Determinants of Income Diversification among Fishing Communities in Western Kenya

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Abstract

Fishing communities in developing countries are among the poorest communities. However, past studies have generally failed to investigate ways of reducing poverty among these communities. In order to address this research gap, this study proposes and investigates income diversification as a potential way of out poverty. In particular, the study analyzes the determinants of income diversification decisions among the fishing communities, with a focus on those living on the Kenyan shores of Lake Victoria. The results show that education level, access to credit and membership in associations are the key factors that explain income diversification behaviour among fish workers.

Key words: Poverty; income Diversification; fish worker

1. Introduction

Empirical evidence shows that fishing communities in developing countries are grappling with high and increasing poverty levels (Smith 1981; Panayotou, 1985, 1988; Platteau, 1989; Jansen, 1997; Pauly, 1997; Bene, 2004; Nevin, 2005; Salagrama, 2006). Although this evidence cuts across all fishing communities in developing countries, it is more pronounced in Africa (Bene, 2004; International Collective in Support of Fishworkers, 2006). This observation is supported by the fact that Africa is the only part of the world where fish supply per person is declining, while at the same time fish supplies are at the lowest level worldwide (WorldFish Center, 2005).

In Africa, there is a strong evidence of high and increasing poverty levels amongst fish workers on the Kenyan shores of Lake Victoria (see Reynolds and Greboval, 1988; Harris *et al.,* 1995; Jansen, 1997; Wilson, 1998; Okeyo-owuor, 1999; Abila, 2000; Yongo, 2000; Bokea and Ikiara, 2000; McCormick and Mitullah, 2002; Abila, 2003; Omwega *et al.,* 2006). For example, Kenyan government statistics show that Nyanza province (where majority of the fish workers reside) has an incidence of poverty of about 65 percent (GoK, 2005). In addition, the incidence of poverty for Nyanza province increased by 50 percent between 1994 and 2005 (Institute of Economic Affairs, 2002; GoK, 2005).

Regardless of the evidence of poverty among fishing communities in developing countries, researchers have failed to investigate potential strategies that can be pursued to reverse the poverty situation. In order to address this research problem, this study proposes and investigates *income diversification* as a potential poverty reduction strategy. In particular, the study investigates the determinants of income diversification decisions among fishing communities.

Past income diversification studies in developing countries have concentrated on farming communities and have ignored fishing communities (see for example Reardon *et al.,* 1992; Reardon, 1997; Abdulai and Delgado, 1999; Woldenhanna and Oskam, 2001; Barrett *et al*., 2000; 2001; Abdulai and CroleRees, 2001; Adugna, 2006; Wouterse and Taylor, 2008). As a result, the determinants of income diversification decisions among fishing communities are not known. In addition to helping generate policies for reducing poverty among fishing communities, information generated from this study will fill the gaps in empirical literature concerning the income diversification behaviour of fishing communities.

The paper is divided into six sections. The second section introduces the theoretical model that explains the income diversification behaviour of fish workers. On the other hand, the third section gives the empirical framework that includes the empirical models and procedures of their estimation. The fourth section describes the data used in estimating the empirical models. The fifth section presents and discusses the results from econometric analysis. Finally, the sixth section gives the conclusion and recommendations.

2. Theoretical Framework

The theoretical model jointly incorporates four time allocation decisions of a fish worker, namely: leisure; fish work; farm work; and non-agricultural work. A fish worker is an individual who mainly engages in fishing and/or fish trade. Fish workers may, in addition to fish work, undertake other income-generating activities (non-fish work) which include farm work and non-agricultural work. Farm work includes subsistence crop production, cash-crop production and livestock farming[1]; while non-agricultural work consists of small-scale non-agricultural businesses and paid non-agricultural jobs.

Up to the late 1990s, most income diversification models assumed risk neutrality (Huffman and Lange, 1989; Abdulai and Delgado, 1999). The assumption of risk neutrality is, however, inconsistent with portfolio and risk theory, which predicts that only individuals that are risk averse and face imperfectly correlated returns across sectors diversify their sectoral income in order to reduce overall risk (Reardon *et al.,* 1992). Considering this argument, some income diversification studies (e.g., Mishra and Goodwin, 1997; Abdulai and CroleRees, 2001; Wouterse and Taylor, 2008) have included risk and risk preferences in analyzing income diversification among farming communities. However, little has been undertaken to determine the role of risk in income diversification. In addition, the role of barriers to income diversification has been weakly addressed.

The theoretical model is a modified version of the Huffman and Lange (1989) model. The modification relates to four time allocation decisions, while allowing for risk aversion in income. The decision making unit is a "fish worker". A fish worker is defined as an individual who engages in fishing or fish processing and trade. The possibility of a fish worker deciding not to diversify income (not to engage in farm work, non-agricultural work or both) is included through non-negativity constraints on the amount of time allocated to these income diversifying activities.

[1] In this study, both fish work and farm work are considered as part of agricultural work. This consideration is consistent with the FAO's definition of agriculture that includes products such as crops, livestock, fish and forestry (FAOSTAT glossary).

