Income Diversification of Rural Households in *Zoba Maekel*, Eritrea

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ABSTRACT
The study, conducted in *Zoba Maekel*, Eritrea, has examined the factors affecting the diversification of income of rural households using two concepts of diversification. The first one is based on household's diversification away from their own farm, which is measured as the proportion of rural households' income from non-farm activities in their total income; whereas the second one focuses on diversification as an increase in the number of rural households' income earning activities regardless of their sectoral or functional classification, which is measured using Shannon Equitability Index. The study has reported that household's income diversifications are highly related to their access to formal credit, livestock possessions, and year of schooling of household's head or average year of schooling of members of the household. Moreover, it has supported the hypothesis that diversification is an *ex-post* coping strategy for low agricultural productivity, and confirmed the presence gender bias in the overall diversification of rural households.

Keywords: income diversification, non-agricultural income, Shannon equitability index, Eritrea, Tobit
JEL Classification: O1, O2, C3

BACKGROUND

The rural sector is commonly viewed by policy makers and implementers as a sector which is stirred more or less by farm, and the income derived by the rural sector as equal with farm income. This erroneous belief stems from the fact that rural households inexorably depend heavily on their farms; mainly on outputs retained from their farms, income earned from the sale of crops or livestock, and income earned from employment on local farms; for much of their livelihoods. As a result, policymakers view the efforts to tackle rural poverty are equivalent to policies that are intended to enhance farm productivities. However, this traditional view of rural households as being purely agricultural is clearly superseded. Since there is growing evidence that a large proportion of rural households' total income is earned away from the agricultural sector and that the rural households are much more than just farmers. For example, in addition to income it earns from its farm, a rural household might earn income from its engagement in local non-farm wage activities, trades, hiring out its labor away from its farm in others farm (off-farm activities), sale of livestock, and from remittances.

According to [3], rural households seldom depend on one source (mainly agriculture) for all their income; use one asset to hold all their wealth; or just use all households' assets in a single activity. Thus, rural households' participation in multiple income generating activities and thereby diversifying their income sources is a custom. As a result, diversification of sources of income has become part of the livelihood strategy of rural households, and it is a widely recognized fact that the path towards a sustainable rural livelihood involves escaping from a lasting dependence on insufficient number of sources of income. Therefore, identifying as well as promoting a diversified sources of income of rural households has gained widespread support among development policy makers, especially in the developing countries, which are facing repeated income and consumption shocks [5]. According to [9, 17], rural households'

livelihood diversification can be defined as households' practices to increase their portfolio of assets and their income sources or activities in order to withstand and/or enhance their living standards.

In general, rural households' income diversification is the spreading out of households' sources of income away from their farm, to employments in local or migratory non-farm wage or self-employments; employments in the farm of others; livestock of others; and reliance on pensions, remittances, rent, and other types of income transfers. Even though the allocation of their labor away from their own farms generally constitutes rural income diversification, the motives for diversification may differ significantly across households. That is diversification can be undertaken for accumulation objectives (because households are drawn to it), driven mainly by "pull" factors. Moreover, some households are forced to undertake income diversification to manage risk, cope with shock, escape from stagnating or declining agricultural productivity, or to escape resource constraint and hence driven by "push" factors [20]. Thus, the diversified income generating activities, which are pursued by rural households, are considered as risk aversion behaviors to reduce households' vulnerability to fluctuations in agricultural productivities; as well as to cope with imperfections in rural labor, credit and land markets, thereby to follow smooth consumption pattern [8, 18].

The available literature reveals that the diversification of rural households' sources of income is the highest in Africa; where about 42 per cent of rural households' income are earned farm non-farm activities, i.e., away from their own farm, compared to the 32 per cent in rural Asia and 40 per cent in rural Latin America [18, 19 and 14]. Moreover, with the prevailing pace of the integration of the agricultural sector into the global markets and with the intensification of rural-urban linkages, there is no doubt that these shares of income from the rural non-farm sector will eventually increase. Reference [19] shows that even though there is regional difference in the level of income diversification, the pattern of this diversification is clearly linked to rural households' access to assets (for example, human capital, social capital, and physical capital) and other types endowments. Thus, household characteristics, private and public asset endowments, as well as geographical area specific characteristics such as agro-climate are believed to play pivotal role in determining rural households' diversification of income sources.

