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# Applied Multiple Regression Method with Exponential Functions: an Estimation of Traditional Catch Fishermen Household Income

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**Abstract:** One of causes low households income of the traditional fishermen in Indonesia is due to seasonal changing issues (capturing and not capturing seasons). Thus, it has been affected to household's income of the traditional fishermen. We estimate affecting factors to household's income of the traditional fishermen in South Sulawesi Indonesia. The traditional fishermen of Barru District, are studied here as a case area that has low income during recent decades. Using Multiple Regression analysis with exponential functions, adjusted $R^2$, hypothesis testing of the regression (F-test and t-test), and followed by classical assumption tests (multicollinearity and heteroscedasticity) of the cross-section data from fieldwork, we found that the head households education, education fishermen's wife, number of dependents, *dummy* of differences housing of fishermen have been significant affected to household income of the traditional fishermen, whereas the age of the head household have not been significant affected.

## 1. Introduction

Traditional fishermen is a small-scale fisheries [1,2,3,4]. They are mostly found in coastal areas [5,6] and becomes one of the main important income sources of coastal communities in developing countries [7,8].

In Indonesia, traditional fishermen are mainly using a simple fishing gears in fish capturing [9] and have been used boats in sizing not more than five GT (groostonase), including outboard motor and non powered motor boats [5,4,6]. However, the destruction of coastal ecosystems, including sea grass meadows and mangroves issues and subsequent consequence to fewer fish [10]. the area of fishing ground have been further away from coastal areas.

Despite, their contributions often lack in quantification [8], but they have been provided a high contribution to the economic development of coastal areas [11]. In addition, they are contributed to sustainable livelihood [2,8], food security and support livelihood and well-being for more than 500 million people of coastal community in Indonesia and other developing countries [8]. However, majority traditional fishermen have been characteristic as poor communities [12,10]. due to mostly have low income in fishing capture [8]. [13] revealed that the traditional fishermen is the largest poor in coastal community strata in many developing countries.

They have an attribute as the poorest of poor communities [14]. Data from [15] reported 32.14 % of 16.42 million people in coastal areas of Indonesia are still living below the poverty line with income indicator of US$ 1 per day or per capita per month of US$ 7-10 [16]. Thus, it affected to their food

quality, saving and invesment for future life. One of the drivers of low income is due to issue of seasons changing in a year [17]. Thus, it has affected to household consumption expenditures of fishermen.

Household's income of the traditional fishermen has been widely studied in many places, particular in developing countries as reported by [18,19,20,4,8,21,17,22]. However, these studies have not been addressed concerning the estimation of traditional catch fishermen household income. In addition, application of the Econometric approaches mainly by dummy variables is limited studied for this issue.

The paper objective is to estimate of traditional fishermen household income by using Econometric approach (dummy variables) [23]. We investigate the coastal areas of Barru District, South Sulawesi Province, Indonesia as a case study.

## 2. Study Area

Geographically, Barru district is located between 4°05'49"- 4°47'35" and 119°35'00"- 119°49'16" latitude (Figure 1), about 102 km from capital of South Sulawesi, Makassar City.

This area covers 1.174,72 km$^2$ (contributed of 2.56% to South Sulawesi area). They are bordering to Pare-Pare City in the Northern part, Sidrap, Soppeng and Bone Districts in the Eastern part, Pangkep District in the Soutern part, and Makassar Strait in the Western part. Furthermore, they are contains of seven sub-District, including Tanete Riaja, Pujananting, Tanete Rilau, Barru, Soppeng Riaja, Balusu and Mallusetasi [24].

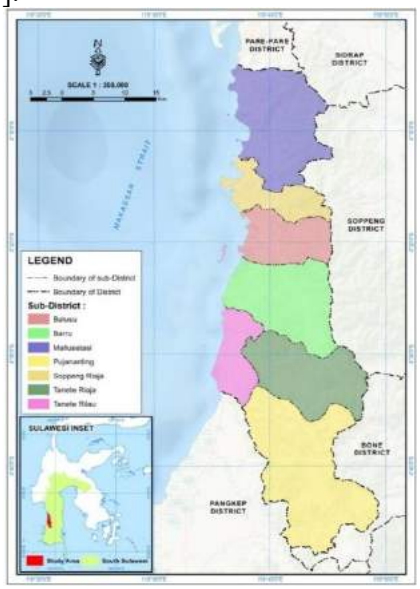


**Figure 1.** Case Study Area: South Sulawesi Province, Indonesia

This area has coastlines of about 78 km and covered by sandy beaches, mangroves, sea grass meadow, coral reefs, aquculture ponds, rice fields, settlement and tourism areas [24].

