

Poverty Reducing Indirect Tax Reforms in Malawi

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Abstract

This paper focuses on the reduction of poverty in Malawi through indirect tax reforms. In methodology, it implements a new indirect tax reform of consumption dominance curves based on six combinations of elements that are essential to people's living standard in Malawi. The goal of these tests is to find whether a change in marginal tax distribution would alleviate the poverty of Malawi. Some results imply positive effects on the reduction of poverty. This may lead to possibility of indirect tax reform in this country. Also, it is based on specific assumptions of poverty line and efficiency cost. Therefore under those conditions Malawi could develop by relying on redistribution of tax on Food, Housing, Medical, Electricity, with nonfood consumption.

Key Words: consumption dominance curve, poverty reducing, indirect tax reform, Malawi

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1. Introduction

Social welfare improvement is a permanent challenge to economists and policy makers. In a global view, poverty alleviation is a priority target for many nonprofit organizations. Eradicating extreme poverty is the first of eight millennium development goals of United Nations Development Programme (UNDP). In November 2014, countries in Africa and China have just renewed their commitment to eliminate poverty jointly. Among the policy investments that focus on poverty reduction, governmental fiscal reform takes the major part. Our interest lies mainly on the use of indirect tax and price subsidies. In this paper, implement a stochastic dominance approach to poverty reduction in one of the world's poorest country, i. e., Malawi, though tax reform. The following section contains a review of related literature. Section 3 states the methodology we used in the test. Section 4 presents the data and the empirical analysis. Then the conclusion summarizes the essential results from all sections.

2. Literature Review

2.1 Literature on poverty measurement

The first important poverty measure P ($P = H[I + (1 - I)G]$) that we need to review here is Sen (1976)'s index. This poverty index is derived from headcount ratio (which is the proportion of poor) (H), income gap ratio (I) and Gini coefficient (G). To interpret P , we need to consider the relations to these previous indices. However, this index is non-additive.

Fortunately, Foster, Greer, and Thorbecke (1984) present a simple new additive poverty measure, which can relate subgroup poverty to total poverty. That is the decomposable poverty measure: $p_{\alpha}(y, z) = \frac{1}{n} \sum_{i=1}^q \left(1 - \frac{y_i}{z}\right)^{\alpha}$, while a larger α gives greater emphasis to the poorest poor. The measure has three properties: (i) It is additively decomposable with population-share weights; (ii) it satisfies the basic properties proposed by Sen (1976); and it is justified by a relative deprivation concept of poverty. According to their poverty measure, the inequality is explained as the squared coefficient of variation if $\alpha = 2$. On the contrary, the poverty measure may be showed by a group of inequality measure indices, for instance, the headcount ratio when $\alpha = 0$ and the income-gap ratio when $\alpha = 1$. Furthermore, the article applied the decomposability to data from the 1970 Nairobi Household Survey. In terms of different subgroups weighted different shares of the total population in poverty level, the percentage shows subgroup poverty reduction would lower total poverty precisely.

Moreover, Clark, Hemming and Ulph (1981) have shown two further types of poverty measurement index derived from Headcount ratio (H), poverty gap ratio (I), Sen (1976)'s index (S) and Takayama (1979)'s index (T). The authors implement all the indices above in an empirical research based on data from the Family Expenditure Survey (F. E. S.) for 1975 and collect complete results of all these poverty measures. It is illustrated that the new P^* series ($P^* = I - (y^* / z), P^{**} = I - (y^* / \bar{y})$, \bar{y} is the mean income of the poor) indices have shown several advantages over S and T in capturing certain aspects of poverty. For instance, P^* is less

dominated by H , and it can give more weight to I and A . Since the inequality aversion parameter is changed, the indices with an explicit welfare base display some ranking changes (Clark, Hemming, and Ulph, 1981).

Another poverty measure is worthy to present is Chakravarty (1983). According to the paper, the poverty index is said to satisfy all the axioms for a good index of poverty. In the paper,

the poverty measure $Q(y, z) = A \left[\sum_{i=1}^q U(z) - U(y_i) \right]$ is defined as the normalized aggregate utility

gap of the poor under a given income configuration y , where $A > 0$ is the coefficient of normalization, q is the number of poor whose income is lower than poverty line. U_i denote the utility function of individual i . There are a few assumptions for U_i such as U_i relies only on the change of y_i , U_i 's are identical to all the individuals, and U_i is increasing and strictly concave.

According to Chakravarty (1983), the Q index $Q(y, z) = \frac{1}{n} \left[\sum_{i=1}^q 1 - \left(\frac{y_i}{z} \right)^e \right]$ (where $0 < e < 1$) is

proved to be the only one that can satisfy the axioms Normalization (N) and Scale Invariance (SI) at that time. The paper also compared Q index to Blackorby and Donaldson (1980a)'s index, and Clark, Hemming and Ulph (1981)'s indices. The merits for Q index showed as it not only satisfies Sen's monotonicity and transfer axioms but also takes greater weight to transfers of income toward the lower part of the income distribution.

Watts (1968) introduces a logarithm index P that looks simple and mathematically tractable in distinguishing poor and non-poor. In fact, it is the logarithm of the welfare index.

The author also compares the index with the welfare ratio ($W = Y / \hat{Y}(N, L, t)$, where $\hat{Y}(N, L, t)$ denote the poverty threshold for a family of size N , place L , at time t) and the headcount. According to Watts, they are not as good as the index P . In parameter, the index P can be represented as $P = \sum N_i \ln(W_i), i \in L$. Apparently, the W index can only take positive values. When $W=1$, the P index is non-positive. The result would be zero if no individuals were below the poverty line. If the poverty increased, the value of P falls. While W is greater than 1, P could be positive even though there are people's revenues that are under the poverty line. In summary, the policy makers will pursue an outcome of maximized P in order to reduce poverty.

However, there are two major problems closely linked to poverty measurement.

- (i) One is the identification problem. Generally, the analyst needs to draw a poverty line to identify the poor. Then problems occur, and there are disagreements on the exact value of this poverty line, which means two analysts using two different poverty lines, may reach different conclusions.
- (ii) The other is the aggregate problem. We need to aggregate all individual poverty experience into a single poverty value for society. This is done using a poverty index. Nevertheless, there are many poverty indices in the literature, thus two analysts using two different indices may reach different conclusions.

