



The motorcycle to passenger car ownership ratio and economic growth: A cross-country analysis



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ABSTRACT

Cross-country statistics have revealed steady growth in the number of motorcycles in many less advanced economic countries (LAEC) with emerging economies due to increased urbanisation and personal wealth. In contrast, an opposite trend is occurring in advanced economic countries (AEC), with cars replacing motorcycles as income grows. Motor vehicle crashes and injuries are an inevitable consequence of a high motorcycle population. This study focused on understanding how economic growth affects the motorcycle to passenger car (MPC) ownership ratio and what factors underlie this relationship. The data used in this analysis contained a sample of 80 countries at various levels of economic developmental growth over the 48-year period between 1963 and 2010. The results pointed to an inverted U-shaped relationship between the MPC ownership ratio and the per capita Gross Domestic Product (GDP). Generally, the MPC ownership ratio increased with income at a lower level and decreased with income at a higher level. The evidence indicated that urbanisation, the total road length per thousand population, and a proxy for purchasing power with regard to vehicle purchases were the underlying factors that contributed to this relationship.

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1. Introduction

The motorcycle is a major means of transportation in many less advanced economic countries (LAEC), such as Vietnam, Malaysia and Cambodia. This is due mainly to the affordability of motorcycles, with more people in LAEC able to purchase them. It is also due to their high manoeuvrability on congested roads. Cross-country statistics have revealed steady growth in the number of motorcycles in many less advanced economic countries (LAEC) with emerging economies due to increased urbanisation and personal wealth. In contrast, an opposite trend is occurring in advanced economic countries (AEC), with cars replacing motorcycles as income grows (Lai et al., 2006; Yamamoto, 2009; Chiou et al., 2009; Pongthanasawan and Sorapipatana, 2010). Motor vehicle crashes and injuries are an inevitable consequence of a high motorcycle population (Abdul Manan and Várhelyi, 2012; NHTSA, 2008; Preusser et al., 1995; Radin Umar et al., 1995; Ranney et al., 2010; Sharma, 2008).

Vehicle ownership is typically influenced by socioeconomic factors (De Jong et al., 2004) and can be modelled by aggregated or disaggregated models. The aggregate model predicts changes

in vehicle ownership, particularly for geographic regions during certain periods (Tanner, 1978; Khan and Willumsen, 1986; Button et al., 1993; Dargay and Gately, 1999; Sillaparcharn, 2007; Ingram and Liu, 1999). The advantage of this technique is that the models do not require extensive survey data. The alternative model uses disaggregate data to model vehicle ownership at the level of users (Whelan, 2007). This model relates an individual's propensity to own a vehicle to various owners' attributes, such as demographic, socioeconomic, household and geographical characteristics, vehicle price, and the availability of other transport modes (Delbosc, 2013; Chiou et al., 2009; Nolan, 2010). Yet, due to the need to collect extensive and detailed socioeconomic survey data, this model structure has rarely been adopted in developing countries.

Over the last three decades, many researchers have investigated the relationship between car ownership and income growth. Linear and logarithmic functions were commonly employed to describe the long-term growth of car ownership in earlier studies (Khan and Willumsen, 1986). However, one of the limitations of these models was that they led to unreasonable vehicle ownership growth at higher income levels. In response to this limitation, a sigmoid curve function with the saturation level of car ownership was adopted (Tanner, 1983; Button et al., 1993; Ingram and Liu, 1999; Dargay and Gately, 1999; Whelan et al., 2000; Whelan, 2001; Pongthanasawan and Sorapipatana, 2010; Sillaparcharn, 2007). With this model, car ownership increases slowly at lower income

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levels, then increases rapidly, and finally approaches saturation level.

Previous studies of the relationship between population density and car ownership revealed that a higher spatial or urban population density was associated with lower car ownership (Yamamoto, 2009; Lam and Tam, 2002; Clark, 2007, 2009; Khan and Willumsen, 1986; Hess and Ong, 2002; Riley, 2002). This is probably due to greater congestion, increased parking constraints and costs, and a more efficient public transport system in densely populated areas (Dargay and Gately, 1999; De Jong and Van de Riet, 2008; Schwanen et al., 2004). Population density was found to have a positive effect on motorcycle ownership (RAND, 2004). According to Wong (2013), this was due to motorcycles offering a more efficient and cheaper means of transport than cars in population-dense areas. Several studies demonstrated that increases in road density were associated with growth in car ownership (Sehatzadeh et al., 2011; Cao and Huang, 2013; De Jong and Van De Riet, 2008). Cao and Huang (2013) indicated that a 1% increase in road density raised car ownership by 0.13%. Motoring cost was also identified as a significant determinant of car ownership, with studies showing that higher motoring costs reduced car ownership (Dargay and Vythoulkas, 1999; Dargay and Hanly, 2007; De Jong and Van de Riet, 2008). Romilly et al. (1998) estimated that a 1% increase in motoring cost decreased car ownership by 0.3% in the short term and 2.2% in the long term. Previous empirical evidence revealed that running cost had a greater impact than purchase costs on the elasticity of car ownership (Whelan et al., 2000; Dargay and Gately, 1999).

