# Role of Attitudes and Norms for Students Car Ownership Intention

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# Abstract

Understanding motivations to buy a car for the first time is an important problem as car ownership is increasing in many developing countries and finding ways to control such developments appear difficult. Higher affordability of cars due to increasing income, arguably coupled with increasing perceived expectations to buy a car, possibly as a prestige object, are seen as a key reason for the growing car ownership in developing countries.

In Indonesia this trend towards more and larger vehicles, especially for the younger generation (age cohort until 30), appears to keep continuing despite the lower average speeds of cars compared to motorcycles in the already congested cities. Beside Indonesia, other developing countries such as China and Lebanon also experience higher intention to own a car by their younger generation. Contrary to this is the discussion on "peak car" in developed countries. The peak car discussions suggest that especially younger people have less desire to drive and purchase cars.

In the first stage of this dissertation, the focus is on car-ownership motivations in Bandung, Indonesia where cars have become the main contributor to traffic congestion. Attitudes towards cars are suggested as being important to explain car ownership trends. By utilizing data from 500 undergraduate students from one university in Bandung, five factors regarding car perception are constructed through principle component analysis: *symbolic/affective*, *arrogant prestige*, *independence*, *comfort*, and *social/env. care*. These five factors plus some socio-demographic variables, such as monthly income, are used as explanatory variables for modelling car ownership using structural equation modelling. The results suggest that primarily *independence*, *arrogant prestige* and some socio-demographic variables significantly influence car purchase decision.

This dissertation expands these results by aiming to understand the role of personal background and the country context on car ownership intentions of younger people in seven countries (China, Indonesia, Japan, Lebanon, Netherlands, Taiwan, and United States of America). A web survey asked students about their attitudes towards car and public transportation, social norms, their socio-demographic situations, current mobility patterns and the intention to own a car after graduation. A descriptive analysis is conducted as well as correlation analysis of the survey data focusing on explaining intentions to own a car in the future. From the results, it is found that there is a significant difference between developing and developed countries; students in

developed countries, particularly the Netherlands, have less desire to purchase cars. The construct "Expectations of others to buy cars" (EOTBC) appears an important determinant of purchase intentions whereas income and the symbolic affective meaning of the car are less correlated with intentions. There are though significant country specific differences, Dutch students appear to have a strong desire to be perceived as not-following expectations, whereas in the other six countries, especially Lebanon, the situation is reversed.

The study is continued by constructing a series of ordered hybrid choice models (OHCM) that focus on exploring the role of *EOTBC* in the surveyed countries. It is also found here that *EOTBC* appears to significantly influence the likelihood to buy a car in the future, when controlling for other factors. In the final part of the dissertation, *EOTBC* is interacted with "strength of influence of others to buy a car" (SOI). The interaction factor reflects perceived purchase pressure by others and is accordingly named "Subjective Social Norms" (SSN). Three possible *SSN* formulations and their psychological justifications are discussed. In the preferred model specification, *SSN* is constructed again as a latent variable expressing the joint pressure from different groups. In addition, here the result suggests that *SSN* significantly influences car ownership intentions.

In conclusion, this dissertation finds strong evidence that attitudes and norms significantly influence car ownership motivations. The study therefore makes an empirical as well as methodological contribution to travel behaviour research. Policy implications, especially for Indonesia, are discussed though remain vague, given the limited population sample from undergraduate students only. The comparison of Indonesia with other developing countries, especially Taiwan suggests though that if in the future, GDP and transportation infrastructure are improved, *SSN* might become a significant determinant of car ownership intentions.

**Keywords:** car ownership, developing countries vs developed countries, attitudes towards cars, norms, structural equation modelling, ordered hybrid choice model

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Kyoto, February 26th, 2015

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# Declaration of Contribution

At various stages during my PhD study, some collaboration has been taken place with colleagues working on the subject. My supervisor, Prof. Satoshi Fujii; my co-supervisor, Associate Prof. Jan-Dirk Schmöcker; Assistant Prof. Maya Abou-Zeid of American University Beirut; Associate Prof. Joan Walker of University California at Berkeley; Associate Prof. Dick Ettema of Utrecht University; and Assistant Prof. Tzu-Chang Lee of National Cheng Kung University advised me at several stages.

The review on the role of social norms in car ownership in Chapter 3 was carried out in collaboration with Assistant Prof. Maya Abou-Zeid during her stay in Kyoto University in 2012 and subsequently jointly published in Abou-Zeid et al (2013). I am a coauthor of that paper and have contributed to it at various stages. For all other chapters and accompanying publications, I declare that I am the first author and took the lead role. My supervisors and collaborators only took an advisory role and supported the data collection.

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(Prawira Fajarindra Belgiawan)

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(Associate Prof. Jan-Dirk Schmöcker)

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(Prof. Satoshi Fujii)

# Preface

Parts of this thesis have been published in the following papers

I. Abou-Zeid, M., Schmöcker, J.-D., Belgiawan, P. F., & Fujii, S. (2013). Mass effects and mobility decisions . **Transportation Letters**, 5(3), 115–130. doi:10.1179/1942786713Z.00000000011 **(Chapter 3)**

II. Belgiawan, P. F., Schmöcker, J.-D., & Fujii, S. (In Press). Understanding car ownership motivations among Indonesian students. **International Journal of Sustainable Transportation**. doi:10.1080/15568318.2014.921846 **(Chapter 4)**

III. Belgiawan, P.F., Schmöcker, J.-D., & Fujii, S. (2012). Explaining the desire to own a car among Indonesian students. In **Proceedings of the 32nd Japan Society of Traffic Engineers Conference** (pp. 259-266). Tokyo: Japan Society of Traffic Engineers **(Chapter 4)**

IV. Belgiawan, P. F., Schmöcker, J.-D., & Fujii, S. (2013). Effects of peer influence, satisfaction and regret on car purchase desire. Procedia Environmental Sciences, 17, 485-493. doi:10.1016/j.proenv.2013.02.063**(Chapter 4)**

V. Belgiawan, P. F., Schmöcker, J.-D., Abou-Zeid, M., Walker, J., Lee, T.-C., Ettema, D. F., & Fujii, S. (2014). Car ownership motivations among undergraduate students in China, Indonesia, Japan, Lebanon, Netherlands, Taiwan, and USA. **Transportation**, 41(6), 1227-1244. doi:10.1007/s11116-014-9548-z **(Chapter 5)**

VI. Belgiawan, P. F., Schmöcker, J.-D., Abou-Zeid, M., Walker, J., & Fujii, S. (2015). The Role of Expectation of Others on Students' Likelihood to Buy a Car. **Proceedings of The 94th Transportation Research Board Annual Meeting**. Washington D.C. **(Chapter 6)**

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# Chapter 1

# Introduction

## 1.1. Background

Understanding motivations to buy a car for the first time is an important problem as car ownership is increasing in many developing countries and finding ways to control such developments appears difficult. Higher affordability of cars due to increasing income, arguably coupled with increasing perceived expectations to buy a car, possibly as a prestige object, are seen as a key reason for the growing car ownership in developing countries. For example, a particular trend of South-East Asian countries is the upgrade process from current motorcycles owners to purchase cars. Van et al.(2010) show that this trend will lead to significantly increasing congestion levels in Hanoi and similar developments can be expected in several other major South-East Asian cities. This trend towards more and larger vehicles appears to keep continuing despite the lower average speeds of cars compared to motorcycles in the already congested cities and despite the well observable other environmental side effects, such as air and noise pollution, accidents and land-use developments trends are also well known.

In Indonesia, similar trend appears to keep continuing. Indonesia, with a total population of 240 million people, is the world's fourth most populous country (United Nations, 2013). In many islands of the country the number of motorized vehicles rapidly increases according to Statistics of Indonesia (2013) in 1987 Indonesians owned around 6 million motorcycles, in 1995 ten million and by 2011 the 80 million motorcycles mark has been reached. Car numbers also keep increasing, though not as fast as motorcycle numbers. In 1987, there were around 1 million cars and by the end of 2011, there were already 10 million private cars on Indonesian streets (Figure 1-1).

Although the number of motorcycles exceeds the car numbers still by a factor eight, the recent increase in cars are the main cause of traffic congestion. In Bandung, one of the cities this study will focus on, car ownership levels reached 115.2 cars/thousand people in 2010 (Statistics of Bandung City, 2010) with rapid continuous growth expected. Furthermore, the trend towards more cars is difficult to control in Indonesia, as almost no cities in Indonesia, except for Jakarta, have an advanced mass

transportation system such as bus rapid transit (BRT). In Bandung, according to Joewono and Kubota (2005), 61.2% of Public Transport (PT) is operated in form of Paratransit (Angkot) while the remainder is bus, taxi and rickshaw.

