UNIVERSITI PUTRA MALAYSIA

RELATIONSHIP BETWEEN NATIONAL PRIVATE VEHICLE OWNERSHIP, URBANIZATION AND ECONOMIC GROWTH

CHU MAY YEN

FK 2021 45

RELATIONSHIP BETWEEN NATIONAL PRIVATE VEHICLE OWNERSHIP, URBANIZATION AND ECONOMIC GROWTH

By

CHU MAY YEN

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

July 2020

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DEDICATION

I would like to dedicate this thesis to my beloved husband, parents and my lovely children, Carenn, Cadenn and Careena.

I would not be able to complete my study without the endless support and encouragement from my beloved family.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

RELATIONSHIP BETWEEN NATIONAL PRIVATE VEHICLE OWNERSHIP, URBANIZATION AND ECONOMIC GROWTH

By

CHU MAY YEN

July 2020

Chairman : Associate Professor Law Teik Hua, PhD
Faculty : Engineering

National private vehicle (motorcycle and car) ownership varies among countries, cities and geographical regions but is strongly related to per capita income at different levels. During the early stages of economic development, the mode of transport is mainly motorcycles. As the countries' economy grows, due to safety, convenience and comfort, car demand increases. However, factors such as urbanization and price level greatly affecting the choice of travel mode. Three empirical investigations were conducted and the research objectives are as follows: (i) to evaluate the relationship between urbanization, price and income level on motorcycle ownership and the effects of interactions between these factors, (ii) to determine the effect of urbanization, inflation and income level on car ownership and the effects of interactions between these factors and (iii) to assess the relative growth in motorcycle ownership as compared to the growth in private car ownership and per capita income. To shed light on the above issues, the negative binomial technique was used for the first objective to analyse on a panel of 73 countries over a period of 51 years, from 1963 to 2013. However, for the second objective, the Gompertz model was applied to analyse on a panel of 73 countries between 1963 and 2013. Finally, panel linear regression analysis was conducted for the third study using time-series cross-sectional data of 76 countries between 1963 and 2013.

The first empirical study was to assess the effect of urbanization, price and per capita income on motorcycle ownership and the effects of interactions between these factors. Results indicated an inverse U-shaped relationship between the price level and motorcycle ownership. The estimated turning point of the inverse U-shaped relationship was found to increase with a rise in urbanization level. This inverse U-shaped relationship turned into U-shaped at a higher urbanization level. The results also confirmed the motorcycle-Kutznets relationship with per capita income and suggested that the inverse U-shaped varied with both price level and urbanization.

The turning point decreased with increased urbanization under low price level, whereas the turning point increased with increasing urbanization under high price level. The second study reports the results of an empirical analysis of an S-curve relationship between car ownership and per capita income. Rapid urbanization induces car ownership, but the deterioration of purchasing power during high inflation may suppress this effect. Thus, the impact of urbanization on car ownership may vary across different inflation rates. This study aimed to examine the effects of urbanization and inflation on the S-shaped curve relationship between car ownership and per capita income. The results indicated that car ownership showed relatively greater elasticity to per capita income under high urbanization levels and low inflation rates. The evidence presented in this study suggests that car ownership reaches a higher saturation level under higher than lower urbanization. The third empirical study examined the relative growth of motorcycles to the relative growth of cars with per capita income. The estimated result pointed to an inverse U-shaped relationship between the relative growth of motorcycles to the relative growth of cars with the per capita income. The underlying factors that contributed to this relationship were urbanization, price level and road density. The impact of the price level and road density on the relative growth of motorcycles to the relative growth of cars was estimated to be positive at all per capita income levels, whereas negative for urbanization in accordance with increases in the per capita income. The key finding of this study indicates that before the threshold point of per capita income the relative growth in motorcycle ownership is greater while the relative growth in car ownership is greater after the threshold.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