## 3. Material and Method

This research was conducted during April-September 2014. We used an Explanatory method [25] for estimate of traditional catch fishermen household income. Cross-Section data from a household fishermen survey. Questionnaires were administered to 107 of 586 total respondents, including 69 of outboard motor boats and 38 of non-powered motor boats. Number of sample about 10-20% of total respondents [26].

We used a Multiple Regression method with Exponential Functions model [23] for analyzed estimate of traditional catch fishermen household income. Than to facilitate the calculation, we transformed it into double log or natural logarithm : [23]

$$Ln\pi RTNPM = Ln\beta_0 + \beta_1\ LnAgKRT + \beta_2\ LnEdKRT + \beta_3 LnEdIstr + \beta_4 LnQAKBRT + \beta_5 LnQAKT + \delta_1 KTR + \delta_2 KB + \delta_3 KSR + \delta_4 KBLs + \mu_1 \quad (1)$$

$$Ln\pi RTNPTM = Ln\beta_6 + \beta_7\ LnAgKRT + \beta_8\ LnEdKRT + \beta_9 LnEdIstr + \beta_{10} LnQAKBRT + \beta_{11} LnQAKT + \delta_5 KTR + \delta_6 KB + \delta_7 KSR + \delta_8 KBLs + \mu_1 \quad (2)$$

where $\pi RTNPM$ is the households income of traditional fishermen (IDR), $\pi RTNPTM$ is the households income of traditional fishermen (IDR), $\beta_0$ dan $\beta_6$ is the intercept; $\beta_1,..., \beta_5$ and $\beta_7,..., \beta_{11}$ is a regression coefficient of independent variable, $\delta_1,..., \delta_8$ is coefficient of *dummy* variables, $AgKRT$ is age of households head (year), $EdKRT$ is formal education of household head (year), $EdIstr$ is formal education of wife of household head (year), $QAKB$ is number of family members working (person), $QAKT$ is number of dependents (person), Dummy of differences housing of the traditional fishermen included: $KTR$: 1 for area of Tanete Rilau sub-District; 0 for others, $KB$ : 1 for area of Barru sub-District; 0 for others, $KSR$: 1 for area of Soppeng Riaja sub-District; 0 for others, $KBls$: 1 for area of Balusu sub-District; 0 for others, $\mu_1$ and $\mu_2$ are disturbance error.

Furthermore, the equations 3 and 4 have completed by the Goodness of fit model and hypothesis and Classical Assumption tests: [23]. The Goodness of fit model was calculated by using adjusted $R^2$ : [23]

$$Adjusted\ R^2 = 1 - (1 - R^2)\frac{(n-1)}{(k-1)} \quad (3)$$

where Adjusted $R^2$ is adjusted determination coefficient, k is number of variables, and n is sampling numbers.

The hypothesis testing of the regression coefficients together used F-test with a certain confidence level: [27]

$$Ftest = \frac{ESS/(k-1)}{RSS/(n-k)} \quad (4)$$

Testing on the partial regression coefficients was used t-test with a certain level of confidence: [27]

$$t\ test = \frac{\beta i}{S\beta i} \quad (5)$$

where $\beta_i$ is the regression coefficient of i. $S\beta_i$ is the standart errors of regression coefficient of i.

Furthermore, Multicollinearity test was using the Variance Inflation Factor (VIF) method: [23]

$$VIF = \frac{1}{1-R_j^2} \quad (6)$$

$R^2_j$ was received from Auxilary Regression between the independent variables and dependent variables, where if VIF < 10, it meant there was not multicollinearity [23]. In the meanwhile, heteroskedasticity test is conducted in disturbance variable form once variance of disturbance variable ($\sigma_i^2$) did not know. Thus, the residual ($\hat{e}_i^2$) of regression results as proxy of residual $\hat{e}_i^2$: [28,23]

$$Ln\hat{e}_i^{\,2} = Ln\sigma^2 + \beta LnX_i + v_i \quad (7)$$

If the coefficient of β not significance through t-test, therefore, it can be concluded not heteroscedasticity. Instead, if β significance, hence the model contains heteroscedasticity [23]

## 4. Result

The test result of multicollinearity did not show multicollinearity due to the VIF < 10 (Table 1) [23]. In the meanwhile, the heteroscedasticity test shows the coefficient (β) was not significant. It can be concluded there was not heteroscedasticity [23] (Table 1).

