Household's Welfare Impact of Fuel Subsidy Removal

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Abstract

This paper aims to analyze the energy subsidy removal on the households' welfare in Indonesia. *First,* we will model theoretically the welfare change measurement. In this paper, we will apply Compensating Variation (CV) and Equivalent Variation (EV) under Linear Expenditure System (LES). *Second,* we will estimate empirically the model by using National Social Economic Survey (*Survei Sosial Ekonomi Nasional, SUSENAS*) and Cost of Living Survey (*Survei Biaya Hidup)* data. *Third*, by using the estimated CV and EV, we will simulate the impacts of the energy subsidy removal on the households' welfare. The CV and EV can be considered as the compensation should be given to the poor households.

1. Introduction

Indonesia has a long history about energy - electricity and fuel- subsidy. The subsidy has become "political commodity" –for example in presidential campaign, political campaign, parliament discussion, etc- since it has played important roles in the societies, not only for consumption but also production and distribution. As a result, economic considerations of the subsidy are frequently disobeyed. However, many studies show that the subsidy has been misallocated. It is about the "fairness problem" of the energy subsidy. Coordinating Ministry for Economic Affairs of Indonesia (2008) showed that subsidy has been the riches' crowd pleaser, that is, the distribution of fuel subsidy is skewed to wealthy households. The Ministry showed that the top 40% of wealthy households enjoyed 70% of the subsidies while the bottom 40% of low income households benefited only 15% of the subsidies. World Bank (2009) showed similar result from a survey conducted in 2005, the richest 40% of households enjoyed 60% of the subsidy. Recent result from World Bank (2011) suggests that 50% of wealthy households consumed 84% of subsidized fuel with the top 10% consuming 40% of total subsidy. In contrast, the bottom 10% only consumed less than 1% of total subsidy. Further analysis suggests that two-third of poor households do not consume fuel at all.

Moreover, energy subsidy has been imposing persistent pressure on Government of Indonesia (GoI) fiscal aspects. Ministry of Energy and Mineral Resources (2010) recorded increasing trend gasoline subsidy expenditure in the last decade. The revised expenditures for subsidy in 2011 accounted for Rp129.7 trillion, higher than the planned Rp 95.9 trillion. The projected realization of fuel subsidy expenditure until the end of 2011, however, amount to Rp160 trillion. The fuel and electricity subsidy has also hamper the development of other alternate energies.

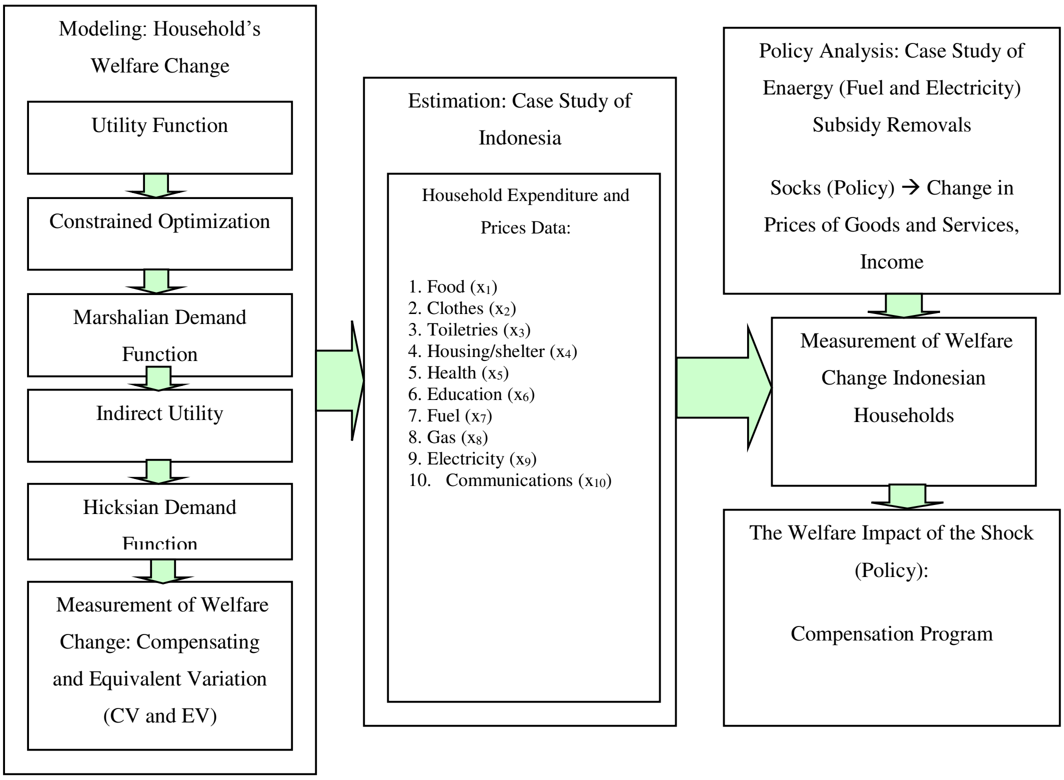
Indonesia has faced several national energy problems (Djamaludin, 2012). *First*, national productions of oil and gas have decreased since the "oil boom" (Booth, 1992) in 1977. Indonesia has national capacity of production only less than 1 million barrel per day, meanwhile national consumption has reached around 1.3 million barrel per day. This yields an increase trend in imports of oil. Indonesia established Law No. 22/2001 on Oil and Gas which is addressed to give legal foundations for rearranging and re-managing national oil and gas sector. *Second,* the availability of national energy in Indonesia is dominantly determined by global market situation, especially international crude price (ICP). Currently, more than 90 percent energy in Indonesia is based on fossil energy, in which 54.4 percent, 26.5 percent and 14.1 percent are from oil, gas, and coal, respectively. *Third*, economic and population growth requires the availability of national electricity energy. Assuming constant growth of 7 percent, the demand on electricity is predicted around 40,000 MW in 2020. The total existing electricity supply is 25,218 MW (21,769 MW by PLN and 3,450 MW by private institution) from generators which are mainly operated by using oil.