The fish worker is assumed to be risk averse in income[2]. The objective of the fish worker is to maximize the expected utility of consumption and leisure. It is assumed that income risk comes from both fish and farm work, while non-agricultural work is not risky. Fish and farm incomes are also assumed to be negatively-correlated. This assumption is based on the fact that, during the main crop growing season (March to August), the intensity of fish work on the Kenyan shores of Lake Victoria is reduced as some fish workers are preoccupied with crop cultivation. However, fish work increases during the dry season (October to February) until land preparation begins (Geheb and Binns, 1997). Fish income risk comes from unpredictable catch per unit of effort, which makes the wage from fish work (fishing and fish processing/trading) uncertain. Farm income risk comes from the reliance on rain-fed agriculture and unpredictable climate, leading to risky output from agricultural production. Both farm and non-agricultural work are considered to have barriers to participation (such as access to credit and market information). In the presence of fish and farm income risk as well as barriers to income diversification, the optimal time allocation between leisure, fish work, farm work and non-agricultural work is obtained by solving the following optimization problem:

$$\underset{T_{fish},T_{farm},T_{nagr}}{Max\ V} = EU\left(C,T_{leis};Z\right) \tag{2.1}$$

Subject to the constraints:

$$\overline{T} = T_{leis} + T_{fish} + T_{farm} + T_{nagr} \tag{2.2}$$

$$C = \tilde{Y} = \tilde{W}_{fish}(\overline{W}_{fish}, \sigma^2_{W_{fish}})T_{fish} + (P_q - K)\tilde{Q} + W_{nagr}T_{nagr} + G \tag{2.3}$$

$$\tilde{Q} = F(T_{farm}; Z, L_C, B, \sigma_e^2) \tag{2.4}$$

$$T_{farm}, T_{nagr} \geq 0 \tag{2.5}$$

[2] Wealth is not considered because fish workers are generally poor, and the poor more frequently find themselves with zero wealth (Schmidt-Hebbel *et al.*, 1992).

Equation (2.1) is the *fish worker's expected utility function* (V); and C denotes consumption whose price is normalized to one; T_{leis} is the fish worker's time allocated to leisure; and Z represents the fish worker's individual characteristics which include age of the fish worker, education, marital status and number of dependents. These characteristics are considered as utility shifters (Sadoulet and de Janvry, 2000; Goetz and Debertin, 2001). Equation (2.2) is the *time constraint*. In this equation, $\overline{T}$ is the time endowment for the fish worker; T_{fish} is time allocated to fish work; T_{farm} is time allocated to farm work; and T_{nagr} is time allocated to non-agricultural work. Equation (2.3) is the *budget constraint*, where $\tilde{Y}$ is the (random) total fish worker income; $\tilde{W}_{fish}$ represents the (random) hourly wage rate, which is a function of the mean ($\overline{W}_{fish}$) and the variance ($\sigma^2_{W_{fish}}$) of wage rate for fish work; $(P_q - K)\tilde{Q}$ is the net income from farming (with P_q being the price of farm output, $\tilde{Q}$ being the (random) farm output and K denoting the cost of producing a unit output); W_{nagr} is the wage rate for non-agricultural work; and G is exogenous income. Equation (2.4) is the *farm production constraint* where L_C depicts location specific characteristics; B represents barriers to farm and non-agricultural work such as access to production credit and market information; and σ^2_e denotes the variance of farm output due to changes in weather. L_C, B and σ^2_e are considered as production shifters. In this model, fish income risk, coming from the variations in the catch per unit of effort is represented by $\sigma^2_{W_{fish}}$, while farm income risk is represented by σ^2_e (the variance of farm output)[3]. Equation (2.5) gives the *non-negativity constraints* on the time variables. The possibility of a fish worker

[3] The riskiness of both fish and farm work makes the income diversification decision by a fish worker more complex than that of a farmer choosing between farm and non-farm work. In addition, there are three activities to choose from (fish, farm and non-agricultural work) rather than two.

not participating in farm work, non-agricultural work or both is included by imposing non-negativity constraints on T_{farm} and T_{nagr}. Time allocated to leisure and fish work is assumed to be strictly positive (i.e., an interior solution). It is worth noting that the utility function V and the farm production function $\tilde{Q}$ for the fish worker are assumed to be quasi-concave, continuous and twice differentiable.

Substituting constraints (2.2-2.4) into the utility function (2.1) and solving for the first order conditions (F.O.C.s) gives:

$$\frac{\partial V}{\partial T_{fish}} = -E\frac{\partial U}{\partial T_{leis}} + E\left(\frac{\partial U}{\partial C}\tilde{W}_{fish}(\overline{W}_{fish}, \sigma^2_{W_{fish}})\right) = 0 \qquad (2.6)$$

$$\frac{\partial V}{\partial T_{farm}} = -E\frac{\partial U}{\partial T_{leis}} + E\left(\frac{\partial U}{\partial C}(P_q - K)\frac{\partial \tilde{Q}}{\partial T_{farm}}\right) \leq 0 \qquad (2.7)$$

$$T_{farm} \geq 0, \quad T_{farm} * \frac{\partial V}{\partial T_{farm}} = 0 \qquad (2.8)$$

$$\frac{\partial V}{\partial T_{nag}} = -E\frac{\partial U}{\partial T_{leis}} + E\left(\frac{\partial U}{\partial C}W_{nagr}\right) \leq 0 \qquad (2.9)$$

$$T_{nagr} \geq 0, \quad T_{nagr} * \frac{\partial V}{\partial T_{nagr}} = 0 \qquad (2.10)$$

Where $\left\{\frac{\partial^2 V}{\partial T^2_{fish}}, \frac{\partial^2 V}{\partial T^2_{farm}}, \frac{\partial^2 V}{\partial T^2_{nagr}}\right\} < 0$, and $|H| < 0$, where $|H|$ refers to determinant of the matrix of the second order partial derivatives of the expected utility function.

The decision criteria for allocating time between leisure, fish work, farm work and non-agricultural work is determined by solving the F.O.C.s, giving the following conditions.

$$E\left(\frac{\partial U}{\partial C}\tilde{W}_{fish}(\overline{W}_{fish},\sigma^2_{W_{fish}})\right) = E\frac{\partial U}{\partial T_{leis}} \quad (2.11)$$

$$E\left(\frac{\partial U}{\partial C}\tilde{W}_{fish}(\overline{W}_{fish},\sigma^2_{W_{fish}})\right) \geq E\left(\frac{\partial U}{\partial C}(P_q - K)\frac{\partial \tilde{Q}}{\partial T_{farm}}\right) \quad (2.12)$$

$$E\left(\frac{\partial U}{\partial C}\tilde{W}_{fish}(\overline{W}_{fish},\sigma^2_{W_{fish}})\right) \geq E\left(\frac{\partial U}{\partial C}W_{nagr}\right) \quad (2.13)$$

On the left-hand side of Equations (2.11-2.13) is the expected marginal utility of allocating time to fish work (EMU_{fish}). On the right hand side of Equations (2.11-2.13), are the expected marginal utilities of allocating time to leisure (EMU_{leis}), farm work (EMU_{farm}) and non-agricultural work (EMU_{nagr}), respectively. EMU_{fish} (which is equal to EMU_{leis}) represents the opportunity cost of diversifying income.

