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Contribution of Fish Production to Farmers' Subjective Well-being in Vietnam – A Logistic Model

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Abstract

There is a growing awareness of the importance of food fish production on human nutrition, employment, poverty, and recreation. However, the role of aquaculture in livelihoods of fish farmers has not been considered rigorously. With 120 farmers interviewed in a field survey and a cumulative logistic model, this study identifies some determinants of subjective well-being of small-scale fish farmers in Vietnam and examines the role of earnings from fish production in generating their happiness. The results confirm that the farmers receive satisfaction from their farm working. Subjective well-being of the farmers increases with their job satisfaction and cash earnings from fish farming. A doubling in cash returns from fish culture relative to household income raises a farmer's happiness probability by an estimated 10.6%. Education also affects farmers' life satisfaction. For better educated farmers, when their satisfaction from fish culture increases by one level, happiness probability is estimated to increase by 0.23%. Wild fish plays an important role in Vietnamese farmers as a doubling in relative income from wild fish captures raises their estimated probability of happiness by 139%.

There is now, more than ever, a growing awareness of the importance of food fish production on human nutrition, employment, poverty (Bailey and Skladany 1991; Edwards 2000) and even recreation in more developed societies (Jolly and Clonts 1993). The contribution of aquaculture development to economic growth and to farmers' incomes has been the focus of various government reports as well as working papers produced by development projects. However, the role of aquaculture in the livelihoods of poor farmers has not been considered rigorously. In particular, it is very difficult to find any literature relating aquaculture adoption to happiness or life satisfaction of the adopters although since the 1990s, a number of studies of the determinants of happiness have been conducted by economists following a long history of well-being analysis by psychologists (Frey and Stutzer 2002). Based on Veenhoven (1991) and Easterline (2001), "happiness," "well-being," and "life satisfaction" are treated as synonyms capable of measurement by self-assessment, such that a higher score on an instrument measuring life satisfaction similarly suggests a higher level of happiness or well-being. Veenhoven (1991) defines life satisfaction as "the degree to which an individual judges the overall quality of his life-as-a-whole favorably."

In Vietnam, seafood is the third most important export product after crude oil and textile-garments. Alongside capture fisheries, aquaculture revenue constituted 4% of Vietnamese gross domestic product in 2003 and $2.35 billion in exports in 2004 (FAO 2005), or 10% of the country's total export revenue. The total area used for aquaculture in Vietnam is 902,229 hectares of 2 million hectare potential water surface areas (Fisheries Informatics Center, FICen 2005) covering 3% of the total land area.

For the increased contribution of fish production in the livelihoods of small-scale farmers (Edwards 2000), there exists a question of whether income from adoption of aquaculture and wild fish catch would raise happiness of farmers. This paper examines the role of earnings from fish production in improving farmers'

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quality of life and verifies the role of fish culture in contributing farmers' happiness.

Cumulative logistic model is used to explore the level of farmers' happiness as well as examine impacts of aquaculture on beneficiaries' lifestyle improvements and thus, complements previous studies on contributions of aquaculture to farmers' lives. Furthermore, microdata measuring happiness, especially related to job satisfaction, are unavailable in a developing country like Vietnam. Thus, data from a field survey used in this study are unique so far.

Methods and Data Description

Regression Model

Subjective well-being is a broader concept than decision utility, including experienced utility as well as procedural utility. Frey and Stutzer (2002) suggest a microeconometric function to measure happiness, $W = \alpha + \beta \boldsymbol{x} + \varepsilon$ where W is level of happiness and $\boldsymbol{x}$ is a vector of explanatory variables of demographics and socioeconomics characteristics.

Given that utility levels are represented by ordinal variables, a farmer's utility (represented by satisfaction or happiness from aquaculture) takes the following function:

$$U_i = \alpha^* + \beta^* \mathbf{x}_\mathrm{i} + \sigma \varepsilon_i, \quad (1)$$

where U is utility level, $\boldsymbol{x}$ is vector of explanatory variables, and i represents individual respondent. However, U_i cannot be observed directly. Instead, according to Greene (2003), there exists a set of cutoff points or thresholds, $\pi_1, \ldots, \pi_{J-1}$, that are used to transform U_i into the observed variable Y as follows:

$$\begin{aligned} &Y_i = 1 \text{ if } \pi_1 = U_i \\ &Y_i = 2 \text{ if } \pi_2 < U_i \leq \pi_2 \\ &Y_i = 3 \text{ if } \pi_3 < U_i \leq \pi_2 \\ &\vdots \\ &Y_i = J \text{ if } U_i \leq \pi_{j-1} \end{aligned} \quad (2)$$

