THE INFLUENCE OF INCOME ON HOUSEHOLD MOTORCYCLE OWNERSHIP IN BULELENG REGENCY, BALI

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Abstract: This study investigates the influence of income on household motorcycle ownership in Buleleng Regency, Bali using a Multinomial Logit Model. The household income in 2011 is about 15%, 28% and 57% to influence a household owning no, 1 and more than 1 motorcycles respectively. The probability of motorcycle ownership rises substantially by more than 15% for the next 20 years if household income in Buleleng Regency increases. This is particulary applied for the household owning more than 1 motorcycle. In contrast, the probability of a household owning no and 1 motorcycle drops significantly by almost 32% and 14% respectively for the next 20 years if household income in Buleleng Regency increases. A huge number of motorcycles used on the road continuously may lead to serious transport problems for the next few years. This is related to the negative impacts of transport including road accidents and traffic pollution. Improving the existing public transport and introducing a high quality public transport service within and to/from Buleleng Regency is urgently required. The fare of such high quality public transport service however, must be sufficiently low to compete with the cost of riding a motorcycle. In addition, a significant amount of fare subsidy from both local and central government is considerably required.

Keywords: Household Income, Motorcycle Ownership, Multinomial Logit Model.

PENGARUH PENDAPATAN TERHADAP KEPEMILIKAN SEPEDA MOTOR DI KABUPATEN BULELENG, BALI

Abstrak: Studi ini mengkaji pengaruh pendapatan rumah tangga terhadap kepemilikan sepeda motor di Kabupaten Buleleng dengan menggunakan model multinomial logit. Pendapatan rumah tangga di tahun 2011 berturut-turut sekitar 15%, 28% dan 57% mempengaruhi kepemilikan sebesar 0, 1 dan lebih dari 1 unit sepeda motor. Probabilitas kepemilikan sepeda motor meningkat secara substansial lebih dari 15% untuk 20 tahun ke depan jika pendapatan rumah tangga di Kabupaten Buleleng meningkat. Hal ini khususnya untuk rumah tangga yang memiliki lebih dari 1 sepeda motor. Sebaliknya, jika kenaikan pendapatan rumah tangga meningkat, probabilitas rumah tangga untuk tidak memiliki sepeda motor dan memiliki 1 unit sepeda motor menurun sebesar hampir 32% dan 14% untuk 20 tahun ke depan. Penggunaan sepeda motor dalam jumlah besar di jalan secara terus menerus dapat menyebabkan permasalahan transportasi yang serius untuk beberapa tahun mendatang. Hal ini terkait dengan dampak negatif dari transportasi termasuk kecelakaan di jalan dan polusi lalu lintas. Meningkatkan kualitas angkutan publik eksisting dan memperkenalkan layanan transportasi publik yang berkualitas tinggi di Kabupaten Buleleng merupakan keperluan yang mendesak di masa depan. Tarif pelayanan publik yang berkualitas tinggi harus seimbang untuk bersaing dengan biaya mengendarai sepeda motor. Selain itu, sejumlah besar subsidi angkutan publik dari pemerintah daerah dan pusat juga sangat diperlukan.

Kata Kunci: Pendapatan Rumah Tangga, Kepemilikan Sepeda Motor, Model Multinomial Logit.

INTRODUCTION

Buleleng Regency in northern Bali with an area of 136.588 km^2 is the largest Regency in Bali province. The population is 786,972 in 2009 (Statistics of Buleleng Regency, 2010). As with many urban and rural areas in Indonesia, this area also faces a general lack of public transport services. In the meantime, motorcycle ownership is accounted for by 95% of all modes of transport (195,009 motorcycles out of 203,541 motorvehicles) with motorcycle annual growth rate by 11.8% (Statistics of Buleleng Regency, 2010). These circumstances are potentially raising traffic congestion in the future particularly in urban area.

It is considered therefore, small motorcycles are the dominating private vehicles in Buleleng Regency. A motorcycle is such a low-cost private transport mode (e.g. low-cost in maintenance and fuel consumption) and offers many advantages to the road user (e.g. handy and door-to-door transport). In addition, motorcycle has a better manoeuvrability compared to other modes of transport particularly on the congested road.