Let j represent farm work or non-agricultural work. If $EMU_{fish} > EMU_j$, the fish worker will specialize in fish work ($i.e.\ T^*_{leis}, T^*_{fish} > 0;\ T^*_j = 0$). However, the fish worker may want to diversify income in order to minimize income risk. If income diversification occurs (i.e., $T^*_{leis}, T^*_{fish}, T^*_j > 0$), then $EMU_{fish} = EMU_j$. Other factors which may influence the expected marginal utilities of allocating time to various activities (and, thus, the income diversification decision) include barriers to income diversification (e.g., lack of access to credit and market information), location, expected wage rates and the need to achieve a minimum expenditure or expand income. For example, removal of barriers to income diversification may increase the expected marginal utility of allocating time to other income-generating activities, motivating a fish worker to diversify income.

In order to formally derive the income diversification decision equations, there is need to solve the optimal time allocation to various activities in terms of the exogenous variables. However, it is worth noting that the expected wage rate for fish work ($\overline{W}_{fish}$) and the wage rate for non-agricultural work (W_{nagr}) are endogenous variables (Huffman and Lange, 1989; Woldenhanna and Oskam, 2001) and can be specified as:

$$\overline{W}_{fish} = \overline{W}_{fish}(Z, FI_C, L_C) \tag{2.14}$$

$$W_{nagr} = W_{nagr}(Z, L_C, B_t) \tag{2.15}$$

Where FI_C represents fish work characteristics such as position in the fish enterprise. Solving the F.O.C.s and substituting Equations (2.14) and (2.15) into the optimum amounts of time allocated to fish work, farm work, non-agricultural work and leisure gives:

$$T^*_{fish} = T^*_{fish}(P_q, K, Z, FI_C, L_C, B, \sigma^2_{W_{fish}}, \sigma^2_e) \qquad T^*_{fish} > 0 \tag{2.16}$$

$$T^*_{farm} = T^*_{farm}(P_q, K, Z, FI_C, L_C, B, \sigma^2_{W_{fish}}, \sigma^2_e) \qquad T^*_{farm} \geq 0 \tag{2.17}$$

$$T^*_{nagr} = T^*_{nagr}(P_q, K, Z, FI_C, L_C, B, \sigma^2_{W_{fish}}, \sigma^2_e) \qquad T^*_{nagr} \geq 0 \tag{2.18}$$

$$T^*_{leis} = T^*_{leis}(P_q, K, Z, FI_C, L_C, B, \sigma^2_{W_{fish}}, \sigma^2_e) \qquad T^*_{leis} > 0 \tag{2.19}$$

Since the time allocated to leisure and fish work is assumed to be strictly positive, the expected marginal utilities and the optimum amounts of time allocated to farm work and non-agricultural work can be used to specify the income diversification decision equations as follows:

$$T^*_j \begin{cases} = 0 \ \ if \ \ EMU_{fish} > EMU_j \\ > 0 \ \ if \ \ EMU_{fish} = EMU_j \end{cases} \qquad j = \{farm, nonagric\} \tag{2.20}$$

3. Empirical Framework

Empirical Model

Following Equations (2.17) and (2.18), the optimal amount of time allocated to income diversifying activity j (T_{ij}^{*}) is specified as a latent variable model as follows[4]:

$$T_{ij}^{*} = \delta_{0j} + \delta_{1j} Z + \delta_{2j} FI_C + \delta_{3j} L_C + \delta_{4j} B + \delta_{5j} \sigma_{W_{fish}}^{2} + \mu_j \quad j = \{farm, nonagric\} \quad (3.1)$$

Where i represents a fish worker; δ_{kj} are the parameters[5]; Z is a set of individual characteristics; FI_C is a set of fish work characteristics; L_C represents locational factors; B denotes barriers to income diversification; $\sigma_{W_{fish}}^{2}$ is the variance of fish income (which measures fish income risk); and μ_j are the error terms that are assumed to be normally distributed with mean of zero and variance of one [$\mu_j \sim N(0,1)$].

The optimal amount of time allocated to income diversifying activity j (T_{ij}^{*}) cannot be observed. However, a fish worker only diversifies income if $EMU_{fish} = EMU_j$ and does not diversify if $EMU_{fish} > EMU_j$. As a result, an indicator variable that captures the decision of fish worker i to diversify income into activity j is used to represent T_{ij}^{*}. The indicator variable, denoted as D_{ij}, is defined as follows:

$$D_{ij} \begin{cases} = 1 \ \ if \ \ T_{ij}^{*} > 0 \ or \ if \ \ EMU_{fish} = EMU_j \\ = 0 \ \ if \ \ T_{ij}^{*} = 0 \ or \ if \ \ EMU_{fish} > EMU_j \end{cases} \qquad j = \{farm, nonagric\} \qquad (3.2)$$

[4]Since there is no data on the prices of farm outputs and inputs and the variance of farm output, these variables are dropped from the empirical models.

[5] k represents all the independent variables including the vector of "ones" for the constant term.

Given that μ_j is a random variable, the probability of fish worker i diversifying income into activity j is specified as follows:

$$\begin{aligned} Prob(D_{ij} = 1 \mid X) &= Prob(T_{ij}^{*} > 0 \mid X) \\ &= Prob(\delta_{0j} + \delta_{1j} Z + \delta_{2j} FI_C + \delta_{3j} L_C + \delta_{4j} B + \delta_{5j} \sigma^2_{W_{fish}} + \mu_j > 0 \mid X) \\ &= F(X'\delta_j) \end{aligned} \quad (3.3)$$

Where X is a $k\,x\,n$ matrix of the independent variables, δ_j is a $k\,x\,1$ vector of parameters and $F(.)$ is the cumulative distribution function (CDF).