**Table 1.** Result tests of multicollinearity and heteroscedasticity to tra-ditional catch fishermen house-hold income

| Independent Variable | OMB | | NPMB | |
|---|---|---|---|---|
| | VIF | *Park test* | VIF | *Park test* |
| *LnAgKRT* | 1.461 | 54.893$^{ns}$ | 1.895 | 4,507.333$^{ns}$ |
| *LnEdKRT* | 5.703 | -43.800$^{ns}$ | 6.230 | -830.970$^{ns}$ |
| *LnEdIstr* | 3.114 | -262.073$^{ns}$ | 2.734 | 5,700.157$^{ns}$ |
| *LnQAKB* | 1.747 | -717.247$^{ns}$ | 1.645 | 14,049.454$^{ns}$ |
| *QAKT* | 4.428 | 129.195$^{ns}$ | 6.986 | -1,234.052$^{ns}$ |
| *KTR* | 1.847 | 0.000$^{ns}$ | 5.221 | 0.000$^{ns}$ |
| *KB* | 3.377 | 0.000$^{ns}$ | 5.621 | 0.000$^{ns}$ |
| *KSR* | 2.055 | 0.000$^{ns}$ | 4.574 | 0.000$^{ns}$ |
| *KBls* | 1.169 | 0.000$^{ns}$ | 1.407 | 0.000$^{ns}$ |

The OMB is Outboard Motor Boats. The NPMB is Non-Powered Motor Boats. If VIF<10, it meant there was not a Multicollinearity, but if VIF>10 there was a Multicollinearity. if the value of β by using Park test not significant, therefore, there was not Heteroskedasticity. Instead, if the value of β by using Park test significant, there was Heteroskedasticity. ns is not significant.

The goodness of fit test of the adjusted R2 pointed out that the independent variables [23] on the factors affecting of the traditional fishermen household's income both the OMB and NPMB has been contributed of 99 % and 82.5 %, respectively,to variance of dependent variables, whereas the rest (0.2 and 17.5 %) not counted in model (Table 2)

The result of F-test [23] demonstrated that the affecting factors to households income of the OMB and NPMB. It indicates that all independent variables as simultaneously has significant effect to households income of the traditional fishermen (Table 2). Furthermore, the influence of partial of each independent variables to fishermen houshold income (Table 2) was used t-test [23]

**Table 2**. Estimate of traditional catch fishermen household income

| Independent variables | ES | OMB | | NPMB | |
|---|---|---|---|---|---|
| | | Coeff.(β) | t-test | Coeff (β) | t-test |
| *LnAgKRT* | - | -0.005$^{ns}$ | -0.480 | 0.027$^{ns}$ | 0.102 |
| *LnEdKRT* | + | -0.008$^{ns}$ | -0.905 | 0.903*** | 4.660 |
| *LnEdIstr* | + | -0.11** | -1.833 | 0.357** | 2.315 |
| *LnQAKB* | + | 0.024*** | 2.650 | 0.531** | 2.607 |
| *QAKT* | - | 1.026*** | 105.233 | -0.154$^{ns}$ | -0.957 |
| *KTR* | + | -0.008$^{ns}$ | -0.565 | 1.808*** | 3.021 |
| *KB* | + | 0.005$^{ns}$ | 0.317 | 1.403*** | 3.054 |
| *KSR* | + | 0.051* | 1.846 | 0.630$^{ns}$ | 1.837 |
| *KBl* | + | -0.001$^{ns}$ | -0.059 | 0.533$^{ns}$ | 1.419 |
| Intercept | | | -0.339 | | -9.026 |
| F-test | | | 520.509 | | 20.335 |
| Adjusted $R^2$ | | | 0.998 | | 0.825 |
| n | | | 69 | | 38 |

*** is a level error significance of 1 % (0,01), or confidence level of 99 %. ** is a level error significance of 5 % (0,05), or confidence level 95 %. * is a level error significance of 10 % (0,10), or confidence level 95 %. ns is not significant. ES is an expectation sign

## 5. Discussion

Variable of age of households age either the OMB or NPMB not significantly affect to households income in this area. It meant that increasing of fishermen age has not effect to changes in their household's income from both fish capturing and non-fish capturing.

This can happen because the average age of traditional fishermen in Barru District Province South Sulawesi Indonesia above 50 years mainly OMB. According to [29] the age of fishermen who are young in age such as the 30 are productive age, because they have good physical ability so that they can perform activities optimally and able to develop themselves by giving priority to success for the welfare of their families, especially to meet the needs of children. Even according to the [30] concerning work on fishing is that the ages of 16 to 18 years prior to arrest should be given training in

the form of apprentices for work safety with crew hours should be no more than eight hours per day and 40 hours per week, and should not work overtime Except when it can not be avoided for safety reasons.