Assuming ε_i has a standard logistic distribution, it follows that the dependence of Y on $\boldsymbol{x}$ is given by the cumulative logit model.

$$\mathrm{Log}[F_{ij}/(1 - F_{ij})] = \alpha^* + \beta^* x_\mathrm{i} \quad j = 1, \ldots, J-1; \quad (3)$$

where $F_{ij} = \sum_{m=1}^{j} p_{im}$ represents cumulative probabilities,

with $p_{ik} = P(Y_i = k)$ (4)

Agresti (2002) defines the cumulative probabilities in simpler form

$$P(Y \leq j|x) = p_1(x) + \cdots + p_j(x) \quad (j = 1, \ldots, J) \quad (5)$$

and the cumulative logits are

$$\mathrm{logit}[P(Y \leq j|x)] = \frac{\log P[Y \leq j|x]}{1 - \log p[(Y \leq j|x)]} \quad (j = 1, \ldots, J-1) \quad (6)$$

A model that simultaneously uses all cumulative logits is given by

$$\mathrm{logit}\left[P(Y_i \leq j|x)\right] = \alpha_j + \mathbf{X}_i^{'} \beta \quad (7)$$

where Y_i is response of the ith respondents and $j = 1, \ldots, J - 1$ and J represents number of categories of responses; in our study, $J = 5$; $\mathbf{X}_i^{'}$ is the transposed vector of explanatory variables.

Each cumulative logit has its own intercept α_j increasing in *j*, but the same coefficient β for each explanatory variable, representing the effect of explanatory variable x on the response Y. The response curves for $j = 1, \ldots J - 1$ have the same shape determined by β. They share exactly the same rate of increase or decrease but are horizontally displaced from each other. According to Agresti (2002), for fixed *j*, the response curve is a logistic regression curve for a binary response with outcomes $Y \leq j$ and $Y > j$.

Allison (1999) states that the coefficients in Equation (7) are related to Equation (1) by

$$\alpha_j = \frac{\alpha^* - \pi_j}{\sigma} \quad (8)$$

$$\text{and } \beta = \beta^*/\sigma. \quad (9)$$

Allison (1999) emphasizes that coefficients β are not affected by the placement of the thresholds. Some of πs may be close together while others far apart, but the effects of the explanatory variables stay the same. The effect of π is on the intercepts.

To measure the farmers' life satisfaction, a proxy for their happiness, subjective well-being, or "utility" (Frey and Stutzer 2002), the respondents were asked "Do you recognize generally a considerable improvement in quality of life in your household because of adoption of fish culture?" Farmers' responses to the question are based from Likert scale ranging from one (strongly agree) to five (strongly disagree). Frequencies of the responses are summarized in Table 1.

Because absolute income may not be a determinant for quality of life (Frank, 2005), relative incomes calculated as the ratios of absolute income from fish culture ("fish income" in brief) and from wild fish capture ("wild fish income" in brief) to total household income are included in the model to examine their effects on life quality improvement in addition to the variable of *income* variable, per capita income. Cash income from fish culture is more appreciated by farmers because cash can be used to buy necessities and improve their livelihood. Therefore, cash income from fish culture relative to total household income is also included in the model. Higher cash income is expected to lead to higher levels of happiness. The income from nonfarm activities relative to total household income is used to control for the effect of nonfarm income.

According to Cantril (1965), a good job and personal characteristics are also associated with happiness. Satisfaction from aquaculture, a proxy for job satisfaction, is thus expected to raise fish farmers' happiness levels. Education level of respondents as well as number of men and land area of a farm are used as controlling variables in the model. In previous research, younger respondents report lower life satisfaction than the older respondents (Frey and Stutzer 2002). The age of respondents also plays an important role in their subjective well-being. The number of men in a household is used to control the possible role of male labor in creating income and improving household livelihood in poor and remote communities where the role of women in the labor market is limited. The importance of farm size in a farmer's livelihood merits inclusion of a land area variable in the model; more land area is likely to result in higher levels of quality of life.