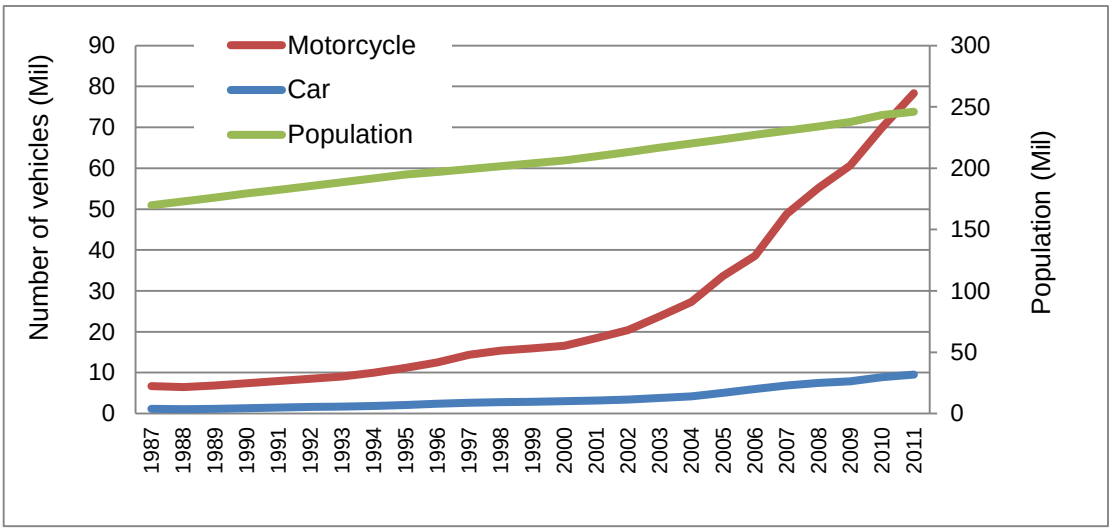


Figure 1-1 Population and Motorized Vehicles in Indonesia 1987-2011. Source: Statistics Indonesia (2013)

Other studies in developing countries find that younger generation have intention to buy a car in the future even though they currently have no car, particularly students in China (Zhu et al., 2012) and Lebanon (Nakkash, 1999).According to Nakkash (1999), 71% of mode choice in greater Beirut area is dominated by cars.

Contrary to this is the discussion on "peak car" in developed countries. Peak car is a hypothesis that travel by passenger vehicles has not grown much recently in a number of the highest income economies, and has even declined, where more income no longer translates into more car travel when income is very high (International Transport Forum, 2011). A number of recent studies from the developed country have found that younger generation, known as "generation Y" seems to use car less, for example in USA (Kuhnimhof et al., 2013) and Netherlands (van der Waard et al., 2013). Sivak and Schoettle (2012) found that in Japan and 6 other developed countries, the number of young people who have driving license is decreasing. Some cite lifestyle changes as an explanation (Institute for Mobility Research, 2013), such as increases in part-time rather than full-time work, living with parents longer, and delaying having children.

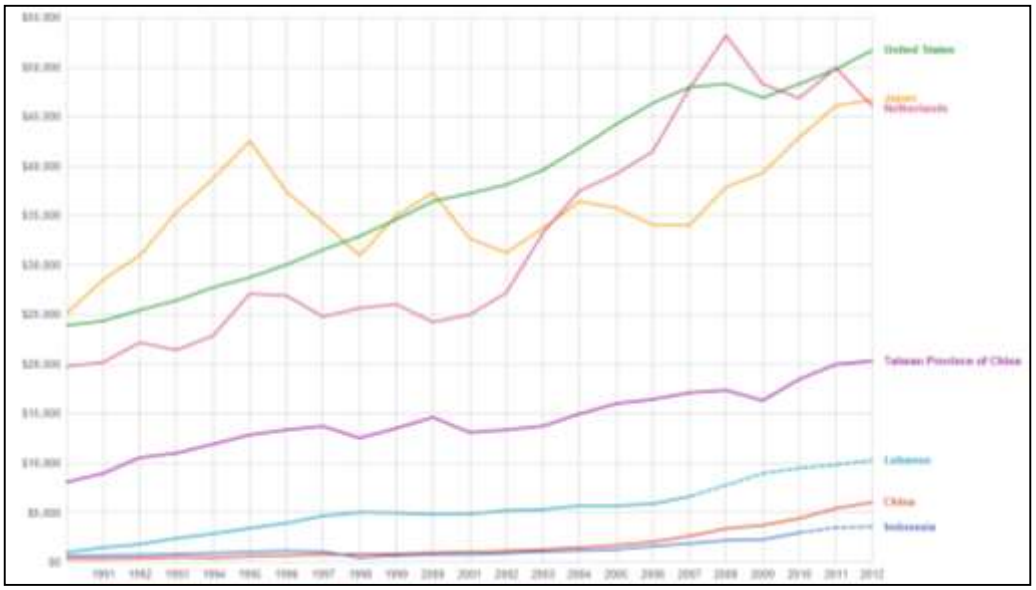

Figure 1-2 GDP Per Capita, Current Price, 7 Countries. Source: IMF (2013)

As shown in Figure 1-2, Netherlands, Japan, and United States belonged to developed countries with GDP per capita above US$40,000. In developed country, such as Japan the number of population in 2010 is increasing from 122 million in 1990 to 128 million people (United Nations, 2013), while the number of car ownership also increasing from 286 per 1,000 people in 1990 to 458 per 1,000 people in 2010 (Oak Ridge National Laboratory, 2013). In USA, the number of population is increasing from 255 million people in 1990 to 312 million people in 2010 (United Nations, 2013), while cars are decreasing from 564 per 1,000 people to 413 per 1,000 people (Oak Ridge National Laboratory, 2013). In Netherlands, the number of population is also increasing from 14.8 million people in 1990 to 16.6 million in 2010 while car ownership number also increasing from 294 cars per 1,000 people in 1990 (Statistics Netherlands, 2013) to 406 cars per 1,000 people in 2010.

Taiwan belonged to semi-developed country, advance economic country (IMF, 2013) with GDP per capita around US$20,000. It is also experienced rapid population growth over the past 60 years (United Nations, 2013). In 2010, Taiwan total population is 23 million people increasing from 20 million people in 1990. The passenger cars in Taiwan at the end of 2010 are 251 per 1,000 people, while motorbike ownerships at the end of 2012 are 649 per 1,000 people respectively (DGBAS, 2013). The latter figure, the highest in the world, illustrates the prevalence of motorbikes in Taiwan. With this background, the students in Taiwan use motorbike a lot. Although 90.6% of them grew up with cars in their family, only 41.0% are regular car user.

Other countries that belonged to developing countries group with GDP per capita around US$15,000 and below are Indonesia, China, and Lebanon. Indonesia, with a total population of 240 million people, China with a total population of 1.36 billion people and Lebanon with a total population of 4 million people in 2010 are countries that experience rapid population growth over the past 60 years (United Nations, 2013). This is also followed by rapid increase of car ownership growth. In Indonesia the number of car ownership increase from 7 cars per 1,000 people in 1990 to 37 cars per 1,000 people in 2010 (Oak Ridge National Laboratory, 2013). In China, the car ownership rates growing from 2 cars per 1,000 people in 1990 to 25 cars per 1,000 people in 2010 (Oak Ridge National Laboratory, 2013). In Lebanon, estimates of car ownership range from 1 car for every 3 persons (Ministry of Environment, 2011) to 1 car for every 2 persons (Ministry of Environment, 2013).

From the information above, it seems that many countries facing the same problem in term of the high number of car ownership. This trend will lead to significantly increasing congestion levels and other negative side effects, such as air and noise pollution, accidents etc. However, in some developed country there is a diminishing trend of car ownership in younger generation (Generation Y). Therefore, to change future mobility, better start from today younger generation. To understand car usage trends and their underlying factors may be useful for deriving policy measures to reduce the usage of cars.

In general, decisions of all kinds including car ownership are influenced by a multitude of factors. Among others, it is well known that the perceived usefulness of an option is often influenced by not only one's perception but also the perception that the decision maker supposes others to have on this option. This has led to a large literature on the role of "expectation of others" on decision-making. Asch (1951) already concludes that "a substantial minority yielded, modifying their judgment in accordance with the majority," indicating the role the general wider social network has on one's decisions. Similarly, to explain travel behaviour related decision-making, the theory of planned behaviour (TPB) is often referred to (Ajzen, 1985; 1991). This theory posits that the immediate antecedent of behaviour is behavioural intentions, which in turn has several determinants that include "subjective norm." The strength of subjective norm refers to an individual's perceptions of how others expect him/her to behave regarding the behaviour in question as well as the individual's motivation to comply with the expectations of those important others. Further, the growing literatures on explaining decisions with social network theory are partially based on the idea that the expectations one perceives determine decisions.

## 1.2. Research Objective

One of the objectives in this dissertation is to break down persons' motivations to purchase cars in order to understand how one possibly can induce a shift towards more sustainable modes. The hypothesis is that not just income but also attitudes towards cars can explain car purchases and travel behaviour. This is in line with studies on soft transport policy measures such as mobility management where it is found that through communicative methods individual attitudes can be influenced, sustainable habits can be formed and a change in travel behaviour is possible (Gärling et al., 2001; Fujii & Gärling, 2003; Taniguchi et al., 2007).

According to Fujii and Gärling (2003), an increase in the frequency of using a travel mode causes the development of a habit of using this travel mode and weakens the choice tendency towards alternative modes; this is found for PT as well as for car choice. Gärling et al.(2001), mention that frequent drivers who are forced to change to PT for a short period continue to choose PT more frequently than before the forced behavioural change. One might hence concludes that it is possible to induce a shift to more sustainable modes by encouraging or enforcing sustainable habits at one life stage.

