AN ECONOMETRIC ANALYSIS OF MOTORCYCLE DEMAND IN SARAWAK, MALAYSIA

Nur Zaimah Ubaidillah[1,*]

Abstract

Motorcycles are considered a primary mode of transport in developing countries due to their affordability and the lack of public transport infrastructure. Nonetheless, it is unclear whether this demand will continue to increase or begin declining into the future due to increases in income or changes in fuel prices. This study aims to understand the long-run factors influencing vehicle ownership, in particular motorcycle ownership, in the context of a state in a developing Asian country, namely Sarawak, Malaysia. This study uses a vector error correction model to analyse the relationship between socio-economic variables (including GDP, fuel price, level of employment and road length) and motorcycle ownership using annual time series data for the period from 1980 to 2017. The results suggest that long-run effects of income and fuel price elasticity regarding motorcycle ownership are estimated to be 0.376 and -0.351 respectively. The study reveals that both income and fuel price are inelastic for motorcycle ownership in the long-run and that motorcycles are considered a necessity good in Sarawak. These results provide useful insight for the government to construct effective policies related to motorcycle demand. While fuel price fluctuations may not significantly affect motorcycle demand, the full removal of fuel subsidies may lead to adverse effects particularly on the overall transport sector. Hence, it is important for policy-makers to carefully design an appropriate fuel subsidy reform along with mitigating strategies particularly for vulnerable groups of the society, to achieve sustainable transport.

Keywords: motorcycle ownership; vector error correction model; fuel price; gross domestic product; climate action

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[1,*]Dr. Nur Zaimah Ubaidillah obtains a Ph.D. in Transport Studies from University of Leeds, United Kingdom. Currently she is a lecturer at Faculty of Economics and Business, Universiti Malaysia Sarawak (UNIMAS), Malaysia. Email: unzaimah@unimas.my

1. INTRODUCTION

In comparison with developed countries, developing countries have lower per capita GDP and hence lower levels of motorisation. However, the level of motorisation is growing at an unprecedented rate in developing countries (Sperling & Salon, 2002). Rising motorisation is generally triggered by economic progress and rising standards of living, therefore creating jobs and generating a need for people to commute from one place to another. Consequently, there are negative externalities resulting from the continuous increase of motorised vehicles, such as traffic congestion, transport emissions, and road accidents. The high number of motorised vehicles has also raised concerns among domestic policy makers as it may deter the country from achieving the Sustainable Development Goals (SDG) particularly in combatting climate change as highlighted in SDG13. The 13th Sustainable Development Goal (SDG13) is to "Take urgent action to combat climate change and its impacts". One of the targets within SDG13 is to "Integrate climate change measures into national policies, strategies and planning" (*The 2030 Agenda for Sustainable Development A/RES/70/1*, 2015, 27). In this case, a strategic economic tool such as fuel subsidy reform, can be implemented through national policy to regulate the demand for fuel-based transport. In comparison to cars, motorcycles are considered as a more sustainable mode of transport as they require less space, fewer resources and emit lower levels of pollution (Jittrapirom, Knoflacher, & Mailer, 2017). Hence, the study of motorcycle ownership is imperative as it may potentially enhance the achievement of sustainable transport, particularly in the context of a developing Asian country, through allowing the reduction of carbon emissions.

As a developing country which has experienced both economic progress and an increasing standard of living, Malaysia is no exemption to rapid motorisation. Similar to other developing nations, the country's trepidations are particularly focused on the effect of mass fuel consumption on economic performance, as the Malaysian government has been subsidising its fuel price for the past few decades causing the price to be relatively low in comparison to other countries. Due to an economic deficit, the Malaysian government gradually reduced fuel subsidisation, ending with a complete removal in 2014, choosing to use a "managed float" system for regulating fuel prices in line with the international fuel price. The effect of changes in policy making through the removal of fuel subsidisation on motorisation remains unclear. It is questionable whether this change in fuel price reduces vehicle demand in the long-run. Socio-economic models using historical data are used by policy-makers to understand the dynamics of growing motorisation over the long-run, as this can be affected by various factors such as income, fuel prices, road length, and

levels of employment, at different time horizons or for different time periods. The dynamism of the long-run relationship lies in the magnitude and direction of factors determining vehicle ownership and is measured in the form of long-run elasticity. Long-run elasticity in this sense is calculated as the responsiveness of one variable to changes in another variable over a longer time horizon (Fearnley & Bekken, 2005).