The discussion on energy subsidy removal and reallocation has emerged in the Indonesian parliament, government and societies. Widodo et al (2012) give some policy recommendations on the fuel subsidy removal and reallocation. *First,* the removal of fuel subsidy can affect the Indonesian economy through aggregate demand side (consumption. investment, government expenditure and net-export, which may result in demand-pull inflation) and aggregate supply side (cost of production, which may cause cost-push inflation). For the reasons of long-term efficiency, competitive advantage, and manageable economic, social and political instability, the GoI should have a clear long-term “scheduled” and “gradual” program of fuel subsidy reduction, and not the “big-bang” total removal of the fuel subsidy. *Second*, the GoI could consider a certain amount of subsidy which is adjusted with the increase of government fiscal capacity and let the domestic fuel price fluctuated as the ICP fluctuated. Societies (both domestic consumers and producers) will learn rationally and adjust logically with the fluctuation of domestic fuel price. *Third,* the GoI should not consider the “sectoral approach” to reallocate the fuel subsidy. It analysis proves the impact of reallocation to four targeted sectors would bring relatively smaller positive effect than the negative effects of fuel subsidy removal. The GoI should consider programs such as “targeted fuel subsidy” to correct the misallocation the fuel subsidy (i.e. subsidy for the poor). As the poor will be affected most, the GoI should consider continuing compensation programs for the poor (example: *Bantuan Langsung Tunai* (BLT) or direct transfer) which take into account regional perspectives. It is predicted that the energy subsidy removal will lead to inflation which harm poor household’s welfare. Therefore, the study on the impact of the “scheduled-gradual” energy subsidy removal on the Indonesian households’ welfare is extremely crucial. It is believed that energy subsidy removal will lead to inflation; hence it will burden the society especially the poor households. This paper aims to analyze the impacts of energy subsidy removal on the households’ welfare in Indonesia.

2. Theoretical Framework

This paper will estimate the measurement of household welfare-change and then use the estimation for analyzing the welfare impact of price changes due to such shocks i.e government policies, fuel and electricity subsidy removals. Figure 1 shows the theoretical framework of this paper. The welfare analysis in this paper is mainly derived from the household consumption. Theoretically, the household demand for goods and services is a function of prices and income (by definition of Marshallian demand function). Therefore, some changes in income and prices of goods and services will directly affect the number of goods and services and indirectly affect household welfare.