Equation (3.3) is estimated by a probit model. The process of estimating a probit model starts with the specification of the likelihood functions. Following Greene (2008), the likelihood function can be given as:

$$L(\delta_j \mid data) = \prod_{i=1}^{n} F(x_i'\delta_j)^{D_{ij}} \left(1 - F(x_i'\delta_j)\right)^{1-D_{ij}} \quad j = \{farm, nonagric\} \qquad (3.4)$$

Where x_i is a $k\,x\,1$ vector of independent variables for each fish worker and $F(.)$ is the CDF of the standard normal distribution. Taking logs of the likelihood function gives:

$$ln\,L = \sum_{i=1}^{n} \left\{ D_{ij}\, ln\,F(x_i'\delta_j) + (1 - D_{ij})\, ln\left(1 - F(x_i'\delta_j)\right) \right\} \quad j = \{farm, nonagric\} \ (3.5)$$

Maximizing the log-likelihood function (Equation 3.5) and solving the first order conditions gives the estimates of δ_j, denoted as $\hat{\delta}_j$. The marginal effects are also calculated to help explain the effect of each variable on the probability of diversifying income. According to Greene (2008), the marginal effect for a continuous variable x_k is expressed as:

$$\frac{\partial\, Prob(D_{ij} = 1 \mid X)}{\partial x_k} = \left(\frac{dF(X'\hat{\delta}_j)}{d(X'\hat{\delta}_j)} \right) \frac{\partial (X'\hat{\delta}_j)}{\partial x_k} = f(X'\hat{\delta}_j) \frac{\partial (X'\hat{\delta}_j)}{\partial x_k} \qquad (3.6)$$

Where $f(.)$ is the probability density function. The marginal effects calculated using Equation (3.6) vary with the values of X (the set of independent variables). As a result, marginal effects are evaluated at the means of the data.

Now assume that x_k is a dummy variable. Also let $\bar{X}_{(1)}$ be the vector of independent variables with x_k equal to one and all the other variables are at their mean values; and $\bar{X}_{(0)}$ is the same vector, but with x_k equal to zero. The marginal effect for the dummy variable is expressed as:

$$\frac{\Delta Prob(D_{ij} = 1 | X)}{\Delta x_k} = F(\bar{X}_{(1)}'\hat{\delta}_j) - F(\bar{X}_{(0)}'\hat{\delta}_j) \qquad (3.7)$$

Hypotheses

It is expected that individual characteristics such as age, education and number of dependents positively influence the probability of income diversification. According to the empirical income diversification literature, age is associated with higher experience and better access to established networks which may stimulate income diversification (Barrett *et al.*, 2001; Abdulai and CroleRees, 2001). Education may reduce the transaction costs for accessing and interpreting information regarding alternative income-generating activities (Pingali *et al.,* 2005). Higher number of dependents among fish workers may encourage income diversification in order to meet the dependents' needs (Deininger and Olinto, 2001). Additional dependents may also serve as a source of labour, thus encouraging income diversification. The influence of marital status on income diversification cannot be predicted *a priori*. Although married couples may have additional family needs which may encourage income diversification, some couples may generate sufficient income by participating in one activity.

The relationship between fish work characteristics and income diversification is missing in the empirical income diversification literature. As a result, intuition is largely used to make predictions on how fish work characteristics are likely to influence the probability of income diversification. It is expected that type of fish work (i.e., being a fisher) positively influences income diversification. This expectation is based on the fact that fishers are generally men while fish traders are generally women. In developing countries, men generally have greater access to financial, physical and human capital compared to women (De Janvry and Sadoulet, 2001; Gladwin *et al.,* 2001; Lanjouw and Lanjouw, 2001; Villarreal, 2002; 2006). Greater access to capital may make men more accessible to alternative income-generating activities than women.

The influence of position in the fish enterprise, experience in fish work, percent of Nile perch in the fish enterprise, percent of omena in the fish enterprise, interaction terms between percent of Nile perch/omena in the fish enterprise and type of fish work, and volume of fish landings on income diversification cannot be predicted *a priori*. Even though a higher position in the fish enterprise may generate financial capital necessary for income diversification, the additional income generated from the higher position may discourage labour allocation to other activities. Additional experience in fish work may encourage specialization in fish work, but may provide more human capital and links to networks necessary for income diversification. More participation in Nile perch and omena and higher fish landings may generate financial capital necessary for income diversification. However, the additional income generated may discourage labour allocation to other activities. The interaction terms between percent of Nile perch/omena in the fish enterprise and type of fish work capture differential labour availability between Nile perch and omena fish workers.

The influence of locational factors, captured by the beach in which fish work is undertaken, cannot be hypothesized *a priori*. Fish workers in the export beach may have more financial capital necessary for income diversification than those in the non-export beach. However, the higher specialization and division of labour at the export beach may discourage income diversification.

Barriers to income diversification, captured through non-membership of associations and lack of access to credit, are expected to negatively influence income diversification. Non-membership of an association may limit the flow of market information or access to loans, while lack of access to loans and other financial assistance may impose capital constraints, thereby discouraging income diversification. In other words, membership of an association and access to credit may encourage income diversification.

Fish income variance (which captures risk factors) is expected to positively influence income diversification. An increase in fish income variance may encourage the fish worker to smooth income through income diversification.

4. Description of the Data

The data used in this study was collected in 2004 from two beaches on the Kenyan shores of Lake Victoria. The two beaches are known as *Uhanya* and *Ogal*. Uhanya is a large export beach, while Ogal is a small non-export export beach[6]. The large export beach (Uhanya) is well integrated into the Nile perch export supply chain and the non-export beach (Ogal) is not

[6]There may be some fish exports coming from Ogal beach but these fish quantities are considered negligible. As a result, Ogal can be referred to as non-export beach in general terms.

integrated into the export supply chain. Consequently, Ogal beach supplies fish to the local markets. Both beaches are in Nyanza province, Western Kenya, an area characterized by high rates of poverty.