In order to find a solution to the problems above, Atkinson (1987) proposes stochastic dominance tests to identify robust poverty orderings. Atkinson (1987) has interpreted the first

order and second order of stochastic dominance conditions. In the first order, the poverty shows reduction when there is an increase on a single person's income. In the second order, indices should obey the Pigou-Dalton principle that a mean-preserving transfer of income from a higher-income individual to a lower-income individual will be a social improvement. In the paper, Atkinson not only provides proof for the power of first and second order dominance but also searches their relation. The first dominance condition can imply but is not implied by the second dominance condition. Therefore, we can see that second order condition is weaker than the first order condition. In order to solve this, they assume that poverty function satisfies the Dalton transfer principle.

However, Zheng (1999) does not agree with Ravallion (1994)'s statements for increasing the power of poverty orderings beyond the second-degree stochastic dominance. According to Zheng (1999), the author uses classes of additively separable poverty measures as Atkinson (1987) does. It is demonstrated in the paper that the third-degree stochastic dominance is the necessary and sufficient condition for unanimous poverty ordering by the class of poverty measurements with satisfying weak transfer sensitivity axiom. In the case of a fixed poverty line, the third degree criterion shows greater power than the second-degree criterion. Nevertheless, its power reduces when the poverty line turns to a range of poverty lines both. Specifically, when the lower bound of poverty line goes to zero, the third degree ordering criterion will collapse to the second degree. To increase the power of higher degrees of stochastic dominance, the author

introduces a strong transfer sensitivity axiom. While this method is same to implement a strong continuity condition. But this method requires more reasonable limitations on the current poverty measures and has no definite answer.

Duclos and Makdissi (2004) expand the explanation to all the orders of the stochastic dominance curves by assuming continuity of the derivative of the poverty function at the poverty line. For all orders application of absolute poverty dominance, this essential assumption provides a possibility of necessary and sufficient condition. The operation of stochastic dominance curves helps economists to set up the ethical robustness of distributive comparisons. Duclos and Makdissi also give detailed interpretation to all the orders of stochastic dominance curve for welfare analysis. When two stochastic dominance curves do not intersect at a certain order, all indices that consistent to the ethical principles in this order are ranked identically between the two distributions. While the first two orders have already been mentioned in reviewing Atkinson (1987), we continue to explain higher orders. In the third order, indices should also obey favorable composite transfers (Kolm, 1976) such as a combination of a beneficial Pigou-Dalton transfer within the low-income group and a reverse Pigou-Dalton transfer within the high-income group will reduce poverty. According to Fishburn and Willig (1984), higher-order indices can also be explained by the generalized transfer principles. Furthermore, the fourth-order presents a similar favorable result when implementing the composite transfers in separate parts in the income distribution.

2.2 Literature on marginal tax reforms

In order to better adapt to the reality, Feldstein (1976) turns the research interest of economists from tax design to tax reform. In the light of comments in this paper, limited criteria of social choice used on optimal tax design have been examined. Altruism and envy are excluded in the utilitarian welfare function. While different tastes in consumption is also ignored for the horizontal equity problem. Plus the egalitarian principle and entitlement principle are violated. When checking the impact of the tax design by the Haig-Simons standard, the author states a few potential conflicts with both economic efficiency and horizontal equity. Compared to optimal tax design, tax reform may be more advantageous due to potential higher efficiency, balance on horizontal equity and proper consideration on legitimate property rights. There is even a section that discusses how postponement can frequently be used to achieve expected tax reforms.

Feldstein proposed this specific social welfare function (SEF):

$$W = \frac{1}{\alpha} \sum_i U_i^\alpha, \alpha < 1,$$

where U_i is individual utility. Ahmad and Stern (1984) also give the welfare weights generated

function: $W = \sum_i \frac{y_i^{1-\varepsilon}}{1-\varepsilon}$, ε is the inequality aversion parameter and $\varepsilon \neq 1$. Both of these tax reforms

may hardly apply in more general economic circumstances with implicit social welfare

functions.

However, the problem solved through a new approach called marginal stochastic dominance rules was provided by a couple of studies in the 1990s. Yitzhaki and Slemrod (1991) illustrated the rational of tax reforms. For a two-commodities case, indirect tax reform can be welfare improving by subsidizing one commodity from taxing the other. This can be shown in the diagram if two concentration curves do not intersect. Then, welfare increases for all additively separable social welfare functions and all increasing s-concave social welfare functions. Yitzhaki and Slemrod (1991)'s research, which were based on data from Israel, established the elementary concept of tax reforms in social welfare promotion under the condition that social welfare functions are not precisely known. For all households with additive increasing concave SEF, if the decision maker put an increase on a commodity to subsidy for another commodity, social welfare improved. Yitzhaki and Thirsk (1990) extend the study of dominance approach for evaluating excise tax bases in Yitzhaki and Slemrod (1991) by using a Computable General Equilibrium model to generate values for the efficiency costs of the tax reform. They adapt the method to the Côte d'Ivoire for making policy decision. We can also view the marginal conditional welfare dominance as the permission of favorable tax reform. Mayshar and Yitzhaki (1995) also propose an extension in a setting with heterogenous households. This is similar to the concept of a Dalton improvement that can be used to evaluate the efficiency of tax reforms. Therefore, the stochastic dominance method has been implemented in marginal tax reform analysis.

To further the stochastic dominance methodology in tax reform issue, Makdissi and Wodon (2002) firstly introduced a graphic tool, which is the Consumption Dominance Curves. The Consumption Dominance Curve can test whether the reduction in poverty induced by a marginal tax reform is robust over a great number of poverty measures and poverty lines. Even though it is similar in spirit to checking for nonintersecting concentration curves as in Yitzhaki and Slemrod (1991), the Consumption Dominance Curve allows researchers to test in every order of restricted stochastic dominance they need. Specifically Makdissi and Wodon (2002) seek further moving of research did in Besley and Kanbur (1988) for poverty measures of the FGT class. For instance, this one includes a great amount of poverty measures and discusses a new situation when various efficiency costs occur in public funds collection via different goods. I will return to explain more on the efficiency cost in the methodology section.

When it comes to the current article, we would like to apply stochastic dominance approach to poverty reduction in one of the world's most poor country, Malawi, through tax reform. Our Section 3 will state the stochastic dominance methodology that we used in the empirical test. Section 4 introduces the data and the empirical analysis. Then a conclusion part follows. References appear at the end of the paper.

3. Methodology

Since Makdissi and Wodon first created the consumption dominance methodology in 2002, Duclos, Makdissi and Wodon (2008) continued to search for a complete interpretation of social welfare improving tax reforms. Here we introduce two major elements from their work in building the theoretic model of Consumption Dominance Curves for indirect tax reforms. There are several subsections: price change on people's income, effect of tax reforms on government's budget, poverty measurement, and poverty reduction.