Figure 1. Theoretical Framework



Estimating Demand, Indirect Utility and Expenditure Function of Energy

To get the measurement of welfare change, we have to estimate the household expenditure function. For that purpose, some steps should be followed. *Firstly*, the household utility function should be established. In this paper, the household's utility function is assumed to be Cobb-Douglas function which can derive the Linear Expenditure System of demand (LES) (Stone, 1954). This assumption is taken because the LES is suitable for the household consumption/demand[1]. LES is widely used for some reasons (Intriligator et al 1996: 255). LES has a straightforward and reasonable interpretation and it is suitable for the household consumption/demand. LES is one of

[1] For detailed information, see Barten (1977), Deaton and Muellbauer (1980), Philips (1993) and Deaton (1986).

the few systems, which automatically satisfy all theoretical restrictions[2]. In addition, it can be derived from a specific utility function[3]. *Secondly*, the LES of household demand can be estimated by using available data. Therefore, the household (Marshallian and Hicksian) demand functions for each food commodity and service can be found. From the estimated demand function, we can derive the household's indirect utility and expenditure function. *Finally*, for the purpose of policy analysis the welfare change can be measured by comparing the household expenditure 'pre-shock' and 'post-shock' or 'before' and 'after' implementation of a specific government policy. These stages will be expressed in the next paragraphs.

To measure the welfare change, we have to estimate the household expenditure function. To do that some steps should be followed. Firstly, the household utility function should be established. And in this study, the household's utility function is assumed to be Cobb-Douglas which can derive the Linear Expenditure System of demand (Stone, 1954). This assumption is taken because the Linear Expenditure System (LES) is suitable for the household food consumption/demand[4]. Secondly, the Linear Expenditure System of household demand can be estimated by using available data. Therefore the household demand function (Marshallian and Hicksian) for each food commodity can be found. From the estimated demand function, we can derive the household indirect utility and expenditure function. Finally, the welfare change can be measured by comparing the household expenditure pre-crisis and post-crisis to get the same utility (welfare). These stages will be expressed in the next paragraphs.

Marshallian Demand System of Energy

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[2] Economic theory suggests that the demand functions must satisfy certain restrictions i.e. budget constraint condition, two homogeneity conditions (absence of money illusion and homogeneous degree zero), Slutsky condition (negativity and symmetry conditions) , aggregation condition (Engel and Cournot aggregation conditions) (Widodo, 2005).

[3] The specific utility function from which the linear expenditure system can be derived is the Stone-Geary utility function (also called the Klein-Rubin utility function). This utility actually is a modified Cobb-Douglas utility function.

[4] For detailed information, see Barten (1977), Deaton and Muellbauer (1980), Philips (1993) and Deaton (1986).

In this study, it is assumed that the rural and urban households have a utility function following the more general Cobb-Douglas. Stone (1954) made the first attempt to estimate a system equation explicitly incorporating the budget constraint, namely the Linear Expenditure System (LES). In the case of developing countries, this system has been used widely in the empirical studies in India by some authors (Pushpam and Ashok (1964), Bhattacharya (1967), Joseph (1968), Ranjan (1985), Satish and Sanjib (1999)).

Formally the individual household's preferences defined on n goods are characterized by a utility function of the Cobb-Douglas form. Klein and Rubin (1948) formulated the LES as the most general linear formulation in prices and income satisfying the budget constraint, homogeneity and Slutsky symmetry. Basically, Samuelson (1948) and Geary (1950), derived that the LES representing the utility function:

$$U(x_1 \ldots\ldots\ldots x_n) = \left(x_1 - x_1^o\right)^{\alpha_1}\left(x_2 - x_2^o\right)^{\alpha_2}\left(x_3 - x_3^o\right)^{\alpha_3} \ldots\ldots\ldots \left(x_n - x_n^o\right)^{\alpha_n}$$

In brief, it can be expressed as:

$$U(x_i) = \prod_{i=1}^{n}\left(x_i - x_i^o\right)^{\alpha_i} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where:

$\sum_{i=1}^{n} \alpha_i = 1$

$x_i - x_i^o > 0$

$0<\alpha_i<1$

Π is product operator

x_i is consumption of commodity i

x_i^o and α_i are the parameters of the utility function

x_i^o is minimum quantity of commodity i consumed

$i \in [1,2,3\ldots\ldots.n]$

The individual household has income M and faces the competitive prices of commodity i ie. p_i. Therefore, the individual household's budget constraint becomes $\sum_{i=1}^{n} p_i x_i \leq M$, where i is [1,2,3……..,n]. Two assumptions are imposed on the individual household's budget constraint. The first assumption is that the budget constraint is satisfied with equality. This means that the individual household exhausts income to maximize utility (non-satiation). The second assumption is that a decision on how much income to allocate to total expenditure is independent of the decision on how to allocate total expenditure amongst all possible goods (*Two-stage budgeting*). These simplifying assumptions lead to linear estimating equations for food consumption and it is shown how the model's structural parameters, i.e. those of household preferences, can be identified for use in the calculation of welfare gains and losses from price changes. Therefore, the budget constraint can be expressed in the matrix form as follows:

$$\mathbf{PX} = M \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

where:

P is a price vector ($p_1 \quad p_2 \quad p_3 \quad \ldots\ldots\ldots\ldots \quad p_n$)

X is a commodity vector :

$$\begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ . \\ . \\ . \\ x_n \end{pmatrix}$$

The individual household's problem is to choose x_i that can maximize its utility $U(x_i)$ subject to its budget constraint. Therefore, the optimal choice of x_i is obtained as a solution to the constrained optimization problem as follows:

$$\max_{x_i} \; U(x_i) = \prod_{i=1}^{n} \left(x_i - x_i^o\right)^{\alpha_i}$$

Subject to:

$\mathbf{PX} \leq M$

To solve the problem, the Lagrange method can be applied. The Lagrange formula for this problem is:

$$\max_{x_i} \quad \Omega = U(x_i) = \prod_{i=1}^{n} \left(x_i - x_i^o\right)^{\alpha_i} + \lambda(M - PX) \qquad \text{..............(3)}$$

Where: λ is the Lagrange multiplier. It is interpreted as the marginal utility of income showing how much the individual household's utility will increase if the individual household's income M is increased by \$1.

Take the derivatives and get the first order condition (FOCs):

$$\frac{\partial \Omega}{\partial x_i} = \alpha_i \frac{U}{\left(x_i - x_i^o\right)} - \lambda p_i = 0 \qquad \text{..................................(4)}$$

where: $U = \prod_{i=1}^{n} \left(x_i - x_i^o\right)^{\alpha_i}$

$$\frac{\partial \Omega}{\partial \lambda} = M - PX = 0 \qquad \text{..(5)}$$

In matrix form (4) and (5) can be represented as follows:

$$\begin{pmatrix} \frac{1}{U\alpha_i} & 0 & 0 & 0 & \cdots & \cdots & \cdots & \cdots & 0 & -\frac{1}{p_1} \\ 0 & \frac{1}{U\alpha_2} & 0 & 0 & \cdots & \cdots & \cdots & \cdots & 0 & -\frac{1}{p_2} \\ 0 & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & 0 & \cdots \\ 0 & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & 0 & \cdots \\ 0 & 0 & 0 & 0 & \cdots & \cdots & \cdots & \cdots & \frac{1}{U\alpha_n} & -\frac{1}{p_n} \\ p_1 & p_2 & p_3 & p_4 & \cdots & \cdots & \cdots & \cdots & p_n & 0 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ \cdots \\ \cdots \\ x_n \\ 1/\lambda \end{pmatrix} = \begin{pmatrix} \frac{x_1^o}{U\alpha_1} \\ \frac{x_2^o}{U\alpha_2} \\ \cdots \\ \cdots \\ \frac{x_n^o}{U\alpha_n} \\ M \end{pmatrix}$$

A x B = C

Equation (4) tells us that the marginal utility of x_i is equal with the marginal utility of income multiplied by price of x_i. From (4) and (5), we have n+1 unknown variables ($x_1, x_2, x_3, \ldots\ldots x_n, \lambda$) and n+1 equations. By applying Cramer's rule, the unknown variables (x_1, x_2, x_3,….. x_n , λ) can be found.:

$$x_1 = \frac{|A_1|}{|A|} \qquad \text{...(6)}$$

Where $|A_1|$ is the determinant of matrix A_1 which is constructed from matrix A by replacing the first column of A with matrix C. And the $|A|$ is the determinant of matrix

A. The other demands ($x_2, x_3, \ldots x_n$) and λ can be found by applying equation (6) in the same way. From (6), we can find the Marshallian (uncompensated) demand function for commodity x_i as follows:

$$x_i = x_i^o + \frac{\alpha_i \left(M - \sum_{j=1}^{n} p_j x_j^o \right)}{p_i \sum_{i=1}^{n} \alpha_i} \quad \text{for all i and j} \quad \ldots\ldots\ldots\ldots\ldots\ldots(7a)$$

Where: $i \in (1,2,\ldots\ldots n)$

$j \in (1,2,\ldots\ldots n)$

Since a restriction that the sum of parameters α_i equals to one, $\sum_{i=1}^{n} \alpha_i = 1$, is imposed equation (7a) becomes:

$$x_i = x_i^o + \frac{\alpha_i \left(M - \sum_{j=1}^{n} p_j x_j^o \right)}{p_i} \quad \text{for all i and j} \quad \ldots\ldots\ldots\ldots\ldots\ldots(7b)$$

