Investigation on the Existence of Income Effect in Mode Choice for the Western Visayas Region, Philippines

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Abstract

An efficient inter-island transport system plays an important role in the successful flow of goods, services and people. The Western Visayas region, consisting of three main islands, is located at the central part of the Philippine archipelago. This region has a significant contribution to the GDP along with its increasing growth rates. Due to its geographic orientation an efficient inter-island transport system is necessary to foster economic growth. Because of this, there is a need to conduct a study that will address the commuter's behaviour on mode choice. Analysis is achieved through the use of discrete choice modeling where the socio-demographic characteristics of the commuters and the modal attributes are analyzed and related to the choices made by the individuals. In this way, the demand for the various transport alternatives may be estimated and the effects of certain policies assessed. This research aims to determine the presence of income effect in the inter-island passenger transport between Iloilo and Negros Occidental in Western Visayas. Income effect is often overlooked in modeling commuter choice. However, this effect is of great significance for poor or developing countries where the transportation expenditure may comprise a substantial fraction of the household budget. A recent study stated that if income effect is not taken into account, then it will result in biased parameter estimates causing incorrect measurement of the utilities if a certain policy will alter the costs of transportation. In this research, logit choice models for each income class were specified. Initial results from the methodology suggested by Jara-Diaz and Videla (1989) indicate that income effect is non-existent in the dataset since marginal utilities of income for each income class are not significant. This result will be considered in the subsequent mode choice modeling for the inter-island passenger transport between Iloilo and Negros Occidental.

Keywords: Inter-island transport, income effect, mode choice

1.Introduction

Mega-transport projects aid in uplifting the economic and social condition of a region, even the whole country[19]. Transportation infrastructure projects are vital for both the society and economy because they can dictate the industrial and residential locations, configure the regional landscapeand facilitate accessibility[25]. A developing country like the Philippines, therefore, needs to be more cautious in consuming its limited resources. One way of ensuring the proper allocation and utilization of resources is s through proper transportation planning and forecasting.

Island regions have seldom been the focus of transportation demand studies, since most studies focus on urban land transportation. The islands are connected to the main island via ferry services which serve as their *lifeline*[14]. Water transportation studies have been conducted in several countries where water transportation is available. Among these are Indonesia, Thailand, Bahrain and Greece[1, 7, 8, 13, 21, 22, 23, 24]. The study on hand focuses on water transport, specifically, the inter-island transport in the Western Visayas region in the Philippines.

The Western Visayas region is located at the central part of the Philippine archipelago, situated between the Sibuyan Sea and the Visayan Sea. It consists of three main land masses with six provinces namely Aklan, Antique, Capiz, and Iloilo in the island of Panay, Guimaras in Guimaras island, and Negros Occidental in the island of Negros, as shown in Fig 1[16, 17].

The Western Visayas region is an important contributor to the economy of the whole country. Not only does the region have a significant contribution to the GDP but the increasing growth rates may help uplift the whole nation as well. It is known that the Western Visayas region is composed of several islands where the flow of goods, services, and people often require inter-island transport. This may somehow pose hindrances to the development of the region, specifically Iloilo City and Bacolod City which are the main urban centers of the region. An affordable, accessible, and reliable inter-island transport system is necessary in order to foster economic growth in the region[4]. Therefore, there is a need to determine whether such an enormous undertaking is feasible or not, the first step would be to understand how the commuters in the area choose the modes they use for travel. The factors that influence these choices need to be addressed. This is done through discrete choice modeling where the socio-demographic characteristics of the commuters and the modal attributes are investigated, analyzed, and related to the choices made by the individuals. In this way, the demand for the various transport alternatives may be estimated and the effects of certain policies assessed.

