CHAPTER 3. AQUACULTURE AND HAPPINESS IN VIETNAM – A MICROECONOMETRIC ANALYSIS

I. Introduction

Aquaculture is a farming activity almost as old as humanity and fish has been cultured for centuries. However, 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, Edwards, Little and Demaine, 2002) and even recreation in more developed societies (Jolly and Clonts, 1993). In Vietnam, aquaculture has also been considered an important economic sector due to its rapid growth and its 30-40% contribution to total national fisheries production (FAO and NACA, 1997). In addition, seafood is the third major export product of Vietnam after crude oil and textile-garments. Alongside fish capture, aquaculture revenue constituted 4% of Vietnamese GDP in 2003 and exported a value of $2.35 billion 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 two million potential water surface areas (FICEN, 2005), cover 3 % of the total land area.

The contribution of aquaculture development to the Vietnamese national economy as well as 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 job satisfaction 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 happiness analysis by psychologists (Frey and Stutzer, 2002). Furthermore, the relationship between income and happiness is confounded by economists and social researchers because the terms of happiness, subjective well-being, satisfaction, utility or even welfare are usually used interchangeably (Easterline, 2001).

Di Tella, MacCulloch and Oswald (2003) state that happiness equations are monotonically increasing in income, and have a similar structure in different countries. Higher income persons are likely happier because they have more opportunities to get what they desire (Frey and Stutzer, 2002). The important role of higher income in lasting human happiness is also supported by Andrews (1986), Argyle (1999), Diener (1984), Diener and Lucas (1999), Lykken and Tellegen (1996), Schwars and Strack (1999). Although it does not provide lasting happiness, more money allows for life style improvements, whether those improvements arise from more money or other desirable objects (Lee, 2006).

Despite of evidence that increased income raises happiness, according to Frank (2004), the absolute income increases of recent decades have failed to translate into corresponding increases in measured well-being. The evidence thus suggests that if income affects happiness, it is relative, not absolute, income that matters. Frey and Stutzer (2002) argue that higher income aspirations reduce individuals' satisfaction with life.

Due to the increased contribution of fish production in the livelihoods of small scale farmers (Edwards, 2000, Edwards, Little and Demaine, 2002), there exists a question of whether income increases from adoption of the enterprise would raise happiness of fish farmers. This study uses cumulative logistic models to explore the level of fish farmers' happiness as well as examine impacts of aquaculture on beneficiaries' life style improvements and thus, complements previous studies on contributions of aquaculture to farmers' lives. Furthermore, secondary micro data measuring happiness, especially related to job satisfaction, is unavailable in a developing country like Vietnam. Thus, this study uses primary data from a survey conducted of fish farmers in Vietnam.

To examine the contribution of aquaculture in improving farmers' happiness, this study contains three parts. The first part is reserved for description of the methodology. The second part investigates the determinants of happiness associated with fish culture and the third part examines the role of earnings from fish culture in improvement of farmers' quality of life.

II. Research Methods

The cumulative logistic model

Since 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, $W = \alpha + \boldsymbol{\beta}\mathbf{x} + \varepsilon$ where W is level of happiness and $\mathbf{x}$ is a vector of explanatory variables of demographics and socioeconomics characteristics. Therefore, cumulative logit models are used to explore the relationship of fish culture to pleasure to the enterprise as well as to improvement of life quality.

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

$$U_i = \alpha^* + \boldsymbol{\beta}^* \mathbf{x}_i + \sigma\varepsilon_i \qquad (1)$$

Where U is utility level, **x** is vector of explanatory variables and *i* represent individual respondent. However, U_i can not be observed directly. Instead, according to Allison (1999) and Greene (2003), there exists a set of cut off points or thresholds, $\pi_{1, \ldots,}$ π_{J-1}, that are used to transform U_i into the observed variable Y as following

$$Y_i = 1 \text{ if } \pi_1 \leqq U_i \qquad (2)$$

$$Y_i = 2 \text{ if } \pi_2 < U_i \leqq \pi_1$$

$$Y_i = 3 \text{ if } \pi_3 < U_i \leqq \pi_2$$

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$$Y_i = J \text{ if } U_i \leqq \pi_{J-1}$$