The two beaches were selected purposively after consultation with the Western Region Director of fisheries. Two groups of fish workers were surveyed at the selected beaches: (1) fishers, including boat owners, managers and crew members; and (2) artisanal fish traders. At each of the beaches, a list of fishers registered with the Beach Management Unit (BMU) was used as a sampling frame for selecting fishers at random. The sample of artisanal fish traders was obtained from registered traders and traders identified with random sampling through the snowball methods.

Structured questionnaires were then administered to sample of fishers and fish traders in the two beaches. The structured survey was accompanied by semi-structured interviews with key informants. Further, a focus group was undertaken with fishers and with artisanal fish traders at each beach. The original aim of this survey was to explore the extent and ways in which the local population around the Kenyan shores of Lake Victoria has been impacted by the establishment and growth in Nile perch exports. But this data is also used to analyze the determinants of income diversification decisions of fish workers.

The sample consists of 151 fishers and 151 fish traders, giving a total of 302 fish workers. However, six observations are removed from the sample because of missing or outlier income values, leaving 296 observations. Of the six, three observations have missing income values while the remaining three have outlier income values. All the six removed observations are fish traders. Table 4.1 shows summary statistics for the 296 fish workers included in the final sample.

Table 4.1: Descriptive Statistics for All Fish Workers

Variable	**Mean**	**Std. Dev.**	**Min**	**Max**
Income diversification, income and poverty				
Income diversification decision into non-fish work (1 if yes; 0 otherwise)	0.260	0.439	0	1
Income diversification decision into farm work (1 if yes; 0 otherwise)	0.118	0.323	0	1
Income diversification decision into non-agricultural work (1 if yes; 0 otherwise)	0.142	0.350	0	1
Small-scale enterprises (1 if owns; 0 otherwise)	0.101	0.302	0	1
Other activities (1 undertakes; 0 otherwise)	0.041	0.198	0	1
Fish income (Kshs/month)	10,671	16,323	100	84,400
Farm income (Kshs/month)	1,252	6,373	0	60,000
Non-agricultural income (Kshs/month)	774	3,809	0	36,327
Total income	12,698	19,003	100	84,400
Incidence of poverty (1 if poor, 0 otherwise)	0.635	0.482	0	1
Depth of poverty (proportion)	0.401	0.368	0	0.997
Individual characteristics				
Gender of the fish worker (1 if male; 0 if female)	0.584	0.494	0	1
Age of the fish worker (yrs)	35.932	11.276	17	68
Education of the fish worker (1 if secondary; 0 otherwise)	0.203	0.403	0	1
Marital status (if married; 0 otherwise)	0.780	0.415	0	1
Number of dependents	6.892	3.703	1	27
Fish work characteristics				
Type of fish work (1 if fisher; 0 if fish trader)	0.510	0.501	0	1
Occupation before fish work				
Student (1 if yes; 0 otherwise)	0.243	0.430	0	1
Farm work (1 if yes; 0 otherwise)	0.247	0.432	0	1
Non-agricultural work (1 if yes; 0 otherwise)	0.368	0.483	0	1
Unemployed (1 if yes; 0 otherwise)	0.142	0.350	0	1
Position in fish enterprise (1 if owner; 0 otherwise)	0.611	0.488	0	1
Experience in fish work (yrs)	9.599	8.697	1	50
Percent of Nile perch in fish enterprise	59.358	43.413	0	100
Percent of omena in fish enterprise	21.149	38.726	0	100
Percent of tilapia in fish enterprise	18.074	32.688	0	100
Higher fish landings (1 if higher; 0 otherwise)	0.064	0.246	0	1
No change in fish landings (1 if no change; 0 otherwise)	0.125	0.331	0	1
Lower fish landings (1 if lower; 0 otherwise)	0.811	0.392	0	1

Locational factors				
Beach (1 if export beach; 0 if non-export beach)	0.507	0.501	0	1
Barriers to income diversification				
Membership of an association (1 if member; 0 otherwise)	0.432	0.496	0	1
Cooperative society (1 if member; 0 otherwise)	0.311	0.464	0	1
Women's Group (1 if member; 0 otherwise)	0.088	0.284	0	1
Welfare association (1 if member; 0 otherwise)	0.020	0.141	0	1
Both cooperative and women's group (1 if member; 0 otherwise)	0.003	0.058	0	1
Both women's group and welfare association (1 if member; 0 otherwise)	0.010	0.100	0	1
Access to loans/financial assistance (1 if access; 0 otherwise)	0.514	0.501	0	1
Risk factors				
Higher fish income variance (1 if higher; 0 otherwise)	0.608	0.489	0	1
No change in fish income variance (1 if no change; 0 otherwise)	0.118	0.323	0	1
Lower fish income variance (1 if lower; 0 otherwise)	0.274	0.447	0	1
Sample size	296			

5. Results and Discussion

Determinants of the Decision to Diversify Income into Farm Work

The probit regression results of the farm work decision equation are presented in Table 5.1. The Wald chi-square test statistic was statistically significant at the one percent significance level. In addition, 88 percent of the observations were correctly predicted, and the pseudo R-squared was 0.134. These diagnostic statistics suggest that the estimated model provided an adequate fit of the data. Put differently, all 16 variables included in the farm work decision equation were jointly able to explain the decision by a fish worker to diversify income into farm work.