For an empirical regression, a logistic model is specified as follows:

$$\text{Logit}[P(happy=j)]=f(pls\_fish, income, fcash\_total, catch\_total, fish\_total, age, edulevel, men, land)$$

where: P is the probability of the farmers' response get the value less than or equal j; happy, categorical variable of improvement in farmer's life quality; j, five scores ($j = 1,\ldots,5$) represent farmers' responses to the question, from one (strongly agree) to five (strongly disagree); *pls_fish*, categorical level of farmer's satisfaction from fish culture, ranging from 1 to 5 for five levels from "strongly dissatisfied" to "strongly satisfied"; *income*, per capita income; *fcash_total*, cash income from fish culture relative to total household income; *nonfarm_total*, nonfarm income relative to total household income; *catch_total*, income from wild fish capture relative to total household income;

TABLE 1. *Frequency of dependent response variables.*[a]

Response level	Frequency	Percent
1 – strongly agreed	4	3.33
2 – agreed	71	59.17
3 – undecided	41	34.17
4 – disagreed	3	2.5
5 – strongly disagreed	1	0.83

[a] Responses to the question "Do you recognize generally a considerable improvement in quality of life in your household because of adoption of fish culture?"

fish_total, income from fish culture relative to total household income; *age*, age of respondent, *age* = 1 if the respondent is older than 40, *age* = 0 otherwise; *edulevel*, education level of respondents, *edulevel* = 1 if the respondent has completed secondary school, *edulevel* = 0 otherwise; *men*, number of men in a respondent's household; *land*, total area of land occupied by a respondent's household.

In another version of this model, a variable of improvement of community life was also added, but the variable is highly correlated with the dependent variable and explicitly dominates other variables. It was thus dropped out of the model.

To investigate possible interaction effects of age, education level, and job satisfaction levels of fish farmers with other variables, the interaction variables are also added into the model.

The cumulative logit of farmers' happiness is

$$\begin{aligned}\text{logit}[P(\text{Happy} \leq 2)] &= \log \frac{P(\text{Happy} \leq 2)}{P(\text{Happy} > 2)} \\ &= \log \frac{P(\text{Happy} \leq 2)}{P(\text{Happy} \leq 2)}\end{aligned}$$

The estimated probability of the farmer's well-being is

$$P(\text{Happy} \leq 2) = \exp\{\text{Logit}[\text{Happy} \leq 2]\}$$

$$\begin{aligned}P(\text{happiness}) &= P(\text{Happy} \leq 2) \\ &= \frac{\exp\{\text{logit}[P(\text{Happy} \leq 2)]\}}{1 + \exp\{\text{logit}[P(\text{Happy} \leq 2)]\}}\end{aligned}$$

The scores of $j = 1, 2$ indicate that the farmer is happy with their life. At fixed threshold $j = 2$, the response curve is a logistic regression curve for a binary response with outcomes $Y \leq 2$ and $Y > 2$. From this, we can obtain the estimated cumulative probability P of farmers' satisfaction or happiness from which we can calculate marginal effects, which are then used to calculate elasticities of continuous explanatory variables for each observation. For dummy variables (say, D), the marginal effects are differences between $P(Y \leq 2 \mid D = 1, x)$ and $P(Y \leq 2 \mid D = 0, x)$.

Data Description

The data for this study are obtained from a 2001 field survey involving 120 fish farmers in three provinces of Binh Phuoc, Tay Ninh, and Long An in Southern Vietnam. Because of poor resources because of dry soil and water scarcity as well as remote distances to urban regions, aquaculture was underdeveloped in the provinces before 1994. Limited resource farmers in these provinces live mainly on subsistence agriculture and are irregularly employed in off-farm labor. Aquaculture has been adopted as a solution for rural development and improvement of farmers' livelihoods.

The investigated region is also the target area of an aquaculture development program, University of Agriculture and Forestry-Aqua Outreach Program (UAF-AOP), which was implemented starting in 1994 under cooperation of the provincial extension agencies and Fisheries Faculty of the University of Agriculture and Forestry (currently renamed Nong Lam University, Thuduc, Hochiminh City, Vietnam). Between 1994 and 2000, the program had transferred appropriate and low-cost technologies, utilizing local resources, to small-scale farmers involved in on-farm trials. Since the beginning of the program, aquaculture has been continuously growing in both water surface and production intensity, mostly within extensive and semiextensive aquaculture systems in the area (Duc 2002).

Headed mostly by men, the surveyed households had an average size of five members, ranging from 1 to 16 and median number of men is 2, while the age of the respondents (also household heads) ranged from 26 to 80, with a mean of 47, mostly concentrated in the 35- to 60-yr old range. The respondents had quite high education levels, with more than 75% of them having completed secondary or higher levels. The rather high educational level of the farmers should make them more willing to adopt new farming technologies, thereby improving their livelihoods.