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

$$\text{Log } [F_{ij}/(1-F_{ij})] = \alpha^* + \boldsymbol{\beta}^* \mathbf{x}_i \qquad j = 1, \ldots, J-1; \qquad (3)$$

where $F_{ij} = \sum_{m=1}^{j} p_{im}$ represents cumulative probabilities (4)

Agresti (2002) defines the cumulative probabilities in simpler form

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

and the cumulative logits are

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

A model that simultaneously uses all cumulative logits is given by

$$\text{logit}[P(Y_i \leq j \mid x)] = \alpha_{ij} + X_{ij}'\beta \qquad (7)$$

where Y_i is response level, i= respondents and j = 1, …, J − 1 and J represents number of categories of responses; in our study, J = 5; X is the 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, …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≤j and Y>j.

Allison (1999) states that the coefficients in equation 2 (or in equation 6) are related to equation (1) by

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

and $\beta = \beta^*/\sigma$. (9)

Allison (1999) emphasizes that coefficients β are not affected by the placement of the thresholds. Some of π's 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.

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 farmers' response from 1 to 5, representing for 'strongly agree' to 'strongly disagree' to asked questions on job satisfaction or happiness, the fixed threshold j=2 represents that the farmer is pleased with his/her fish farming experiences or that he/she is happy with their life. At 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 calculated 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 $P(Y \leq 2 \mid D=0, x)$.

Elasticities are also calculated to measure the magnitude of effects of explanatory variables. Since 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 tend 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.

Data description

The data for this study are obtained from a 2001 field survey involving 120 fish farmers in 3 provinces of Binh Phuoc, Tay Ninh and Long An in Southern Vietnam. Because of poor resources due to dry soil and water deficiency 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, UAF-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 semi-extensive aquaculture systems in the area (Duc, 2001).

This study is limited to small-scale fish farmers, examining the relationship between their adoption of aquaculture technology and the improvement of their quality of life. According to Edwards et al. (1996) small-scale farms have relatively little land area, often as small as 0.5-1.0 ha, typically nutrient-poor; rain-fed with seasonal or unreliable rainfall; dominated by crops, with a few animals fed from agricultural by-products on or near the farm. Nevertheless, irrespective of the economic or other benefits of large-scale aquaculture operations, greater emphasis is placed on small-scale farming in developing countries. According to Pillay (1990), this is largely because of the opportunities small scale operations offer for part- and full-time employment, helping to sustain peasants and fishermen in rural areas, and reducing the drift of populations to urban centers. Edwards and Demaine (1997) also discuss small-scale farmers in the definition of "rural aquaculture". They define this type of aquaculture as "the farming of aquatic organisms by small-scale farming households using mainly extensive and semi-intensive husbandry for household consumption and/or income".

The levels of pleasure from fish culture are proxy for job satisfaction, the respondents were asked by the question of "*Do you feel to be completely satisfied or pleased by integrating fish culture into farming?*" To measure the farmers' life satisfaction, a proxy for their 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 since adoption of fish culture*?" Farmers' responses to the above questions are based from Leikert scale ranging from 1 ("strongly agree") to 5 ("strongly disagree"). Frequencies of the responses are summarized in Table 1.

Headed mostly by men, the surveyed households had an average size of five members, ranging from one to sixteen and median number of men is two, while the age of the respondents (also household heads) ranged from 26 to 80, with a mean of 47, mostly concentrated in the 35 - 60 ages. 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.

Prior to the development project, aquaculture was underdeveloped in the survey area. However, overall pond area has considerably increased since 1995, the beginning of the UAF-Aqua Outreach Program. This study focuses on small-scale fish farmers, whose pond area is generally small or very small, ranging from 40 to 9000m^2, and the ratio of pond to land ranges from 0.25 – 80%. The land area owned by households in this survey ranges from 500 m^2 to 12 ha.