3.1 Poverty measure

In terms of poverty reduction, we have to define the basic poverty measurement. Suppose the policy maker wants to decrease an additive index of poverty below:

$$(1) P(z) = \int_0^{\infty} p(y, z) dF(y)$$

where y is the real income, $F(\cdot)$ is the cumulative distribution function of income, z is the poverty line (in real terms), and $p(y, z)$ is a function that measures the poverty of individual with an income y and using a poverty line z . It is convenient to define y and z as real variables. Compared to nominal definition of income space, the real setting of income space keeps poverty line invariant to tax reforms (Duclos, Makdissi and Araar, 2013). In the current paper, it also keeps the assumptions of the equality between nominal and real incomes for the sake of defining

reference prices to pre-reform prices. We also assume the poverty index should be non-negative to all individuals. This can be represented by $p(y, z) = 0$, for all $y > z$ and $p(y, z) > 0$ for all $y < z$.

Duclos and Makdissi (2004) use the properties of $P(z)$ to define classes of poverty indices $\Pi^s(z)$ for some order s . These classes are defined by

$$(2) \quad \Pi^s(z) = \left\{ P(z) \left| \begin{array}{l} p(y, z) \in \hat{C}^s(z), \\ (-1)^i p^i(y, z) \geq 0, \forall i = 0, 1, 2, \dots, s, \\ p^{(t)}(z, z) = 0, \forall t = 0, 1, 2, \dots, s, \end{array} \right. \right\},$$

where $p^i(y, z)$ represents the i th derivative of $p(y, z)$ with respect to y and \hat{C}^s is the set of continuous functions that are s -times differentiable on $[0, z]$. For poverty indices $P \in \Pi^1(z)$, an increase in the income of any one individual will weakly reduce the poverty index. Also, if two individuals exchange revenues, the poverty level will not be affected due to the symmetry of poverty indices. What is more, for poverty indices $P \in \Pi^2(z)$ that are also convex, it demonstrates that when there is a transfer from any one richer individual to a poorer individual should weakly decrease poverty (Pigou-Dalton principle of transfer). In terms of the poverty indices, $P \in \Pi^3(z)$ must also obey the Kolm (1976) principle of transfers. Kolm (1976) states that a Pigou-Dalton transfer that takes place at the bottom of the income distribution should have a greater effect on poverty than one occurring at higher income level in the distribution. Therefore, the transfer of income undertaken in a lower part of the distribution will decrease poverty even if government imposes a symmetric great transfer in a higher part of the distribution. Indices of a class $P \in \Pi^s(z)$ when $s > 3$ can be interpreted as referring to a generalized transfer principle

suggested by Fishburn and Willig (1984). While poverty indices $P \in \Pi^4(z)$, the fourth-order presents implementing the composite transfers in separate parts in the income distribution. In the light of Duclos, Makdissi, and Araar (2013), the greater the order s , and the greater is the sensibility of an index to changes occurring in the lower part of the distribution.

3.2 Price change on individual income

In order to define marginal change in a certain consumption commodity's price, we need to make a few assumptions. At first, we consider there is a vector q of K consumer prices. Also, we assume the vector of producer prices to be 1 and tax rates t of K goods as customary such that we obtain $q = 1 + t$, and $dq_k = dt_k$, where dq_k and dt_k denote the price and the tax rate on good k . As usual, we denote y to be the nominal income; then indirect utility function can be shown as $v(y, q)$. The vector of reference prices q^R is used to evaluate individuals' welfare in the circumstance of changing tax rates. Real or equivalent income level after the tax reform can be denoted as y^R , then y^R is measured through reference prices q^R so that $v(y, q) = v(y^R, q^R)$. Plus the real income $y^R = \rho(y, q, q^R)$, we then have

$$(3) \quad v(y, q) \equiv v(\rho(y, q, q^R), q^R).$$

As you can see in equation (3), we define that y^R to represent the level of income which provides under q^R the same utility as y yields under q .

According to Roy's identity, consumer's Marshallian demand function for good i can be calculated as

$$(4) \quad x_i^m = -\frac{\partial V}{\partial p_i} / \frac{\partial V}{\partial Y}$$

where p_i is the price vector of good i , Y is consumer's income, and V is indirect utility function.

We can apply Roy's identity and assume that reference prices to pre-reform prices so that

$$(5) \quad \left. \frac{\partial \rho(y, q, q^R)}{\partial t_k} \right|_{q=q^R} = -x_k(y, q^R).$$

Intuitively, we can interpret equation (5) that observed consumption of good k before tax reform is a sufficient statistic to know the impact on consumer welfare of a marginal change in the price of good k .

3.3 The reform impact on government budget

This subsection proposes to test whether a revenue-neutral tax reform scenario can reduce poverty. For the sake of keeping government's revenue intact, the decision maker must finance a marginal tax reduction for a good i from a marginal increase in the good j . We can build the framework by assuming K consumption goods and denote by T the per capita tax revenue of the overall indirect tax system:

$$(6) \quad T(q) = \sum_{k=1}^K t_k X_k(q).$$

The impact of the marginal tax reform on per capital tax revenue then is dT , then we obtain

$$(7) \quad dT = \left[X_i(q) + \sum_{k=1}^K t_k \frac{\partial X_k(q)}{\partial t_i} \right] dt_i + \left[X_j(q) + \sum_{k=1}^K t_k \frac{\partial X_k(q)}{\partial t_j} \right] dt_j.$$

While we require revenue neutrality, this lead to $dT = 0$. From equation (7), have

$$(8) \quad dt_j = -\gamma_{i,j} \left(\frac{X_i(q)}{X_j(q)} \right) dt_i, \text{ where } \gamma_{i,j} = \frac{1 + \frac{1}{X_i(q)} \sum_{k=1}^K t_k \frac{\partial X_k(q)}{\partial t_i}}{1 + \frac{1}{X_j(q)} \sum_{k=1}^K t_k \frac{\partial X_k(q)}{\partial t_j}}.$$

$\gamma_{i,j}$ is named as the efficiency ratio of obtaining one dollar of public funds by taxing good j instead of good i .