Before the development project, aquaculture was underdeveloped in the survey area. However, overall pond area has considerably increased since 1995, the beginning of the UAF-AOP. This study focuses on small-scale fish farmers, whose pond area is generally small or very small, ranging from 40 to 9000 m^2, and the ratio of pond to land ranges from 0.25 to 80.00%. The land area owned by households in this survey ranges from 500 m^2 to 12 ha.

Employing enterprise budgeting methods (Jolly and Clonts 1993), household income includes farming income, off-farm income and nonfarm income, and also income from wild-caught fish, which plays an important role in the livelihoods of the target farmers. Total household income is divided by household size to get per capita income. Farming income includes incomes from farming enterprises such as rice cultivation, livestock, fish culture, nonrice crop farming, and fruit trees, all of which contribute to farmers' annual incomes. Any enterprises practiced solely for consumption and which do not contribute to a farmer's income are ignored in this study because farmers do not consider them as sources of income and their role in farmers' livelihoods is not empirically relevant. Because a few farmers suffer economic losses during the study year, the household income, farming income, nonfarming income, and income from fish culture (fish income) are added with 1000 to make their profits positive and enable positive ratios of fish income to household income and farming income as relative values of income received from the enterprise.

In this study, "fish income" is defined as total income from fish production, including cash income received from fish harvest sales and "forgone" income from the amount of fish given away and eaten, while "wild fish catch income" is cash income received from selling wild fish caught off-farm. Cash income from fish culture is more appreciated by the farmers because they can use cash to buy necessities and to improve their livelihood. To explore their effects on farmers' satisfaction or happiness, incomes either in their absolute or in relative values are assumed exogenous in regressed models. Descriptive statistics are summarized in Table 2.

Results and Discussion

The SAS logistic regression procedure with backward selection is used, setting a maximum P value of 10%. From the logistic procedure, the best fit model is selected. The proportional odds test ($\chi^2 = 38.0631$, $P = 0.1481$; Table 3) confirms regressed parameters are the same across logits, simultaneously for all predictors, allowing to use cumulative logit model to

TABLE 2. *Summary of data descriptive statistics.*

Variables	Mean	Standard error	Minimum	Maximum
Age	47.5167	0.97086	26	80
Edulevel	2.00833	0.7503	0	4
Hhsize	5.01667	0.1661	1	16
Men	2.39167	0.0934	0	5
Land (m^2)	14660.42	1734.047	500	120000
Pond/land	12.9407	1.4581	0.2439	80
Hhincome ($)	1215.298	85.6945	−637.931	5043.103
Farmincome ($)	686.9075	70.2029	−1051.72	5043.103
Fish/household income	27.7569	2.3284	1.4030	100
Fish/farm income	46.9511	6.3367	−579.688	215.3846
Fish_income ($)	304.55	44.5622	14.4828	4172.414
Fishcash ($)	176.5397	20.5130	0.0000	1103.448
Capita income ($)	260.6084	20.2045	−159.483	1425.69
Nonfarm_income ($)	494.1379	691.3666	0.0000	4137.9300
Catch_income ($)	10.8184	38.8199	0.0000	344.8276
Involve	0.2500	0.4348	0.0000	1.0000
Fish expectation	15.7174	18.5256	−8.0033	75.8571
Fish yield (kg/m^2)	0.5826	0.5706	0.015	3.3333

explore effect of determinants on the dependent variable (probability of life satisfaction or happiness). The chi-square tests for goodness-of-fit of the model (Table 3) justify that the regression results are significant ($P < 0.0001$).

Marginal effects and elasticities are also calculated to measure the magnitude of effects of explanatory variables. Because elasticities are nonlinear functions of the observed data, the logit function is not guaranteed to pass through the mean point (Train 1986). Further elasticity is calculated at the means, and tends to overestimate the probability response to a change in an explanatory variable (Hensher and Johnson 1981). The elasticity measured at means is thus not used to measure effects of continuous variables. Instead, based on Hensher and Johnson's (1981) formulation, the weighted average elasticities are calculated from the marginal effects.

The logistic regression coefficients, marginal effects, and elasticities are reported in Table 3. The results show that the cumulative probability of life quality improvement increases with higher levels of farmer's satisfaction from fish culture. The weighted marginal effect of *plsfish* is 0.1425, showing that the farmers' satisfaction from fish production is positively related to their happiness. The estimated probability of happiness increases by 14.25% when their job satisfaction goes up one level, that is, the score of their response in Likert scale is estimated to increase by 1 unit in given other variables.