In particular influencing younger people´s habits appears to be important. According to e.g. Lanzendorf (2003) and also Simma and Axhausen (2003), the way one grows up influences the way one travels, including habits and one's perspectives on the car, for the rest of one's life course. Another study from the public health domain (Millstein & Litt, 1990) shows that habits developed during the adolescence period will have a significant impact on the lifelong lifestyle of individuals. Furthermore, in particular, commuting behaviour is mostly habitual and habits are usually formed immediately after getting a job. It is expected that these habits be influenced though by behavioural intentions developed before getting a job (Fujii & Gärling, 2003). Thus, the main foci of this research are university students where it is expected that their current habits could influence their commuting behaviour not only presently but also after they graduate and obtain a job.

This dissertation also hypothesizes that maybe also here partly a "chain-reaction" related to expectations of others to buy a car (EOTBC) might be one of the reasons of car purchase intention. Initially some people are less motivated to buy a car, be it due to environmental values or generally because PT has become so good that a car is not needed anymore. Therefore, it starts to become more socially expected not to have a car and hence the expectations reduce. Another objective of this dissertation is to quantify the relative importance of EOTBC and the interaction between expectation of others

and strength of influence of others, namely subjective social norms (SSN) compared to other factors that are usually considered to explain car ownership.

In order to propose policies to control car ownership in Indonesia, this dissertation is started from understanding students' car ownership in Indonesia, what factors determine it. Then the study is expanded by involving three developing countries which also experiencing severe traffic congestions due to increasing of cars. This study also includes three developed countries that according to several studies mentioned before, experiencing a "peak car" situation. By doing the comparative study between developed and developing countries, it is hoped that how developed countries reach the state of peak car can be learnt and finally some policies to control the number of car ownership in developing countries mainly in Indonesia can be proposed. To summarize in this dissertation the objectives are:

1. To understand the factors determining car purchase decisions especially attitudinal factors and other variables that lead to actual car purchases and desire to buy cars in the future among students in Indonesia (Bandung)
2. To analyse the differences among university students in the seven countries in terms of their stated intentions to buy a car in the future (next 10 years) using attitudinal factors, norm factors and other variables.
3. To explore the role of attitudes and norms on car purchase intentions in more detail between developed and developing countries.
4. To explain more about how perceived expectation are built up, by proposing several formulation of how SSN (interaction between expectation of others to buy cars and strength of influence of others) influences car intention.
5. To compare the results of role of attitudes and norms between Indonesia and other countries in order to propose policies to control the number of car ownership in Indonesia.

## 1.3. Outline of the Dissertation

This dissertation is organized into seven chapters. This introduction chapter explains about background of the study, objectives of the study and the outline of the dissertation. Chapter 2, "Attitudes and Car Ownership Modelling," reviews previous studies related with history of car ownership modelling as well as the role of psychological determinants, attitudes in car ownership modelling. Chapter 3, "Social Norms and Car Ownership," reviews literature that explains the role of social norms or mass effect in car ownership intentions. In this chapter, empirical evidences of social norms in transportation field as well as outside transportation are also discussed.

Chapter 4, "Role of Attitudes for Car Ownership Decisions of Students in Bandung City," focuses solely on undergraduate students of Bandung City, Indonesia. In this chapter, how the data is gathered and how the questionnaire is design are discussed. The discussion is continued by showing the descriptive analysis and exploring determinant factors mainly attitudes towards car ownership. Some significant factors are found for car ownership models (structural equation modelling) as well as car desire model (binary logistic regression). This chapter also briefly discuss about the effect of peer influence towards car ownership.

Chapter 5, "Descriptive Analysis of Students Car Ownership in Developed and Developing Countries" discusses about mobility context of the seven surveyed countries as well as the data collection method, which consist of respondent selection as well as questionnaire design. The description about respondent's car ownership present, past and future as well as their mobility pattern are shown here. This chapter continues by discussing possibly explanatory variables for car intention models. Further, the correlation between car purchase intention and possibly explanatory variables in the seven countries are also shown. Finally, the correlation between EOTBC and other variables also presented here since EOTBC is one of the focus for the subsequent chapter.

Chapter 6, "Ordered Hybrid Choice Models with Expectation and Subjective Social Norms as Explanatory Factors," presents the ordered hybrid choice model (OHCM) of car ownership intention with latent factors. The role of EOTBC for four sample groups i.e., all samples, developed countries only, developing countries only, and country specific EOTBC, are distinguished here. Further, this chapter presents several models where EOTBC and "strength of influence to buy a car" are interacted. The term used as the name of the interaction factor is Subjective Social Norms (SSN). Different model specifications are discussed that might explain the role of social influences in mobility decisions. The significant results are used for policy recommendation especially for developing countries.

Chapter 7, concludes this study by summarizing the central findings of this study and discussing important policy implications, shortcoming of the study as well as recommendation for future study and, finally, concluding the contribution of this study.

In Appendix A, the questionnaire used for Chapter 4 is presented in the first part, while in the second part the questionnaire used for Chapter 5 and Chapter 6 is also presented. Appendix B shows the model specification of structural equation modelling for Chapter 4. Finally, Appendix C shows the model specification of ordinal hybrid

choice model used for Chapter 6. The structure of this dissertation is shown in Figure 1.3.

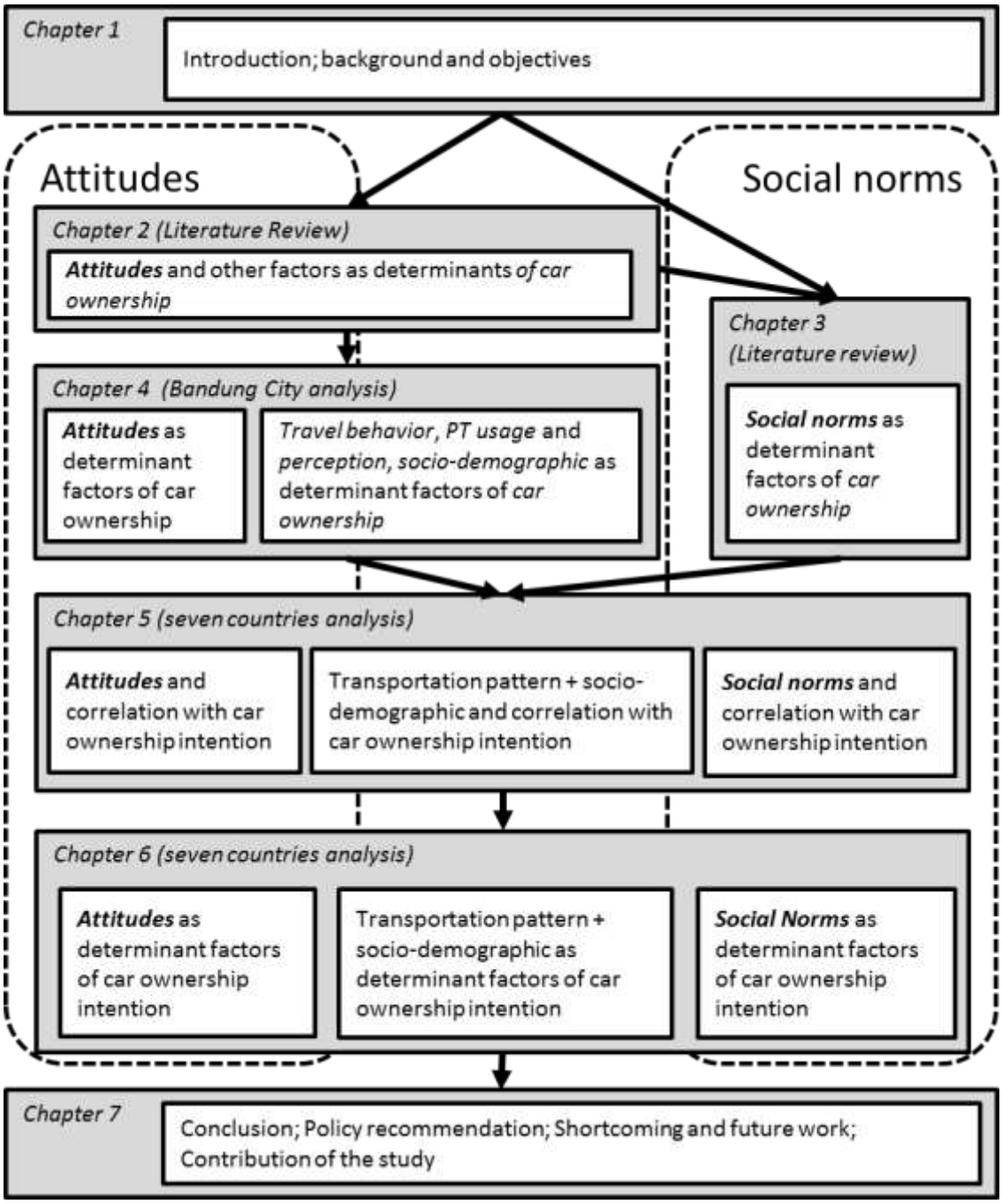


Figure 1-3 Structure of dissertation

# Chapter 2

# Attitudes and Car Ownership Modelling

## 2.1. Introduction

There is a rich body of literature on factors that explain car ownership. Those research can be categorized into two levels, aggregate or disaggregate. Aggregate model uses accumulation of household decisions at different geographic scales such as traffic analysis zone, region, state, or even country level to explain car ownership whereas disaggregate model uses individual or household as the basic unit of analysis. Several researchers have made reviews and comparison on previous car ownership research (De Jong et al., 2004).

