000547	0.4882	0.000541
Wonogiri	0.62	0.00049	0.5757	0.000471	0.549	0.000555
Karanganyar	0.58	0.00055	0.5598	0.00054	0.5465	0.000611
Sragen	0.64	0.00052	0.6002	0.000502	0.5763	0.000623
Grobongan	0.62	0.00042	0.5926	0.000414	0.5768	0.000502
Blora	0.61	0.00054	0.5873	0.000528	0.5762	0.000633
Rembang	0.6	0.00065	0.5553	0.000626	0.5323	0.000705
Pati	0.55	0.00046	0.5038	0.00044	0.4796	0.000444
Kudus	0.6	0.00056	0.5678	0.000546	0.5502	0.000629
Jepara	0.55	0.00048	0.5034	0.000467	0.4844	0.000471
Demak	0.54	0.00049	0.5265	0.000485	0.5162	0.000512
Semarang	0.62	0.00051	0.5896	0.000503	0.5734	0.000607
Temanggung	0.54	0.0006	0.5076	0.00058	0.4916	0.00059
Kendal	0.52	0.00052	0.5016	0.000512	0.4941	0.000514
Batang	0.54	0.00061	0.4966	0.00058	0.4737	0.000576
Pekalongan	0.63	0.00053	0.5885	0.000518	0.5708	0.000624
Pemalang	0.56	0.00043	0.5359	0.000416	0.5197	0.000448
Tegal	0.61	0.00041	0.5837	0.0004	0.5656	0.000477
Brebes	0.6	0.00037	0.5536	0.000356	0.5305	0.000399
Magelang (City)	0.58	0.00137	0.5642	0.001347	0.5541	0.001537
Surakarta (City)	0.56	0.00069	0.5458	0.00068	0.5353	0.000747
Salatiga (City)	0.6	0.00118	0.5716	0.001157	0.556	0.001344
Semarang (City)	0.62	0.0004	0.5746	0.000389	0.5519	0.000455
Pekalongan (City)	0.54	0.00096	0.5022	0.000919	0.4817	0.000924
Tegal (City)	0.55	0.00102	0.5148	0.000988	0.4985	0.00102

Table 3.1 provides the headcount index, poverty gap index, and poverty severity index for each location. Let us see Cilacap, the headcount index of Cilacap is 0.62 or 62 % with standard error 0.00038. It means that there are 62% of people in Cilacap are poor. Poverty gap index of Cilacap is 0.5853 or 58.53, it means that the gap between the average gap of expenditure for every people and poverty line. The standard error of poverty gap index is about 0.000374. Whereas poverty severity in Cilacap is 0.5689 or 56.89% with standard error 0.000447. It means that the severity in Cilacap is 56.89%.

3.5 Poverty Maps of Central Java and The Interpretation.

Poverty map is a visual presentation of the spatial incidence of poverty that can facilitate a better focus pro poor interventions and guide the allocation of public spending to reduce poverty. Since the poverty indicators at county or city levels have been calculated and available for each poverty indicator, we can make poverty maps for each poverty indicators. These are the maps by virtue of poverty measures in every county or city

Figure 3.1 Poverty Map by virtue of headcount index

Figure 3.2 Poverty map by virtue of poverty gap index

Figure 3.3 Poverty Class by Virtue of Poverty Severity Index

In the calculation of poverty map, the poverty map is not only influenced by geographic condition but also the demographic condition of the county or city. Let us see

the county of Sukoharjo, for the incidence of poverty; it is in the interval of 0.51-0.542 where it is included in the lowest poverty incidence. It means that the poor people in Sukoharjo are about 51% until 54.2%. For the poverty gap; it is in the interval of 0.4742-0.5079 where it is included in the lowest poverty gap index. It means that the gap between the average gap of expenditure for every people and poverty line is about 47.42% until 50.79% and for the severity poverty; it is in the interval of 0.4583-0.4928 where it is included in the lowest poverty severity index or the severity level in county of Sukoharjo is about 45.83% until 49.28%.

To interpret the other location, we can use the same interpretation on Sukoharjo. Using the poverty poverty maps, we can make the priority in poverty reduction program.

4. The Conclusions

As mentioned in the previous chapter, we will conclude that

1. The estimation of consumption model is

$$\ln y_{ch} = 14.127 - 0.4a + (3.555\times10^{-6})b - (1.728\times10^{-6})c - (1.888\times10^{-5})d$$

where

a = Household size

b = Working status of household size

c = Occupation sector of household head (agriculture)

d = Occupation sector of household head (mining)

2. Using the consumption model of Central Java, we have calculated the poverty indicators (headcount index, poverty gap index, poverty severity index) and made poverty maps by virtue of poverty indicators

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