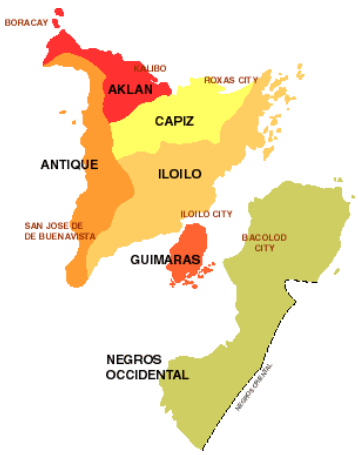

Fig 1. Map of Western Visayas (Region VI)

This research intends to determine whether the *income effect* exists in the inter-island passenger transport between Iloilo and Negros Occidental. To facilitate the investigation, several binary logit choice models were developed for each income class in the dataset. Investigation and understanding of these concepts may help devise new policies in order to improve the overall condition and productivity of the transport system. As we know, transportation management is not just about constructing roads and other transportation infrastructure to solve the perennial problem of congestion or to increase the supply single-handedly. The more important thing to accomplish is be able to know what projects to construct and the proper timing so that these projects may significantly improve the traffic condition in the most economical way possible. This can be accomplished through accurate models.

2.Literature Review

It is common that income effects are often ignored or assumed to be negligible in modeling commuter choice[11]. The reason for this is that, previous arguments state that transportation expenditures comprise a small fraction of the total budget of the commuters[3]. However, this may not be true for poor or developing countries and that transportation expenditure may now be a substantial fraction of the budget due to the aggressive transport pricing policies being considered worldwide. Even if income is included in the specification, it is often thought of as a proxy variable for other variables such as taste[11, 26], but these two are not the same[10]. Jara-Diaz has shown that ignoring income effect or inappropriately accounting for it is incorrect.

Detecting the effect of income in choice modeling is a dilemma for planners since its most appropriate specification in the model have not yet been established[3, 11]. Some planners simply insert the income attribute in the model to account for its effect in commuter choice. However, this line of thinking is a bit flawed in the sense that, in this manner, income is just treated like any other socio-economic variable in the model as if the transportation costs do not affect the wealth or budget of a commuter[3]. There are other ways on including income in the model like the common way of dividing the cost by the individual incomes, linear in cost or a logarithm transformation, logarithm of income minus cost, the Translog and

the Leontief model[9, 15]. However, we focus on the methodology proposed by Jara-Diaz and Videla[11] where the dataset is segmented into different income classes. This facilitates the computation of the different marginal utilities of income among the different income classes. It has been shown that the marginal utility of income should decrease with income.

If income effect is not taken into account in the models, then this will result in biased parameter estimates[3]. This would result in incorrect measurement of the utilities if a certain policy will alter the costs of transportation.

3. Methodology

There are currently various ways by which one may travel around the Western Visayas region, specifically, between the islands of Panay, Guimaras, and Negros as shown in Fig. 2. RORO services and fast craft ferry operations provide direct link from Iloilo to Bacolod and vice versa. RORO services between Iloilo and Bacolod (Route A) are available every 2 to 3 hours night and day. There are also fast craft ferry operations (Route B) between Iloilo and Bacolod which are operated by three shipping companies. These three companies combined are responsible for providing 20 trips per day per direction from 6:00AM until 6:30PM. Another alternative in going to Bacolod from Iloilo is to pass through the island of Guimaras where pump boats generally leave the wharf every 15 minutes. There are two ways to traverse the island of Guimaras from Iloilo. One way is to go via the Buenavista route (Route C) and the other one is through Jordan (Route D) but both these routes converge in San Lorenzo where 2 daily pump boat trips take the commuters from San Lorenzo, Guimaras to Pulupandan in Negros Occidental. However, only routes A and B are to be included in this current study.