Meanwhile, household income has long been considered as the main factor to influence motorcycle ownership in both urban and rural areas. Study on local household income therefore, is required to analyse its effect on motorcycle ownership. This is important because the high number of motorcycle ownership is significantly discouraging the use of public transport and is potentially to increase number of road accidents (Prabnasak, *et.al*, 2011).

Furthermore, a study on motorcycle ownership considering local household income is essential in present and future study of mode choices (Hsu and Lin, 2007). Within a local boundary, a study on motorcycle is expected to find solution and regulation concerning motorcycle in the traffic system, while a study on mode choice evaluates a mode shift to/from motorcycle and its effect on the road network (Leong and Sadullah, 2007).

This paper aimed at investigating motorcycle ownerhsip using a Multinomial Logit (MNL) model. The model is constructed to analyse the influence of local household income on motorcycle ownership in Buleleng Regency. The model results would identify motorcycle ownership pattern which could be used to support transport policies to control the future use of these private vehicles in Buleleng Regency.

LITERATURE REVIEW

Previous Studies

There were many studies have been conducted in relation to the nature of private motorvehicle (e.g car and motorcycle) ownerships in Southeast Asia region including by Leong and Sadullah, (2007), Hsu and Lin (2007), Hsu, *et al* (2007), Putranto (2003), Wedagama (2009a; 2009b) and (Prabnasak, *et.al*, 2011). Each region has its own kind such as household characteristics, income and motorvehicle ownerships. The number of such studies is still quite small however, relative to those in developed countries (Prabnasak, *et.al*, 2011).

In general, previous studies (e.g. Leong and Sadullah, (2007); Hsu and Lin (2007); Hsu, *et al* (2007); Putranto (2003) and Prabnasak, *et.al*, (2011)) show that household income as well as the motorcycle ownership tends to increase until the income reaches a certain level. However, once income exceeds that level the degree of motorcycle ownership is likely to reduce and the degree of car ownership will eventually exceed it. Apparently, most reported studies indicated that income should have a significant effect on household vehicle ownerships. Motorcycle is popular amongst low and medium income people while private car is greater for high

income households (Prabnasak, *et.al*, 2011).

Wedagama (2009a) studied a motorcycle ownership in the city of Denpasar, Bali. The study results showed that the local household income may have a possibility to influence the motorcycle ownership. In this previous study, a single-modal (motorcycle) ownership model was constructed using MNL regression. In addition, using the same set of data, Wedagama (2009b) also studied both car and motorcycle ownerships in the city of Denpasar, Bali using Poisson regression model. This previous study also indicated that income may have a relation to both car and motorcycle ownerships.

Multinomial Logit Model

The Multinomial Logit (MNL) model is used to determine the probabilities of choice from each alternative ownership categories based on utility functions that are estimated for each alternative. One category is selected as the reference category, normally the first, the last or the value with the lowest or the highest frequency. The probability of each category is compared to the probability of reference category. For categories i = 2….K, the probability of each category is as follows (Borooah, 2001; Washington, *et.al*, 2003):

$$\Pr(Y = i) = \frac{\exp(Z_i)}{1 + \sum_{h=2}^{K} \exp(Z_{hi})} \quad \ldots\ldots\ldots (1)$$

Where: $\alpha_i + \sum_{h=1}^{H} \beta_{ih} x_{ih} = Z_i$.

For the reference category,

$$\Pr(Y = 1) = \frac{1}{1 + \sum_{h=2}^{K} \exp(Z_{hi})} \quad \ldots\ldots\ldots (2)$$

After rearranging equation (1) and (2), the MNL model can be written as follows:

$$\text{Ln}\left(\frac{P(Y = i)}{P(Y = 1)}\right) = \alpha_i + \sum_{h=1}^{H} \beta_{ih} x_{ih} = Z_i \quad \ldots (3)$$

Where:

i : the number of ownership categories

β_{ih}, X_{ih} : vectors of the estimated parameters and predictor variables respectively

$\frac{P(Y = i)}{P(Y = 1)}$: the probability of each private vehicle ownerships with, in this case, the first category as the reference.