Employing Enterprise Budgeting methods (Jolly, 1993), household income includes farming income, off-farm income and non-farm 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, non-rice 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 some farmers suffer economic losses during the study year, the household income, farming income, non-farming income and income from fish culture (fish income) are added to 1000 after being converted to USD value 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 of on farmers’ satisfaction or happiness, incomes either in their absolute or in relative values are assumed exogenous in regressed models.

Michalos (1991) and Inglehart (1990), cited by Easterline (2002), state that “individual well-being is determined by the gap between aspiration and achievement”, thus this study includes farmer’s expectation to earnings from fish culture (called ‘fish expectation’ in brief) which is defined as the difference between the farmer’s estimated value of fish income relative to his total household income and the real value we calculated from collected economic data of his actual operations. Descriptive statistics are summarized in table 2.

III. Satisfaction from fish culture

The pleasure of farmers receive by engaging in fish culture may be considered a proxy for ‘job satisfaction’, where ‘job’ is the fish culture enterprise in which all respondents of this study are involved.

Using a cumulative logit model to estimate farmers’ satisfaction to fish culture, the first explanatory variable included is fish yield which is fish production divided by pond area. When fish yields increase, the satisfaction derived from fish culture is expected to increase. Demographic characteristics, such as age and education level of the respondents, are also included in the model, as suggested as Frey and Stutzer (2002).

Per capita income is included to control the effect of income on a respondent's satisfaction from fish culture. In the target area, fish culture represents an increasing contribution to household income of small scale farmers (Duc 2001) although it is not the most important source. Due to capital constraint involved with fish culture (Duc, 2002), higher income farmers are expected to be more likely to gain satisfaction from fish culture. The absolute level of income from fish culture in addition to income as a proportion of total household income and farming income are major variables of interest and are considered exogenous to the farmers' satisfaction. The variables are used to explore the utility effects of earnings from fish culture. The number of men in a household represents the role of male labor in the household in household livelihoods.

Land area is also considered because of its important role in the small scale farmers' livelihoods (Quan, 1998); higher land area is expected to increase satisfaction derived from fish culture, assuming that farmers would expand operations in order to increase profits and hence utility. On the other hand, for small scale farmers, whose land is the only material resource invested in production, the relative area of pond to total land area defines the scale of fish culture on their farms and represents a farmer's investment in fish farming. The other explanatory variables are farmers' involvement in on-farm trials with support from AOP, their 'fish expectation' which is measured by the gap of their estimates of contribution of fish farming to household income in percentage and the real values calculated from production data.

The cumulative logit model for the satisfaction farmers receive from fish culture is specified as follows

Logit[P(pls_fish≤j)] = f(yield, income, fish-farminc, fishincome, age, edulevel, men, land, pond-land, involve, expectation) Model (1)

where:

- *pls_fish*: categorical variable for satisfaction derived from fish culture where j indicates the value of the Leikert scale, representing five levels of job satisfaction from "strongly satisfied" to "strongly dissatisfied", j = 1…5

- *yield*: farmer's productivity of fish culture, total fish production divided by pond area

- *income*: capita household income in US dollar

- *fish_income:* total income from fish production

- *fish_farmincome:* the ratio of *fish_income* to farming income

- *age:* age of respondent; *age* = 1 if the respondent is older than 40, *age* = 0 otherwise.

- *edulevel:* education level of respondent; *edulevel* = 1 if the respondent has completed secondary school, *edulevel* = 0 otherwise

- *men*: number of men in household

- *land:* farmer's total occupied land

- *pond-land*: the ratio of pond area to total area of land (*land*)

- *involve*: involvement with extension services; *involve* = 1 if the farmer is involved with extension services (UAF-AOP's on-farm trials); *involve* = 0 otherwise.