Eritrea, which is located in the Horn of Africa, is one of the world's poorest countries with the lowest per capita incomes and high incidence of absolute poverty [12]. The overall poverty estimate for the country is 66 per cent, with 37 per cent living in extreme poverty [23]. It is more prevalent in the rural areas, since around 67 per cent of the poor are living in rural Eritrea [1]. With its economy predominantly based on agriculture; cultivation of crops, animal husbandry and trade related to these activities are the main sources of income for the rural Eritreans. On the average, they account for about 60 per cent of total households' income [24]. Moreover, from the entire population of the country, more than 70 per cent is engaged in rural and agricultural based economic activities, and thus earn their livelihood mainly from the agricultural sector.

In Eritrea, rural areas are not only the places where most of the country's poor lives, but also the places where livelihood is no longer considered as being a synonym for farming activities. Instead, it has been acknowledged that people in rural Eritrea pursue multiple strategies to make a living and earn income from various sources, which is reflected in the combination of crops farmers grow as well as the diversification of their activities in non-farm sector. A good understanding about the determinants of diversification of sources of income by rural households' away from their agricultural plot (farm), as well as their overall diversification

measured in terms of the number of rural households' income earning activities is essential for designing policies that are intended to further promote diversification of activities and income by rural households. For this reason, the study aims to undertake a quantitative assessment of factors that affect income diversification of rural households away from their own farm as well as rural households' overall diversification in terms of the mix of activities households participates on. Therefore, the study is organized in six sections. Section one of the study examines the general background of rural income diversification. In the second section, classifications of income sources of rural households is given. Section three of the study briefly discusses the methodology used for collecting the data as well as techniques followed on the measurements of dependent and independent variables. The fourth section highlights the econometric model which is adopted for the study, the framework used for measuring income diversity and the techniques of estimation followed. In the fifth section, empirical results of the study are discussed. Finally, findings of the study are summarized in the sixth section.

CLASSIFICATION OF SOURCES OF INCOME

In the livelihood literature, there are wide ranges of techniques in classifying the sources of income of rural household that can help us understand the reasons and ways of diversification of rural households away from their own farm. Usually, terms like non-farm or more generally off the farm income are applied, in a seemingly identical way, however with somewhat different meanings. According to [8, 9], off-farm income, for example, refers to income earned in the form of not only wage but also includes in kind payments for labor on others farm. This includes sharecropping and other types of non-wage labor arrangements which is still ubiquitous in many less developed countries. On the other hand, off-farm income has also been referred to all income that are earned from activities that are away from household's own farm, regardless of sectoral or functional classification; where as non-farm income is usually deployed to mean income arising from outside the agriculture [4]. Therefore, based on [4]'s classification, we have followed farm vs. off-farm sources of income, where the off-farm sources of income refers to income sources away from farmer's own farm, regardless of their sectoral or functional classification. Thus, based on this classification, we have identified wage-employment in non-farm sector, wage-employment in farm sector, self-employment in non-farm sector, both self and wage-employments away from household's own farm (off-farm) and agricultural self-employment (livestock production) as the five different income sources away from household's farm income (crop production), in the research area. Based on these classifications, we look at rural households' income diversification either as diversifying away from farm income, or as an expansion in the number of household's income earning activities.[1]

Measuring Income Diversity

We have followed two measures regarding the diversification of rural household's sources of income. Most of the time, income diversification of a rural household refers to an increase in the proportion or share of household's income from sources that are away from its own farm. Thus, based on this definition, the extent of diversification of a rural household out of its own farm can be measured using the percentage of household's non-farm income in total household income. Where non-farm income refers to household's income earned from both non-farm self and wage-employments. On the other hand, the number of income sources of a rural household as well as the relative importance of these sources can be used as a measure of income diversifications of a rural household. Thus, using the six sources of income, which are identified in the study area, and applying the Shannon Equitability Index (SE) concept, we can examine the overall diversity of household's income. In calculating a household's Shannon equitability

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[1] Refer to [25, 26] for details on the determinants of income diversification or determinants of participation in various rural non-farm activities in the case of Eritrea.

index, the number of income sources of a rural household and their proportion in household's total income are taken into account. As the number of income sources of a rural household increases and if the income earned from these sources are evenly distributed among these sources, then the value of household's *SE* will obviously increase. Following [27, 2], *SE* is derived from a concept which was originally used to assess the diversity of species, called the Shannon index *(S).* The original Shannon index concept, which has been modified to fit to our study, is given by

$$S_{income} = -\sum_{i=1}^{I}[(income\ share_i).\ln(income\ share_i)]$$

Where the number of income earning activities of a rural household is given by *I*. Moreover, the *income share$_i$* refers to the income share of an income earning activity *i* in household's total income. Both the number of household's income sources and their evenness are taken into account in calculating the Shannon index (S_{income}), which is calculated for every household. The value of the Shannon index tends to increase with an increase with diversity. Therefore, based on S_{income} discussed above, the following formula can be used to calculate the Shannon equitability index (*SE*).

$$SE = \left[\frac{S_{income}}{-\sum_{i=1}^{I}\left[\left(\frac{1}{I}.\ln\left(\frac{1}{I}\right)\right)\right]}\right].100$$

The denominator refers to the maximum possible S_{income} value. The value of the Shannon equitability index, which is obtained from the above formula, represents the share of the actual income diversification in relation to the maximal possible diversity of income. Moreover, its value ranges from zero to 100.

