An Econometric Analysis of Road Transport Demand in Malaysia

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Abstract

As Malaysia is trending towards globalization, vast economic expansion and rapid urbanization had led to increasing travel demand. This triggers greater needs for mobility and raises the demand for road transport among the citizens. This study estimates an econometric model to explain the relationship between socio-economic variables (real gross domestic product, road network, urban population, and fuel price) and road based vehicles in Malaysia. The tests which are included in this study are Augmented Dickey Fuller (ADF) and Phillips Perron (PP) unit root test, Johansen Juselius cointegration test and Vector Error Correction Model using annual time series data for the period of 1980 to 2010. The findings are: all variables are stationary by using ADF and PP test in first difference. Second, long run relationship exists among the variables. Third, short-run unidirectional causality occur between real gross domestic product to road vehicles and from urban population to road network and fuel price. The relevance of this contribution should be seen in the importance of policy aspects in determining future demand of road vehicle ownership in Malaysia.

Keyword : Road Vehicle Ownership, Real GDP, Urban Population, Oil Price, Vector Error Correction Model

1. Introduction

In recent years, the patterns of transportation for Malaysia has radically changed align with the transformation of Malaysian economy. As Malaysia experience tremendous economic expansion, the increase in standard of living has revolutionized the process of urbanization which triggered the greater need of mobility for its citizen. Rapid increase of mobility has ignited the policymakers on the importance of identifying the factors affecting the demand in Malaysia. The National Automotive Policy (2009) was introduced with five major objectives including: (i) to promote a competitive and viable automotive sector, in particular national manufacturers; (ii) to become a regional hub for manufacturing, assembly and distribution for automotive vehicles; (iii) to enhance value added and local capabilities in the automotive sector; (iv) to promote export-oriented Malaysian manufacturers as well as component and parts vendors; and (v) to promote competitive and broad-based Bumiputera participation in vehicle manufacturing, distribution and importation as well as in component and parts manufacturing.

In the genesis of the emergence of urbanization and enhanced standard of living, the importance of transportation in Malaysia is reflected in the number of car ownership per population of 361 motor vehicles per 1000 population which almost reach those in the high income countries such as South Korea (363 motor vehicles per 100 population) and Denmark (480 motor vehicles per 1000 population).[1] The travel demand in Malaysia is contributed by several grounds. Travel demand growth in Kuala Lumpur according to Ensor (2004) for instance, is promoted by a number of factors including population growth, growth of real GDP, rising average incomes and increasing female participation in the workforce, increasing working age group (between 15 to 64 years) and rising urbanization. Mustapa, Tan and Leong (2011) further highlighted that the key drivers of rapid motorization in Malaysia are due to increasing per capita GDP, growing population and urbanization, increasing subsidies on transport fuels and promotion of domestic automobile industry by the government.

Malaysia Motorization Trends and Challenges

The rapid growth of road-based motorization in Malaysia is reflected by the ever-increasing demand for transport and the expansion of road network. According to the Department of Statistics (2012), the road transport in Malaysia primarily consists of motorcars, motorcycles, taxi, buses and goods vehicle. Table 1 shows the registered road transport vehicles in Malaysia for selected years in percentage. It can be seen that motorcars lags behind motorcycles as the main mode of transportation with 44 per cent and 47 per cent respectively. The rising trend of road motorization in Malaysia has motivated this study to be undertaken. Therefore, the study is conducted to analyze the long-run and short-run relationship between road transport demand and its socio-economic variables.

TABLE 1 REGISTERED ROAD TRANSPORT VEHICLES IN MALAYSIA (SELECTED YEARS)

Year	Motor Cars	Motor Cycles	Taxi	Buses	Good Vehicles	Others	Total
1990	33.15	55.58	0.63	0.49	6.96	3.19	100.00
1995	37.02	52.32	0.80	0.52	6.39	2.95	100.00
2000	39.12	50.54	0.63	0.46	6.28	2.98	100.00
2005	43.69	47.30	0.53	0.39	5.43	2.66	100.00
2009	44.73	47.01	0.42	0.35	4.92	2.57	100.00

Note: All figures are in percentage. Source: Road Transport Department, Malaysia (2011).

This paper is organized as follows: the next section reviews previous literatures concerning transport demand; the third section describes the data and methodology; the fourth section presents the empirical results for this research and finally the fifth section presents some concluding remarks.

2. Literature Review/Background Information

[1] Motor vehicles include cars, buses, and freight vehicles but do not include two-wheelers. Population refers to midyear population in the year for which data are available. The data is obtained from National Automotive Policy (2009).

Empirically, a large body of literatures is found in the context of road-based transportation which is either based on private based vehicles or public based vehicles. Some studies focus on the demand for transport, while other studies are associated with transport elasticity and the forecasting. (Singh, 2006; Ogut, 2006; Mehrara and Mohsenzadeh, 2012; Gkritza, Golias and Karlaftis, 2004) Ogut (2006) applied a fuzzy multiple-regression model to determine car ownership in Turkey. The data utilized in this research includes the urbanization rate, average family size, gross national product per capita, average car cost, gasoline price and total length of roads using annual time series data from 1970 to 2000. Ogut found that instead of providing a crisp output, the model also provide an output range for car ownership in Turkey.