A wide range of studies on elasticities for vehicle ownership have been published, predominantly for developed countries (Witt & Johnson, 1986; Espey, 1997; Dargay, Gately & Sommer, 2007). Despite this extensive research, the number of studies on long-run elasticity in the case of developing countries is still limited, particularly with respect to vehicle ownership, and specifically motorcycle ownership. This has raised questions of the transferability of long-run elasticity values from studies in developed countries to developing countries. Thus, the objective of this study is centred on understanding the long-run factors influencing vehicle ownership, particularly motorcycle ownership, in the context of a state in a developing Asian country, namely Sarawak, Malaysia. In addition, the study also analyses the causal relationships between factors that explain motorcycle ownership in the short-run.

2. LITERATURE REVIEW

Modelling of vehicle ownership demand has continuously developed over the past few decades, with two main forms emerging, namely the aggregate and disaggregate models. Aggregate models consist of three main types of model; these are Time series, Cohort models, and the Car market model. Aggregate Cohort models include segregating the car population into different groups by year of production and then shifting the cohorts into the future, explaining how the cohort changes as it becomes older, acquiring, keeping, and losing cars. The Aggregate Car market model can be shown by differentiating between car demand and car supply in the car market, separating the model from the aggregate time series model (de Jong, Pieters, Daly & Smit., 2004, 381-382). Time series aggregate modelling is essential as it enables the analysis of how vehicle ownership responds to changes in socio-economic factors such as Gross Domestic Product, and fuel price, over time. According to Stock & Watson (2007), the relevant part of time series regression relies on the assumption that when future conditions display similarity to a past time series, historical trends of data can be used to forecast this future time series. The idea that historical data can be generalised to the future heavily relies on the stationarity concept. Under these assumptions, aggregate modelling is suitable for long-run forecasting. The drawback of aggregate models according to de

Jong et al. (2004) is the inability to include vehicle types and policy variables causing the model to be restricted to a limited number of variables. However, in the case of developing countries where more disaggregate data are found to be difficult to obtain, aggregate data modelling would be the most appropriate method.

As developed countries have a different socio-economic background as well as different levels of transport infrastructure, it is doubtful that comparing the results of aggregate studies from developed countries with those in developing countries is plausible, or whether the estimated elasticities for determinants of vehicle ownership would be transferable. Hence, this study contributes to research in this field by estimating an aggregate model for motorcycle ownership in a developing country. Malaysia is selected for the case study because of its level of economic development and rising level of mobility, characterised by very high rates of private vehicle ownership, including both cars and motorcycles. Within the developing countries of Asia, rates of motorisation vary from 5 vehicles per 1000 inhabitants in Bangladesh, to 405 vehicles per 1000 inhabitants in Malaysia. The rate of motorisation in Malaysia is very high and almost reaches those of developed countries, for example the United Kingdom, which has a level of 575 vehicles per 1000 inhabitants, and Japan with a level of 607 vehicles per 1000 inhabitants (OICA, 2018) .

Moreover, changes of government policy, specifically the abolishment of fuel subsidisation, encourage the undertaking of this study. Almost all studies utilise income as one required factor in their model, acting as a benchmark of wealth. Among a large number of studies identifying the determinants of vehicle ownership, the role of income and fuel price is highlighted (Espey, 1997; Dargay, 2010; Van-Dender & Clever, 2013; Sandu, 2015; Lu, Ma, Sun, & Wang, 2017). Fuel price is another frequently used explanatory variable in vehicle ownership models, serving as the cost of using a vehicle. Fuel price elasticity can influence vehicle ownership, in this case through price regulation as the identification of long-run aggregate demand may provide ways to explore the stable travel patterns in a different time period. Estimations of long-run transport demand shed some light on whether future vehicle ownership will be similar to past patterns. For example, the analysis of long-run elasticity of vehicle ownership with respect to changes in fuel price may provide policy makers with insights for determining future policy related to fuel price, whether to increase or reduce the fuel price, or even remove government subsidisations, which is an essential tool in economic policy.