METHODOLOGY

Four villages from the three Sub zones of Central Region (*Zoba Maekel*), one of the six administrative zones that comprise the country, are selected for the study. Taking time and financial constraints into account, purposive sampling is followed in the selection of the central region. The unit of observation (unit of analysis) is a rural household, where a household according to [8], is defined as a social unit that shares the same abode or hearth.

In the study area, sampling frame did not exist at a household level. Thus, multistage sampling procedures are used at different levels of sampling, in order to develop an unbiased and representative sampling frame as well as to capture the advantages of these designs. Information about the 81villages in the three Sub Zones, is collected from the Administration of *Zoba Maekel*. The sub zones are used as the first stage sampling units,

In the second stage, four villages were selected randomly from the three Sub Zones, which was selected earlier. All the selected villages have administrative records of households' list. However, their accuracies are questionable, since they were prepared for other purposes. Therefore, rather than relying on the existing administrative records, preparation of fresh lists for each village was deemed essential. Thus, a Household Listing Schedule is developed in the third stage, and a total of 5,253 households in all the selected villages have been listed by visiting their residential places. To ensure that households from the entire lists are represented, sampling interval and a random start are calculated for each village. Following this procedure and using a standardized questionnaire, a total of 202 households are randomly selected from the four villages, namely: *Shimanugs-Laelay, Hazega, Zigib and Adi-Tsenaf.*

Measurement of the Independent Variables
To collect the required data, a standardized questionnaire is administered to the randomly selected 202 rural households from the four villages. A list independent variables (regressors) is prepared from the data, which is collected at the household level. In our empirical analysis, the same set of independent variables are used in both regression models. Thus, it is imperative to give a short explanation of these independent variables. Some of the set of explanatory variables that are considered in the study include detailed household's demographic characteristics as well as physical capital, which comprises land and livestock owned by a household. Together, they are considered as productive assets. For the purpose of the study, landholding or the total area of land owned by a household is measured in *tsmdi* (local measurement, where *one tsimdi* = 0.25 hectare), and it includes rain-fed and irrigated lands. To have a standard measure for household's livestock ownership, conversion factors are applied to the different types animals owned by a household. Thus, [10]'s livestock conversion factors are used where a tropical livestock unit (TLU) is equivalent to a standard Zebu Bovine of 250 Kg live weight.

Moreover, under the category of human capital, a set of variables at the household level and at the head of household level are considered. These include: head of household's age; level of education of household's head and average education of members of a household, which are measured by the number of completed years spent by member of a household in school; dependency ratio; adult members of a household versus the number of dependents. To show the marginal rate of return of having additional years of age on rural household's income diversification, the variable age of head of household is modelled quadratically. Moreover, the variable sex of head of household is presented as a categorical variable, which takes the value of one for a male headed household and zero for female headed household. The dependency ratio measures the ratio of dependent or members of a household who are above 65 and below 15 years of age to the number of economically active (adults) members of a household (members of a household who are 15 to 65 years old).

In calculating a household's social capital index, the technique which has been developed by [13] is adopted, where the number household's membership in organizations or associations, which measures the density of membership of all household members, is multiplied by the household's decision making index in these organizations. Household's decision making index is calculated from the subjective evaluation of the household members regarding their role in decision making process of the organizations or groups (ranging from very active to not very active).[2]

To measure household's access to different types of formal credits, another dummy variable is introduced, which is given by "access to formal credit". It takes the value of one for a household that participates in any kind of formal credit schemes and zero otherwise.

Household's access to the market is measured using its proxy "distance to the nearest tarmac road". Households are asked to estimate how long, on the average, does it take them to reach to the nearest tarmac road on foot. In addition to these, location dummies, which correspond to each village, are included to separate or control the effect of closeness to the market from other spatially fixed effects.

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[2] Interested readers may refer to [13: p. 18] for detailed procedures on calculating a household's social capital index.