3.4 Consumption dominance curve and poverty reduction condition

The standard to evaluate the efficiency of poverty reduction tax policy can be derived from stochastic dominance curves. If $q = q^R$, $s = 1, 2, \dots$ let

$$(9) \quad D^s(z) = \frac{1}{(s-1)!} \int_0^z [z-y]^{(s-1)} dF(y).$$

Then equation (9) can turn to a more general form. Though real income:

$$(10) \quad D^s(z) = \frac{1}{(s-1)!} \int_{\theta} \int_0^{\eta(z, \theta, q, q^R)} [z - \rho(y, \theta, q, q^R)]^{(s-1)} dF(y, \theta).$$

Then we can reduce equation (10) to equation (9) and obtain that

$z = \eta(z, \theta, q, q^R) = \rho(z, \theta, q, q^R)$ when $q = q^R$. Hence, dominance curves are the accumulation of powers of poverty gaps. Theoretically, these curves can be seen as weighted sums of individual deprivation. Therefore, it would be thoughtful to study the impact of changes in prices on the dominance curves. From equation (5) and (10), we can acquire derivatives of (10) that

$$(11) \quad \left. \frac{\partial D^s(z)}{\partial t_k} \right|_{q=q^R} = \begin{cases} x_k(z, q^R) f(z), & s = 1 \\ \frac{1}{(s-2)!} \int_0^z x_k(y, q^R) (z-y)^{s-2} dF(y) & s = 2, 3, \dots, \end{cases}$$

Note here $f(z)$ means the density of income z . All of these can help us build the concept of Consumption Dominance (CD) curves:

$$(12) \quad CD_k^s(z) = \frac{\partial D^s(z)}{\partial t_k}, \quad s = 1, 2, \dots$$

The CD curves in equation (11) can be interpreted as the ethically weight cost of taxing k while normalized CD curves, $\overline{CD}_k^s(z)$, are the CD curves from (12) for commodity k normalized by the average consumption of k :

$$(13) \quad \overline{CD}_k^s(z) = \frac{CD_k^s(z)}{X_k(q)}.$$

Then \overline{CD} curves are the social cost of taxing good k as proportion of the average welfare cost.

The cost only includes s and z .

Therefore, we can define the condition of pro-poor. According to Duclos, Makdissi and Wodon (2008), a marginal tax reduction on good i financed by a marginal increase in the tax on good j is relatively pro-poor for all indices $P \in \Pi^s(z)$ and for all poverty lines $z \in [0, z^+]$ if and only if

$$(14) \quad \overline{CD}_i^s(z) - \gamma \overline{CD}_j^s(z) \geq 0, \quad \forall z \in [0, z^+],$$

where $\overline{CD}_i^s(z)$ and $\overline{CD}_j^s(z)$ are the consumption-dominance curves of good i and j , $s \in \{1, 2, 3, \dots\}$.

When it comes to the efficiency and dominance, Proposition 1 from Makdissi and Wodon (2002) have noted that the marginal tax reform will reduce poverty at a given order of dominance if the $\overline{CD}_i^s(z)$ is above the $\overline{CD}_j^s(z)$ for every income level under the maximum poverty line. Hence, the difference between \overline{CD} -curves of goods is the result that we are trying to assess.

In addition, the ratio $\frac{\overline{CD}_i^s(z)}{\overline{CD}_j^s(z)}$ of normalized consumption dominance curves can be interpreted as the distributive benefit of taxing good j instead of good i . Denote this distributive benefit ratio as $\delta^s(z) = \frac{\overline{CD}_i^s(z)}{\overline{CD}_j^s(z)}$. Plus, if $\overline{CD}_j^s(z) = 0$, the $\delta^s(z)$ goes to infinity, but we will define it as γ^{++} which represents as large a finite value as we wish. Then the complete definition of $\delta^s(z)$ is given by

$$(15) \quad \delta^s(z) = \begin{cases} \frac{\overline{CD}_i^s(z)}{\overline{CD}_j^s(z)} & \text{if } \overline{CD}_j^s(z) \neq 0 \\ \gamma^{++} & \text{if } \overline{CD}_j^s(z) = 0 \end{cases}.$$

Comparing distributive benefit $\delta^s(z)$ to economic cost γ is crucial in determining whether a tax reform that increases tax on good j and decreases tax on good i is socially improving.

We can rewrite (14) as

$$(16) \quad \overline{CD}_i^s(y) - \gamma \overline{CD}_j^s(y) \geq 0, \forall y \in [0, z^+].$$

Then we combine (15) and (16), to obtain

$$(17) \quad \delta^s(y) \geq \gamma, \forall y \in [0, z^+].$$

Then we can define

$$(18) \quad \gamma^s(z^+) = \sup \{ \gamma : \delta^s(y) \geq \gamma, \forall y \in [0, z^+] \}.$$

Equation (18) identifies the layout value of the efficiency ratio compatible with a poverty reduction at order s .

4 Data introduction and empirical analysis

4.1 Data Source

Malawi is among the least developed countries in the world, and the scourge of general poverty poses major problems in this country. According to Poverty and Vulnerability Assessment (PVA), referred by Malawi Growth and Development Strategy (MGDS), over 52 percent of the population in Malawi lives below the poverty line and 22 percent of people live in extreme poverty. For those 22 percent, they can not satisfy the estimated daily food supply. Compared to last survey data taken in 1998, there is no statistically significant difference from the figure until 2006 since MGDS covers strategy of poverty reduction in Malawi in the period 2006 to 2011. In 1998, 54.1 percent of people were poor, and 23.6 percent were extremely poor according to Government of Malawi (2006).

The data we use in the current paper is coming from Republic of Malawi, the third Integrated Household Survey (IHS3) in the period 2010 to 2011, which was conducted by National Statistic Office (NSO) of Malawi. “The Survey is a nationally representative sample survey designed to provide information on the various aspects of household welfare in Malawi. The survey collected information from a sample of 12,288 households statistically designed to be representative at both national, district, urban and rural levels enabling the provision of reliable estimates for these levels.” (NSO, 2012) The survey conductors state that it can be used for further analysis to inform policy making. In the current paper, we use IHS3 summary to collect general information of people’s living conditions in Malawi. The survey also feeds into the construction and evaluation of Malawi’s medium development framework that is evaluated by MGDS. Before running the tests, we found the data that contain detail information on poverty and income equality, demographic characteristics, health, education, labour force participation, credit and loan, household enterprises, asset ownership, agriculture, housing and environment, child anthropometrics and food security indicators (NSO, 2012).