- *expectation:* farmer's expectation to role of fish farming in household income, the gap of the value estimated by the farmer about the ratio between *fish_income* and their household income and the actual ratio calculated by the Enterprise Budgeting method

The interaction between respondent's age, expectation in earnings from fish culture, and involvement in extension and other variables are also added in the model.

To identify the determinants of a farmer's satisfaction derived from their fish culture enterprise, 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 and the regression results are reported in Table 3. The intercepts in the regressed logistic models indicate probability of each level of satisfaction (*pls_fish* $\leq$ j), given explanatory variables *x*, increases in *j* and the logit is an increasing function of this probability. That means the probability increases with the lower levels of satisfaction as all explanatory variables are constant.

The cumulative logit of satisfaction from fish culture is

$$\text{logit}\,[\text{P}\,(\text{Pls\_fish} \leq 2)] = \log\frac{\text{P(Pls\_fish} \leq 2)}{\text{P(Pls\_fish} > 2)} = \log\frac{\text{P(Pls\_fish} \leq 2)}{1 - \text{P(Pls\_fish} \leq 2)}$$

The estimated probability of the farmer's satisfaction from fish culture is

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

$$\text{P(satisfaction)} = \text{P (Pls\_fish} \leq 2) = \frac{\exp\{\text{logit[P(Pls\_fish} \leq 2)]\}}{1 + \exp\{\text{logit[P(Pls\_fish} \leq 2)]\}}$$

At j = 2, the response curve is a logistic regression curve for a binary response with outcomes P(*pls_fish*$\leq$2) and P(*pls_fish*>2), we can get the estimated cumulative probability *p* of farmers' satisfaction to calculate marginal effects of continuous explanatory variables. Estimated coefficients, marginal effects and elasticities of explanatory variables are described in Table 3.

Among farmers who were not involved with extension services, better educated farmers are more satisfied from their fish culture relative to the less educated. The negative effect of the interaction between education level and involvement in extension service suggests that the better educated farmers who involve with extension services obtain less satisfaction from their fish culture. In other word, less educated farmers involved in more extension services would get more satisfaction to their fish farming activities.

Unexpectedly, neither per capita income nor absolute fish income significantly affects on the pleasure farmers derived from their fish culture. However, the regression results show that higher income from fish culture relative to farming income higher the cumulative probability of farmer's satisfaction, especially for farmers not involved in the UAF - Aqua Outreach Program (UAF-AOP).

The positive effect of relative income from fish culture (*fishincome/farmincome*) decreases for farmers involved in extension activities, although involvement in AOP activities generally have a positive effect on the probability that farmers will be satisfied. A 10% growth in income from fish culture relative to farming income increases the satisfaction probability of AOP-non-involved farmers by 2% but just increase the satisfaction of AOP-involved farmers by (2.009 – 1.958) = 0.051%. This shows that among farmers involving AOP activities, those who obtain higher relative income from fish culture seem not satisfied in their achievement from the enterprise despite the fact that farmers involved in extension activities are more satisfied to their fish production in general.

The income from aquaculture in this study is not only cash income from the enterprise but also includes 'hidden' indirect benefits from fish consumed and given away, but those benefits are not observable by the farmers. Their higher satisfaction from fish farming may be a positive consequence derived from more indirect benefits they get from this enterprise. Although income from fish culture has no explicit effect on farmers' satisfaction, fish production benefits the farmers as an available source of fresh and high valued food locally. This benefit is very important in rural areas with limited resources due to dry soil and water deficiency.

The effect of age is significant in the model; older farmers have a higher probability of satisfaction from fish culture. The marginal satisfaction of *age* is 0.15. For older farmers, a larger relative area of pond to total land area tends to increase probability of farmer's satisfaction from fish culture. A 10% increase in the ratio between pond surface and land area would raise satisfaction for younger farmers by only 0.7%, but would increase satisfaction for older farmers by 1.3%.