Equation (7) can be also reflected as the Linear Expenditure System as follows:

$$p_i x_i = p_i x_i^o + \alpha_i \left(M - \sum_{j=1}^{n} p_j x_j^o \right) \quad \text{for all i and j} \quad \ldots\ldots\ldots\ldots\ldots(8)$$

This equation system (8) can be interpreted as stating that expenditure on good i , given as $p_i x_i$, can be broken down into two components. The first part is the expenditure on a certain base amount x_i^o of good i , which is the minimum expenditure to which the consumer is committed (*subsistence expenditure*), $p_i x_i^o$ (Stone 1954). Samuelson (1948) interpreted x_i^o as a necessary set of goods resulting in an informal convention of viewing x_i^o as non-negative quantity. The restriction of x_i^o to be non-negative values however is unnecessarily strict. The utility function is still defined whenever: $x_i - x_i^o > 0$. Thus the interpretation of x_i^o as a *necessary level of consumption* is misleading (Pollak, 1968). The x_i^o allowed to be negative provides additional flexibility in allowing price-elastic goods. The usefulness of this generality in price elasticity depends on the level of aggregation at which the system is treated. The broader the category of goods, the more probable it is that the category would be price elastic. Solari (in Howe 1954:13) interprets negativity of x_i^o as *superior* or *deluxe* commodities.

In order to preserve the committed quantity interpretation of the x_i^o's when some x_i^o are negative, Solari (1971) redefines the quantity $\sum_{j=1}^{n} p_j x_j^o$ as 'augmented supernumerary income' (in contrast to the usual interpretation as supernumerary income, regardless of the signs of the x_i^o). Then, defining n* such that all goods with $i \leq n^*$ have positive x_i^o and goods for $i > n^*$ are superior with negative x_i^o, Solari interprets $\sum_{j=1}^{n^*} p_j x_j^o$ as *supernumerary income* and $\sum_{j=n^*+1}^{n} p_j x_j^o$ as *fictitious income*. The sum of 'Solary-supernumerary income' and fictitious income equals augmented supernumerary income. Although somewhat convoluted, these redefinition allow the interpretation of 'Solari-supernumerary income' as expenditure in excess of the necessary to cover committed quantities.

The second part is a fraction α_i of the *supernumerary income*, defined as the income above the 'subsistence income' $\sum_{j=1}^{n} p_j x_j^o$ needed to purchase a base amount of all goods. The α_i are scaled to sum to one to simplify the demand functions. The α_i is referred to as the *marginal budget share*, $\alpha_i / \sum \alpha_i$. It indicates the proportion in which the incremental income is allocated.

As stated above, the Linear Expenditure System (LES) satisfies the condition of:

(i) homogeneity of degree zero in prices

(ii) the budget constraint (Engel Aggregation and Cournot Aggregation conditions)

(iii)Slutsky conditions (negativity and symmetry conditions)

by construction. In combination with fourth i.e. the negative semi-definiteness of he Slutsky-Hicks substitution term matrix, they insure that the demand function in question is generated by the maximization of utility function. Those conditions lead to some restrictions. First, the α_i's are positive which is incorporated in the specification of the utility function. Second, the sum of the marginal budget share is equal to one $\sum_{i=1}^{n}\alpha_i = 1$ that results in demand system of the form shown in equation (8). Third, inferior and complementary goods are not allowed. However, at the high level of aggregation employed in this study, this limitation (inferior and complementary) is not very restrictive. The higher the level of aggregation, the less likely it is that consumption of any given category would decline with the increase in income and some α_i's could be negative (Howe 1974:18).

The LES is widely used for three reasons. First, it has a straightforward and reasonable interpretation. Second, it satisfies the theory of demand (theoretical restrictions). Third, it can be derived from a specific utility function (the Stone-Geary or Klein-Rubin utility function) (Intriligator, Bodkin and Hsiao 1996:255).