Now we can use IHS3 dataset to do the stochastic dominance test for tax reform. As there are enormous factors that affect people’s living standard, we have to choose variables that are valuable in interpreting consumption circumstance applied in the test. Those variables are food, housing, electricity, health, transportation and education. The target of the current section is to

test for dominance of those variables relative to nonfood consumption. Therefore, we have six combinations of tests as below:

- A. Food and Nonfood expenditures
- B. Housing and Nonfood expenditures (the housing consumption has already been excluded from nonfood consumption in 1)
- C. Electricity and Nonfood expenditures (the electricity consumption has already been excluded from nonfood consumption in 1)
- D. Health and Nonfood expenditures (the health consumption has already been excluded from nonfood consumption in 1)
- E. Transportation and Nonfood expenditures (the transportation consumption has already been excluded from nonfood consumption in 1)
- F. Education and Nonfood expenditures (the education consumption has already been excluded from nonfood consumption in 1)

Note: All Consumption Dominance curve have been cost normalized. Moreover, among the 12271 observations in the data, when we check for the distribution of the poor population, there is only 0.39 percent of the population below 0.2 of the poverty line. To avoid the lack of

observation from 0 to 0.2 of the poverty line, we took the dominance test from 0.2 to 3 of the poverty line.

4.2 Empirical analysis

This subsection will present all the combinations of commodities in marginal tax substitution reform separately.

4.2.1 Combination A: consumption dominance curve analysis of food and nonfood

consumption

Figure 1 is the first order of normalized expected food expenditures and nonfood expenditures at different incomes z . The food \overline{CD} -curve is everywhere above nonfood \overline{CD} -curve in the first order. Therefore, a tax reform (decrease tax or increase subsidy on food more than increase tax on nonfood) will reduce poverty for any poverty lines between 0 and 3 under the assumption that $\gamma = 1$. We can say that food consumption dominates nonfood consumption when $s = 1$. There is no doubt that any poverty line below 3 it is first-order poverty improving to implement a balanced-budget indirect tax reform if we assume $\gamma = 1$. Reducing the margin taxes on food expenditures and increasing taxes on nonfood expenditures can achieve this result.

Please note here, that according to table 4 in Duclos, Makdissi, Araar (2013) (Table 1 below in the current paper), although γ close to 1, it is always slightly different. For this reason

we test for sensitivity to different values of γ . For our current food and nonfood issue, our goal is to find out whether to tax nonfood consumption to subsidize food consumption would be poverty improving.

While in terms of efficiency ratio between food and nonfood expenditures, a number of graphs at the end to this subsection show the main results. We also attached a table of precise value of γ in each poverty line except \overline{CD} -curves graphs. To start with, we set the range of income per capita from 0 to 3. Then from Figure 2, 3 to 4 we can reach the conclusion that the food consumption curve keeps higher than nonfood curve in the 1, 2, and 3 order graphs. Therefore we can say that tax nonfood will reduce poverty. In the light of test results, the policy is Dalton improving even till $\gamma = 1.3$. Table 2 presents critical efficiency ratios, and the efficiency ratios keep greater than 1 while $\gamma = 1$. All those data lead us to conclude that tax nonfood for food consumption to be pro-poor at any poverty index. The test results will show next page.

Table 1 Estimates of the efficiency costs of tax reforms using estimated price elasticities
Efficiency $\gamma_{i,j}$ parameters estimated from estimates of own and cross-price elasticities
for aggregate consumption categories

	C1	C2	C3	C4	C5	C6	C7	C8	C9
C1	1.000	0.944	0.963	0.959	0.833	0.844	0.962	0.977	0.965
C2	1.060	1.000	1.020	1.017	0.883	0.895	1.019	1.035	1.023
C3	1.039	0.980	1.000	0.997	0.865	0.877	0.999	1.014	1.002
C4	1.042	0.983	1.004	1.000	0.868	0.880	1.002	1.018	1.006
C5	1.201	1.133	1.156	1.152	1.000	1.014	1.155	1.173	1.159
C6	1.185	1.118	1.140	1.136	0.987	1.000	1.139	1.157	1.143
C7	1.040	0.981	1.001	0.998	0.866	0.878	1.000	1.016	1.003
C8	1.024	0.966	0.986	0.982	0.853	0.864	0.985	1.000	0.988
C9	1.036	0.978	0.998	0.994	0.863	0.875	0.997	1.012	1.000

i stands for line goods and j for column ones

$\gamma_{i,j}$ can be interpreted as the efficiency cost of subsidizing i and taxing j

The aggregate consumption categories are:

C1: Food, beverage and tobacco

C2: Clothing and footwear

C3: Gross rent, fuel and power

C4: House furnishings and operations

C5: Medical care

C6: Education

C7; Transport and communication

C8: Recreation

C9: Other

Source: Based on (27) and on the elasticity estimates for Mexico found in Regmi and Seale (2010). All the values come from Duclos, Makdissi, Araar (2013). We use this table to illustrate the rationale of taking $\gamma = 1$.

Table 2 Critical efficiency ratios for different maximum poverty lines z^+ and for different orders between food and nonfood consumption ($\gamma = 1$).

	$z^+ = 1$	$z^+ = 2$	$z^+ = 3$
$\gamma_1(z^+)$	1.803387 (0.0266431)	1.579632 (0.0380448)	1.321238 (0.0599104)
$\gamma_2(z^+)$	1.4872530 (0.0298748)	1.3780700 (0.0253053)	1.3312270 (0.0236797)
$\gamma_3(z^+)$	1.502236 (0.0304611)	1.425758 (0.0264042)	1.382594 (0.0248142)

Figure 1 \overline{CD} -curves of Food and Nonfood consumption in the first order. Note that the consumption of food is above nonfood from $z = 0.2$ to $z = 3$ during the graph.

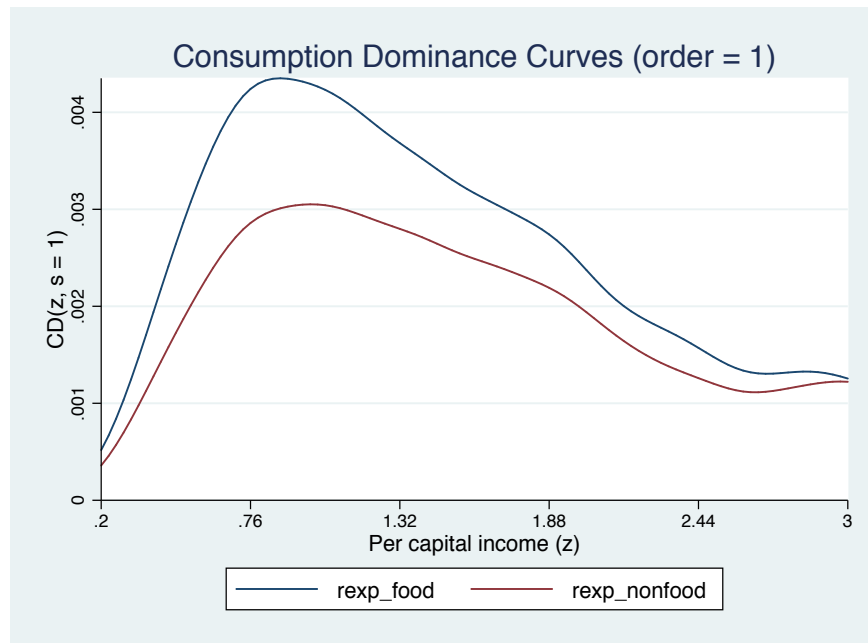


Figure 2 The efficiency ratio in the first order. Note that the ratio between food expenditure and nonfood expenditure is above 1 from $z = 0.2$ to $z = 3$ during the graph.