The regression results also show that younger farmers with higher expectations from fish culture are more satisfied with fish culture, although the effect is fairly small. A 10% increase in expectation on fish culture results in a 1% rise in the probability of satisfaction level of younger farmers (less than 40 years old) from their fish enterprise relative to the older.

In general, farmers' expectation on earnings from fish culture raises their satisfaction from the enterprise. This scenario seems not to support the discussion of Frey and Stutzer (2002) who argue that 'wants are insatiable', the more one gets, the more one wants and higher expectation leads to less satisfaction. Their argument is possibly appropriate to the farmers who are older than 40 years old in this study or have limited pond surface in the target area. Nevertheless, with higher expectation on earnings from fish culture as a solution to poverty alleviation, small scale farmers can maximize their use of limited resources to pursue fish farming, resulting in more production and higher income from the enterprise.

In brief, absolute income, aquaculture productivity and the number of men in household do not directly increase farmers' satisfaction levels. Higher satisfaction is associated with involvement in extension activities, larger pond ratio, higher expectations and higher relative income from aquaculture. Higher age and education levels are also raise the probability of farmers' satisfaction from the enterprise.

IV. Fish culture and life quality improvement

To explore the role of aquaculture play in improving farmers' quality of life, a cumulative logit function is also employed for categorical responses of farmers' happiness. The Leikert scale, from one to five, is used again to represent five responses from "strongly agree" to "strongly disagree". Five levels representing improvement of farmers' life quality are also created in response to the question of "*Do you recognize in generally a considerable improvement in life quality of your household since adoption of* *fish culture*?" It should be noted that responses from farmers are subjective; therefore the "happiness" term in this study is considered subjective well-being.

Easterline (2001) states that the terms of happiness and subjective well-being are usually used interchangeable, the level of happiness term in this study is thus assumed identical to farmers' responses on life quality improvement, a proxy for subjective well-being. This section of the paper concentrates on examination of the role of earnings from fish culture in improving farmers' quality of life; and also verifies the role of fish culture in contributing farmers' long run happiness.

Because absolute income may be not a determinant for quality of life (Frank, 2004) relative incomes calculated as the ratios of absolute income from fish culture ("fish income" in brief) and from captured wild fish ("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 non-farm activities relative to total household income is used to control for the effect of non-farm 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 the lower life satisfaction than the older respondents (Frey and Stutzer, 2002). The age variable plays an important role. The number of men in a household controls for the possible role of male labor in creating income and improving household livelihood in poor and remote communities where women's role in the labor market are 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. The logit model is specified as follows

$$Logit[P(\ happy \leq j)] = f(pls\_fish,\ income,\ fcash\_total,\ nonfarm\_total,\ catch\_total,\ fish\_total,\ age,\ edulevel,\ men,\ land) \quad \text{Model (2)}$$

where:

- *happy*: categorical variable of improvement in farmer's life quality
- *pls_fish*: categorical level of farmer's satisfaction from fish culture, ranging from 1 – 5 for five levels from "strongly satisfied" to "strongly dissatisfied"
- *income*: per capita income
- *fcash_total*: cash income from fish culture relative to total household income
- *nonfarm_total*: non-farm income relative to total household income
- *catch_total*: income from wild fish capture relative to total household income
- *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 (2).

Similarly to the model (1) for job satisfaction, the cumulative logit of farmers' happiness is

$$\text{logit}\,[\text{P (Happy} \leq 2)] = \log\frac{\text{P(Happy} \leq 2)}{\text{P(Happy} > 2)} = \log\frac{\text{P(Happy} \leq 2)}{1 - \text{P(Happy} \leq 2)}$$

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

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

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

Model (2) has two versions, distinguished by two different types of variable *pls_fish* representing farmer's satisfaction from fish culture: the first (model 2a) uses variable *plsfish* with its scaled data collected directly from interviews while the second (model 2b) uses the alternative *pls* with data from the predicted probability that a farmer is satisfied with his aquaculture operation, P(*pls_fish* $\leq$ 2), estimated from model (1). That means the variable of *pls* is continuous while the *plsfish* is categorical.