De Jong et al.(2004) distinguish previous research of car ownership from 1995 into several model categories such as: aggregate time series models, aggregate cohort models, aggregate car market models, etc. These models were compared on the basis of sixteen criteria ranging from level of aggregation, data requirement, inclusion of attitudinal variables etc. Most of the models can be categorized in to static or dynamic (based on data span period); short or long term (based on forecast horizon); and also aggregate or disaggregate (based on data type).

A recent car ownership model review is conducted by Anowar et al. (2014) which categorizes car ownership modelling approaches into four types i.e. exogenous static models, endogenous static models, exogenous dynamic models, and endogenous dynamic models. Exogenous static models consider that the decision process is in isolation of other choices, whereas endogenous static models explore the joint nature of the relationship between car ownership and other decision process accommodating potential endogeneity issues. The other two types of models (dynamic exogenous and endogenous) analyze car ownership as behavioural process that evolves over time. The more detail discussion can be seen in Anowar et al. ( (2014).

While there are many ways to distinguish or categorize previous car ownership models (De Jong et al., 2004; Anowar et al., 2014), in this chapter car ownership is categorized based on three categories i.e. at the aggregate level, at the disaggregate level, and at the disaggregate level with attitudes. By this categorization, the history of

car ownership and the inclusion of psychological factors (attitudes) in the car ownership models can be discussed more.

## 2.2. Aggregate Car Ownership Modelling

Early research regarding car ownership at aggregate level was conducted at nation-wide level. To model nation-wide car ownership models, gross domestic product (GDP) is generally found to be the most important factor (Tanner, 1978). Tanner (1978), states that car ownership explicitly depends on future levels of a nation's economic growth and motoring cost. The indicator of economic growth was the Gross Domestic Product (GDP) at fixed price (1970 price for that research). While the indicator of motoring costs were derived from consumers' expenditure (car purchase + oil price) at current and fixed price. After considerable trials of alternatives, Tanner (1978) proposed an equation for car ownership per person that includes, besides GDP, income per person, population density, growth of population over 10 years, the population proportions under 15 and over 64, and the percentage of self-employed people. Together these factors "explained" 89 percent of the variation in car ownership between countries.

Other studies on car ownership also find GDP to be a key determinant to replicate and predict car ownership levels (Khan & Willumsen, 1986; Button et al., 1993; Dargay & Gately, 1999; Lam & Tam, 2002; Sillaparcharn, 2007; Li et al.,2010). Khan and Willumsen (1986) suggest that the growth in car ownership is connected to commitments of future resources towards additional investments in roads and road maintenance. The research insists that car ownership should be considered as a policy variable rather than an exogenous factor. The variables influencing car ownership level according to them are Gross National Product (GNP) per capita, purchase tax associated with cars, associated ownership tax (road license), import duty of cars, price per litre of fuel, and population density.

Button et al.(1993) model vehicles per population assuming a saturation level of car ownership per capita and sets of explanatory variables on car ownership. The saturation level is treated as a statistical parameter necessary for forecasting model while explanatory variables are time trends, country dummy variables (since countries vary in many ways which are impossible to quantify), GDP of the countries at constants price. Their model confirms the importance of income in car ownership level. Button et al.(1993) summarize that much of the growth in car ownership in developing countries occurs in urban areas which contrast with the situation in most industrialized countries where better PT available. In the Button et al.(1993) research, in terms of percentage of population living in urban area, however, it is found that the statistical analysis of low

income countries reveals no consistent overall relationship with per capita car ownership. They find that for many individual countries there do seem to exist a positive, linear relationship between car ownership and level of urbanization.

Dargay and Gately (1999) make projections of the growth of car ownership from 1960 to 2015, for OECD countries and a number of developing countries, including China, India, and Pakistan. Their model treats car ownership as a function of per-capita income. The significant finding is that car ownership grows as per-capita income grows especially in the relatively low-income countries, where the most rapid growth of car ownership occur. Lam and Tam (2002) model car ownership based on eight key variables that affect it i.e. annual GDP, annual passenger trips on PT, annual railway passenger kilometre, average annual license fee per private car, average first registration tax per private car, population, and population density. They find that the first registration tax significantly reduce car ownership when it increase.

Sillaparcharn (2007) proposes car ownership model in Thailand at the aggregate level stating that since data collection at household level is very expensive, many developing country including Thailand prefer to use model that requires less data such as an aggregate model. Sillaparcharn (2007) includes GDP per capita, population density and urbanization level in the model and find that those explanatory variables are significant. Li et al. (2010) employ ordinary least square (OLS) regression model to examine the urban from influence on car ownership across 36 megacities in China. They examine the relationship between dependent variable, car ownership per hundred household at city level and some explanatory variables. These explanatory variables are resultant urban form factors (household disposal income, GDP per capita, total population, built up area, road density, and road area per person), and other explanatory variables (number of buses per 10,000 persons, the number of taxis per 10,000 persons, and other dummy variables). Li et al. (2010) find that richer and larger cities with adequate infrastructure are inclined to have more car whereas compact cities with high population density tend to support car ownership. Their other significant finding is that contrary to developed countries, household that is close to the city centre tend to own more cars than household far from the city centre does. This finding according to Li et al. (2010) helps one to understand the differences in car ownership behaviour between the developing and developed worlds.

Explaining car ownership levels by GDP development has also some important disadvantages though. The main weakness is that there is no reason to expect relations of this kind to apply unchanged over long periods and in particular, when saturation is being approached (Tanner, 1978). Further, and possibly more important, this method

cannot be used for proposing sustainable transport policies. For example, one does not have to (nor wants to) reduce the GDP to reduce car ownership levels. This explains the motivation for more disaggregate studies on car ownership levels.

### 2.3. Disaggregate Car Ownership Modelling

At disaggregate level, several studies have been carried out to identify factors that affect car purchase decisions of individuals especially household car ownership. In this sub-chapter previous research of car ownership at the disaggregate level will be discussed in chronological order.

First, a study that introduces a multinomial logit (MNL) model for household car type intention, with car characteristics and socio-economic variables as explanatory variables is performed by Lave and Train (1979). The car type choice can be categorized into 10 categories: subsubcompact, sports car, subcompact-A, subcompact-B, compact-A, compact-B, intermediate, standard-A, standard-B, and Luxury. Two important findings are the effect of an increase in gasoline taxes, and the effects of an excise tax on larger car, however note that their model are for new cars only (intention to buy a car). Manski and Sherman (1980) also use MNL to estimate two models of household choice among motor vehicles, the first is explaining vehicle choice in single vehicle households, while the second is explaining the composition of holdings in two-vehicle households. The explanatory variables are vehicle seating capacity, weight, noise level, price, operating cost and transaction cost etc. They find that even though the influence of price, operating cost varies among socio-demographic groups, those variables are all important determinants of vehicle utility.

Related to car market, Berkovec and Rust (1985) present a 2-step estimation technique of single vehicle household car choice model by using nested multinomial logit (NMNL) model rather than using the more restrictive MNL. The data used for this study is from a home interview survey conducted in 1978 by the National Science Foundation and consists of socio-economic characteristics and car holdings in June 1977 and June 1978. They report that in each period of time consumers are more likely to keep a currently owned car instead of upgrading it, and second, there is an evidence of mis-specification for the 2-step estimation. Still related to car market study, Berkovec (1985) simulates a model for American car market that combines a disaggregate model of household car number and type choice with an econometric model of used vehicle scrappage and simple models for new car. The study shows that micro-simulation approaches to model car sales are feasible and that reasonable forecast of aggregate variables can be performed by disaggregate model. Also discussing about car market in

US, Mannering and Winston (1985) estimate an MNL model of type choice for single and two-vehicle household. The explanatory variables are vehicle characteristics (operating cost, age, shoulder room, luggage space and engine technology), vehicle indicator, household characteristics (income and family size), household past vehicle usage, and lagged utilization variables. Lagged utilization variables can partly be understand as brand loyalty that is found to be significant variables for car intention.

Golob (1990) develops a dynamic (panel data) structural equation modelling (SEM) that links four dependent travel behaviour variables at two points in time, one year apart. Those dependent variables are car ownership, travel time per week by car, travel time by public transit, and travel time by non-motorized modes. The data used in this research is from the Dutch National Mobility Panel from 1985-1988. The research finds that car ownership, total travel times by car and by PT, are mutually interdependent which can be comprehended, as the travel times by PT is an important determinant of car ownership.

Gilbert (1992) attempts to better capture the dynamic elements of car ownership decisions by analysing the length of car ownership using duration or hazard model. There are several events that may end car ownership i.e. the car is replaced with new car (upgrade); the car is replaced with used car; and the car is disposed without replacement. The data used in this research are panel data from August 1978 through December 1984. The explanatory variables used are some that do not change over time and some that change over time such as annual household income. The research finds that for upgrading, significant variables are education (grade school), occupation (manager/skill), life stage (all but young family), region, and vehicle make.