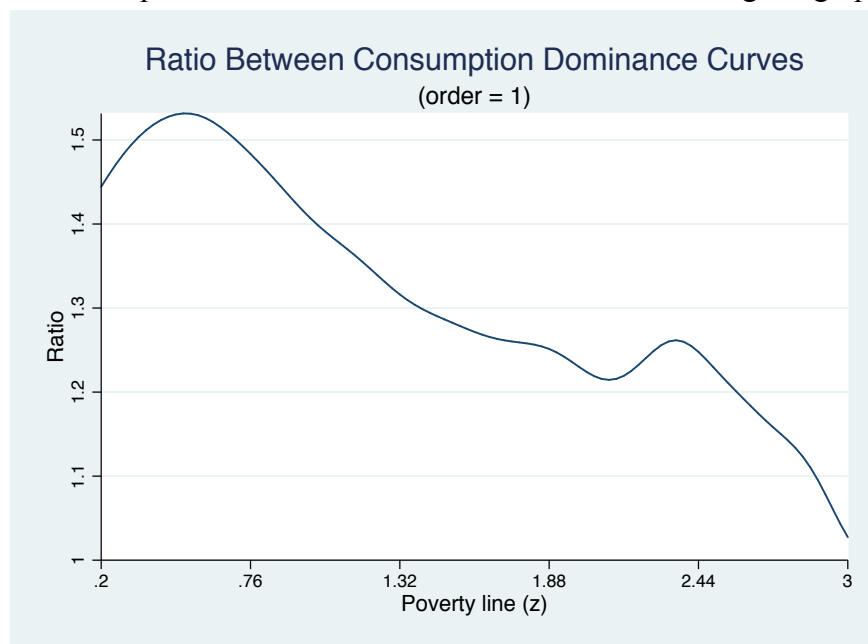
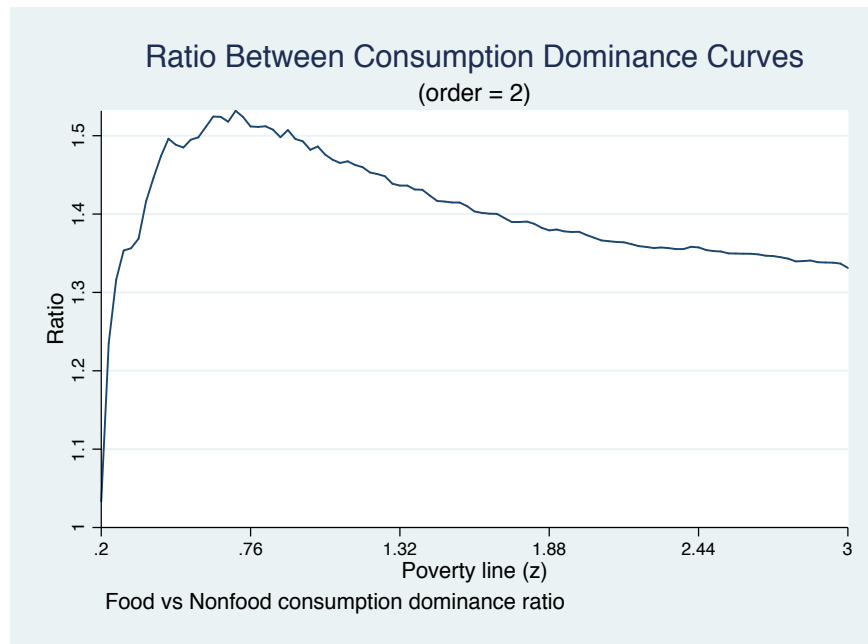
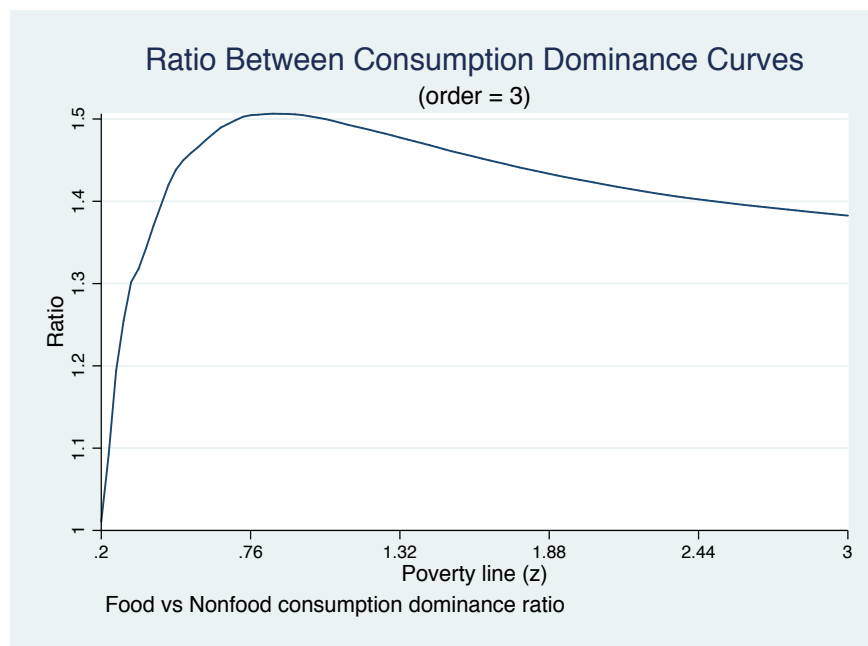
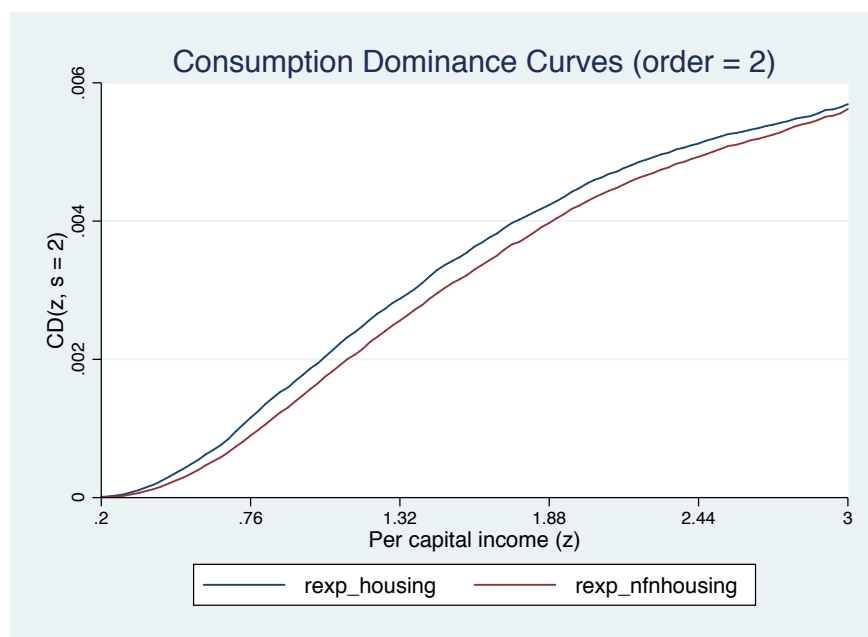