The predicted value *pls* in model (2b) is also considered an instrument to correct for potential endogeneity of *pls_fish* in the model (2a). The intercepts in the regressed logistic models indicate probability of each level of happiness (*pls_fish* $\leq$ j), given explanatory variables *x*, increases in *j* and the logit is an increasing function of this probability.

The logit regression coefficients, marginal effects and elasticities for explanatory variables in both models are respectively reported in Table 4 and Table 5. The results show that the cumulative probability of life quality improvement increases with higher levels of farmer's satisfaction to fish culture. It should be noted here that the negative sign of *plsfish* in model (2a) indicates a positive effect on farmers' satisfaction. That is, *plsfish* values are lower for higher levels of satisfaction. The elasticity of happiness respect with to *plsfish* is -0.6364 and respect with to cumulative probability of farmer's satisfaction, *pls*, is 0.91. This means the farmers' satisfaction from fish production is positively related to their happiness. When a fish farmer's satisfaction from fish culture increases by 1%, his (her) probability of happiness increases by 0.91%.

Age has a positive effect on the probability of improvement in life quality of farmers in both versions of model 2. In model (2a), better educated farmers who are more satisfied with their fish culture would be happier relative to those with lower education and satisfaction levels.

Effects of income on farmer's happiness are interesting in this study. Income per capita has a positive effect on the cumulative probability of happiness in model (2a). A *c.p.* 10% increase in income per capita raises the probability of happiness by 3.1%. Happiness is income inelastic; so fish farmers would have to get more income to increase their happiness levels. However, income effect is insignificant in model (2b). Non-farm income lowers the happiness levels. A 1% rise in non-farm income relative to total household income lowers the probability of happiness by 1.2%. All of the interviewed fish farmers are household heads, and most of their non-farm 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 commitment to the farming operations for most time of their life. The more non-farm money the farmers receive from other people, the less happiness they get because they feel they are more dependent on the others. Negative effect of non-farm income thus indicates farmers receive utility from their working on the farm.

The regression results of both models (2a) and (2b) show that for older farmers, higher relative income from fish farming seems to lower their happiness levels. For farmers older than 40 years old, when relative income from fish culture increases by 10% their happiness probability decreases by 3.2% (in model 2a) or 2.6% (in model 2b). 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 relative to total income increases by 10%, the happiness probability of older farmers decreases by 3.2%. 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 technology and/or operations to the young fish farmers community.

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 in the two models. A 10% increase in cash returns from fish culture relative to household income raises a farmer's happiness probability by 1.06% in model (2a) and by 0.93% in model (2b).

Earnings from wild fish capture also significantly contribute to well-being of the fish farmers, as the higher it is relative to total income, the higher the positive effects in both models. When income from wild fish sales increases by 1%, the probability of farmers' happiness increases by from 1.11% (Model 2b) to 1.39% (model 2a).

In short, the contribution of fish culture to improvement of farmers' livelihoods and well-being can be represented by their pleasure and cash earnings from the enterprise. Although negatively affected by higher relative non-farm income, the probability of their happiness increases with higher age. The regression that includes a categorical variable for farmers' pleasure, *pls_fish,* (model 2a) affirms that per capita income is still an important determinant of life quality improvement, a proxy for subjective well-being or happiness, which supports to findings from previous studies (Andrews, 1986, Argyle, 1999, Diener, 1984, Diener and Lucas, 1999, Lykken and Tellegen, 1996, Schwars and Strack, 1999, and Di Tella, MacCulloch and Oswald, 2003).

Furtherly, the significance of predicted probability of farmers' satisfaction (via *pls* variable) on their happiness probability enables us to use the model (1) as the first stage and its predicted value as an instrument in a two-stage estimation of happiness determinants. Substituting *pls* in model (2b) by its determinants found in model (1), we can get marginal effects and elasticities of happiness respected to the determinants which are reported in Table 6.