The number of crop failures, in the last five years, that a household may have possibly suffered is used as a proxy measure for low agricultural output (shock).

Measurement of the Dependent Variables

As discussed above, two definitions and thus two models of rural household's income diversification are adopted for the purpose of the study. In both models, the same set of explanatory variables are used to help us compare the effect of these variables on the two dependent variables: the overall diversity of rural household's income, which is measured using Shannon equitability index and the household's share of non-farm income in their total income. These two dependent variables, which are continuous however with a limited range between zero and 100, are used to measure rural households' income diversity. In calculating the values of these two dependent variables, large number of observations are found to have zero values. This indicates that either the household is not participating in any activity away from its own farm or the household derives all its income from only one source.

THE MODEL

The values of the two measures of household's income diversification lie between zero and 100 per cent. Thus, conventional linear regression methods have difficulties in explaining the qualitative difference between these zeroes and continuous observations. Therefore, the study has applied a Tobit model. Though Tobit models are originally developed for censored data, they are widely used for models that have negative values for their underlying latent dependent variables, commonly known as corner solution model. For example, for more or less similar settings (similar set of dependent and independent variables), [21, 6] have used Tobit models. In our study, the presence of zero values in the dependent variables are due to non-diversification or non-participation of rural households in other income earing activities beside their own farm rather than a zero income from an activity. In a Tobit model, it is assumed that the values of the dependent variable are clustered around its limiting value, usually zero. Moreover, in estimating a regression line, Tobit models use all observations, both those at the above specified limit and those above it. Thus, compared to the alternative regression models that only use observations above the limit in estimating a regression line, Tobit models are more preferred [16]. According to [12, 15], the stochastic model underlying a Tobit is expressed by the following relationship:

$$Di = h_j\tilde{a} + e_j \quad \text{if } h_j\tilde{a} + e_j > 0$$
$$= 0 \quad \text{if } h_j\tilde{a} + e_j \leq 0 \qquad j=1, 2,...,N.$$

In the above regression model, the dependent variable is given by D_i, the vector h_i represents the set of independent variables, and the number of observations is given by N, the vector $\tilde{a}$ indicates the unknown parameters that will be estimated, while e_j refers to the randomly distributed residuals. The above presented Tobit model assumes that the ($h_j\tilde{a} + e_j$), which is an underlying stochastic index, is observed only when it is positive. However, it is qualified as an unobserved, latent variable.

EMPIRICAL RESULTS

As discussed above, two definitions of rural household's income diversification are adopted in the study. Thus, to examine the influence of different factors (explanatory variables) on rural household's income diversification, two Tobit regression models corresponding to these two definitions of diversification are estimated, and they are presented in table 1. Generally, Tobit estimates are found to be inconsistent when the variance of the residuals is not constant or when they are heteroscedastic or if they are not distributed normally. Therefore, during the estimation process, robust standard errors are used.

The two Tobit regression results, which are presented in table 1 below, examines the factors that affect rural household's income diversification. In the first column of table 1, the determinants of the share of a household's non-farm income in its total income is examined. Thus, results of the study shows that head of the household's age has a positive and statistically significant influence on the diversification of a rural household out of its farm. However, after the age of head of the household crossed a certain threshold level, that share starts to decrease. Thus, an inverted U-shape relationship between head of the household's age and the diversification of the household away from its farm is reported in the study area. Another key asset that affects the diversification of a rural household's income away from their own farm is the human capital. Here, the level of education has the expected effect, that is, as the average number of completed years of schooling of household members increases, household's motivations to obtain income from own-farming gets lower, and the household becomes more motivated and have greater incentives to commit their time and resources to self-employment and wage-employment activities in the non-farm sector. Consequently, education is more likely to increase the share of non-farm income in rural household's total income, since it increases the degree of awareness of the rural household members and it helps them to acquire employable skills which can be absorbed by the non-farm sector. Moreover, the higher the number of crop failures or shocks faced by a household in the last five years has a statistically significant impact on increasing the share of non-farm income of rural household's in their total income. It forces or pushes the household to look for coping mechanisms by engaging in likes of trade, handicrafts and wage- employments. Furthermore, the higher the number of livestock units a household owns, the more will it diversify out of its own farm. Because, a household can sell some of its livestock or use them as a collateral to finance its participation in non-farm self-employments like starting up of a business. Finally, the more access a household has to formal credit, which is measured its access to formal credit in the last five years, has an increasing effect on the share of non-farm income in total household's income by diversifying their income sources out of their farm. Because it relaxes the financial constraints that hinders investment in non-farm self-employment activities.