Table 5.1: Probit Regression Results for Income Diversification Decision

Variable	**Farm Work**		**Non-agricultural Work**	
	Coef.	**Marginal Effect**	**Coef.**	**Marginal Effect**
Individual characteristics				
Age of the fish worker (yrs)	0.020 (0.321)	0.003* (1.679)	0.110* (1.943)	0.005** (2.148)
Age squared	2.900E-05 (0.038)		-0.001* (-1.655)	

Education of the fish worker (1 if secondary; 0 otherwise)	0.544** (2.320)	0.104* (1.942)	-0.020 (-0.083)	-0.004 (-0.083)
Marital status (if married; 0 otherwise)	-0.053 (-0.196)	-0.008 (-0.192)	-0.435* (-1.722)	-0.101 (-1.420)
Number of dependents	0.040 (1.504)	0.006 (1.442)	0.015 (0.608)	0.003 (0.608)
Fish work characteristics				
Type of fish work (1 if fisher; 0 if fish trader)	1.167** (2.107)	0.015 (0.420)	2.382*** (3.191)	0.148*** (2.914)
Position in fish enterprise (1 if owner; 0 otherwise)	-0.225 (-0.967)	-0.036 (-0.956)	0.520** (2.183)	0.098** (2.171)
Percent of Nile perch in fish enterprise	0.008 (1.476)	3.557E-04 (0.622)	0.017** (2.312)	0.001* (1.727)
Percent of omena in fish enterprise	0.007 (1.109)	-3.521E-04 (-0.548)	0.022*** (2.953)	0.002* (1.702)
Percent of Nile perch * Type of fish work	-0.012* (-1.783)		-0.018** (-2.261)	
Percent of omena * Type of fish work	-0.017** (-2.453)		-0.027*** (-2.888)	
Locational factors				
Beach (1 if export beach; 0 if non-export beach)	-0.097 (-0.380)	-0.015 (-0.374)	0.248 (1.140)	0.050 (1.167)
Barriers to income diversification				
Membership of an association (1 if member; 0 otherwise)	0.399* (1.775)	0.064* (1.700)	0.125 (0.594)	0.025 (0.593)
Access to loans/financial assistance (1 if access; 0 otherwise)	0.517** (2.215)	0.080** (2.195)	0.233 (1.081)	0.047 (1.074)
Risk factors				
Higher fish income variance (1 if higher; 0 otherwise)	-0.352 (-0.970)	-0.057 (-0.912)	0.031 (0.086)	0.006 (0.087)
Lower fish income variance (1 if lower; 0 otherwise)	-0.277 (-0.811)	-0.039 (-0.868)	0.115 (0.292)	0.024 (0.288)
Constant	-3.109** (-2.422)		-5.842*** (-4.174)	
Model Statistics				
Number of observations	296		296	
Log pseudolikelihood	-93.162		-104.196	
Wald chi-square (df=16)	30.100**		35.570***	
Percentage correctly predicted	87.8		85.1	
Pseudo R-squared	0.134		0.138	

***, **, * denote statistical significance at the one percent, five percent and 10 percent levels, respectively; t-values (in parentheses) are calculated from robust standard errors; df is degrees of freedom.

The marginal effect of age on the probability of diversifying income into farm work was positive and statistically significant at the 10 percent level. In particular, an increase in the age of the fish worker by one year increased the probability of diversifying income into farm work by 0.3

percent. This finding may be due to more work experience and acquisition of resources which come with increase in age. Additional work experience may be a source of human capital that may help reduce transaction costs for searching for and interpreting farming information. Acquisition of resources (such as land) may improve the ability of the fish workers to effectively undertake farm work.

Education positively and significantly influenced the probability of diversifying income into farm work at the five percent significance level. This result implies that fish workers with secondary education had a higher probability of diversifying income into farm work than those with primary or no formal education. In particular, the marginal effect shows that obtaining secondary education increased the probability of diversifying income into farm work by 10 percent. Such a result reflects the fact that secondary education may reduce the transaction costs for searching for and interpreting market information regarding alternative income-generating activities, thus encouraging income diversification. Improving education among fishing communities in Western Kenya is, however, a key challenge as descriptive statistics suggest that only 20 percent of the fish workers had secondary education, while 80 percent had primary or no formal education.

Type of fish work positively and significantly influenced the probability of diversifying income into farm work at the five percent significance level. This result implies that fishers had a higher probability of diversifying income into farm work than fish traders. The positive effect of type of fish work may be because fish trading is more lucrative than fishing, which may serve as a disincentive for fish traders to diversify income into farm work. In addition, fishers, who are generally men, may have greater access to land than fish traders, who are generally women. Among the communities in Western Kenya, men have a greater access to land than women (Villarreal, 2002; 2006). Women only have access to land through their husbands. Moreover, the customs of the Luo community (the major fishing community) stipulates that widows cannot restart agricultural chores until they are inherited[7]. Widows may also lose their husband's land if they are not inherited (Villarreal, 2006).

The interaction terms between percent of Nile perch or omena in the fish enterprise and type of fish work[8] negatively and significantly influenced the probability of diversifying income into farm work at the 10 and five percent significance levels, respectively. This result can be explained by the high labour requirements in fishing compared to fish trade which may make it difficult for fishers to undertake alternative activities like farm work (which also require substantial labour allocation). In particular, omena fishing requires more labour allocation than Nile perch fishing (Geheb and Binns, 1997), which is why the effect of the interaction term between percent of omena and type of fish work is slightly lower. As noted by Geheb and Binns (1997), the highest demand for casual labour comes from omena fishing, where the fishing technique employed (*kindege*) and the large size of the net demand a minimum crew size of four per boat. In addition, omena fishing occurs only at night (Geheb and Binns, 1997; Wilson, 1998). The four crew members on the boat are normally supplemented by additional two or three spare crew members who rest on shore, serving as the alternative to the boat crew when they become

[7] According to the customs of the Luo community, a woman who loses her husband through death should be "inherited" by one of the brothers of the deceased or whoever the husband's family decides on. The property of the deceased, including his land is then inherited along with the wife and children (Villarreal, 2006).