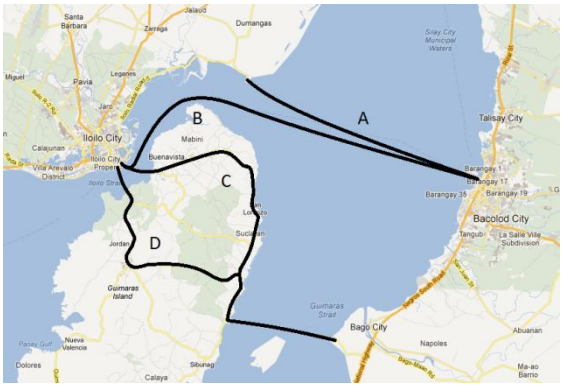

Fig.2. Major Iloilo- Negros Occidental Travel Routes
Source: Google Maps, 2013

The main inter-island passenger travel alternatives used to travel from Iloilo to Bacolod is shown in Table 1. It can be seen that the fast craft ferry in Iloilo City serves more passengers on a daily basis due to the larger passenger capacity and slightly more frequent trips. The fast craft ferry is also faster as compared to the RORO, however, the fare for the fast craft ferry is almost four times the fare for the RORO which docks in Dumangas, approximately 28km north of Iloilo City.

Table 1. Iloilo - Negros Occidental Inter-island Main Travel Options.

Transport Mode	Average Number of Passengers per trip	Average Number of Trips per day	Average Total Travel Time [*Hour*]	Travel Fare [*PHP/ pax*]
RORO (Roll-on Roll-off)	95	19	2.15	80
Fast craft Ferry	195	23	2	335

Gaining knowledge and information on how choices are made, allow officials to fittingly manage the transportation network. This is done through mode choice analysis wherein the transport mode chosen by a particular individual is predicted by formulating equations which take into account one's socio demographic characteristics and the attributes of the transportation alternatives available to the respondent. The aim is to be able to accurately characterize the influential factors affecting mode choice. Realistic and accurate

models lead to less wastage of resources. In this research, binary logit choice models for the different income classes are first developed taking into account the possible effect of income in the commuters' preferences.

A binary logit model for a given alternative i, given that ε_n is logistically distributed, has the following choice probability[2, 20].

$$P_n(i) = Pr(U_{in} \geq U_{jn}) \quad (1)$$

Which maybe specified as

$$P_n(i) = \frac{e^{\mu V_{in}}}{e^{\mu V_{in}} + e^{\mu V_{jn}}} \quad (2)$$

Utilities can be divided into two parts, the systematic component and the disturbance or random component, are stated as follows:

$$U_{in} = V_{in} + \varepsilon_{in} \text{and} U_{jn} = V_{jn} + \varepsilon_{jn} \quad (3)$$

The $V_{in}$and V_{jn}represent the systematic part which are ordinal measurements. In specifying the systematic part, we can say that

$$V_{in} = \beta_1 x_{in1} + \beta_2 x_{in2} + \ldots + \beta_K x_{inK} \quad (4)$$

From this modeling technique, it is now possible to determine the existence of income effect. The presence of income effect in mode choice is important since the total transportation expenditure for a whole month may be a significant proportion of the total income or budget for that particular month. This may possibly be true for the case of the Western Visayas region in the Philippines. Table 2 shows the number of families in the region according to their respective income classes. It can be seen that majority of the families have small monthly budgets.

Table 2. Number of families by income class in the Western Visayas region

Western Visayas Region (for the year 2009)	
Income Class – Monthly (in PHP)	Number of families
Under 3300	75,000
3301 – 5000	166,000
5001 – 8300	412,000
8301 – 20830	584,000
20831 and over	215,000

Source: National Statistics Office(2013)

The methodology presented here is based solely on the concepts and theories presented in Jara-Diaz and Videla[11]. The following procedure summarizes the test as developed by Jara-Diaz andVidela.

1. Check whether the coefficient of the square-of-the-cost term is positive and significant.
2. If yes, then, divide the dataset according to income strata
3. Add a square-of-the-cost term, c^2, to each of the different linear specification of the models for each income class. This specification is also a function of cost and other modal attributes. This is done since only a higher-order Taylor series expansion of the linear model reveals the effect on income in mode choice.
4. Test the significance of the added term, c^2, by using the values from the variance-covariance matrices of the coefficients.

Furthermore, there are three additional properties that need to be satisfied by the models developed.