Formal education duration of the traditional fishermen household's head not significantly affected to the traditional fishermen household's income in this area. This may occur due to the knowledge passed down from their parents can become knowledgeable in carrying out their profession as a fisherman. This is also in line as reported by [31] in rural area of Africa. Furthermore, low level of fishermen formal education of fishermen tend to harper in the transfer of technology and skills. In addition, it has consequence to their management ability and business scale [22]. In contrast, formal education of the NPMB traditional fishermen has been positive affected on the error level 1 % or the confidence level 99 % to households income. It indicates that each increase in education level of the NPMB traditional fishermen, hence there was a greater tendency of their household's income. This result was contrast in Madura Strait as reported by [17].

Poor in education level and lack of infrastructures and capital especially to support their activities have been mostly issue and faced by the traditional fishermen in South Sulawesi and elsewhere in Indonesia [32]. Thus, it could affect to the low income and subsequently cause to increase of poverty [13].

The wife education variable in this case the wife of the fisherman negatively affects the household income of the OMB, meaning that the higher level of wife education will decrease the household income. This can happen because the lack of creative wife in looking for alternative jobs for additional household income. In fishermen households to supplement family income, usually the wives perform other activities that can bring in additional income [22]. The low level of education that fishermen have in their families because of the economic limitations of their families, the inability of both parents to send their children to school, requires the fishermen to quit school and spend more time at home or help their parents [33].

The formal education level of traditional fishermen's wives in Indonesia is so low that it is less able to help husbands (fishermen) provide information or knowledge such as innovation in the marine world, although the wives assist husbands in earning a living in other jobs such as farming. This is in line with findings in Vietnam that the level of women's education in fisheries households is lower and there is little opportunity to work in processing fish despite having access to credit [34].

Unlike the case with the wife of a NPMB has a positive effect of household income. This can happen because the fishermen's wife is more creative looking for additional income such as working as a farm laborer. The findings are in line with low education levels in the North-East Madagascar Malagasy fishermen community that are positively associated with fisherman's income [35]. It also affirms the benefits of education as an investment [36] for the improvement of individual income and welfare [37,35].

The variable number of working family members positively to OBM and NPMB income. This is not in line with findings in Romania that regional household income is negatively affected by job vacancies [38], will But in line with findings in Bangladesh that household income from agriculture and non-agricultural sectors in Bangladesh is positively affected by family size [39]. The role of members of family members working like women/ wives, not only acting as housewives in family members, but also doing productive activities to supplement income [33]. According to [40] efforts to increase income can be done with Involving family members, especially women (wives) for activities outside fishing activities. The role of women from low-income households tends to use more time for productive activities compared to women's jobs from high-income households [41].

Furthermore, the variable number of family members who bear the positive effect of the income of households of motorboat fishermen, on the contrary the income of households without motor boat is not influenced by the number of family members borne. The large number of family members who will use a small amount of income will result in low levels of consumption [42] because the number of family dependents will encourage fishermen to work hard to meet Needs of family members [6]. This affects the productivity of work, intelligence, and declining ability to invest [42].

Dummy regional differences, both in the area of OMB and NPMB using cross-section data as independent variables to household income of fishermen in the west coastal area of Barru District of South Sulawesi province of Indonesia. For motor boat fishermen, the dummy variable of Soppeng Riaja sub-District has a positive effect on household income has been in line with the expectation sign. Similarly, household income of NPMBM fishermen is also positively influenced at a 1 percent error rate of dummy of Tanete Rilau sub-District and Barru District.

The results are different from the findings of research [17] in the Madura Strait estimates factors affecting household income of fishermen but can not yet compare the areas where fishermen live, which of course has different work results from both seafaring and non-sea fishing, as well as differences in capture technology [43,44], and modern and traditional boats [4] especially during famine season [45].

Coastal fishing communities are a bunch of lively people inhabiting the coastal regions to form and have a distinctive culture associated with its dependence on the utilization of coastal resources in conducting economic activities [46]. This refers to [47], that coastal communities have rights over common property resources that provide the benefits and efficiency of the sustainability of existing resources.

## 6. Conclusion

Based on the result and discussion, it can be concluded that the Estimate of Traditional Catch Fishermen Household Income OMB Barru sub-District of South Sulawesi Province in Indonesia positively is the number of family members who work, the number of family members borne, and the dummy of different areas of Soppeng District Riaja, then the negative formal education of the wife, while that does not have a significant influence is the age of the head of the household, Education head of household, dummy differences in Tanete Rilau sub-District, Barru sub district, and Balusu Household income OMB.

Different estimation of household income of NPMB, found that education of head of household, wife education, Number of family member work, and dummy of Tanete Rilau and Barru sub-District have positive effect, Head of household, number of family members borne, dummy of Soppeng Riaja and Balusu Sub-district.

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