The previous mentioned studies do not include spatial aspect in the car ownership model. The incorporation of land-use or build environment in the model has been started from Cervero (1996) which explores the influence of mixed land-uses to encourage non-auto commuting using the 1985 American Housing Survey. The research estimates binomial discrete choice model using specific variables such as land-uses variables (single housing, low-rise, mid-rise, high-rise multi-family building, commercial or non-residential building and grocery) and control variables (annual income, PT adequacy, and commuting distance). The research finds that the likelihood of non-auto commuting increases significantly as neighbourhood density rise and where the land use become more mixed (where there are shop and other non-residential activities). Also incorporating spatial element, Schimek (1996) uses multivariate regression to model household motor vehicle ownership and usage using the 1990 Nationwide Personal Transportation Survey data owned by the US Department of

Transportation. The explanatory variables are income, socio-demographic, and urban density. The finding is that if all else being equal, household in higher density area travel less in private car, however Schimek (1996) also finds that the effect of density is so small to have an impact on total vehicle travel which means that the increase of urban activities do not necessarily reduce car use.

Most of studies on car ownership mentioned above, use MNL as their modelling technique. To test whether MNL is still a more favourable modelling technique for car ownership, Bhat and Pulugurta (1998) compare two types of alternative behavioural mechanism to model household car ownership, which are the ordered-response, and the unordered-response mechanism. The ordered-response is represented by the ordered-response logit (ORL) model while the unordered-response, which is based on random utility maximization (RUM) principles, is represented by the multinomial logit (MNL) model. They use socio-economic variables and residential location/type attributes as explanatory variables for the models that use the 1991 Boston Region Household Activity Survey, the 1990 Bay Area Household Travel Survey, the 1991 wave of the Puget Sound Household Travel Panel Survey, and the 1987 wave of the Dutch Mobility Panel Survey. According to the findings, they recommend that, as a general guideline, car ownership modelling must be pursued using the unordered-response such as MNL and not using the ordered-response such as ORL.

Ryan and Han (1999) estimate MNL vehicle ownership model using 1995 Oahu (Hawaii) household interview survey data and also in addition the 1990 census data on several American cities such as Atlanta, Kansas City and New York. The explanatory variables are household income, parking cost, ownership cost, vehicle availability, and vehicle contribution to accessibility. They find that these variables predict rather accurately the shares in vehicle-ownership. Soltani (2005) also using MNL, explores the impact of built environment on car ownership in Adelaide, using socio-economic factor such as household size, household type, household income and build environment factor such as density, land use mix and design features as explanatory variables. The result shows that dwelling density and land use mix are significant in the model where the more dense the dwelling the lesser the likelihood of owning a car.

Yamamoto et al.(1999) develop a household-vehicle-transaction model assuming three types of competing risks: replacing one of the vehicle (upgrading); disposing of one vehicle; and acquiring one vehicle to add the number of vehicle in the household. The data used is from a panel survey households conducted in California in 1993, 1994 and 1996 using 664 households. The findings of this research are households that have disposed of their vehicles in the last transaction have higher probabilities of acquiring a

new vehicle while households that have acquired a vehicle have lower probabilities of any transaction. Yamamoto and Kitamura (2000) continue their research examining household car durations using panel data from a panel survey households conducted in California in 1993, 1994 and 1996, which total 2688 samples obtained. This research examines the actual duration and the duration for which the households intend to hold a vehicle using hazard-based duration model. The findings of this research are household with more vehicle and those with higher income tend to have shorter car holding duration, especially younger people tend to be hold their car shorter than their intention.

Kitamura et al (2000) examine the effect of car and PT accessibility on vehicle ownership, vehicle type choice and vehicle use in a car dominated area in California using revealed-preference (RP) and stated-preference (SP) data for the electric vehicle demand. They use ordered probit model (ORP) to model household vehicle ownership; tobit model to model vehicles per household member and per driver; MNL to model vehicle type choice; and also ordinary least square models to model vehicle use. The results in general find that PT accessibility does not matter anymore when it comes to household vehicle ownership and use, therefore improving PT service level does not necessarily reduce car ownership. This research is followed by Kitamura et al. (2001)which confirmed the findings of the previous research. Kitamura et al. (2001) examine car ownership, which is influenced by accessibility, car, and PT with a hypothesis that accessibility is no longer affect car ownership or use in the metropolises of developed countries where motorization has matured. The data used are from Kyoto-Osaka-Kobe and the southern California coast. Their study results show that improving PT accessibility in metropolitan area may not yield any appreciable consequence for car ownership and usage because role of accessibility appear to diminish as metropolitan area is motorized suggesting that car ownership and usage are independent in a motorized metropolis.

Mannering et al.(2002) explore motivations behind consumer preference for leasing by using nested-logit model of vehicle acquisition decision model which includes the vehicle type and whether to lease or purchase the vehicle. They argued that the attraction to leasing arises from the ongoing desire to upgrade their vehicle during the 1990s because of the unprecedented income growth of US household.

For the case of developing countries, Dissanayake and Morikawa (2002) use nested logit (NL) model to analyse variations of household travel behaviour related to vehicle ownership, mode choice and trip-chaining consideration in BMR (Bangkok metropolitan area and five adjacent provinces). The finding is that the most important

factors that encouraging trip chaining are the distance to destination and time compatibility.

Hess and Ong (2002) test an ORL model that explains car ownership based on the land use pattern of household, neighbourhood and urban design characteristics. The case study is Portland, Oregon where they examine the link between land use mix or urban design and car ownership. Their finding is that households located in dense, mixed-land use area are more likely access their activity place by walking or biking thus exhibits lesser need for cars. Independent of all factors, observed or unobserved, mixed-land use has an effect on car ownership. Using the same ordered response model, Chu (2002) develops an ORP model to investigate household car ownership in the New York City area. There are four findings of this research i.e. in a highly urbanized area, income and driving license are the primary determinant of car ownership; the increase of highway accessibility in New York City will not encourage car ownership increase; two-vehicle may be the upper bound for car ownership for nearly all the households in New York City; and the last, balanced land use development negatively influences car ownership.

Whelan (2007) develops econometric models of household car ownership and apply them to generate forecast across Britain to the year 2031. The explanatory variables used in those models are household income, household structure, motoring costs, accessibility, the provision of company vehicles and license holding. The models are successfully validated and the forecast compares favourably with the actual data from 2001 census.

For household car ownership models, Potoglou and Susilo (2008) compare MNL (unordered response), ORL, and ORP for three data sets: the 2001 National Household Travel Survey for the Baltimore Metropolitan Area (Maryland), the 2005 Dutch National Travel Survey, and the 2000 Osaka (Japan) Metropolitan Person Trip Data. The explanatory variables used are household life-cycle stage, income, race, type of dwelling, number of workers and residential density. They find that MNL should be preferred compared to ORL and ORP.

Potoglou and Kanaroglou (2008) examine car ownership, which is influenced by family structure, socio-economic characteristics, and accessibility at the place of residence as explanatory variables in Hamilton, Canada. By using MNL controlling for socio-demographic and economic characteristics, they find that commuting distance is a significant variable for car ownership, in which car ownership is primarily a necessity for those who work at long distance from their house. Still using the data from Hamilton, Canada, Potoglou (2008) reports empirical finding on the relationship between

dependent variable, vehicle-type choices which are categorized into four categories (passenger car, pickup, SUV and Van), and explanatory variables i.e. socio-demographic, urban characteristics, and travel-to-work attitudes. The results suggest that after controlling for socio demographic characteristics and travel to work attitudes, preferences for less fuel-efficient vehicle are affected by the diversity of home based land use.

Van Acker and Witlox (2010) use SEM to explain car ownership as a mediating variable between car usage and the built environment. Using explanatory variables such as characteristics of the built environment, personal and household characteristics, and aspects of car travel behaviour, they find that, if car ownership is treated as dependent variable and at the same time explanatory variable, it is more likely mediates the relationship between the built environment and car usage. Which means that car ownership should be considered as mediating variable when proposing a policy to discourage car usage.

Caulfield (2012) examines the characteristics of household owning multiple cars in Dublin, Ireland using data from the 2006 Census of Ireland with MNL model. The findings are factors such as age, number of resident workers and the household composition all influence the number of cars in a household; the occupation of respondents does not have a significant impact on number of cars; and the presence of public transport does not necessarily reduce the number of car ownership.

Zegras and Hannan (2012) examine household car ownership in Santiago, Chile, in 1991 and 2001 and incorporate measures of relative location, subway proximity, residential density, and land use mix in the MNL model. The data used in the study is from the 1991 and 2001 household O-D surveys. They find that between two data sets, the influence of land use mix, although negatively influence car ownership, decline over time suggesting that household preferences for car ownership are dynamic over time and that they respond to rapidly changing environments.

Anastasopoulos et al. (2012) investigate the determinants of household car and motorcycle ownership in Athens, Greece using fixed and random parameters bivariate ORP model. The explanatory variables are number of cars in a household, age, population density, income, family members and distance to work. They find that several variables, which are remained constant (fixed parameters), are important in determining car ownership such as income, distance and population density, while some other random variables (estimated parameters) also significantly influence car ownership.

Paleti et al. (2013) present a household vehicle ownership multinomial probit (MNP) model formulation that incorporates spatial spillover effect arising from both observed and unobserved factors in the Los Angeles region. The data sets used in the study are from the California add-on component of the 2009 National Household Travel Survey. The explanatory variables are socio-demographics (household income, race, distance to work, education, etc.), existing vehicle flee characteristics and accessibility measures. The results show that the spatial interaction parameter is statistically significant and the model that include spatial spill over gives superior goodness of fit than the model without spatial dependency effects.