Using Maximum Likelihood estimation, a set of utility function coefficients which makes the model best fit the calibration dataset are estimated. In order to optimise the model performance, explanatory variables can be selected to remain in or out of the model. Coefficients with significance value of 5% or t-statistics value greater than 1.96 are considered statistically significant. The equation above expressed the logit (log odds) as a liner function of the independent factors (Xs). Therefore, equation (3) allows for the interpretation of the logit weights for variables in the same way as in linear regressions.

DATA DESCRIPTION

Home interview survey for the local household was carried out in 2011 in Buleleng Regency. A stratified random sampling method was followed so the samples obtained representing all classes of local household in the case study area. In total, 3000 questionnaires were effective and used for this study. It is reported that 705 out of 3000 households (23.5%) owning no motorcycle, while 1696 (56.5%) and 599 (20%) households owning 1 and more than 1 motorcycles respectively. Figure 1 shows the study area.

The dependent or response variable is motorcycle ownership, which is nominal or categorical in nature. Independent variables (predictors) consist income, number of workers and students in the household which all are continuous

variables. The categorical variable is represented with dummy variables following the coding system in SPSS, software used in this study. Study variables and their codes are shown in Table 1.

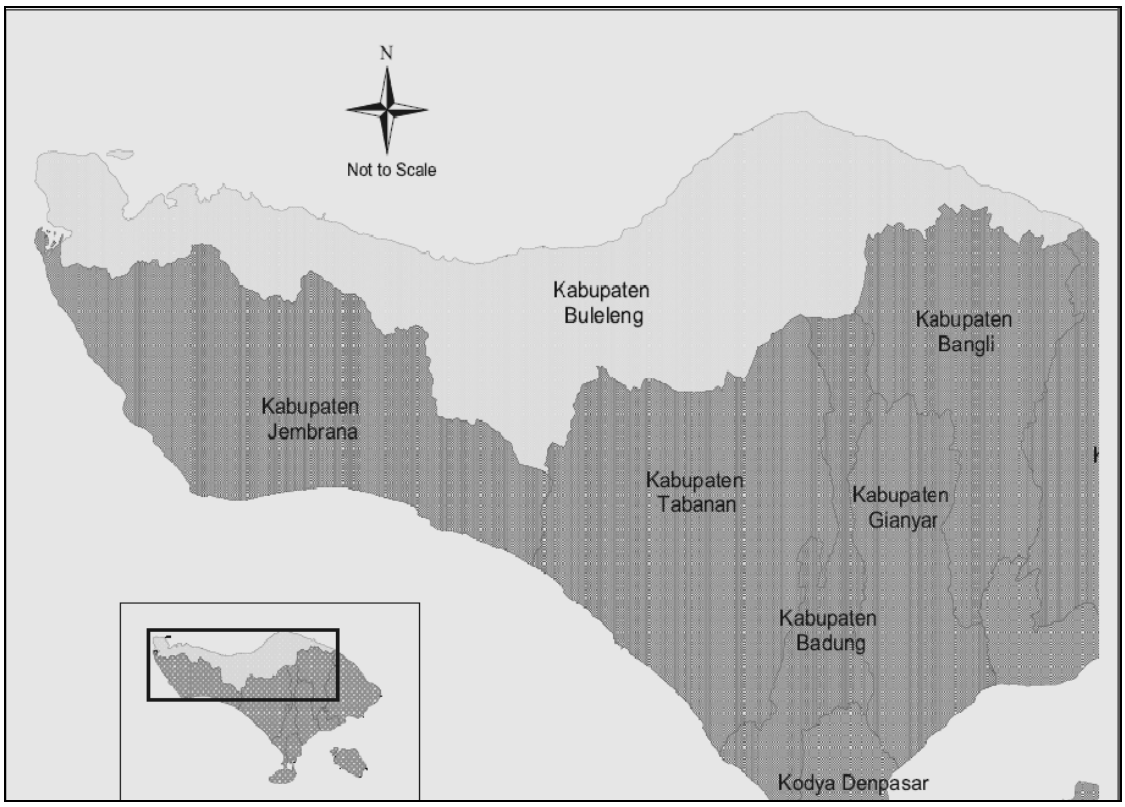

Figure 1 Study Area-Buleleng Regency

Table 1 Study Variables

No	Description	Variable Name and Coding
1.	Motorcycle ownership	0: A household owns no motorcycle. 1: A household owns 1 motorcycle. 2: A household owns more than1 motorcycles.
2.	Total household income per month	Income
3.	Number of worker in a household	Workers
4.	Number of student in a household	Student

MODEL DEVELOPMENT AND ANALYSIS

This study constructs an MNL model based on a single-modal ownership approach. The output of the model is probabilities of motorcycle ownerships in a household. As mentioned earlier, the dependent variable is motorcycle ownership. As the reference or the base category for the dependent variable is a household owning no motorcycle (code = 0).