Indirect Utility and Expenditure Function of Energy

The indirect utility function V(**P**,M) can be found by substituting the Marshallian demand x_i (equation 7b) into the utility function $U(x_i)$ (equation 1). Therefore the indirect utility function is:

$$V(P,M) = \prod_{i=a}^{n}\left(\frac{\alpha_i\left(M - \sum_{j=1}^{n} p_j x_j^o\right)}{p_i}\right)^{\alpha_i} \quad \text{for all i and j} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(9)$$

Equation (9) shows the household's utility function as a function of income and commodity prices. By inverting the indirect utility function the expenditure function E(**P**,U), which is a function of certain level of utility and commodity prices, can be expressed as follows:

$$E(P,U) = \frac{U}{\prod_{i=1}^{n}\left(\frac{\alpha_i}{p_i}\right)^{\alpha_i}} + \sum_{i=1}^{n} p_i x_i^{o}$$ for all i and j ………………………….(10)

Hicksian Demand of Energy

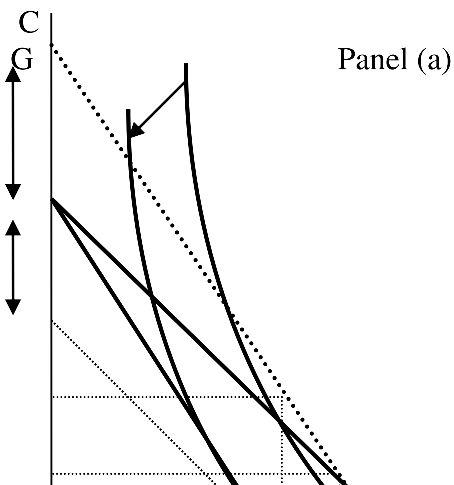
By derivation the expenditure function E(**P**,U) with respect to a particular price (using the Shephard lemma), the Hicksian demand function can be represented as:

$$h_i = \frac{\partial E}{\partial p_i} = x_i^{o} - \frac{\alpha_i U p_i}{\prod_{i=1}^{n}\left(\frac{\alpha_i}{p_i}\right)^{\alpha_i}}$$ for all i …... …… ………………………(11)

Welfare Changes due to Energy Subsidy Removals

The economic crisis has brought some increases in food prices and decreases of the household's income. The Equivalent Variation (EV) and Compensation Variation (CV) will be applied to analyze the impact of the economic crisis on economic welfare. The Equivalent Variation (EV) can be defined as the dollar amount that the household would be indifferent to in accepting the changes in energy prices and income (wealth). It is the change in her/his wealth that would be equivalent to the prices and income change in term of its welfare impact (EV is negative if the prices and income changes would make the household worse off). Meanwhile, the Compensating Variation (CV) measures the net revenue of the planner who must compensate the household for the energy prices and income changes, bringing the household back to its welfare (utility level) (Mas-Colell, A., Whinston, M.D. and Green, J.R., 1995:82). The CV is negative if the planner would have to pay household a positive level of compensation because the prices and income changes make household worse off). Figure 2 visualizes the EV and CV when there is only an increase in price of one good.

Figure 2. The Compensation Variation and Equivalent Variation



CV

H

EV

I

E3

E1

E2

E4

IC1

IC2

BL2 BL1

R

P_r

Panel (b)

P_r2 F A

P_r1 D B

R

EV and CV. Suppose C is composite goods and R is energy. Consider a household has income M that is spent for Energy (R) and Composite goods (C) at price P_c and P_r1, respectively. The budget line is shown by BL1. Suppose there is an increase in price of Energy from P_r1 to P_r2. Therefore, the budget line becomes BL2. The household's equilibrium moves from E1 to E2. It derives the Marshallian demand curve FB (panel b). To get the original utility IC1, the household should be compensated such that BL2 shifting until coincides with IC1 at E3. The compensating variation is represented by GH in panel (a) or area P_r2ABP_r1 (panel b). The equivalent variation is represented by HI in panel (a) or P_r2FDP_r1 (panel b).

If there are changes in prices and income, the EV and CV can be formulated as:

$$EV = E(p^o, U') - E(p', U') + (M' - M^o) \quad \text{...(12a)}$$

$$CV = E(p^o, U^o) - E(p', U^o) + (M' - M^o) \quad \text{.......................................(13a)}$$

In the context of Linear Expenditure System (LES), equation (12a) and (13a) become:

$$EV = \left(\prod_{i=1}^{n}\left(\frac{p_i^o}{p_i'}\right)^{\alpha_i} - 1\right)M^o - \prod_{i=1}^{n}\left(\frac{p_i^o}{p_i'}\right)^{\alpha_i}\sum_{i=1}^{n} p_i' x_i^o + \sum_{i=1}^{n} p_i^o x_i^o + (M' - M^o) \quad \text{.........(12b)}$$

$$CV = \left(1 - \prod_{i=1}^{n}\left(\frac{p_i'}{p_i^o}\right)^{\alpha_i}\right)M^o - \sum_{i=1}^{n} p_i' x_i^o + \prod_{i=1}^{n}\left(\frac{p_i'}{p_i^o}\right)^{\alpha_i}\sum_{i=1}^{n} p_i^o x_i^o + (M' - M^o) \quad \text{............(13b)}$$