[8] These interaction terms are included in the analysis to capture the intercept and slope differences between fishers and fish traders. In addition, the inclusion of the interaction terms improves the model fit for both farm work and non-agricultural work decision equations.

tired. On the contrary, Nile perch fishing uses set gill-nets, and therefore requires fewer crew members per fishing unit, with two people normally being sufficient.

Membership of an association positively and significantly influenced the probability of diversifying income into farm work at the 10 percent significance level. Moreover, the marginal effect of this variable shows that being a member of an association increased the probability of diversifying income into farm work by six percent. These results suggest that reduction of barriers to income diversification may encourage diversification into farm work. Membership of an association may provide farming information to fish workers (e.g., where to buy farm inputs, purchase irrigation equipment, access extension services or to sell farm output). Additionally, some associations may provide loans/financial assistance to their members, thereby encouraging investment in farming (see Ngugi and Kariuki, 2009).

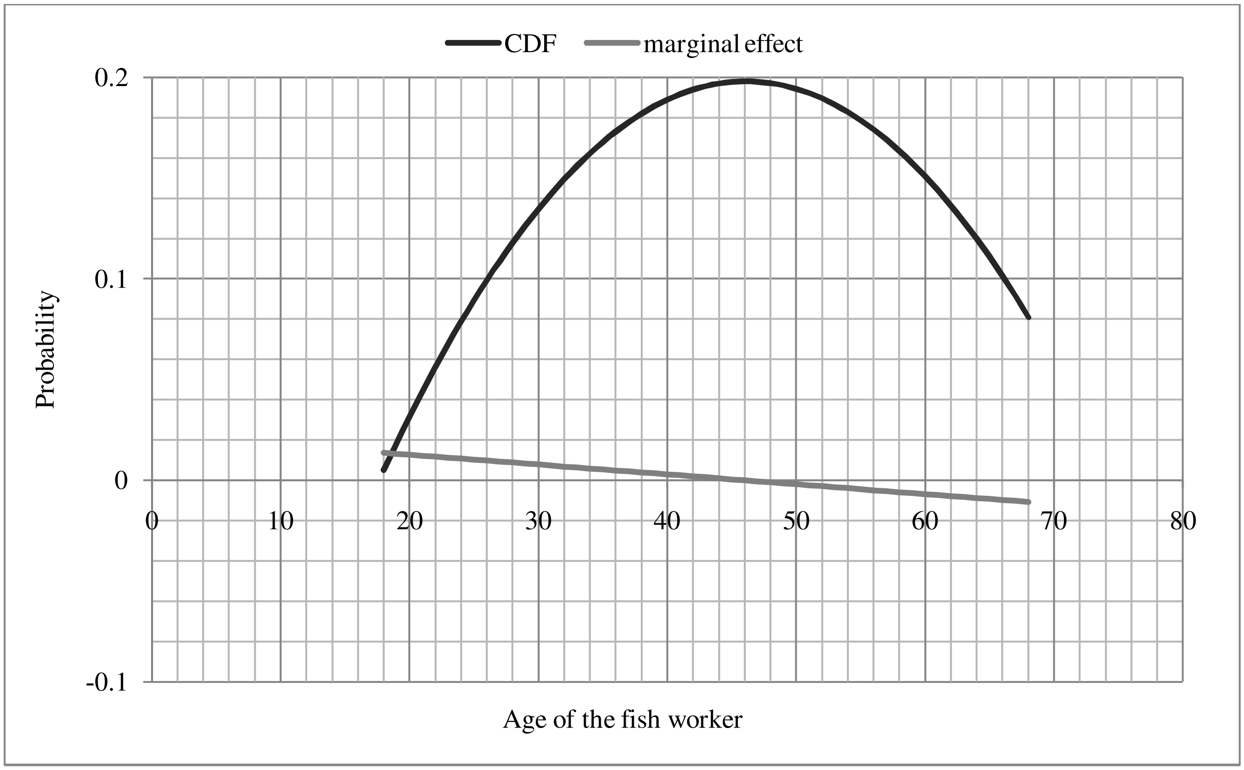
Access to loans and financial assistance positively and significantly influenced the probability of diversifying income into farm work at the five percent significance level. The marginal effect for this variable indicates that access to loans/financial assistance increased the probability of diversifying income into farm work by eight percent. Loans/financial assistance may relax financial constraints, allowing the fish workers to make farm investments. Since past studies have noted that many fish workers are unable to save (e.g., Geheb and Binns, 1997; Ong'ang'a, 2002; Omwega *et al.,* 2006), accessing loans and other forms of financial assistance may help stimulate income diversification.

Determinants of the Decision to Diversify Income into Non-Agricultural Work

The probit regression results of the non-agricultural work decision equation are also presented in Table 5.1. The Wald chi-square test statistic was statistically significant at one percent. In addition, 85 percent of the observations were correctly predicted and the pseudo R-squared was 0.138. These diagnostic tests indicate that all 16 variables included in the non-agricultural work decision equation were jointly able to explain the decision by a fish worker to diversify income into non-agricultural work.

Age of the fish worker positively and significantly influenced the probability of diversifying income into non-agricultural work at the 10 percent significance level. On the other hand, age squared negatively and significantly influenced the probability of diversifying income into non-agricultural work at the 10 percent significance level. The positive effect of age and the negative effect of age squared shows that age had a parabolic effect on the probability of diversifying income into non-agricultural work. In other words, an increase in the age of the fish worker increases the probability of diversifying income into non-agricultural until 46 years, after which the effect of age starts to decline (see Figure 5.1). The marginal effect calculated at the mean age shows that an increase in the age of the fish worker by one year increased the probability of diversifying income into non-agricultural work by 0.5 percent. The positive effect of age up to 46 years may be due to increased work experience and access to networks.