A number of research studies have stated the importance of factors of the built-environment, such as population density, and road networks, in determining vehicle ownership (Van-Dender & Clever, 2013; Law, Hamid & Goh, 2015). For

instance, population density is found to negatively influence vehicle ownership (Riley, 2002; Clark, 2007). Cost variables such motoring costs and vehicle purchase costs are also deemed important variables in vehicle ownership and highlighted in studies by Romilly, Song & Liu (1998), Dargay (2002), and Duffy & Robinson (2004). Dargay (2002) found that car purchase costs are more sensitive than fuel costs and that the sensitivity increases with the level of urbanisation. Rural households are highly dependent on cars and have fewer alternative transport options compared to urban households, therefore costs matter less. In a time series study by Prevedouros & An (1998) for selected developed and developing countries, it was found that GDP is an important determinant of automobile ownership. The study also highlighted that for aggregate time series studies, factors such as population, income, employment, fuel price, and transport infrastructure, are vital in determining automobile ownership.

In recent years, models have been shifting from static models to dynamic models. Static models are described as a modelling approach used under static or unchanging circumstances. In the vehicle ownership equation, this indicates that the relationship between vehicle ownership and the explanatory variables, for example gross domestic product (GDP) and fuel price, occur promptly, which is not the case, as people's tastes and preferences change over time. Due to this condition, static models are only relevant to analyse the short-run effects of a shock. The limitation of static aggregate time series models is that it is not possible for the equation to adjust between the dependent variable and independent variables, as the process happens instantaneously. On the other hand, dynamic models are recognised as the modelling approach to be used under changing conditions. This means the explanatory variables are reflected by time "lags" where a value in a past period can predict the dependent variable in the future. This is essential to determine the response of vehicle ownership to time-varying determinants, for instance, changes in factors such as fuel price over time and how policies related to that can be constructed in the long-run. Bradburn and Hyman (2002) applied ECM to analyse car stock in Great Britain from 1950 to 2000 finding that GDP and petrol price both had a significant but inelastic influence on car stock in Great Britain, with a positive influence of 0.97-0.99, and negative influence of -0.07 respectively. ECM is “an autoregressive distributed lag (ADL) specification for two or more variables with provisions for the possible long-run relationships among the variables” (Brandt & Williams, 2006, 7). In this study, a Vector Error Correction Model (VECM) was applied as it was “considered best when based on a simple, unbiased specification that accounts for uncertainty about the dynamics and the model” (Brandt and Williams, 2006, 12). VECM is “based on describing the long- and short-run

components of a multivariate time-series regression model, researchers can test for a variety of relationships among the common long- and short-run dynamics and how they are related across the various series" (Brandt and Williams, 2006, 8). Taking into account the above-mentioned studies, it can be clarified that, to date, there is an insufficient number of studies that can be found specifically relating to time series aggregate models in motorcycle analysis in the case of developing countries. Therefore, this paper provides an aggregate model analysis specifically using state level data to analyse the long-run effects of socio-economic variables, specifically GDP per capita, fuel price, employment level, and road length, on motorcycle ownership in Sarawak, Malaysia; this is an extension of the study by Ubaidillah (2013) focusing on the state of Sarawak, one of the largest states in Malaysia.

Points raised in the abovementioned discussion have triggered a need to investigate the long-term relationship between motorcycle demand, and the factors of GDP, fuel price, level of employment, and road length. Furthermore, there is a limited number of studies on motorcycle demand using time-series data, particularly regarding developing countries or individual states within a developing country. This paper is organised as follows: Section 2 provides an overview of the literature on vehicle ownership. Section 3 presents the data and methodology for motorcycle demand in Sarawak. Section 4 presents the estimated results and discussion. Finally, section 5 concludes the findings and presents future recommendations for further research.