HUBUNGAN ANTARA PEMILIKAN KENDERAAN SWASTA NASIONAL, URBANISASI DAN PERTUMBUHAN EKONOMI

Oleh

CHU MAY YEN

Julai 2020

Pengerusi : Profesor Madya Law Teik Hua, PhD
Fakulti : Kejuruteraan

Pemilikan kenderaan persendirian (motosikal dan kereta) berbeza antara negara, bandar dan kawasan geografi tetapi berkaitan rapat dengan kenaikan pendapatan per kapita. Semasa peringkat awal pembangunan ekonomi, mod pengangkutan yang utama ialah motosikal. Apabila ekonomi sesebuah negara telah berkembang, peningkatan permintaan terhadap kereta kian meningkat disebabkan keselamatan, kemudahan dan keselesaan. Walau bagaimanapun, faktor seperti urbanisasi dan inflasi sangat mempengaruhi pemilihan mod perjalanan.Tiga penyelidikan empirikal telah dijalankan dan objektif penyelidikan adalah seperti berikut: (i) untuk menilai kesan urbanisasi, inflasi dan pertumbuhan ekonomi ke atas pemilikan motosikal dan kesan interaksi antara faktor-faktor ini, (ii) untuk menentukan kesan urbanisasi, inflasi dah pertumbuhan ekonomi ke atas pemilikan kereta dan kesan interaksi antara faktor-faktor ini dan (iii) untuk menilai kesan langsung dan tidak langsung inflasi ke atas pemilikan motosikal berbanding pertumbuhan dalam pemilikan kereta disebarkan melalui impak inflasi ke atas pertumbuhan ekonomi. Bagi memberi penerangan tentang isu-isu di atas, teknik negatif binomial digunakan untuk objektif pertama untuk menganalisis 73 buah negara dalam tempoh 51 tahun, dari 1963 ke 2013. Untuk objektif kedua, model Gompertz telah digunakan dan akhirnya, analisis regresi linear panel dilakukan untuk kajian ketiga menggunakan data keratan rentas siri masa 76 negara antara tahun 1963 dan 2013.

Kajian empirikal pertama adalah untuk menilai kesan urbanisasi, harga dan tahap pendapatan terhadap pemilikan motosikal dan kesan interaksi antara faktor-faktor ini. Hasil kajian menunjukkan hubungan berbentuk U terbalik antara tahap harga dan pemilikan motosikal. Titik perubahan meningkat dengan peningkatan urbanisasi dan menjadi berbentuk U pada tahap urbanisasi yang lebih tinggi. Hasilnya juga mengesahkan hubungan motosikal-Kutznets dengan pendapatan dan menunjukkan bahawa bentuk U terbalik berbeza dengan tahap harga dan urbanisasi. Titik

perubahan menurun dengan peningkatan urbanisasi di bawah tingkat harga rendah, sedangkan titik perubahan meningkat dengan peningkatan urbanisasi di bawah harga tinggi. Kajian empirikal kedua melaporkan hasil analisis empirikal hubungan lengkung-S antara pemilikan kereta dengan pembangunan ekonomi. Proses pembandaran yang pesat mendorong pertumbuhan pemilikan kerata, tetapi kemerosotan kuasa pembelian semasa kadar inflasi yang tinggi akan menekan kesan pembandaran. Oleh itu, kesan pembandaran terhadap pemilikan kereta mungkin berbeza mengikut kadar inflasi yang berlainan. Tujuan kajian ini adalah untuk mengkaji kesan pembandaran dan inflasi terhadap hubungan lengkung-S antara pemilikan kereta dan pembangunan ekonomi. Hasil keputusan menunjukkan bahawa pemilikan kereta mempunyai keanjalan yang lebih besar pada pendapatan per kapita semasa kadar pembandaran yang tinggi dan kadar inflasi yang rendah. Bukti yang dibentangkan dalam kajian ini menunjukkan bahawa pemilikan kereta mencapai tahap ketepuan yang lebih tinggi semasa kadar pembandaran yang lebih tinggi berbanding dengan kadar yang lebih rendah. Kajian empirikal ketiga mengkaji pertumbuhan relatif motosikal dengan pertumbuhan relatif kereta dengan pendapatan per kapita. Hasil anggaran menunjukkan hubungan berbentuk U terbalik antara pertumbuhan relatif motosikal dengan pertumbuhan relatif kereta dan pendapatan per kapita. Faktor asas yang menyumbang kepada hubungan ini adalah pembandaran, tahap harga dan kepadatan jalan. Kesan tahap harga dan kepadatan jalan terhadap pertumbuhan relatif motosikal kepada pertumbuhan relatif kereta dianggarkan positif pada semua tingkat pendapatan per kapita, sedangkan negatif untuk pembandaran sesuai dengan kenaikan pendapatan per kapita. Penemuan utama kajian ini menunjukkan bahawa sebelum titik perubahan pendapatan per kapita, pertumbuhan relatif pemilikan motosikal lebih besar sementara selepas titik perubahan pertumbuhan relatif pemilikan kenderaan lebih besar.