Mehrara and Mohsenzadeh (2012) investigated on the road travel demand in Iran using quarterly time series data from 2006 to 2010. Mehrara and Mohsenzadeh applied the Seemingly Unrelated Regression model concerning per trip in every mode of road transport to fare, income, service level, fare of other transport modes and population. Based on the results, it is found that developed public transportation network is the main factor for demand of public transport in passenger public transport fleet and highways does not suit as a substitute for road transport as a result to undeveloped railroad network. It is worth noting that, apart from transport demand and projections, the research on elasticity is studied by Gkritza, Golias and Karlaftis (2004). Gkritza et al applies Seemingly Unrelated Regression Equation Model using monthly data for a city served by three different modes of public transportation in Greece. The results indicate that urban public transport demand in Athens is inelastic with respect to fares but highly inelastic with respect to automobile fuel cost.

3. Data and Methodology

Data Description

The data that will be used are annual time series data of the number of road vehicles registered (RV), real gross domestic product (RGDP), urban population (UP), fuel price (FP) and road network (RN) from 1980 to 2010. The RV and RN data is from Department of Statistics, Malaysia. The RV data is based on the total number of registered vehicles while RN is based on total road network in kilometers (km). The RGDP and UP data are obtained from World Bank (2012). The data on RGDP is in constant US dollars. The data on fuel price is obtained from the Ministry of Domestic Trade, Co-operatives and Consumerism (2012) based on the RON97 values in US dollars. All the data are transformed into natural logarithm.

Methodology

Augmented Dickey Fuller & Phillips-Perron Unit Root Test

The ADF test is described by Said and Dickey (1984) as the basic autoregeressive unit root test to accommodate general autoregressive moving average (ARMA) (p, q) models with unknown orders. Equation

(1) is the test regression estimation of the ADF test in which D_t is a vector of deterministic terms (constant and trend etc). The p lagged difference terms, Δy_{t-j} are used to approximate the ARMA structure of the errors and the value for p for serially uncorrelated error ε_t.

$$y_t = \beta' D_t + \phi y_{t-1} + \sum_{j=1}^{p} \psi_j \Delta y_{t-j} + \varepsilon_t \qquad (1)$$

The difference between ADF and PP tests depend on how serial correlation and heteroscedasticity in the errors are dealt. Specifically, the PP test neglects any serial correlation in the test regression whereby the ADF tests apply a parametric autoregression to approximate the test regression's estimation of the ARMA structure of the errors. The PP test regression is presented as follows:

$$\Delta y_t = \beta' D_t + \pi y_{t-1} + u_t \qquad (2)$$

Cointegration test

In order to identify the cointegration relationship of all the variables included in the system, Johansen and Juselius (1990) procedure is utilized. The importance of cointegration test is to seek the existence of spuriousness in the regression. If, the variables are found to be cointegrated, hence, there exists a linear, stable and long-run relationship among the variables. This implies that the variables tend to move in steady path in the long run. The Johansen and Juselius test is based on the two test statistics which are the trace statistics and maximum eigenvalue test statistics. The trace statistics (3) and maximum eigenvalue test (4) are as follow:

$$\lambda_{trace}(r_0) = -T \sum_{j=r_0+1}^{k} \log(1 - \hat{\lambda}_j) \qquad (3)$$

$$\lambda_{\max(r_0)} = -T \log 1 - \hat{\lambda}_{r_0+1} \qquad (4)$$

Vector Error Correction Model

Vector Error Correction Model (VECM) is a restrictive Vector Autoregressive (VAR) model that restricts the endogenous variables' behavior in the long run in order to converge to the long run equilibrium relationship and permits the long run dynamics. In the case of at least one cointegrating vector to be found exist among the variables, therefore a corresponding error-correction representation that connote that changes of the dependant variable can be formulates as function of disequilibrium in the relationship of the cointegration and fluctuations in other explanatory variables. The regression equation form for VECM can be expressed as below:

$$\Delta Y_t = \alpha_1 + p_1 e_1 + \sum_{i=0}^{n} \beta_i \Delta Y_{t-i} + \sum_{i=0}^{n} \delta_i \Delta X_{t-i} + \sum_{i=0}^{n} \gamma_i Z_{t-i}$$

$$\Delta X_t = \alpha_2 + p_2 e_{i-1} + \sum_{i=0}^{n} \beta_i \Delta Y_{t-i} + \sum_{i=0}^{n} \delta_i \Delta X_{t-i} + \sum_{i=0}^{n} \gamma_i Z_{t-i} \qquad (5)$$

4. Results and Discussion

Unit Root and Cointegration test

Table 2 presents the ADF and PP tests at level and difference. The results found that the null hypothesis of non stationarity at level for the series failed to be rejected. However, the series are found to be stationary at first difference which shows that the variables are all integrated at I (1). Based on the empirical results in Table 3, both Trace statistic and Max-Eigen statistic indicate the existence of cointegration between the variables implying that there a common trend exists in the model.