Estimated coefficients measure the change in the logit for a one-unit change in the predictor variable while keeping the other predictor variables constant. A positive and negative estimated coefficient implies an increase and a decrease respectively in the likelihood that a household owning no motorcycle, 1 motorcycle and more than 1 motorcycle. Significance (sig.) value indicates whether or not a change in the predictor significantly changes the logit at the acceptance level. If sig. value is greater than the accepted confidence level

(greater than 5% or confidence level of 95%), then there is insufficient evidence that a change in the predictor affects the response category with respect to the reference category.

As shown in Table 2, the developed model is significant at 5% level (Final Model significance is less than 0.001). In addition, model prediction accuracy is significantly higher by more than 25% of data proportion accuracy. This indicated that the developed model is fit in to the data and appropriate to use for the analyses.

Table 2 An MNL Model Result

Variables	1 Motorcycle		More than1 Motorcycles	
	β	Sig.	β	Sig.
Constant	-0.862	0.000	-4.677	0.000
Workers	-0.069	0.199	0.067	0.348
Student	0.294	0.000	0.457	0.000
Income	0.622	0.000	1.334	0.000
No. observation	3000			
Final Model (sig.)	0.000			
Data Proportion accuracy	33.3%			
Model prediction accuracy	57.6%			

Note: the reference category is a household owning no motorcycle

Where:

Workers	:	Number of workers in a household
Student	:	Number of student in a household
Income	:	Total income of a household per month

Based on Table 2, number of students and local household income are significant predictors at 5% level on a category of a household owning 1 and more than 1 motorcycles. The analysis is limited to income as this study focuses on the income effect on motorcycle ownership.

The value of Exp(β) for income on 1 and more than 1 motorcycles are 1.863 and 3.798 respectively which implies that the odds increased by 86.3% (1.863-1) and almost 4 times respectively. Hence, income is about 86.3% and 4 times more likely to influence a household owning 1 and more than 1 motorcycles respectively than owning no motorcycle. Local household income therefore, is considered significant to influence motorcycle ownership in particular owning more than 1 motorcycle.

In this study an increase of household income is used to investigate the effect of the variable over the model. This is based on an assumption that household income is the only factor changing over the time. Based on Table 2, the model probabilities are determined as follows:

$$\text{Ln}\ \frac{P(1motorcycle)}{P(nomotorcycle)} = 0.622*\text{Income};$$

$$\text{Ln}\ \frac{P(morethan1motorcycle)}{P(nomotorcycle)} = 1.334*\text{Income} \quad (4)$$

In theory, future local household income is a function of Gross Domestic Product (GDP). The influence of household income on motorcycle

ownership is examined on the assumption that an increase in local household income presents in the input dataset affecting the model outputs. In order to do so, an increase in GDP of Buleleng is calculated with every 5 years for the next 20 years.

In fact, no information of GDP and annual inflation of Buleleng Regency is provided for 2011 yet. As a result, this study uses such available information in 2009. The average annual growth of GDP in 2009 is 6.10% (Statistics of Buleleng Regency, 2010). Since no information on annual inflation of Buleleng Regency, this study uses the annual inflation of Bali province in 2009 instead. The present income (PI) in 2009 however, is taken from the average household income obtained from the home interview survey in 2011. Table 3 shows the calculation of the future income (FI) for the next 20 years in the study area.

Table 3 Future Income in Buleleng for the next 20 years

	Average Annual Growth of GDP	Average Annual Inflation	Nominal growth (i)	Present Income (PI) – Rupiahs	Future Income (FI)-Rupiahs	Percentage Increase
2011	6.10%	4.37%	1.63%	2,878,716.000	-	-
2016	6.10%	4.37%	1.63%		3,277,709.547	12.17%
2021	6.10%	4.37%	1.63%		3,732,004.087	22.86%
2026	6.10%	4.37%	1.63%		4,249,264.404	32.25%
2031	6.10%	4.37%	1.63%		4,838,217.631	40.50%

Note: Future income $FI = PI(1+i)^n$

Where
- i is nominal growth rate
- n is time in years.