ACKNOWLEDGEMENTS

It is a pleasure to express my gratitude to the many individuals who have helped me in the preparation and completion of my study. First and foremost, I would like to express my deepest gratitude to my supervisor, Assoc. Professor Dr. Law Teik Hua, for his invaluable advice, encouragement, guidance and endless support, throughout the research study. I am grateful to work under his supervision and have learned to conduct research systematically and innovatively.

I would also like to thank the other members of my thesis supervisory committee, Assoc. Professor Dr. Hussain Hamid and Prof. Dr. Law Siong Hook for the assistance and support they provided at all levels of my study in Universiti Putra Malaysia.

My gratitude also goes to the members and students of Road Safety Research Centre for their support and company over these three years –Dr. Ng Choy Peng, Muzamir, and Alvin.

I sincerely thank my buddies who are always there to listen, motivate and providing moral support –Suk Ling, Boney and Siew Kin.

Last but not least, I would like to thank my beloved family members especially my parents, my husband, my mother-in-law and my children for their unconditional love, patience, sacrifice, encouragement, spiritual and emotional support through prayers.

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

Law Teik Hua, PhD
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Hussain Hamid, PhD
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Member)

Law Siong Hook, PhD Professor
School of Business Management
Universiti Putra Malaysia
(Member)

ZALILAH MOHD SHARIFF, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date : 11 February 2021

Declaration by graduate student

I hereby confirm that:

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Name and Matric No: Chu May Yen, GS45744

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LIST OF ABBREVIATIONS

Av	Average
CO_2	Carbon Dioxide
COPOP	Car Ownership per Population age 16-64
CPI	Consumer Price Index
EKC	Environmental Kuznets Curve
EUROSTAT	Statistical Office of the European Communities
GDP	Gross Domestic Product
HDI	Human Development Index
Inf	Inflation
IRF	International Road Federation
LR	Log-likelihood Ratio Test
Max	Maximum
Min	Minimum
MO	Motorcycle Ownership
MOPOP	Motorcycle Ownership per Population age 16-64
MPCO	Motorcycle to Private Car Ownership
NB	Negative Binomial
Obs.	Observation
PVO	Private Vehicle Ownership
PWT	Penn World Table
RGDP	Real Gross Domestic Product per capita
ROADL	Road Density
Std. Dev	Standard deviation
VO	Vehicle Ownership

URBRUR	Urban population over rural population
WB	World Bank
WDI	World Development Indicator
WDI	World Development Index
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

1.1 Introduction

Chapter 1 outlines the research questions addressed in this dissertation and discusses background issues related to the research. This chapter identifies the rationale underlying the need for a better understanding of the effect of the economy on national private vehicle (cars and motorcycles) ownership (PVO). Section 1.2 begins with an overview of the problem of national PVO worldwide, followed by a brief overview of previous studies on the relationship between national PVO and the economy. The objectives of the research are then described, followed by a discussion on the significance of the study and the scope of this research. An outline of the dissertation, including a brief account of the contents of each chapter, and the research contribution is then presented.