In the case of car ownership modelling in developing countries, Dash et al. (2013) develop all-India disaggregate model for vehicle ownership using data sets from the survey conducted by the Government of India between July 2009 and June 2010. Their study find that income (economic standard) and household size are two important determinants of vehicle ownership. For rural households, they are found to be more likely to own cars than the urban ones and households with regular income are found to be more likely to own cars. Presence of children and elderly members also increase the likelihood to own a car, especially more if there is also youngster in the family. In other developing countries, Pan et al.(2013) examine the effect of rail transit in Shanghai on household car ownership, using income, commuting time, commuting by MRT and MRT usage intention as explanatory variables. They find that despite positive effect generated by extensive MRT system, people are still continuing to have a car and in fact people live near MRT station are still having intention to buy a car therefore construction of metro line does not necessarily reduce car ownership intention.

Gómez-Gélvez and Obando (2013) analyse the determinants of household car ownership in Bogotá, Colombia, based on disaggregate data sets from 1995 and 2005 mobility surveys using MNL and ORL. The explanatory variables are household income, number of household members, residential location, company cars, and quality of PT. The results show that the model with ORL presents higher accuracy in predicting high ownership level, thus it is more suitable for car ownership forecasting. They also find that income has the greatest impact on car ownership. For the recent case (2005 data), contrary to the previous case (1995 data) commuting distance positively influences car ownership, the higher working distance the higher propensity to own cars. Interesting to note that they also find that the implementation of Bus Rapid Transit (BRT) does not necessarily lower the car ownership level. Using different timeline data sets in the same geographical context, Gómez-Gélvez and Obando (2014) analyses the determinants of car and motorcycle ownership as well as the relationship between both levels in Bogotá,

Colombia, using ORP based on the 2011 Mobility Survey. The explanatory variables are income, household size, residential location, age, gender, and PT accessibility. They find that income and distance positively influence car ownership but in the case of income, it negatively influences motorcycle ownership, they also find that car and motorcycle ownership are not significantly correlated.

Anowar et al.(2014) estimate a generalized version of the ordered response logit model to study vehicle ownership evolution in Montreal, Canada using cross-section data sets from 1998, 2003 and 2008. The explanatory variables used are demographic variables, transit measures, land use characteristics, and temporal variables. They find that socio-demographic variables to be an important predictor of car ownership though those variables change over time; they also find that if household located in the mix land use with better access to PT, the number of car owner is decreasing.

There are several car-modelling techniques mentioned above such as ORL, ORP, MNP, and MNL. The last one is extensively used in car ownership model and is recommended over others model (Bhat & Pulugurta, 1998; Potoglou & Susilo, 2008). MNL is based on the Random Utility Maximization (RUM) principle, which is popular and arguably still the most dominant framework for understanding travel behaviour choice since 1970 – present (McFadden, 2001). RUM principles assume that behaviour can be explained by a utility function that is explained by socio-demographic and other specific attributes. However, this approach might be criticized from a behavioural point of view, as it does not take into account the behavioural intention, habit and other factors. Finally it is more important to understand car ownership model at disaggregate level that incorporate psychological factor.

## 2.4. Psychological Factors in Car Ownership Model

### 2.4.1. The role of attitudes in choice process

Car ownership models discussed above do not consider individual behavioural intentions. Still related to the previous discussion of RUM, Figure 2-1, taken from McFadden (2001), describes well the choice process that incorporates economic theory and psychological theory. McFadden (2001) states that in psychological theories of the choice process, the individual is less organized and more adaptive and imitative, than in the economists' standard model. "Attitudes" play a major role in determining how consumers define the decision-making task. "Affect" and "motivation" are key determinants of attitudes, and they influence the "perceptions" that feed into the choice process, as can be seen by the light arrow in Figure 2-1.

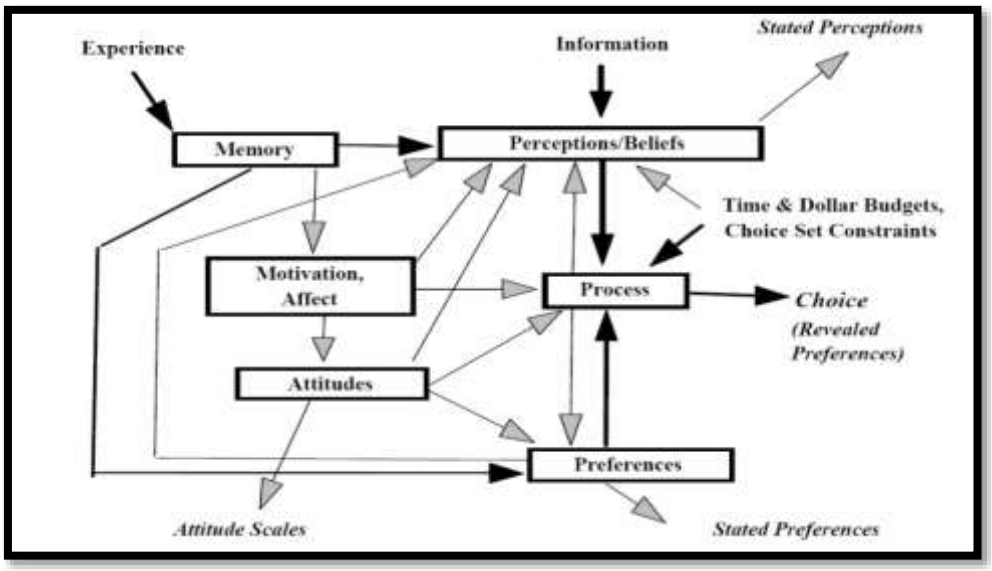


Figure 2-1 The choice process according to McFadden (2001). Source: McFadden (2001)

In the psychological theory, according to the theory of planned behaviour (Ajzen, 1985; 1991), "behaviour" is constructed by "intention." Intentions to perform behaviours of different kinds can be predicted with high accuracy from attitudes toward the behaviour, subjective norms, and perceived behavioural control; and these intentions, together with perceptions of behavioural control, account for considerable variance in actual behaviour. Figure 2-2 illustrates the theory of planned behaviour.

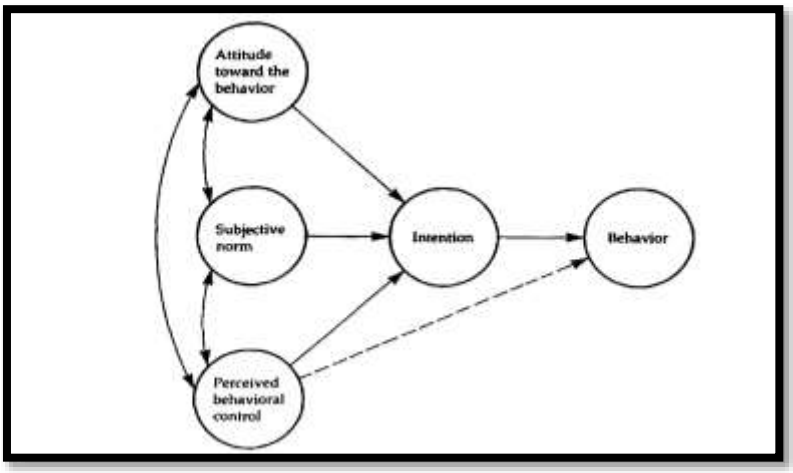


Figure 2-2 Theory of planned behaviour. Source: Ajzen (1991)

"Attitude toward the behaviour," "subjective norms," and "perceived behavioural control" are shown to be related to appropriate sets of salient behavioural, normative,

and control beliefs about the behaviour, but the exact nature of these relations is still uncertain. Attitudes are defined as a person's subjective evaluation of a given behaviour or object, and subjective norm refers to the social pressure a person perceives to perform that behaviour, while perceived behavioural control stands for the control a person has over factors that may facilitate or obstruct the implementation of that behaviour.

Another definition of attitudes is stated by Eagly and Chaiken(1993). Attitude is defined as "a psychological tendency that is expressed by evaluating a particular entity with some degree of favour and disfavour." Attitude is one of numerous implicit states or dispositions that psychologists have constructed to explain why people react in a certain ways in the presence of certain stimuli. As shown in Figure 2-3, attitude is an inferred state that accounts for covariation between stimuli denoting attitude object and evaluative response of these stimuli. The evaluative response here is divided into three classes (cognitive, affective, and behavioural)