In accordance with Frey and Stutzer (2002), the marginal utility of age dummy variable is 0.0946. Younger respondents appear to be more pessimistic than older respondents. Involvement with extension services also positively influences farmers' happiness as indicated by its marginal effect of 0.0125. Farmers who are better educated and are more satisfied with fish culture would be happier than those in other categories.

Pond surface relative to land area also increases happiness of the farmers, especially as respondent's age increases. A 10% increase in relative pond area raises happiness probability of younger farmers by 0.66% but increases that of older farmers by 1.15%. This suggests that farmers who have larger scale fish culture operations get more satisfaction and happiness.

Farmers' expectation on fish culture also increases their happiness. Farmers who are younger and have higher expectation level on fish culture are likely to be happier than the olders. A 10% increase in farmer's expectation level on fish culture contributes a 1.55% increase in happiness probability of the younger farmers. This contribution is less for older farmers by 0.86% but in total effect, they still experience higher happiness levels with higher expectation levels. For farmers who have larger relative pond areas, the happiness effect of their expectation level on fish production is also less but by a small amount.

Per capita income has no effect on farmers' happiness. However, opposite to the negative effect of non-farm income, income from fish culture relative to farming income or income from wild fish capture relative to total household income raises farmers' happiness while the ratio of fish income to total household income lowers their utility. The negative effect of non-farm income indicates fish farmers are happier when they are working on the farm. In other words, non-farm work leads to dissatisfaction with life while farm work has the positive effect. Nevertheless, an 11.8% decrease in farmers' happiness, caused by a 10% increase in relative non-farm income, may be offset by a 10% increase in relative cash income obtained from wild fish catch.

Aquaculture contributes to happiness both through relative pond size and by earnings from the enterprise. Although the positive effect is lower for farmers who involved with AOP's extension services, relative income from fish culture raises the farmers' happiness. A 10% growth in relative income from fish culture contributes to a 1.8% increase in happiness probability of the farmers who were not involved with AOP's on-farm trials activities. For those who were involved with the AOP's trial activities, the farmers who have lower relative income from fish culture appear to be happier because they are expected to get more income from their fish production with more continuous support from AOP's aquaculture extension services.

The contribution of earnings from aquaculture to fish farmers' happiness is reflected by the cash income the farmers receive from the enterprise. Affirming its important role in fish farmers' well-being, a 10% increase in cash income relative to household income raises their happiness by 0.9%.

V. Conclusion

Neither income per capita nor absolute income from fish culture has a significant effect on the pleasure farmers receive from fish culture. However, the regression results show that relative income from fish culture raises the cumulative probability of a farmer's satisfaction from fish culture, demonstrating that relative income, not absolute income, is associated with job satisfaction. The higher satisfaction is also expressed by the farmers who were involved with AOP's aquaculture extension services, who have higher expectation level on income earning from fish culture and who have larger pond surface relative to total land area. Older farmers are more satisfied with fish culture and are generally happier than the younger.

The negative effect of non-farm relative to total household income indicates farmers are happy with working on their farms. The probability that small scale fish farmers are happier is raised by higher relative income from wild fish caught, by higher ages of respondents and by involvement in extension activities. The cumulative logit regression also justifies that satisfaction from fish culture has positively contributed to increase probability of small scale farmers' happiness. This significant effect allows one to conclude that aquaculture contributes to happiness both through relative pond size and by earnings from the enterprise.

This study is a case study for researching on the contribution of aquaculture to the well-being of fish farmers in Vietnam, a developing country where aquaculture is an important national economic sector. A possible area of future research is the potential endogeneity of income as functions of happiness and job satisfaction. In this study, the number of observation is small, consisting of interviews from only 120 farmers. Future research on this topic should be conducted at a larger scale, with more observations, in order to confirm the findings of this study.