Figure 3 The economy efficiency ratio between food and nonfood $s = 2$ Figure 4 The economy efficiency ratio between food and nonfood $s = 3$ 

4.2.2 Combination B: housing and nonfood (except housing) consumption dominance curve analysis

For housing versus nonfood consumption, from our test results, the first-order housing CD curve and nonfood CD curve cross at approximate income $z = 1.3$. The intersection means that for any poverty line below 1.3, it is first-order poverty improving to implement an indirect tax reform by subsidizing housing expenditures from taxing nonfood expenditures. Since 57.21% of the population is covered at poverty line equal to 1.3. 57.21% of people would benefit under the condition of revenue-neutral reform. According to Figure 5 above, for $s = 2$, these curves display the cumulative shares of housing and nonfood expenditures under certain level of per capita income. It is Dalton improving as housing expenditure keeps above nonfood expenditure. Hence, if we tax nonfood (no housing) expenditures and use the revenue to subsidize housing expenditures, the poverty would decline for any poverty index belonging to $\Pi^1(z)$ and any poverty lines between 0.2 and 3. To provide more evidence, we give the γ values in specific poverty lines in Table 3 below. As all efficiency ratios are greater than 1 while $\gamma = 1$ in Table 3, decision makers would like to implement an increase of tax on nonfood consumption and a decrease of tax on housing consumption.

Figure 5 The economy efficiency ratio between housing and nonfood $s = 2$ Table 3 Critical efficiency ratios for different maximum poverty lines z^+ and for different orders between housing and nonfood consumption ($\gamma = 1$).

	$z^+ = 1$	$z^+ = 2$	$z^+ = 3$
$\gamma_1(z^+)$	1.042596 (0.0437801)	0.9333887 (0.0497330)	0.7963439 (0.0545950)
$\gamma_2(z^+)$	1.1830390 (0.0460715)	1.0587120 (0.0391393)	1.0124190 (0.0367523)
$\gamma_3(z^+)$	1.275631 (0.0497263)	1.125919 (0.0417095)	1.07273 (0.0390799)

4.2.3 Combination C: Electricity and nonfood (except electricity) expenditures analysis

The results show that electricity consumption curve is all above the nonfood consumption curve. Then we can reduce poverty in Malawi at any poverty index by increasing tax on nonfood

expenditures and decreasing the same amount of tax on electricity expenditures belonging to $\Pi^1(z)$ at any poverty lines between 0.2 and 3. Similar to previous two combinations, we present all the exact values of efficiency cost in Table 4 below. Due to the situation that all ratios are larger than 1, we enhance the favor of marginal tax reform.

Table 4 Critical efficiency ratios for different maximum poverty lines z^+ and for different orders between electricity and nonfood consumption ($\gamma = 1$).

	$z^+ = 1$	$z^+ = 2$	$z^+ = 3$
$\gamma_1(z^+)$	1.264518 (0.0358233)	1.222773 (0.0492209)	1.070669 (0.0682071)
$\gamma_2(z^+)$	1.6453140 (0.0415805)	1.3424360 (0.0301986)	1.3052430 (0.0279082)
$\gamma_3(z^+)$	1.860552 (0.0479173)	1.48138 (0.0338106)	1.388039 (0.0302688)

4.2.4 Combination D: Health and nonfood (except health) expenditures analysis

If we assume γ equal to 1, according to test results of health and nonfood consumption, if we tax nonfood expenditures and use the revenue to subsidize health expenditures, the poverty would decrease belonging to $\Pi^1(z)$ at any poverty lines between 0.2 and 3. When γ is equal to 1, From Table 5 we have all the ratio values greater than 1. This illustrates that the tax policy of taxing nonfood consumption to subsidize health consumption could be pro-poor.

Table 5 Critical efficiency ratios for different maximum poverty lines z^+ and for different orders between health and nonfood consumption ($\gamma = 1$).

	$z^+ = 1$	$z^+ = 2$	$z^+ = 3$
$\gamma_1(z^+)$	1.353961 (0.0981449)	1.162107 (0.1154006)	1.021653 (0.1718584)
$\gamma_2(z^+)$	1.2531520 (0.0745428)	1.3329740 (0.0654690)	1.2817580 (0.0580586)
$\gamma_3(z^+)$	1.279458 (0.0806608)	1.313989 (0.0661963)	1.303187 (0.0606713)

4.2.5 Combination E: Transportation and nonfood (except transportation) expenditure analysis

For transportation, the results are different from all the results before. Therefore, we can not improve the poor's living standard by increasing tax on nonfood expenditures and decreasing tax on transportation if γ equal to 1. On the contrary, if we tax transportation expenditures to support nonfood expenditures, we can reduce poverty.