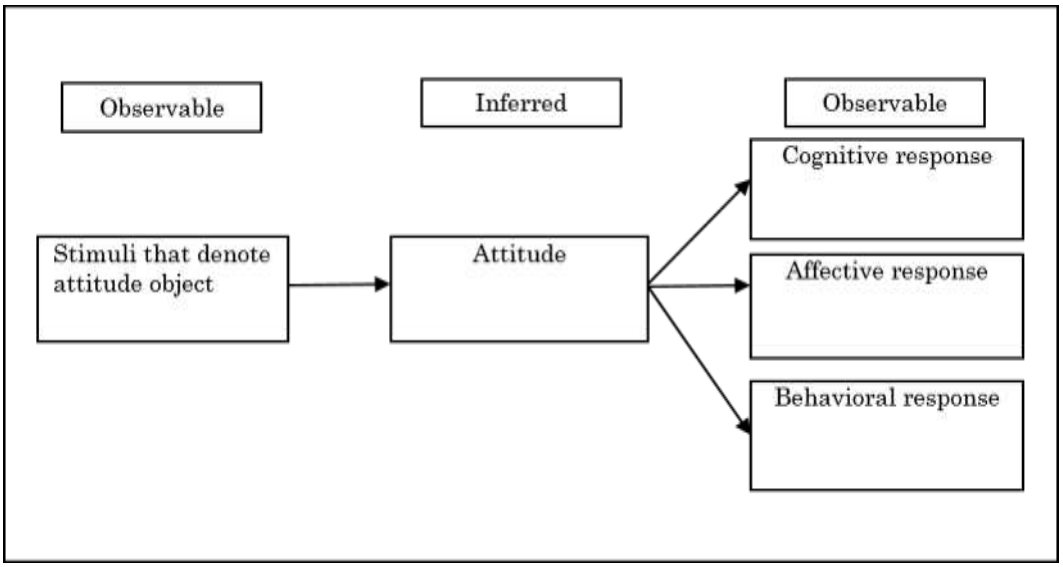


Figure 2-3 Attitude as an inferred state. Source: Eagley and Chaiken (1993)

The cognitive category contains thoughts that people have about attitude object. The affective category consists of feelings or emotions that people have in relation to the attitude object. The behavioural category encompasses people's actions with respect to the attitude object. Regarding attitude evaluation, in general, people who evaluate an attitude object favourably are likely to associate it with positive attributes and unlikely to associate it with negative attributes, whereas people who evaluate an attitude object unfavourably are likely to associate it with negative attributes and unlikely to associate it with positive attributes.

### 2.4.2. Attitudes and Car Ownership

Regarding car ownership and car usage models, most likely attitudes toward the "behaviour object" are the significant determinants for car ownership or car usage behaviour. The discussion starts from Wu et al.(1999) which examine vehicle ownership preferences of non-owning household in China using data from 373 household that do not own vehicle by using SEM. The dependent variable is intention to own a car in the future while the explanatory variables are their attitudes toward vehicle ownership, self-evaluations of personality traits, and attributes of the household and household head. The model also includes stated preference (SP) questions in which prices of cars (standard car and mini-car), maintenance expenses, amount of the family's savings, and monthly income are selected as control factors. This study finds that attitudes toward vehicle ownership significantly influence vehicle ownership preference, and the accuracy of vehicle choice models can be improved by considering symbolic utility.

In terms of attractiveness of car use based on attitudinal variables, Steg et al.(2001) perform a study which aims at clarifying the relative importance of symbolic-affective as opposed to instrumental-reasoned motives for car use. "Symbolic" factor is a status value, an expression of personal identity while "Affective" factor can be considered as deeper or emotional feelings. Because the attributes are quite similar, usually symbolic and affective are grouped together. "Instrumental" values are mostly related to functional attributes. Steg et al.(2001) also examine which motivational dimensions are underlying the (un)attractiveness of car use, in order to distinguish a limited set of main motives categories. The data sets used in this study come from interview of 185 adults in Groningen and Rotterdam, the Netherlands. Overall, the results indicate that both instrumental-reasoned and symbolic-affective functions of the motor car are significant dimensions underlying the attractiveness of car use.

Public transport is often perceived to be a poor alternative for car use. Steg (2003) describes who may be open to use public transport often, and how people might be persuaded to use it. The results of the study show that especially fervent car users dislike public transport. For them, the car outperforms public transport not only because of its instrumental function, but also because car represents cultural and psychological values, e.g. the car is a symbol of freedom and independence, a status symbol and driving is pleasure.

Parkany et al.(2004) review previous research where attitudes are used as determinant variables for car ownership and car choice and also explore the influence of attitudes for route choice decision using simple logit model. Much of the previous research reviewed and done by Parkany et al.(2004) show that attitudinal variables are

important components in the travel behaviour decision process. Attitudes can be incorporated into latent variables and then used in discrete choice model or SEM. Many different approaches and results from the previous research can be seen in Parkany et al.(2004).

Another incorporation of attitudes in discrete choice model can be seen in Choo and Mokhtarian (2004). They explore the travel attitude, personality, lifestyle, and mobility factors as explanatory variables along with demographic factors that influence individuals' vehicle type choice using MNL. The dependent variable, individual type choices are categorized into nine categories i.e. small, compact, mid-sized, large, luxury, sports, minivan/van, pickup, and sport utility vehicle. The data used in this study is from a 1998 mail-out/mail-back survey of 1,904 residents in the San Francisco Bay Area. They conclude that future models of vehicle type choice can be substantially more powerful with the inclusion of travel attitudes, personality, lifestyle, and mobility factors.

Marell et al. (2004) test the hypothesis that households' intentions to upgrade their old car have a direct positive relationship to households aspiration (psychological construct) for a new car and have a direct negative relationship to the car perceived quality using a rotating panel where car owners are interviewed every four months for two years. Marell et al. (2004) define aspiration level analogously as the minimal quality of a new car that the household accepts. The research finds that an increase in aspiration level contributes to an increase in replacement intentions over time. Many factors affect aspiration level, one of them is environmental concern, in which it influences consumers to buy more environmentally friendly cars.

Steg (2005) performs two studies, which aim at examining various motives for car use. In the first study, random selections of 185 respondents of Groningen and Rotterdam (Netherlands) who possess a driving license were interviewed. The examination is performed on how many factors of car use motives can be distinguished. The result, based on exploratory analysis by principal component analysis and followed by regression analysis shows that "symbolic-affective" become the most important factor for car use decisions, followed by "instrumental" and "independence" factors respectively. Further, this study continue by testing Dittmar's model of the meaning of material possession, using confirmatory factor analysis. The results confirms that three factors of car use could be distinguished according to Dittmar (1992, as cited in Steg, 2005)

In the second study by Steg (2005), the sample comprises a random selection of 113 commuters who regularly travelled during rush hours in and around Rotterdam. This study examines individual differences in the significance of these three factors on

commuter car use during rush hours. From the results of study 2, it appeared that commuter car use was most strongly related to symbolic and affective motives and not to instrumental motives. In both studies, most group differences are found in the evaluation of the symbolic and affective motives (and not the instrumental ones). Especially frequent drivers, respondents with a positive car attitude, male, and younger respondents' values these non-instrumental motives for car use. It proves that people do not only drive their car because it is necessary to do so, but also because they love driving. Interestingly, Steg (2005) finds that "independence" emerges as a separate factor in the explorative analysis in the first study hence it is suggested that future research should clarify whether independence is indeed a separate factor influencing car use.

Still related to attitudes and personality traits discussed above, Johansson et al.(2006) hypothesize that difference in people's attitudes and personality traits lead them to attribute varying importance to environmental considerations, safety, comfort, convenience and flexibility. The difference in personality traits can be revealed in the individuals' choice of transports and in other actions of their everyday lives. Conditioning on a set of exogenous individual characteristics, the research uses indicators of attitudes and personality traits to form latent variables for inclusion in an, otherwise standard, discrete choice model. With sample of Swedish commuters, the research concludes that attitudes and personality traits can make mode choice models more powerful, and socioeconomic variables may aid in forecasting such variables.

Bolduc et al.(2008) empirically evaluate the application of hybrid choice model including attitudes and perceptions as latent explanatory variables influencing private vehicle choice made by Canadian consumer when faced with new technology. This study uses data of 1,500 Canadian consumers, which were collected in 2002 and 2003 by Simon Fraser University. This research finds that with the inclusion of perception and attitude as latent variables, the model become more realistic and gives a better description of the consumers profile and their adoption of new car technologies.

Marell et al.(2009) investigate the impact of changes in aspired quality level and current quality level on households' car upgrading intentions and actual purchases of cars, in particular whether there are influences of need recognition and opportunity recognition on choices of car upgrading. The data sets used are total of 1083 respondents that were randomly sampled from the Swedish national car register interviewed over telephone every fourth month during 2.5 years. The determinant of aspired level are the same as Marell et al. (2004) study (family structure, optimism about the future economy and environmental concerns). This research finds that a

decrease in current quality level of the car (need recognition) and an increase in aspired quality level (opportunity recognition) contribute equally to an increase in upgrading intention.

Weinberger and Goetzke (2010; 2011) obtain two significant results by studying the effect of past personal experience and peer behaviour on auto ownership decision. Firstly, people learn preferences and attitudes towards travel behaviour from transportation options in their past, then they carry these preference and attitudes into current situations which influence their car ownership decision. Secondly, people are influenced in their transportation decision by social peers and neighbours to own a car. This condition is known also as "conformity effect."

Zhao (2011) examines the relations between attitude (subjective car dependence), behaviour (actual car use), and intention (intention to reduce car use) usingSEM while controlling for other determinant variables (demographic, socio-economics, and land use and transit use). The data sets used in this research are from the Londoners' Lifestyle and Car Dependence Survey between 2005 and 2006 carried out by Transport for London. The research finds that attitudes mediates the impact of behaviour on intention, which is shown that attitudes is necessary to model car reduction intention.