for all i and j

Where: P^o is commodity prices pre-energy subsidy removals

P' is commodity prices post- energy subsidy removals

p_i^o is commodity i prices pre- energy subsidy removals

p_i' is commodity i prices post- energy subsidy removals

U^0 is level of utility (welfare) pre- energy subsidy removals

U' is level of utility (welfare) post- energy subsidy removals

M^0 is income (expenditure) pre- energy subsidy removals

M' is income (expenditure) post- energy subsidy removals

By knowing the change in prices and income due to the energy subsidy removals, we can find the change in welfare measured by CV and EV. The EV and CV indicate whether the household is worse off or better off under the economic crisis. This will answer the first question of this paper i.e. how much the individual household should be compensated due to the economic crisis to hold the same utility (welfare). And by comparing the welfare change of the urban and rural individual households, we can answer the second question of which society, rural or urban, is most affected by the economic crisis.

3. Methodology

Data

In estimating the coefficient of LES, this paper uses the secondary data, Social Economic National Survey (*Survei Sosial Ekonomi Nasional, SUSENAS*) and Living Cost Survey (*Survey Biaya Hidup*) published by Indonesian Bureau for Statistic. This paper is based on groups of living expenditures:

1. Food (x_1)
2. Clothes (x_2)
3. Toiletries (x_3)
4. Housing/shelter (x_4)

5. Health (x_5)
6. Education (x_6)
7. Fuel (x_7)
8. Gas (x_8)
9. Electricity (x_9)
10. Communications (x_{10})

Estimation

From econometrics point view, the estimation of a linear expenditure system (LES) shows certain complications because, while it is linear in the variables, it is non-linear in the parameters, involving the products of α_i and x_i^o in equation systems (2) and (3). There are several approaches to estimation of the system (see Intriligator, Baskin, Hsaio 1996). Researchers could apply one of the approaches: selecting α_i and x_i^o simultaneously by setting up a grid of possible values for the 2n-1 parameters (the –1 based on the fact that the α_i sum tends to unity, $\sum_{i=1}^{n} \alpha_i = 1$) and obtaining that point on the grid where the total sum of squares over all goods and all observations is minimized.

The reason is that when estimating a system of equation seemingly unrelated regression (SUR), the estimation may be iterated. In this case, the initial estimation is done to estimate variance. A new set of residuals is generated and used to estimate a new variance-covariance matrix. The matrix is then used to compute a new set of parameter estimator. The iteration proceeds until the parameters converge or until the maximum number of iteration reached. When the random errors follow a multivariate normal distribution these estimators will be the maximum likelihood estimators (Judge et al 1982:324).

Rewriting equation (4) to accommodate a sample t=1,2,3,…..T and 10 goods yields the following econometric non-linear system:

$$p_{1t}x_{1t} = p_{1t}x^{o}_{1t} + \alpha_1\left(M - \sum_{j=1}^{10} p_j x^{o}_j\right) + e_{1t}$$

$$p_{2t}x_{2t} = p_{2t}x^{o}_{2t} + \alpha_2\left(M - \sum_{j=1}^{10} p_j x^{o}_j\right) + e_{2t} \qquad \text{for all i and j} \quad \ldots\ldots\ldots(11)$$

....

....

$$p_{10t}x_{10t} = p_{10t}x^{o}_{10t} + \alpha_{10}\left(M - \sum_{j=1}^{10} p_j x^{o}_j\right) + e_{10t}$$

Where: e_{it} is error term equation (good) i at time t.

Given that the covariance matrix $E\left[e_t e_t^{'}\right] = \xi$ where $e_t^{'} = \left(e_{1t}, e_{2t}, \ldots\ldots\ldots e_{10t}\right)$ and ξ is not diagonal matrix, this system can be viewed as a set of non-linear seemingly unrelated regression (SUR) equations. There is an added complication, however. Because $\sum_{i=1}^{10} p_{it} x_{it} = M$ the sum of the dependent variables is equal to one of the explanatory variables for all t, it can be shown that $\left(e_{1t} + e_{2t} + \ldots\ldots\ldots + e_{10t}\right) = 0$ and hence ξ is singular, leading to a breakdown in both estimation procedures. The problem is overcome by estimating only 9 of the ten equations, say the first nine, and using the constraint that $\sum_{i=1}^{10} \alpha_i = 1$, to obtain an estimate of the remaining coefficient α_{10} (Barten, 1977).