1.2 Background of the Study

Growth in national PVO can be expected following rapid economic development to meet increased travel demands. As the gap between travel time by public transport and a car increases, cars become more attractive (Limtanakool et al., 2006) and with increasing travel distance and time, car travel increases (Carse et al., 2013). Excessive development in PVO has led to many transport-related problems, such as traffic congestion, road safety and air pollution. Previous studies indicated that congested traffic conditions tended to lead to higher fuel consumption (Bao et al., 2017; Jiang et al., 2018). In 2014, worldwide, 23% of total CO_2 emissions were from fuel combustion-related to transport (freight, air and sea), and 20% of emissions were from road transport (International Energy Agency, 2016).

Motorcycles are the favoured mode of transport in South-East Asia countries[1] , as they are a relatively cheap form of transport and offer a fast means of travel on congested city streets. Furthermore, they require just a small parking space. The number of motorcycles has increased each year in South East Asia countries, with concurrent rises in the total number of motorcycle-related deaths. Motorcycle-related deaths account for 43% of all deaths in South East Asia countries (WHO, 2018). Automobile transport can be considered relatively safe as compared with that of motorcycles transport. For example, an investigation of motorcycle-related deaths indicated that riding a motorcycle was 39.4 and 17.5 times riskier (crash risk per distance) than driving a car in the United Kingdom and Australia, respectively (Houston, 2011). Radin Umar et al. (1995) indicated that the motorcyclist fatality rate was 17 times higher than the car fatality rate in Malaysia. Although automobile transport may be associated with reduced mortality rates, rapid growth in automobile

[1] The percentage of motorcycles in South-East Asia countries, such as Vietnam (95%), Cambodia (72%), Laos (77%), Philippines (55%) and Malaysia (47%).

numbers contributes to air pollution and traffic congestion. Automobile transport contributed 75% of the total road transport emissions (Fontaras et. al., 2017).

Traditional approaches to alleviating the adverse effects of increases in car ownership predominantly rely on raising driving costs, for example by introducing congestion charges in central business districts and imposing high taxation on cars. One approach adopted by higher-income countries is to enhance the efficiency and convenience of public transportation services. In contrast, lower-income countries may not be able to invest in such services because doing so would require sacrificing investment in social development, a more crucial area. Against this background, suitable approaches to transport management are required that do not impose large financial burdens on consumers and are suited to diverse conditions in different countries.

Recently, several studies confirmed an inverse U-shaped relationship between motorcycle ownership (MO) and income (Sillaparcharn, 2007; Nishitateno and Burke, 2014; Law et al., 2015). Nishitateno and Burke (2014) referred this relationship as motorcycle-Kuznets curve. According to this relationship, MO increases when countries shift from low-income to middle-income status, with associated developments in urbanisation and road infrastructure, as well as changes in travel needs. This inverse relationship between MO and income indicated that MO grows as a nation's economy develops, but decreases once incomes exceed a specific level (as illustrated in Figure 1.1). As reported in previous studies (Dargay and Gately, 1999; Dargay and Hanly, 2007; Wu et al., 2014), car ownership grew moderately in the early stages of income level, then rose at an accelerating rate until a maximum was reached at an inflection point, after which car ownership continued to grow but at a decelerating rate, finally stabilizing as saturation was approached at higher-income level. This growth trend was represented by an S-shaped growth curve, as shown in Figure 1.2.

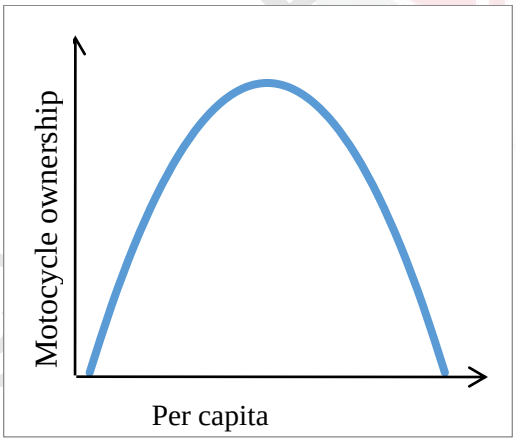

Figure 1.1 : Illustration of motorcycle ownership with per capita income (Nishitateno and Burke, 2014; Law et al., 2015)