Transportation is another great expenditure which is part of the total consumption of people's life. According to test results, compared to nonfood consumption, transportation consumption shows increasing trend and achieves 1.14 when the poverty line is 3. Plus, we have precise critical efficiency ratio value under critical poverty lines in Table 6 below. In Table 6, only when poverty equal to 3 in first order can we have the efficient ratio greater than 1. Therefore, the test shows tax reform in the field of transportation may not be as effective as we assume in the poverty reduction.

Table 6 Critical efficiency ratios for different maximum poverty lines z^+ and for different orders between transportation and nonfood consumption ($\gamma = 1$).

	$z^+ = 1$	$z^+ = 2$	$z^+ = 3$
$\gamma_1(z^+)$	0.5583413 (0.0492572)	0.7873532 (0.0668428)	1.1418020 (0.1133003)
$\gamma_2(z^+)$	0.3495817 (0.0221913)	0.5539402 (0.0281443)	0.6387369 (0.03001)
$\gamma_3(z^+)$	0.2771461 (0.0179445)	0.456182 (0.0241457)	0.5356448 (0.0259215)

4.2.6 Combination F: Education and nonfood (except education) expenditure analysis

Education is one of the most essential parts in people's life. Due to the future potential of increasing power to support the family income, education always attracts great attention. Maybe the cost for going to school is relatively high, then we could not receive effective results from taxing nonfood consumption to subsidize education. From Table 7, we have all the value less than 1 at poverty line equal to 1, 2, and 3 respectively. The tax reform does not work well in education after poverty line is past about 0.4. Therefore, we can only conclude that the tax reform is effective when the poverty line is 0.4 times of the mean income per capita. This may imply that while taking tax reform to support education at the bottom of income distribution, the results may be efficient. Mostly, the test results would not suggest to government to impose a tax reform on education and nonfood expenditures. Table 7 is presented on the next page.

Table 7 Critical efficiency ratios for different maximum poverty lines z^+ and for different orders between education and nonfood consumption ($\gamma = 1$).

	$z^+ = 1$	$z^+ = 2$	$z^+ = 3$
$\gamma_1 (z^+)$	0.7487102 (0.0598986)	0.716877 (0.0892959)	0.750568 (0.1493429)
$\gamma_2 (z^+)$	0.7609271 (0.0453895)	0.7438686 (0.0414074)	0.7162158 (0.0383121)
$\gamma_3 (z^+)$	0.8103208 (0.0487639)	0.7604511 (0.0414462)	0.7467968 (0.0394199)

5. Conclusion

This paper implements the consumption dominance curve methodology in Malawi's household dataset in order to find out whether an indirect tax reform is pro-poor or not. It also provides theoretic support of poverty measurement and statistical inference to deal with the relationship of efficiency cost ratio and distribution. During the application of the poverty reducing marginal tax reforms in Malawi's indirect tax system, six combinations of publicly supported goods have been taken into consideration. The empirical results illustrate that, among the six combinations A, B, C, D, E, and F we choose from the entire group of elements affect living standard index, food, housing, electricity, and health consumption can be subsidized by imposing marginal tax on nonfood expenditures. Nevertheless, increasing marginal tax on consumption of nonfood expenditures would not affect the support on transportation and education. Further study can extend the relative pro-poorness test on tax reform to absolute pro-poorness.

References

- Ahmad, E., & Stern, N. (1984). The theory of reform and indian indirect taxes. *Journal of Public Economics*, 25(3), 259-298.
- Atkinson, A. B. (1987). On the measurement of poverty. *Econometrica: Journal of the Econometric Society*, , 749-764.
- Besley, T., & Kanbur, R. (1988). Food subsidies and poverty alleviation. *The Economic Journal*, 98(392), 701-719.
- Blackorby, C., & Donaldson, D. (1980). Ethical indices for the measurement of poverty. *Econometrica*, 48(4), 1053-1060.
- Chakravarty, S. R. (1983). A new index of poverty. *Mathematical Social Sciences*, 6(3), 307-313.
- Clark, S., Hemming, R., & Ulph, D. (1981). On indices for the measurement of poverty. *The Economic Journal*, 91(362), 515-526.
- Duclos, J., & Makdissi, P. (2004). Restricted and unrestricted dominance for welfare, inequality, and poverty orderings. *Journal of Public Economic Theory*, 6(1), 145-164.
- Duclos, J., Makdissi, P., & Araar, A. (2014). Pro-poor indirect tax reforms, with an application to Mexico. *International Tax and Public Finance*, 21(1), 87-118.
- Duclos, J. Y., Makdissi, P., & Wodon, Q. (2008). Socially improving tax reforms. *International Economic Review*, 49(4), 1505-1537.
- Feldstein, M. (1976). On the theory of tax reform. *Journal of Public Economics*, 6(1), 77-104.
- Fishburn, P. C., & Willig, R. D. (1984). Transfer principles in income redistribution. *Journal of Public Economics*, 25(3), 323-328.
- Foster, J., Greer, J., & Thorbecke, E. (1984). A class of decomposable poverty measures. *Econometrica: Journal of the Econometric Society*, 761-766.
- Government of Malawi. (2006). Malawi growth and development strategy (MGDS): 2006/11.
- Kolm, S. (1976). Unequal inequalities. I. *Journal of Economic Theory*, 12(3), 416-442.

- Makdissi, P., & Wodon, Q. (2002). Consumption dominance curves: Testing for the impact of indirect tax reforms on poverty. *Economics Letters*, 75(2), 227-235.
- Mayshar, J., & Yitzhaki, S. (1995). Dalton-improving indirect tax reform. *The American Economic Review*, 85(4), 793-807.
- National Statistical Office (NSO), 2012. Integrated household survey 2010/11. Household Socio-Economics Characteristics. Zomba Malawi.
- Ravallion, M. (Ed.). (1994). *Poverty comparisons (Vol. 56)*. Taylor & Francis.
- Sen, A. (1976). Poverty: An ordinal approach to measurement. *Econometrica*, 44(2), 219-231.
- Takayama, N. (1979). Poverty, income inequality, and their measures: Professor Sen's axiomatic approach reconsidered. *Econometrica*, 47(3), 747-759.
- Watts, H. W. (1968). *An economic definition of poverty*, Institute for Research on Poverty.
- Yitzhaki, S., & Slemrod, J. (1991). Welfare dominance: An application to commodity taxation. *The American Economic Review*, 480-496.
- Yitzhaki, S., & Thirsk, W. (1990). Welfare dominance and the design of excise taxation in the côte d'ivoire. *Journal of Development Economics*, 33(1), 1-18.
- Zheng, B. (1999). On the power of poverty orderings. *Social Choice and Welfare*, 16(3), 349-371.