The literature on motorcycle ownership is rather scarce, with most studies conducted in East Asian countries, such as Taiwan, Malaysia, Indonesia, Thailand, Japan and Vietnam (Pongthanasawan and Sorapipatana, 2010; Sillaparcharn, 2007; Tuan, 2011; Tuan and Shimizu, 2005; Sanko et al., 2009; Hsu, 2005; Nagai et al., 2003; Dao and Duc, 2005). Previous evidence revealed an inverted U-shaped relationship between motorcycle ownership and income growth (Pongthanasawan and Sorapipatana, 2010; Sillaparcharn, 2007; Tuan, 2011; Senbil et al., 2007; Nishitatenno and Burke, 2014). Pongthanasawan and Sorapipatana (2010) indicated that as a country developed, motorcycle ownership increased but that it fell once income level exceeded the threshold level. The study attributed this finding to motorcycle ownership growing with the increasing demand for transport in the early stages of economic growth. Eventually, probably due to the prestige, convenience, safety and comfort, people shifted from motorcycles to car ownership as their income grew.

Although previous empirical studies have addressed the relationship between motorcycle ownership and income growth, there is little explanation provided for the mechanisms by which income growth leads to the inverted U-shaped relationship. The present study focused on understanding how economic growth affects the motorcycle to passenger car (MPC) ownership ratio and what factors underlie this relationship. In particular, several variables that are correlated with economic growth of a country, such as urbanisation, road density and a proxy for purchasing power with regards to vehicle purchases were used to explain this relationship. The findings of this study aim to enhance the understanding of the determinants of passenger car and motorcycle ownership and the mechanisms affecting the growth of passenger car and motorcycle ownership. This would allow policy makers to formulate more effective transport policies and strategies.

2. Data and variable description

The data used in this analysis contained a sample of 80 countries at various levels of economic developmental growth over the 48-year period between 1963 and 2010. The unbalanced panel

data consisted of 1,934 annual observations; certain variables were missing for some countries and some years in the sample.¹ The countries were classified into two groups: AEC (with the Human Development Index (HDI)² in 2010 of 0.86 or greater) and LAEC. The list of countries included in the sample is presented in Tables 1 and 2.

The dependent variable was the MPC ownership ratio, and it was derived by dividing the total number of motorcycles (including motorcycles and mopeds) by the total number of passenger cars for a particular country and the year. The data on motorcycle ownership and passenger car ownership were derived primarily from various editions of the International Road Federation (IRF) World Road Statistic annual yearbooks. Supplement data were derived from Asean Japan Transport Partnership Information Centre, United Nations Economic Commission for Europe Transport Division Database and International Road and Traffic Accident Database.

The per capita Real Gross Domestic Product (GDP) (Int \$ 2005 constant prices: Chain series) was used as a key variable and utilized as a proxy for income. The per capita GDP contributes to the change in the MPC ownership ratio because it determines the level of road users' affordability in purchasing motor vehicles. The per capita GDP was obtained from the Penn World Table version 7.0 (Heston et al., 2011). Data on the urban population percentage, which was used to examine the impact of urban population density on the MPC ownership ratio, were obtained from the World Development Indicator (WDI, 2009). The consumer price index (CPI)³, a measure for inflation, was used as a proxy for purchasing power with regard to vehicle purchases. This data is drawn from the WDI and it is only available for the year 1960 onwards.

The total road length per thousand population was used as another explanatory variable to determine the MPC ownership ratio. Previous studies have frequently used the total road length per thousand population to explain travel patterns and vehicle ownership (Bento et al., 2005; Ingram and Liu, 1999; Riley, 2002). Data on the this variable were obtained from the WDI and the IRF databases.

3. Methodology

The use of panel data regression methods has become increasingly popular with greater availability of panel data for cross-country data sets. Empirical studies have found that panel data are generally more informative, which offers greater variability, less linearity between variables, and provides more efficient estimates (Elhorst, 2010; Greene, 2003; Hsiao, 2003). Because the data used in this study is a panel data set, we used the panel linear regression with exogenous covariates.

A major concern of using panel data in regression analysis is the unobserved heterogeneity. Heterogeneity bias refers to the confounding effects of unmeasured time-invariant variables, which are omitted from regression models. Ignoring these effects could lead to inconsistent estimates of model parameters (Hsiao, 2003). Econometrically, the use of a fixed effects or random effects model could control for heterogeneity and provide consistent and efficient estimates of model parameters in the presence of

¹ The study by Shao et al. (2011) indicates that it is common to have unbalanced panel data for two main reasons. First, the sampling design is not balanced. Second, some data are missing, although the original design is balanced.

² The HDI, published annually by the United Nations, measures per capita income, life expectancy and educational achievement.

³ According to the WDI, CPI reflects changes in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly.

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