Figure 5.1: The Effect of Age on the Probability of Diversifying Income into Non-Agricultural Work



Note: this graph shows the change in probability when age is varied while other variable are held constant

Marital status negatively and significantly influenced the probability of diversifying income into non-agricultural work at the 10 percent significance level. The negative effect of the marital status implies that married fish workers had a lower probability of diversifying income into non-agricultural work compared to those who were single. The negative effect of marriage may be because married couples are able to jointly generate income that meets their household consumption requirements. Additionally, some married couples may want to stay together and, therefore, may prefer undertaking fish work collectively, rather than undertaking separate activities (which may mean staying apart). For example, the husband may be a fisher and the wife is a fish trader, both operating in the same beach.

Type of fish work positively and significantly influenced the probability of diversifying income into non-agricultural work at the one percent significance level. This result implies that fishers had a higher probability of diversifying income into non-agricultural than fish traders. The marginal effect shows that being a fisher increased the probability of diversifying income into non-agricultural work by 15 percent. This marginal effect reflects the effects of type of fish work, the interaction term between percent of Nile perch in the fish enterprise and type of fish work and the interaction term between percent of omena in the fish enterprise and type of fish work. As stated earlier, fishers around Lake Victoria have better access to productive and financial resources than fish traders. Better accessibility to resources may give the fishers an advantage when investing in alternative income-generating activities. For example, male fishers can own land easily while female fish traders may have restrictions on land ownership (Villarreal, 2006). Since land can be used as collateral in applying for loans, fishers who own land may obtain loans, which may relax their financial constraints. On the contrary, fish traders who do not own land can be disadvantaged by the collateral-based lending policies of financial institutions.

Position in the fish enterprise positively and significantly influenced the probability of diversifying income into non-agricultural work at the five percent significance level. This result means that fish enterprise owners had a higher probability of diversifying income into non-agricultural work than fish enterprise employees. The marginal effect shows that ownership of a fish enterprise increased the probability of diversifying income into non-agricultural work by ten percent. This finding may be due to a higher income endowment by fish enterprise owners, which may serve as a source of capital necessary for starting a non-agricultural enterprise. In addition, fish enterprise owners may be endowed with enterprise management skills which may be applicable to non-agricultural enterprises. As well, fish enterprise owners may have better access to established networks (such as cooperatives), which may serve as source of market information and initial capital.

Percent of Nile perch positively and significantly influenced the probability of diversifying income into non-agricultural work at the five percent significance level. According to the marginal effect, a 10 percent increase in the amount of Nile perch in the fish enterprise increased the probability of diversifying income into non-agricultural work by one percent. This marginal effect reflects the effects of percent of Nile perch in the fish enterprise and the interaction term between percent of Nile perch in the fish enterprise and type of fish work. A higher percentage of Nile perch may mean more income for fish workers since Nile perch is of high value and is the main income earner around Lake Victoria (Shoko *et al.,* 2005; Geheb *et al.,* 2008). An increase in fish income due to more participation in Nile perch fishing or trade may therefore relax the financial constraints of fish workers allowing them to invest in other income-generating activities. This effect is positive and may be seen as an '*income effect*'. Similarly, an increase in fish income due to more participation in Nile perch may discourage labour allocation to other activities as fish workers may be more comfortable in fish work. This effect is negative and may be seen as a '*substitution effect*'. The positive influence of percent of Nile perch on income diversification decision found in this study therefore means that the income effect was greater than the substitution effect.

Percent of omena in the fish enterprise positively and significantly influenced the probability of diversifying income into non-agricultural work at the one percent significance level. The marginal effect shows that a 10 percent increase in the amount of omena in the fish enterprise increased the probability of diversifying income into non-agricultural work by two percent. This marginal effect reflects the effects of percent of omena in the fish enterprise and the interaction term between percent of omena in the fish enterprise and type of fish work. Since omena fish is the second most important income earner in Lake Victoria fisheries after Nile perch (Mwakubo *et al.*, 2007), the income-substitution effect argument may also apply to omena. As a result, the positive effect of percent of omena in the fish enterprise may be because the income effect (due to more participation in omena fishing or trade) is greater than the substitution effect.

The interaction terms between percent of Nile perch or omena and type of fish work negatively and significantly influenced the probability of diversifying income into non-agricultural work at the five percent and one percent significance levels, respectively. The negative effects of the interaction terms may be due to lower ability of fishers to release labour to other activities compared to fish traders. Fishers may get exhausted after fish work, making alternative activities, such as non-agricultural work, less attractive. Fishers may also be reluctant to leave their fishing nets unattended because of theft (Geheb and Binns, 1997; Abila, 2000). The scenario is different for fish traders who may have more time to undertake other income-generating activities. A closer look at the interaction terms reveals that the effect of the interaction term between percent of omena and type of fish work was slightly lower than the effect of the interaction term between percent of Nile perch and type of fish work. This may mean that omena fishers have a lower ability of releasing labour to other activities compared to Nile perch fishers. A similar result was found in the farm work decision equation.

6. Conclusion and Recommendations

Income diversification is a potential way out of poverty for fishing communities in developing countries[9]. In order to develop policies aimed at stimulating income diversification among fishing communities, there is need to identify the determinants of their income diversification behaviour. This study finds that education, type of fish work, the interaction terms between percent of Nile perch or omena in fish enterprise and type of fish work, membership of association and access to loans/financial assistance explained the decision to diversify income into farm work. On the other hand, age, marital status, type of fish work, position in fish enterprise, percent of Nile perch in fish enterprise, percent of omena in fish enterprise, and the interaction terms between percent of Nile perch or omena in fish enterprise and type of fish work explained the decision to diversify income into non-agricultural work.

Income diversification into farm work can be stimulated by providing adult education, improving access to loans/financial assistance and encouraging membership of associations. On other hand, income diversification into non-agricultural work can be stimulated by improving access to loans/ financial assistance. The role of loans/financial assistance in stimulating income diversification is supported by the evidence of declining fish landings in many developing countries (including Kenya), which implies reduced fish incomes. As a result, there is need to put in place alternative ways of financing fish workers who wish to diversify away from fish work.

[9] The impact of income diversification on fish workers' welfare is assessed in a different paper.

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