- the cost coefficient is negative and its absolute value should decrease with the income
- the square-of-the-cost coefficient is positive and should decrease with income
- lambda should also decrease with income;

$$\lambda_i = -\alpha_c - \alpha_{c^2} c_i \quad (5)$$

where the α's are the coefficients of the cost and square-of-the-cost terms

4. Results

For this research, surveys were first conducted in the two main ports of Iloilo and these are located in Iloilo City and in the municipality of Dumangas, as shown in Fig. 3. The surveys were conducted last February 2013. In Iloilo City, the survey was conducted in the fast craft terminals which cater to all fast craft ferry services to Bacolod City. In Dumangas, surveys were conducted in the Dumangas RORO Passenger Terminal going to Bacolod City.

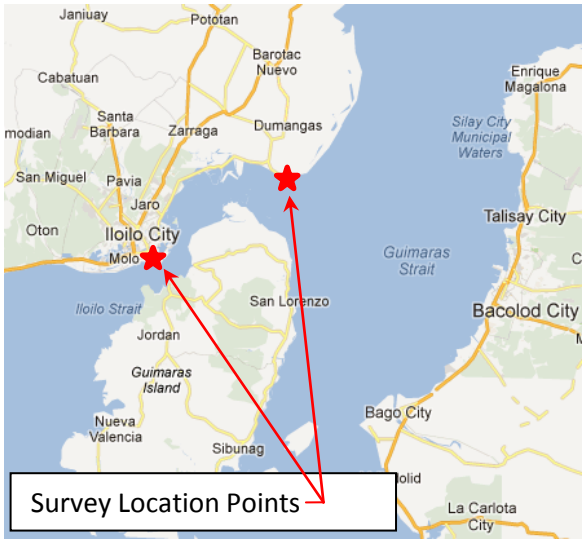

Fig. 3. Survey Form Distribution Locations

A total of 1171 samples from the original 1254 samples were processed for this study. This serves as part of the preliminary dataset that is currently being expanded. Table 3 shows the distribution of the respondents according to the different income classes which is somehow comparable to the distribution of income shown in Table 2.

Table 3. Number of families by income class in the sample

Income Class – Monthly (in PHP)	Number of families
Under 3300	119
3301 – 5000	185
5001 – 8300	234
8301 – 20830	346
20831 and over	287

The dataset compiled for this study is composed of an almost equal number of male and female respondents. Approximately 35% of the respondents chose the RORO while the remaining 65% chose fast craft ferries to travel to Bacolod City from Iloilo. The average age of the commuters is roughly 30 years old. The number of single and married respondents is almost the same. The mean personal income is approximately 15,600 Philippine pesos per month. Aside from these, it is interesting to note that most of the trips between Iloilo and Negros Occidental are either home-based trips or leisure/vacation trips, as shown in Fig. 4 below.

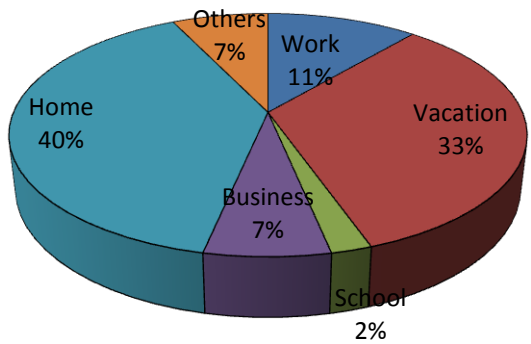

Fig. 4. Distribution of respondents according to trip purpose

Given the dataset available at hand, it is first processed and then fed to the NLOGIT software to develop binary logit models which will be the basis for the investigation of income effect. By using the whole sample, a binary logit model is formulated. It can be seen in Table 4 that TOTCOST2, square of the total cost, is positive and significant. This suggests that the whole sample should be divided into different income classes.