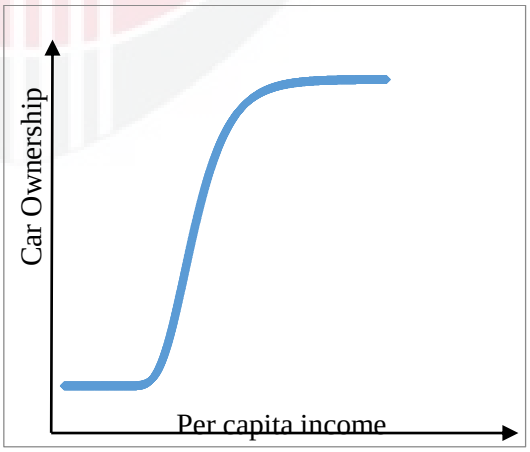

Figure 1.2 : Illustration of car ownership with per capita income (Dargay and Gately, 1999; Wu et at. 2014)

1.3 Problem Statements

The earlier explanations in Section 1.2 put forward for growth in PVO assume that PVO is solely determined by income levels, without considering the effect of price level. The economic literature consistently indicates that inflation raises the price of services and goods, and hence reduces buying power (Molana, 1990; Manzoor et al., 2011). Thus, increased demand for vehicles with lower operating and purchase costs, such as motorcycles and mopeds, can be expected as price increases. However, as noted by Law et al. (2015), the positive impact of inflation on MO declined as income continued to grow. Law et al. (2015) argued that this was due to cars becoming essential and more affordable as incomes rose to higher levels. Based on this premise, the effect of price level on motorcycle or car purchases can be expected to vary at different per capita income levels. Thus, per capita income levels can be expected to affect the inverse U-shaped relationship between MO and per capita income.

Growth in the export of natural resources, manufactured goods and agricultural products facilitates rapid urbanisation and growth of countries (Schultz, 1953; Zhang, 2017; Gollin et al., 2007, 2016). Urbanisation is defined as a process in which there is a gradual increase in the concentration of a population residing in urban area, with associated development and constriction (housing, road, etc.) (Shin, 2015). Urbanisation induces growth in car ownership due to the need to travel longer-distance to commercial centres (De Vos and Witlox, 2013), but high inflation may suppress this effect, with erosion of purchasing power. To date, no studies have examined the effects of inflation and urbanisation on the S-shaped growth curve relationship between car ownership per capita income. Knowledge of the link between car ownership and per capita income is crucial for policy makers, as it is important for developing effective approaches for urban transportation planning and reducing environmental health impacts. Therefore, the S-shaped link between car ownership and per capita income requires further investigation.

According to Law et al. (2015), motorists tended to select cheaper modes of transportation (e. g. motorcycles and mopeds) under high inflation, which led to higher relative growth in MO as compared to growth in private car ownership. Increase in price of goods due to inflation may affect the choice of mode at a different level of per capita income. Furthermore, urbanisation induced travel demand but distance to travel may affect the choice of transport mode. Thus, all these factors may impact the relative growth of MO to private car at different level of per capita income. Specifically, the substitution effect of motorcycle to car at higher per capita income level.

The inverse U-shaped relationship between MO and state of economy, and car S-shaped growth curve gives rise to the following questions.

1. At what level of income does the turning point of the motorcycle-Kuznets curve will occur?
2. What impact do high urbanisation and high prive level have on the turning point of the motorcycle-Kuznets curve?
3. Are decreases in purchasing power caused by increases in price level associated with a corresponding increase in MO?
4. What do different levels of inflation have on the impact of urbanisation on car ownership?
5. What effects do different urbanisation and inflation conditions (i.e. high urbanisation/low inflation or high inflation/low urbanisation) have on local authority in transportation-related infrastructure planning?