Table 1
Tobit estimates of the determinants of rural households' income diversification

Variables	Household's non-farm income share in their total income		Shannon Equitability index	
Method: ML - Censored Normal (TOBIT) (Quadratic hill climbing)				
Sample:202 Included observations: 200 Left censoring (value) at zero QML (Huber/White) standard errors & covariance				
	Coefficients	z-Statistic	Coefficients	z-Statistic
Constant	-1.639267	-3.42	111.3333	4.71
Rain fed area	-0.002978	-0.14	1.931467	1.56
Irrigated Area	-0.126379	-1.11	-7.231239	-1.00
Livestock Possession	0.049725	**2.26****	2.919175	**3.03****
Sex (head of household (HoH)	0.067762	0.79	8.00967	**1.99****
Age of HoH	0.044164	**2.32****	-0.973036	-1.12
(Age of HoH)^2	-0.000378	**-2.19****	0.005797	0.73
Household's head year of Schooling	0.012721	1.10	1.048216	**2.37****
Household members average Education	0.051086	**2.45****	0.035877	0.03
Adult members	0.032675	1.03	-1.961551	-1.36
Shock	0.085364	**3.43****	0.713049	**1.78***
No. of dependents (<15 & >65 years of age)	0.005522	0.16	-0.668166	-0.44
Dependency Ratio	0.089551	1.22	-4.125114	**-1.65***
Distance to the market	-0.002329	-0.93	-0.031722	-0.18
Social capital	-0.000433	-0.91	0.272780	**2.05****
Access to formal credit	0.093810	**2.38****	6.227043	**2.25****
Dummy for Hzega	0.037122	0.14	-5.815499	-0.30
Dummy for Zigib	0.063396	0.70	-8.368548	-1.62
Dummy for Adi Tsenaf	0.018688	0.10	-6.19803	-0.44
R-squared		0.439775		0.342812
Adjusted R-squared		0.359529		0.252331
Log likelihood		-99.21642		-861.8702
Avg. log likelihood		-0.496082		-4.309351
Left censored obs		86		3
Uncensored obs		114		197

Note: **, * indicates statistical significance at 5 per cent and 10 per cent levels, respectively

Considering the second model, which deals with the determinants of the overall degree of diversification of rural households, the study has reported that possession of livestock has an increasing effect on the overall level of diversification. Because, livestock are considered as a sign of wealth, as a household can sell some or use them as a collateral in financing the opening of self-employment in the non-farm sector or participate in more income generating activities. Similarly, the probability that a rural household is a male-headed (or sex of head of the household) has an increasing effect on the overall diversification, which implies that there is gender bias in the overall diversification of rural households, and male-headed households

earn their income from more income sources than their female-headed counterparts do. Similarly, the number of completed years of schooling of head of a household as well as access to formal credit of a household have a positive effect on increasing a household's Shannon equitability index, which measures household's overall diversification. In addition to these, a positive and statistically significant effect of households' social capital index on their overall diversification is reported by the study, implying that households with extended social networks or safety nets are more likely to broaden their participation in various income sources. Moreover, shock or the occurrence of low agricultural productivity (crop failures) within the last five years has an increasing effect on the overall diversification of rural households, which supports the hypothesis that diversification is an *ex-post* coping strategy for low agricultural productivity. These results imply that the number of rural households' sources of income as well as their income significantly increases as the value of the variables with significant effects increases keeping the effect of other variables constant, and the income earned from these activates tend to be evenly distributed among these sources. On the contrary, a household's dependency ratio is found to have a decreasing effect on its overall diversification. This negative effect implies that a household with higher dependency ratio or having more dependents (members of a household who are above 65 and below 15 years of age) per household's economically active members are found to have fewer number of sources of income, which are more unevenly distributed.

SUMMARY

The study, based on Tobit regression analysis two income diversification models, concludes that the units of livestock owned by a rural household positively influences diversification of a household away from its own farm and its overall income diversity. Moreover, the study has reported that gender bias is prevalent in the overall diversification of rural households, as the probability of being male-headed household has an increasing effect on their overall income diversity. In addition to theses, access to formal credit and shock have an increasing effect on the diversification a rural household away from its own farm as well as on its overall diversification. Furthermore, the results of the study reported that an increase in the level of average education of members of households leads to an increase in their share of non-farm income, and an increase in year of schooling of head of households has an increasing effect on the overall level of diversification of rural households. Finally, even though the age of household's head has a positive role on diversification of a household away from its own farm, its role decreases after reaching a certain threshold age level.

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