3. METHODS

To study the long-run elasticity of vehicle ownership, it is essential to gather statistical data on the socio-economic situation in Sarawak. These data consist of annual time series observations of five variables from the year 1980 to 2017. Yearly time series data from 1980 to 2017 is utilised in this study. A description of the data is presented in Table 1.

The underpinning theory utilized in this study is based on the Neoclassical Theory of Demand. This is where there exists an inverse relationship between price and demand for a commodity, *ceteris paribus*. The law also uses the income elasticity of demand to distinguish whether a commodity is identified as a necessity (normal) or luxury good. Some studies on vehicle ownership demand, for instance Romilly et al. (1998), and Dargay (2010), incorporate income, fuel price, road length, and employment level, in their analysis, studying the influence of these variables on vehicle ownership. A change in real income is expected to positively affect the demand for

Table 1: List of Variables

Variable	Description	Source
Real Gross Domestic Product	Real Gross Domestic Product per capita (RGDP)	Department of Statistics (DoS, 2019)
Motorcycle per capita	Total number of motorcycles per 1000 inhabitants (MOTOR)	Department of Statistics (DoS, 2019)
Employment	Total number of people employed (EMP)	Department of Statistics (DoS, 2019)
Fuel price	RON97 price (2010 constant price) in USD (FP)	Ministry of Domestic Trade, Co-operatives and Consumerism (2019)
Road length	Road length in kilometres (km) (ROAD)	Department of Statistics (DoS, 2019)

transportation. Since income represents the economic condition of the citizen, greater wealth accumulation would make the citizen better off and influence a higher demand for mobility, thus leading towards higher demand for road vehicles. It is noted that the cost of travelling is a critical element in transportation demand. Fuel price is used as a proxy variable for transportation cost.

Therefore, this study expected that an increase in fuel price costs would assist in reducing the frequency of travelling and hence generate negative elasticity in the demand for road transport based vehicles. Other variables, such as road length are considered as factors of the built-environment and are expected to have a positive impact towards motorcycle ownership (Law et al., 2015). Employment level is also considered in the model as it represents a need to travel, or how the purpose of work influences the requirement to travel, and is expected to have a negative sign. Following consideration of the variables in these studies and the data availabilities in Sarawak, the proposed model for motorcycle ownership in Sarawak is presented in Equation 1.

$$lnMOTOR_t = \beta_0 + \beta_1 . lnRGDP_t + \beta_2 \cdot lnFP_t + \beta_3 \cdot lnROAD_t + \beta_4 \cdot lnEMP_t + u_t \quad (1)$$

All data were transformed into their natural logarithm allowing for the observation of long-run elasticity directly from the long-run cointegration equation where $MOTOR_t$ is the dependent variable, and $RGDP_t$, FP_t, $ROAD_t$, and EMP_t, are the independent variables in the year t, u_t is the error term, while coefficients β_1, β_2, β_3, and β_4 are the long-run elasticities to be estimated.

The long-run elasticity and causal relationship between

motorcycle ownership, and the explanatory variables, RGDP per capita, fuel price, road length, and employment, in Sarawak will be analysed using a three-step testing procedure. First, the Augmented Dickey Fuller (Dickey & Fuller, 1979) unit root test was applied to test whether the variables had a unit root. Second, the Johansen-Juselius cointegration test was utilised to identify the existence of long-run relationships in the model. Third, after detecting a long-run relationship, the study proceeds with a Vector Error Correction Model (VECM) to estimate the long-run relationship and short-run causality. The justification of using VECM in this study is based on several grounds. (1) To obtain a long-run cointegration matrix that presents the long-run equilibrium relationships between variables; (2) To obtain short-run coefficient matrices that include the parameter of short-run adjustment for each variable with the other variables; (3) To obtain an Error Correction Term (ECT). VECM is used as the series are found to be stationary at first difference and cointegrated, indicating long-run dynamics among the variables (after performing the analysis) (Shrestha & Bhatta, 2018).