1.4 Objectives of the Study

The primary objective of this study was to assess the relationship between national private vehicle (motorcycles and cars) ownership, urbanisation, and economy. The specific objectives were as follows:

1. To examine the effect of urbanisation, price level and per capita income on MO and the effects of the interactions between these factors
2. To investigate the effects of urbanisation and inflation rate on the S-shaped growth curve relationship between car ownership and per capita income
3. To assess the relative growth in MO as compared to relative growth in car ownership and per capita income

1.5 Significance of the study

The significance of this research is contributing to the current literature on national PVO and per capita income in three ways. First, this dissertation provides an understanding of the motorcycle-Kuznets relationship between MO with per capita income and between MO with the price level. The verification of this finding would help to determine the investment and precautious measurement needed for different urbanisation, price and economy level. Second, this dissertation assessed the effect of urbanisation and inflation on the S-shaped curve for car ownership and per capita income. Verification of the findings of this study could help to determine the type of investment needed at different urbanisation and inflation levels to ease urbanisation and transportation policies. Third, by assessing the effect of per capita income on the MPCO, this dissertation provides insights into the transportation field. The finding of this study is crucial to determine the type of investment needed at various mixed-mode conditions of motorcycle and car at different per capita income levels.

1.6 Scopes of the study

This study focused on national private vehicle (motorcycles and cars) ownership, urbanisation, and per capita income in a panel data with different levels of development and growth over a 51-year-period (1963 to 2013). The sources of all data used were drawn from,

(1) International Road Federation (IRF), World Road Statistic (WRS)
(2) Penn World Table 9.0 (PWT 9.0)
(3) World Development Indicator (WDI)
(4) European Statistics (EUROSTAT)

The sample size of the countries chosen was decided due to the reliable observation of the number of motorcycles and cars for each country. Countries being omitted mainly due to missing data from IRF. The countries chosen were those with at least a minimum of 5 years' observations during the study period to provide a comprehensive and reliable data set for analysing the research problems.

1.7 Outline of the dissertation

This dissertation aimed to evaluate the relationship between national PVO and urbanisation, and economy. With this aim in mind, it focused on three empirical studies and is structured into five chapters.

To provide a context within which to consider these empirical studies, the relevant literature is discussed in Chapter 2. An overview on global development trends in growth of national PVO according to the types of private vehicle (motorcycles and cars) is presented to aid understanding of the association of growth of national PVO with per capita income. Then, Kuznets curve in relation to MO and per capita income is discussed from theoretical and empirical perspectives. A review of car ownership model is presented, followed by review of the relationship between inflation and income. Lastly, the role of urbanisation in growth in PVO is discussed.

Chapter 3 outlines the methodology of the research. This chapter begins by presenting a flow chart of the study design. The frameworks and model for the three empirical studies are then presented. This chapter also outlines the data sources and descriptions of the variables, in addition to the methodology employed in analysing the data.

Chapter 4 presents the results and discussion sections. In total, three empirical investigations were conducted. The first empirical study assessed the relationship between MO and per capita income in terms of the motorcycle-Kuznets curve. The second empirical investigation analysed the relationship between car ownership and per capita income. The third empirical study assess the relative growth in MO as

compared to relative growth in car ownership and per capita income.

Chapter 5 is the final chapter and concludes the research. This chapter presents the main findings of the dissertation, research contributions, policy implications, limitations and directions for future research.

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BIODATA OF STUDENT

The student was born on 17th August 1982 in a small and humble city in Kajang, Malaysia. She was awarded a double degree with Bachelor of Engineering (Civil) (Hons.) majoring in Civil and Environmental Engineering at the National University of Malaysia and Bachelor of Science in Civil Engineering at the University Duisburg-Essen, Germany in 2007.

She received her Master of Science (Civil and Structural Engineering) from National University of Malaysia in 2010. Following this, she served as a lecturer in UCSI University, Kuala Lumpur in December 2010. In 2016, she pursued her PhD in Highway and Transport Engineering in Universiti Putra Malaysia (UPM) and worked as a research assistance in Road Safety Research Centre, UPM for 3 years.

LIST OF PUBLICATIONS

Chu, M.Y., Law, T.H., Hamid,H., Law, S. H., 2019. The motorcycle to car ownership ratio: inflation and it's indirect effects,IOP Conf. Series: Materials Science and Engineering, 512(2019) 012015.

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