The first nine equations were estimated using the data and the maximum likelihood estimation procedure. The nature of the model provides some guide as to what might be good starting values for an iterative algorithm[5]. Since the constraint the minimum observation of expenditure on good i at time t (x_{it}) greater than the minimum expenditure x_i^{o} should be satisfied, the minimum x_{it} observation seems a reasonable starting value for x_i^{o} in iteration process. Also the average budget share, $T^{-1}\sum_{t=1}^{T}\left(p_{it}x_{it}/M_t\right)$, is likely to be a good starting value for α_i in the iterating process (Griffith et al, 1982). It is because the estimates of the budget share α_i will not much differ with the average

[5] For a detailed explanation about iterative algorithms, see Griffith *et al* 1982.

budget share. In this paper, we use database SUSENAS to derive the coefficients of LES:

Minimum living expenditure i: $x_i^o = Min[x_{ij}]$ where $j \ \forall \ all \ data \ base$

Marginal budget share for living expenditure i: $\propto_i = \frac{x_i}{\sum x_i}$

Elasticity of change ΔP_j with respect to change ΔP_i: $\varepsilon_{ij} = \frac{\partial ln P_j}{\partial ln P_i} = f(\propto_i, \propto_j, \Delta P_i) = \frac{\propto_j}{\propto_i} \Delta P_i$`

`

4. Results and Analysis

Table 1 shows the impacts of fuel subsidy reductions (for some scenarios of reductions: Rp 500, Rp 1,000; Rp 1,500 and Rp 2,000) on the poor household's welfare. It also represents the ammount of compesation that at least is given the poor household for the same level of welfare (before the fuel subsidy reduction). Fuel subsidy reductions Rp 500; Rp 1,000; Rp 1,500 and Rp 2,000 will reduce poor household's welfare by -Rp 25,491; -Rp 50,982; -Rp 76,473 and –Rp 101,964 per month per household, respectively.

Table 1 The Impact of Fuel Subsidy Reduction on Poor Household's Welfare: Some Scenarios (Rp/Month/Household)

	Fuel Subsidy Reductions: Scenarios			
Measurement	Rp 500	Rp 1,000	Rp 1,500	Rp 2,000
1. Direct Impact				
Compensating Variation	-2,217	-4,434	-6,651	-8,868
Equivalent Variation	-2,205	-4,390	-6,556	-8,707
2. Indirect Impact				
Compensating Variation	-23,274	-46,548	-69,822	-93,096
Equivalent Variation	-21,770	-40,915	-57,901	-73,085
3. Total Impact				

Compensating Variation	-25,491	-50,982	-76,473	-101,964
Equivalent Variation	-23,976	-45,305	-64,457	-81,792

Table 2 shows the impacts of electricity subsidy reductions (for some scenarios of reductions: Rp 50, Rp 100; Rp 150 and Rp 200) on the poor household's welfare. It also represents the amount of compensation that at least is given the poor household for the same level of welfare (before the electricity subsidy reduction). Electricity subsidy reductions Rp 50; Rp 100; Rp 150 and Rp 200 will reduce poor household's welfare by -Rp 12,946; -Rp 25,893; -Rp 38,839 and –Rp 51,785 per month per household, respectively.

Table 2 The Impact of Electricity Subsidy Reduction on Poor Household's Welfare: Some Scenarios (Rp/Month/Household)

	Fuel Subsidy Reductions: Scenarios			
Measurement	Rp 50	Rp 100	Rp 150	Rp 200
1. Direct Impact				
Compensating Variation	-217	-434	-651	-869
Equivalent Variation	-217	-434	-650	-867
2. Indirect Impact				
Compensating Variation	-12,729	-25,458	-38,187	-50,917
Equivalent Variation	-12,325	-23,897	-34,791	-45,073
3. Total Impact				
Compensating Variation	-12,946	-25,893	-38,839	-51,785
Equivalent Variation	-12,542	-24,331	-35,442	-45,940

5. Conclusions

This paper aims to analyze the impacts of fuel and electricity subsidy removals on the households' welfare in Indonesia. *First,* we model theoretically the welfare change measurement. In this paper, we apply Compensating Variation (CV) under Linear

Expenditure System (LES). *Second,* we estimate empirically the model by using National Social Economic Survey (*Survei Sosial Ekonomi Nasional, SUSENAS*) data. *Third*, by using the estimated CV and EV, we simulate the impacts of fuel and electricity subsidy removals on the households' welfare. The CV can be considered as the compensation should be given to the poor household.

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