3.1 Augmented Dickey Fuller Unit Root Test

The first step in analysing the long-run relationship of motorcycle ownership is by testing the unit root. Stock and Watson (2007) mentioned that in a time series regression analysis, the concept of stationarity is where the historical data can be used to forecast the future. This can be further elaborated by Gujarati (2004) with the assumption that time series data is stationary in cases where the mean and variance are constant over time. The concept of stationarity is important as non-stationarity may lead to a series of spurious regression in which the relationship between the variables is not meaningful at all and may lead to an incorrect conclusion from the model.

3.2 Johansen Juselius Cointegration Test

The Johansen & Juselius (1990) test is employed to ascertain whether the cointegration for all the variables is incorporated in the system (Johansen & Juselius, 1990). Cointegrated variables indicate a linear, stable, and long-run relationship among the variables revealing that the said variables tend to move in a steady path in the long-run. The series is considered to be cointegrated if the null hypothesis is rejected, enabling the VECM analysis to be conducted.

3.3 Vector Error Correction Model

After validating the cointegration relationships within the series, a Granger Causality test is carried out within the Vector Error Correction Model (VECM) framework. Vector Error Correction Model (VECM) is a restrictive Vector Autoregressive (VAR) model that confines the

behaviour of the endogenous variables in the long-run. This serves the purpose of converging on the relationship of the long-run equilibrium and allows for long run dynamics to be analyzed. For the scenario of a cointegrating vector which exists among the variables, a corresponding error-correction depiction signifies that changes of the dependent variable can be expressed as a disequilibrium function in the relationship of the cointegration and fluctuations in other explanatory variables. The following equation can be considered in respect of a single case of cointegration.

$$\Delta\ LNMOTOR_t\ = \alpha_0\ + \sum_{i=1}^{m} \beta_{1,i} \Delta LNMOTOR_{t-i} + \sum_{i=1}^{m} \beta_{2,i} \Delta LNRGDP_{t-i} + \sum_{i=1}^{m} \beta_{3,i} \Delta LNFP_{t-i} + \sum_{i=1}^{m} \beta_{4,i} \Delta LNROAD_{t-i} + \sum_{i=1}^{m} \beta_{5,i} \Delta LNEMP_{t-i} + \theta_1 ECT_{t-i}\ +\ \varepsilon_{1t} \quad (2)$$

Where Δ indicates the lag operator; α_0, βs are the estimated coefficients; m is the optimal lag length; ε_t is the residual; and θ measures the response of LNMOTOR in departure from the equilibrium. ECT measures the speed of adjustment if there is a deviation in the long-run equilibrium, which is corrected by short-run adjustments. This will be shown by an ECT value that is negative and statistically significant. In testing whether LNRGDP does not Granger cause LNMOTOR; H_0: $\beta_{2,i} = 0$ for all i. The rejection of H_0 shows that LNRGDP Granger causes LNMOTOR.

4. RESULTS

4.1 Augmented Dickey-Fuller (ADF) Unit Root Test and Johansen-Juselius Cointegration Test

Based on the ADF tests, the null hypothesis of unit root failed to be rejected for all variables thus indicating unit root at level. Conversely, after first differencing, the null hypothesis of a unit root was rejected, and all the variables were found to be stationary indicating integration at I (1). The Johansen-Juselius cointegration results suggest the presence of one cointegrating vector in the system for trace statistics at the 5% significance level but no cointegrating vector using Max-eigen statistics. Therefore, the study follows the result from the trace statistic for one cointegration vector (Lutkepohl, Saikkonen & Trenkler, 2001). The results also point out that the assumption of non-causality among the variables is to be ruled out and that long-run relationships do exist among the variables.