Age has a positive effect on the probability of improvement in life quality of farmers. The regression results show that for older farmers, higher relative income from fish farming seems to lower their happiness levels. For farmers older than 40 yr, when relative income from fish culture doubles their estimated probability of happiness decreases by 32%. The negative influence of relative income from fish production to farming income may be related to the negative effect of relative income from fish culture to total household income for older farmers. As fish income of older farmers relative to total income doubles, their probability of happiness is estimated to decrease by 32%. This result shows that income from fish culture is unlikely to increase happiness of the older. However, the result suggests that the younger farmers are happier with the higher income from aquaculture, a new farming operation introduced to their community. That implies a potential to introduce the new farming technology to the young fish farmers' community.

Although the coefficient of education is insignificant in the regressed model, the interaction between education level and job satisfaction is significant, suggesting that better educated farmers who are more satisfied with their fish culture would be slightly happier relative to those with lower education and satisfaction levels. For better educated farmers, when their pleasure to fish culture increases by one level, that is, when the score of their response in Likert scale increases by 1 unit their probability of happiness is estimated to increase by 0.23%.

The role of income in farmers' happiness is a major interest in this study. Income per capita has a positive effect on the cumulative probability of happiness. When the income per capita of farmers doubles, their probability of happiness is estimated to increase by 31%. Happiness is income inelastic; so fish farmers would have to get more income to increase their happiness levels. Nonfarm income lowers the happiness levels. A 10% rise in nonfarm income relative to total household income is estimated to lower farmers' probability of happiness by 12%. All of the interviewed fish farmers are household heads, and most of their nonfarm income comes from younger family members working for local manufacturing and service sectors as well as from remittances from their relatives living in urban regions. The interviewed farmers are committed to the farming operations for most of their life. The more nonfarm money the farmers receive from other people, the less happiness they get because they feel they are more

TABLE 3. *Results of statistical tests for model appropriateness and goodness-of-fit.*

Test	Chi-square	P value
Proportional odds assumption	38.0631	0.1481
Likelihood ratio	60.7548	<0.0001
Score	48.3879	<0.0001
Wald	39.6088	<0.0001

TABLE 4. *Estimates and marginal effects for subjective well-being.*

	Regression estimates		Marginal effect	Elasticity
Parameter	Coefficient	Standard error	Weight average	Weight average
Intercept1	−4.6981***	1.4666		
Intercept2	0.061	1.2983		
Intercept3	3.4474**	1.4154		
Intercept4	4.9001***	1.6641		
Plsfish	0.7632**	0.365	0.1425	
Income	0.00179*	0.00102	0.0003	0.3145
Fcash_total	0.0256**	0.0129	0.0048	0.1057
Nonfarm_total	−0.042***	0.0131	−0.0078	−1.1966
Catch_total	0.0704***	0.0256	0.0131	1.3871
Fish_total	−0.1553	1.878		
Age	4.0651***	1.487	0.0503823	
Edulevel	2.6866	1.6944		
Fish_total.age	−5.8222***	2.1138	−0.9486	−0.2663
Plsfish.edulevel	1.5786*	0.812	0.2615	

*, ** and *** significant at 90%, 95%, and 99% level; model rescaled R^2 is 0.4718

dependent on others. The negative effect of nonfarm income thus indicates farmers receive utility from their working on the farm.

The important role of income in small-scale farmers' livelihoods can be represented via cash income as they can use cash to improve their life, leading to a happiness increase. Cash earned from fish culture has a similar positive effect. A 100% increase in cash returns from fish culture relative to household income is estimated to raise a farmer's happiness probability by 10.6%.

Earnings from wild fish capture still significantly contribute to well-being of fish farmers, as the higher it is relative to total income, the higher the positive effects in both models. If relative income from wild fish increases doubles, estimated probability of farmers' subjective well-being is estimated to increase by 139%.

Conclusion

Not only confirming that the older farmers get higher probability of happiness, the logistic regression also affirms that per capita income is still an important determinant of life quality improvement, a proxy for subjective well-being. The contribution of fish culture to improvement of farmers' livelihoods and well-being can be exhibited by their pleasure and cash earnings from the enterprise. Earnings from wild fish capture also significantly contribute to well-being of fish farmers. Negative effect of higher relative nonfarm income on their happiness indicates that fish farmers receive satisfaction from their working on the farm.

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