The probability of income to influence motorcycle ownership is computed using equation (1) as shown in Table 4. Thus, the percent change of income effect probability on motorcycle ownership is shown in Table 5.

Table 4 Income Effect Probability on Motorcycle Ownership

	Probability		
Year	No motorcycle	1 Motorcycle	More than 1 motorcycles
2011	15%	28%	57%
2016	13.4%	26.9%	59.7%
2021	12.1%	25.9%	62.1%
2026	11%	25%	64%
2031	10.1%	24.2%	65.7%

Table 5 Percent Change of Income Effect Probability on Motorcycle Ownership

	% Change		
Year	No motorcycle	1 Motorcycle	More than 1 motorcycle
2011	-	-	-
2016	-10.9%	-3.9%	4.8%
2021	-19.7%	-7.5%	8.9%
2026	-26.9%	-10.7%	12.3%
2031	-32.8%	-13.6%	15.3%

DISCUSSIONS

Based on Table 4, an increase in local household income may lift up more than 1 motorcycle ownership for the next 20 years. In 2011, the probability of a local household income to influence more than 1 motorcycle ownerships is about 57%. This is such a high number compared to owning no and 1 motorcycle which are 15% and 28% respectively. In addition, for the next 20 years, an increase in local household income tend to reduce the probability of a household to own no and 1 motorcycle but to increase more than 1 motorcycles ownership.

The probability of motorcycle ownership rises substantially by more than 15% in next 20 years if household income in Buleleng Regency increases as shown in Table 5. This is in particular applied for a household owning more than 1 motorcycles. In contrast, the probability of a household owning no and 1 motorcycle drops significantly by almost 32% and 14% respectively for the next 20 years if household income in Buleleng Regency increases. It looks obvious that if the existing condition carries on into the future ('business as usual'), the number of motorcycle in Buleleng Regency will significantly increase. More specifically, if the income for the next 20 years increases the huge demand for motorcycles is still exists.

A great number of motorcycles used on the road could subsequently lead to serious transport problems in Buleleng for the next few years. This is connected to the negative impacts of transport including road accident and traffic pollution. To overcome this situation, household vehicle ownership may need to be restrained using a transport policy such as the price mechanism through an increase in vehicle expenditures by rising vehicle tax, fuel cost and parking fare (Prabnasak, *et.al*, 2011).

Before applying such policies however, improving the existing public transport or introducing a high quality public transport service within and to/from Buleleng Regency must be firstly implemented. So that people travels within and to/from Buleleng Regency have the main alternative modes of transport once the price mechanism policy is applied.

In introducing a high quality public transport service however, the fare must be sufficiently low to compete with the cost of using a motorcycle (Wedagama, 2009a). Simultaneously, the service quality must be high enough to negotiate the main advantage of motorcycle (i.e. door-to-door service). Since the quality of service is certainly related to the operation cost, a significant amount of fare subsidy is urgently required (Prabnasak, *et.al*, 2011).

CONCLUSIONS

The influence of household income on motorcycle ownerhsip in Buleleng Regency is investigated using a Multinomial Logit Model. The household income in 2011 is about 15%, 28% and 57% to influence a household owning no, 1 and more than 1 motorcycles respectively. The probability of motorcycle ownership rises substantially by more than 15% in next 20 years if household income in Buleleng Regency increases. This is particulary applied for the household owning more than 1 motorcycle. In contrast, the probability of a household owning no and 1 motorcycle drops significantly by almost 32% and 14% respectively for the next 20 years if household income in Buleleng Regency increases. The household income therefore, is considered significant to influence motorcycle ownership in Buleleng Regency.

A great number of motorcycles used on the road could subsequently lead to serious transport problems for the next few years. This is connected to the negative impacts of transport including

road accident and traffic pollution. Improving the existing public transport or introducing a high quality public transport service within and to/from Buleleng Regency is urgently required. The fare of such high quality public transport service however, must be sufficiently low to compete with the cost of using a motorcycle. In addition, a significant amount of fare subsidy from both local and central government is considerably required

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