4.2 Vector Error Correction Model Estimates

The existence of cointegration based on the previous Johansen-Juselius cointegration test allows for the VECM to be estimated. The results of the normalised long-run

equation for motorcycle ownership demand can be found in Table 2. Since all variables are in logarithms, the cointegration relationship implies long-run elasticity of the explanatory variables with regards to motorcycle ownership. VECM is utilised for capturing the dynamics of the long-run equation in the time series. According to the long-run equation shown in Table 2, it is evident that all the explanatory variables are found to be statistically significant at the 5% level. Based on these results, the long-run motorcycle ownership elasticities with respect to RGDP per capita, road length, and employment are 0.376, 0.337 and 3.514, respectively. A negative elasticity was found for fuel price with a value of -0.351. As wealth increases, people are more likely to purchase a vehicle to fulfil their needs to travel, as suggested by Bradburn and Hyman (2002), and Dargay (2010). In the long-run, the effect of income in Sarawak towards motorcycle demand is significant but inelastic, perhaps as a result of higher purchasing power, people tend to switch to other modes of vehicle such as cars which are more preferable due to various factors such as prestige, convenience, safety, and comfort (Law et al., 2015). The value of elasticity which is 0.376 indicates that motorcycles are considered as normal goods or necessities in Sarawak. A good is normal in the case where income elasticity is greater than or equivalent to zero. A normal good is considered as a necessity good when the value of elasticity is less than one. The income elasticity is lower compared to Duffy and Robinson (2004) who also studied motorcycle demand finding an elasticity of 1.73 from the year 1964 to 1995, and 3.80 from 1964 to 2000. However, since there are limited studies in developing countries using a similar technique on vehicle ownership, it is difficult to draw a valuable comparison.

It is also expected that fuel price influences vehicle ownership (Dargay, 2007). However, fuel price elasticity was found to be -0.351 which is significant but inelastic and is higher than that found in the previous study by Bradburn and Hyman (2002) which was -0.07. This indicates that, although motorcycle ownership declines as fuel price rises, the changes are not substantial. As the primary mode of transport other than cars, motorcycles are perceived as the main means of transportation for low to middle income commuters in Sarawak. The main reason for a continuous high demand is due to the advantages of motorcycles in comparison to cars, such as low-price, less space for parking, small engine size, and the associated low fuel consumption (Hsu, Mohd. Sadullah, & Nguyen, 2003). The results also found that elasticity for road length is significant at 0.337. Based on these results, motorcycle ownership rises as road length increases, indicating that demand increases with greater infrastructure. It is noted that the relationship between employment and

Table 2: The cointegrating vector normalised on LNMOTOR representing the Long-run Model Estimations

Variables	LMOTOR	LRGDP	LFP	LROAD	LEMP
Coefficient	1.000	0.376	-0.351	0.337	3.514
(t-statistics)		[2.540]	[3.208]	[7.680]	[10.729]

Notes: ** represent 5 % level of significance.

Table 3: Short-run Causality Results based on VECM

	Independent variables					
Dependent variables	χ^2 *statistics of lagged 1st differenced term*					Ect_{t-1} coefficient (t-stat)
	Δ lnMOTOR	ΔlnRGDP	ΔlnFP	Δ lnROAD	Δ lnEMP	
ΔlnMOTOR	-	14.32	13.134	1.245	3.474	-0.518*** [-3.246]
ΔlnGDP	8.679**	-	4.356	10.825	1.246	0.457 [1.998]
ΔlnFP	9.759**	2.787	-	9.200	1.623	0.315 [1.197]
ΔlnROAD	2.728	7.586	3.676	-	2.444	0.906 [2.417]
ΔlnEMP	8.231	2.154	5.914	1.491	-	0.084 [1.457]

Note: ***, **, * denotes significance at the 1%, 5%, 10% significance levels, respectively. The figure in parenthesis (…) denotes the t-statistic value, while the figure in the squared brackets […] represents the p-value.