TABLE 2 AUGMENTED DICKEY-FULLER AND PHILLIPS-PERRON UNIT ROOT TEST RESULTS FOR SERIES

	Augmented Dickey-Fuller		Phillips-Perron	
Variables	**Level**	**First Difference**	**Level**	**First Difference**
RV	-0.6730(0)	-5.2733 (0)**	-0.6689(1)	-5.2887(2)**
RN	-3.2695(0)	-11.8358(0)**	-2.9034(3)	-11.8831(3)**
RGDP	-1.0081(0)	-4.3601(0)**	-0.9710(2)	-4.3705(1)**
UP	-2.6189(1)	-3..8544(0)**	-2.7077(4)	-3.8650(1)**
FP	-0.8556(0)	-5.8868(0)**	-0.9386(2)	-5.88668(0)**

**Notes: Significance at the 1% level.

TABLE 3 JOHANSEN-JUSELIUS MULTIVARIAT COINTEGRATION TEST RESULTS

H_0:	H_1:	Trace Statistic	Critical Value	Max-Eigen Statistic	Critical Value
r=0	r=1	107.73**	76.07	49.43**	38.77
r≤1	r=2	58.30**	54.46	32.21	32.24
r≤2	r=3	26.09	35.65	15.36	25.52
r≤3	r=4	10.72	20.04	7.60	18.63
r≤4	r=5	3.12	6.65	3.12	6.65

Notes: (**) denotes rejection of the hypothesis at the 1%. The letter “r” represents the number of co-integrating equations. The critical values are based on MacKinnon (1996).

Vector Error Correction Model Estimates

The normalized cointegration equation is depicted in Table 4 which shows that all the variables are significant whereby RGDP and RN have a positive effect on RV while UP and FP are vice versa. The RGDP coefficient indicates that in Malaysia, a one per cent increment in RGDP (while others held constant) contributes to 1.08 per cent increase in RV. For RN coefficient, it is indicated that a one per cent increase in RN leads to a 0.75 per cent increment in RV. FP and UP however carries negative and significant coefficient towards RV. It points out that greater standard of living and better road network influence road-based mobilization in Malaysia.

TABLE 4 NORMALIZED EQUATION TEST RESULTS

Normalized cointegration coefficients				
LnRV	LnRGDP	LnRN	LnUP	LnFP
1.0000	1.0834 (6.1187)	0.7560 (5.2240)	-0.9182 (-3.5089)	-0.6783 (-8.2143)

Notes: (*) denotes rejection of the hypothesis at the 5%. Numbers in brackets are t-statistics.

TABLE 5 VECTOR ERROR-CORRECTION MODEL (VECM)

Dependent variable	ΔRV	ΔRGDP	ΔRN	ΔUP	ΔFP	Coefficient of ECT (*T*-ratio)
ΔRV	-	0.0200*	0.9092	0.0571	0.8072	-0.6863*(-4.2664)
ΔRGDP	0.4006	-	0.9445	0.0689	0.7437	-0.0727 (-0.4818)
ΔRN	0.5228	0.5507	-	0.0157*	0.2601	-0.0347 (-0.1724)
ΔUP	0.6500	0.8689	0.5616	-	0.5461	-0.0080 (-1.2268)
ΔFP	0.3348	0.5464	0.2713	0.0285*	-	-0.8775 (-1.2268)

Note: The above values are the values of F. Numbers in squared brackets are p-values. In the table, * shows that coefficients are significant at 5% level.

The specification of VECM only applies to cointegrated series in identifying the short-run and long-run relationship of the variables. The results can be seen in Table 5. The econometric exogeneity of the model can be seen in the statistical significance of the error correction term (ECT). In the long-run, it is found that cointegrating vector of RV equation of VECM is significant at 5 per cent with the speed of convergence to equilibrium of 68.63 per cent. It is noted that causal relationships exist from RGDP to RV as well as UP to RN and FP in the short-run.

5. Conclusion

The study used five annual time series variables from 1980 to 2010 to assess the road vehicle ownership in Malaysia. The study confirms that the Malaysian road transport demand and all the variables moved together over the sample period in the long-run. The results also imply that, the RGDP causes RV while UP causes RN and FP in the short-run. Since majority of the road transport demand is from private based vehicles, it is important for the policy makers to consider the effect of fuel price and supply. Is it sufficient for the future generation? The existence of hybrid cars also assists in the petrol-demanding sector. However, the technology is considered as still new and the country does not possess sufficient infrastructure as well as the maintaining costs are deemed high. Policy makers ought to ensure that since the demand for road transport is increasing, it is essential to provide greater and more efficient public transportation system subject to all states in Malaysia.

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