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Table 1. Frequencies of dependent response variables

	Level	Frequency	Percent
Satisfied with	1 – *strongly satisfied*	25	20.83
fish culture?	2 – *satisfied*	74	61.67
(*pls_fish*)	3 – *undecided*	19	15.83
	4 – *dissatisfied*	2	1.67
	5 – *strongly dissatisfied*	0	0
Improving	1 – *strongly agreed*	4	3.33
quality of life?	2 – *agreed*	71	59.17
(*happy*)	3 – *undecided*	41	34.17
	4 – *disagreed*	3	2.5
	5 – *strongly disagreed*	1	0.83

Table 2. Summary of data descriptive statistics

	Mean	S.E	Minimum	Maximum
age	47.5167	0.97086	26	80
age (dummy)	0.7417	0.4396	0.0000	1.0000
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
pls	0.8289	0.1586	0.3432	0.9989
yield (kg/m^2)	0.5826	0.5706	0.015	3.3333

Table 3. Estimates and marginal effects for farmers' satisfaction from fish culture

	Regression Estimates		Marginal effect	Elasticity
Parameter	Coef.	Error	Weight average	Weight average
Intercept1	-6.2185***	1.2781		
Intercept2	-2.2659**	1.098		
Intercept3	0.5158	1.2447		
fish_farminc	1.8626*	0.9848	0.2176	0.2009
age	1.2231*	0.6944	0.1500	
edulevel	0.4164	0.5091	0.0267	
pond_land	0.0616**	0.0272	0.0072	0.0725
involve	2.3381**	0.9999	0.0203	
expectation	0.1387***	0.0335	0.0162	0.1713
age.pond_land	0.0642**	0.0301	0.0073	0.0539
age.expectation	-0.0795***	0.0297	-0.0090	-0.0953
pond_land.expectatio	-0.003***	0.00087	-0.0004	-0.0036
fish_farminc.involve	-1.865*	0.9881	-0.2108	-0.1958
edulevel.involve	-2.1587*	1.2277	-0.1951	

** significant at 90% level, ** significant at 95% level, *** significant at 99% level*

Table 4. Estimates and marginal effects for happiness from Model 2a

	Regression Estimates		Marginal effect	Elasticity
Parameter	Coef.	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	-0.6364
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	-0.2306

** significant at 90% level, ** significant at 95% level, *** significant at 99% level*

Table 5. Estimates and marginal effects from Model 2b

	Estimate		Marginal effect	Elasticity
Parameter	Estimate	Error	Weight average	Weight average
Intercept	-7.1014***	1.368		
Intercept	-2.6582**	1.1576		
Intercept	0.4729	1.1957		
Intercept	1.8806	1.4714		
pls	3.1232**	1.4613	0.6172	0.9059
fcash_total	0.0226*	0.013	0.0045	0.0926
nonfarm_total	-0.0415***	0.013	-0.0082	-1.1800
catch_total	0.057**	0.0225	0.0113	1.1093
fish_total	0.4852	1.746		
age	3.7583***	1.4564	0.0020	
fish_total.age	-6.0363***	2.0856	-1.1659	-0.3208

** significant at 90% level, ** significant at 95% level, *** significant at 99% level*

Table 6. Marginal effects and elasticities of variables on happiness (two-stage regression)

Parameter	Logit parameter	Marginal Effect	Elasticity
fcash_total	0.0226	0.0045	0.0926
nonfarm_total	-0.0415	-0.0082	-1.1799
catch_total	0.0570	0.0113	1.1093
age	7.5783	0.0946	
fish_total.age	-6.0363	-1.1659	-0.3208
fish_farminc	5.8173	0.1343	0.1820
pond_land	0.1924	0.0044	0.0657
involve	7.3024	0.0125	
expectation	0.4332	0.0100	0.1552
age.pond_land	0.2005	0.0045	0.0488
age.expectation	-0.2483	-0.0056	-0.0864
pond_land.expectatio	-0.0095	-0.0002	-0.0032
fish_farminc.involve	-5.8248	-0.1301	-0.1774
edulevel.involve	-6.7421	-0.1204	