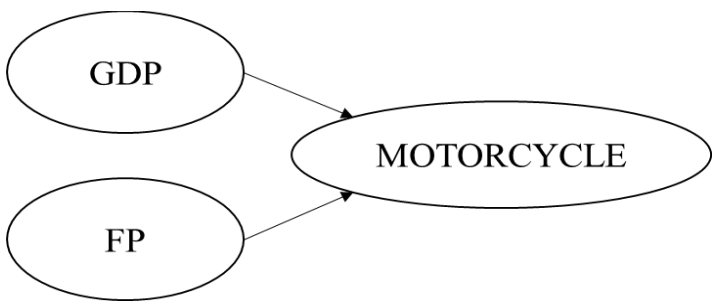

Figure 1: Short-run Causal Relationship

motorcycle ownership is significant and elastic at 3.514. The reason for this is due to the affordability of motorcycles as the best option for a first mode of transport, especially for new workers (Hsu et al., 2003). Compared to cars, the motorcycle can be purchased at a lower cost, also having lower maintenance and operation costs. The value of ECT

which is the error correction mechanism is found to have an expected negative coefficient with significant t-statistic value. This explains that the model is stable and with a 51.8% annual speed of adjustment, converging towards the long-run equilibrium in any case of shock or disturbance in the system. The results also enable the short-run Granger causality of the model to be estimated as shown in Table 3, Figure 1. Table 3 shows that GDP and fuel price can exert not only long-run effects but also short-run effects on motorcycle ownership.

5. CONCLUSION

The study uses annual time series variables from 1980 to 2017 to analyse the motorcycle ownership demand in Sarawak state, Malaysia. The favoured specification was a Vector Error Correction Model to analyse the short-run and long-run relationships between motorcycle ownership, and the explanatory variables of RGDP, fuel price, road length and level of employment. In the short-run, it can be concluded that RGDP and fuel price are significant determining factors. All explanatory variables were found to be significant in influencing motorcycle ownership in the long-run. Based on the findings, in can be said that monetary variables such as RGDP per capita and fuel price do significantly influence motorcycle ownership. Discussions on elasticities in the previous section indicate that motorcycles are considered as normal goods which act as a necessity in everyday life in the state of Sarawak. The positive elasticity of income indicates that motorcycle ownership increases with income growth in the case of Malaysia, a developing country, but as the elasticity is less than 1, these changes are less sensitive to the economic cycle. In addition, the negative but inelastic fuel price indicates that policies to reduce subsidies may not be effective in controlling the demand for motorcycle ownership. Considering any changes in the fuel price, the user will continue to choose a motorcycle as it is the cheapest, least expensive option. Furthermore, motorcycles are considered as the most sustainable private motorized vehicle in comparison to cars, both in terms of fuel consumption and regarding pollution emissions.

The Malaysian government has yet to implement the abolishment of fuel subsidies. Fuel subsidy reform is part of the government initiatives for combatting climate change by lowering the dependency for fuel-based transport. The implementation of fuel subsidy reform is also important for the country's economy in terms of handling fiscal deficits, currency depreciation, and the fall of current account surplus. While the study shows that fuel price fluctuations may not significantly affect motorcycle demand, the notion of full removal of fuel subsidies may lead to adverse effects, particularly to the transport sector overall, as the Malaysian society is highly dependent on motorized transport. Hence, it is

important for policy makers to carefully design an appropriate fuel subsidy reform, countering any possible political and societal resistance along with mitigating strategies, particularly for vulnerable groups of society. Frequent price adjustments could also help users to gradually become accustomed to fluctuating changes in the fuel price, making road users more likely to adjust to potential fuel subsidy reforms. It is also recommended that the government consider usage of renewable energy resources in the transport sector with emphasis on motorcycle use.

The findings also reveal a negative but inelastic relationship between road length and motorcycle demand in the long-run. This indicates the importance of providing a transport infrastructure conducive to motorcyclists by improving traffic planning performance, for instance, designing a specific lane for motorcyclists and improving parking availability for motorcycles. Limitations of this study include the need to integrate a longer time series period, and an issue with data availability whereby some variables are not available at the state level. Future studies should be conducted to analyse the travel behaviour in Sarawak using disaggregate data to further understand how various factors, such as socio-economic factors, factors of the built-environment, and psychological factors, influence how people commute, as well as their effects on other transport related issues.

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