Table 4. Estimated coefficients for TOTCOST and TOTCOST2*(t-statistic in parentheses)*

Variable	ALL	0–8300 (1)	8301–20830 (2)	20831 and above (3)
α_{RORO}	-1.9533 *(0.0000)*	-1.7990 *(0.0000)*	-2.01277 *(0.0000)*	-2.12904 *(0.0000)*
TOT COST	-0.0117 *(0.0000)*	-0.0133 *(0.0000)*	-0.0119 *(0.0000)*	-0.0080 *(0.0191)*
TOT COST2	0.0000 *(0.0000)*	0.0000 *(0.0001)*	0.0000 *(0.0095)*	0.0000 *(0.1758)*
Sample size	1171	538	346	287

Using the income-segregated dataset, different binomial logit choice models for the different possible income class combinations were developed. A square-of-the-cost term is added to the utility function toverify the existence of income effect. Table 4 also shows the coefficients of the alternative specific constant for RORO (α_{RORO}), the total cost (TOTCOST) and the total cost-squared (TOTCOST2) variables for the three final income classes identified for this study. The constant term

for RORO is significant in the whole dataset and in the different income groups identified. It can also be observed that the coefficients of the costs are all significant, negative, and the absolute values decrease with income. As for the square-of-the-cost term, the coefficients are all significant, except for the 20831-and-above income group, positive and the coefficients decrease with income as well. These conditions satisfy the first three properties for the detection on income effect mentioned above.

By utilizing these coefficients, along with the values from the variance-covariance matrices, the marginal utility of income may be computed. Table 5 shows the marginal utility of income for each income class including the corresponding *t*-value to test for its significance. From the following table, it can be seen that these λ's are significant at the 95% level of confidence .

Table 5. Marginal utility of income at different income levels

Income Group	$\lambda(c_j)$	$\boldsymbol{\lambda(\bar{c})}$ (*t*-statistic)
0-8300	0.0133263700 – 0.0000093265 c_j	0.010292595 *(7.67)*
8301-20830	0.0119170100 – 0.0000060995 c_j	0.009932942 *(11.32)*
20831 and above	0.0080491300 – 0.0000045649 c_j	0.006564241 *(9.99)*

A test for the difference between the marginal utilities for each income group is finally performed according to the procedure outlined by Jara-Diaz and Videla[11]. Table 6 shows the comparison of the λ's in the different income groups. The test indicates that the hypothesis stating λ_1 and λ_2 are equal may not be rejected at the 95% level of confidence. However, both λ_1 and λ_2 are statistically different from λ_3.

Table 6. Test on the difference of marginal utility of income between income groups.

Income groups considered	$\boldsymbol{\lambda_i(\bar{c}) - \lambda_j(\bar{c})}$	(*t*-statistic)
(1) (2)	0.00036	0.22
(1) (3)	0.00373	2.50
(2) (3)	0.00337	3.07

5. Conclusion

The methodology for detecting income effect developed by Jara-Diaz and Videla[11] was applied to the preliminary dataset collected for the inter-island passenger transport between Iloilo and Negros Occidental in Western Visayas region. Income is often neglected in mode choice models, and if in case it is included, it serves as a proxy variable for other attributes. This is often incorrect as the model specification may be microeconomically inconsistent and the welfare analysis will also be incorrect[12].

Since, an affordable, accessible, and reliable inter-island transport system is demanded in order to foster economic growth in the region, there is a need to accurately characterize how commuters respond to variations in policies and certain conditions. The factors that influence these choices need to be addressed. This is done through discrete choice modeling where the socio-demographic characteristics of the commuters and the modal attributes are investigated, analyzed, and related to the choices made by the individuals. Gaining knowledge and information on how choices are made, allow officials to fittingly manage the transportation network. In this way, the demand for the various transport alternatives may be estimated and the effects of certain policies assessed. Realistic and accurate models lead to less wastage of resources. Forecasts are essential in transportation planning since it is through this step that social gains are contrasted against the different associated costs and therefore be able to rightfully guide in policy recommendations[7].

In this paper, it was shown that income effect is present in some income classes of the dataset since two of the three marginal utilities of income are statistically different from each other. This result will be taken into account in the subsequent mode choice modeling for the inter-island passenger transport between Iloilo and Negros Occidental to avoid biased or theoretically-flawed models. In Jara-Diaz and Videla[11], the authors stated that when the income variable is not correctly included in the specification may result in unclear interpretations of the utility function. They added that properly accounting for income effect is not a matter of goodness of fit or accuracy of the forecast but a matter of correct understanding and evaluation of utilities.

6. Acknowledgment

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