To show that social-symbolic (status) aspect are important to (some) car users, Gatersleben (2011) presents data sets from four empirical studies in UK households, which explore the influence of materialism (variable often studied in psychological field) to car ownership. The research finds that in particular, individual who have stronger materialistic values are more likely to believe car as a status symbol thus they are less likely to be willing to reduce their car usage. This research confirms the Steg (2005) findings about social-symbolic factors related to car and concludes that as long as the car is perceived as a symbol of success, road or public transport infrastructure investments are unlikely to result in major improvements to transport problems caused by excessive car ownership and usage.

Still related to vehicle choice and attitudes, Beck et al.(2013) identify how environmental attitudes can influence the vehicle choice using latent class model (LCM) with the data obtained from 2009 survey which involve 650 respondents in Australia. Two models are estimated, one without attitudinal variables and the other with attitudinal variables. The research have found that the inclusion of attitudinal variables in modelling choice is better able to explain the differences in preferences that exist for car.

All of the studies on attitudes towards car have been carried out with data from developed countries and there appears to be a lack of work with data from the

developing countries, with the exception of the study by Wu et al.(1999) which studies China context. For other Asian countries (including China), Van and Fujii (2011) study the relationship between attitudes and cars with PT across six Asian countries (Japan, Thailand, China, Vietnam, Indonesia, and the Philippines) students. In this research, three main dimensions of attitudes towards car are proposed referred to as "symbolic/affective", "instrumental", "social orderliness." The latter one has been found only in this study with Asian data. It comprises of beliefs such as environmental friendliness, safety, altruism, quietness etc.

The findings of this research in terms of symbolic affective aspect is that it appears respondents in a higher income society, where it may be economically easier to own car, will perceive car as a lower symbolic status than other and vice versa, this is proven by Japan has lowest score on symbolic affective while Vietnam has highest score. In term of instrumental, the highest score in Japan where road networks and traffic management system are well developed that generally the congestion level is low comparatively to the other Asian countries, the lowest instrumental is in Indonesia where such traffic system have not yet been constructed well thus contribute to high level of congestion. Finally, in terms of social orderliness of travel modes among countries, the scores for car in the Japanese sample seems to be different from those in the other countries which indicates that Japanese students evaluate car at low value because of social externalities such as air pollution, congestion etc.

Another study based on developing countries context especially in South America, comes from Galdames et al.(2011) who study the role of psychological factors (attitude, affect, and social aspects) as latent variables in the mode choice process. This study used data sets from a survey that was conducted in 2007 and 2008 in Chile, where the respondents are university lecturers, researchers, and clerical officers. The framework of this research is Theory of Interpersonal Behaviour (TIB) by Triandis (1977 as cited in Galdames et al., 2011) which suggests that observed behaviour correspond to intention is mediated by habit and contextual situation. This research finds that not all psychological factors is necessary to be included, this is shown by strong correlation between habit, and attitude detected through SEM suggest that attitude is enough to explain behaviour.

## 2.5. Summary

To summarize, all of the literatures discussed above mention about the significant of some explanatory variables as the determinants of car usage, car ownership as well as car intention. The more detail of the summary can be seen in Table 2-1.

Table 2-1 Determinant Factors of Car Use, Car Ownership, and Car Intention

| Factor | Generally finding, notes | References |
|---|---|---|
| GDP | Positive effect, powerful but has some disadvantages, it cannot be used for proposing sustainable transport policy | Tanner (1978); Khan and Willumsen (1986); Button et al. (1993); Dargay and Gately (1999); Lam and Tam (2002); Sillaparcharn (2007); Li et al. (2010) |
| Personal income | Positive effect, mostly (non-)linear effect, obvious. Policy related to vehicle restriction or reduction might influence the reduction of car ownership given income constant. | Ryan and Han (1999); Chu (2002); Anastasopoulos et al. (2012); Dash et al. (2013); Gómez-Gélvez and Obando (2013; 2014) |
| Commuting distance | Positive effect, the longer the distance to work, the more likely car is used. Policy related to land-use development might reduce the distance from house to work/school. | Dissanayake and Morikawa (2002); Potoglou and Kanaroglou (2008); Anastasopoulos et al. (2012); Gómez-Gélvez and Obando (2013; 2014) |
| Built environment | Negative effect, if the neighbourhood density rises or the more mixed land use become, the less people will buy or owning a car | Cervero (1996); Schimek (1996); Soltani (2005); Hess and Ong (2002); Zegras and Hannan (2012); Anowar et al. (2014) |
| PT availability and frequency of using PT | Negative effect, obvious, policy to improve PT service might be proposed to reduce car ownership | Golob (1990); Cervero (1996); Steg (2003); Anowar et al., (2014) |
| **Attitudinal Factors** | | |
| Symbolic-affective | Positive effect, the more car perceived as status symbol the higher the likelihood to own or use car | Wu et al. (1999);Steg et al. (2001); Steg (2005); Weinberger and Goetzke (2010; 2011); Gatersleben,(2011) |
| Instrumental; | Positive effect, the more car perceived as valuable instrumentally (fast, convenience) the more likely car is used or owned | Steg (2005); Van and Fujii (2011) |
| Independence; | Positive effect, the more car perceived as gives more freedom the more likely car is used or owned | Steg (2005) |
| Social-orderliness | Positive effect, the more car perceived as environmentally friendly, safe and altruism the more likely car is used or owned | Van and Fujii (2011) |

From the discussion above, it appears that explaining car ownership at the aggregate level especially using GDP as determinant variables (Tanner, 1978; Khan & Willumsen, 1986; Button et al., 1993; Dargay & Gately, 1999; Lam & Tam, 2002; Sillaparcharn, 2007; Li et al., 2010) is powerful but has also some important

disadvantages. This explains the motivation for more disaggregate studies on car ownership levels. This partly explain the necessity to model car ownership at the disaggregate level.

At the disaggregate level, it seems that income (Ryan & Han, 1999; Chu, 2002; Anastasopoulos et al., 2012; Dash et al., 2013; Gómez-Gélvez & Obando, 2013; 2014), commuting distance (Dissanayake & Morikawa, 2002; Potoglou & Kanaroglou, 2008; Anastasopoulos et al., 2012; Gómez-Gélvez & Obando, 2013; 2014) and also built environment (Soltani, 2005; Hess & Ong, 2002; Zegras & Hannan, 2012; Anowar et al., 2014) are important determinants of car ownership. Therefore, in Chapter 4, income and commuting distance will be incorporated as determinant variables for car ownership model. Even though mixed land use also contribute to car ownership, in this dissertation that aspect is not incorporated in the model. Still at the aggregate level it is found that the presence of PT or the PT accessibility does not necessarily reduce car ownership (Kitamura et al., 2000; Kitamura et al., 2001; Gómez-Gélvez & Obando, 2013) but some others find that PT significantly influence the reduction of car ownership (Cervero, 1996; Anowar et al., 2014) especially when using it frequently (Golob, 1990).

Although most of the literatures mainly discuss about car ownership and car type choice at households level using cross-section data, few of them use panel data to explain car-upgrading intention. For example using hazard duration model to explain car upgrading, car replacement with used one, and also disposal (Gilbert, 1992; Yamamoto et al., 1999; Yamamoto & Kitamura, 2000) and using aspiration level as determinant to upgrade car (Marell et al., 2004; Marell et al., 2009). According to Marell et al.(2009) psychological factors can influence the decrease in perceived current quality of car which somehow related to satisfaction or regret of car (need recognition).

Regarding psychological factors in car ownership, according to above discussion, attitude is an important determinant of car ownership (Wuet al., 1999; Weinberger & Goetzke, 2010; 2011; Gatersleben, 2011). While some describe the importance of attitude factors towards vehicle mode choice (Choo & Mokhtarian, 2004; Parkany et al., 2004; Johansson et al., 2006; Bolduc et al., 2008; Galdames et al., 2011; Beck et al., 2013), others discuss about the relation between attitudes and car use (Steg et al., 2001; Steg, 2003; 2005).

Given the apparent importance of attitudinal factors to explain car ownership, this dissertation aims to enrich literatures on attitudes in developing countries. In contrast to Van and Fujii (2011) this dissertation is focused on car ownership and car purchase decisions. The primary objective is to understand whether attitudinal factors

found in particular by Steg (2005) i.e. “symbolic affective”, “instrumental”, and “independence” as well as by Van and Fujii (2011) i.e. “symbolic affective”, “instrumental”, and “social orderliness” can be observed to be of any importance, in particular of more importance than income level. The hypothesis is that, besides instrumental factors, comfort and possibly social orderliness are believed to be car purchase motivations as well as the role of the car as a status symbol (or as Frank, 2005 definition, a “positional good”).

One important findings of Weinberger and Goetzke (2010; 2011) that also needed to be noted is that people are influenced in their transportation decision by social peers and neighbours to own a car. This condition is known also as “conformity effect”. Conformity refers to the act of changing one’s behaviour to match the response of others (Cialdini et al, 2004). Influence of others as a determinant of intention, can also be understood as subjective norms in TPB (Ajzen, 1985; 1991) which refers to the perceived social pressure to perform or not to perform the behaviour. The more detail discussion regarding “conformity” or influence of others or subjective norms towards mobility decisions can be found in Chapter 3.

# Chapter 3

# Social Norms and Car Ownership

## 3.1. Introduction

Short and long-term mobility decisions are made within social contexts. Recent transportation research has increasingly focused on this. For example, individual mode choice decisions are found to be better explainable by considering not only an individual's travel patterns but also tours and activities of other household members (Ronald et al., 2012; Pinjari & Bhat, 2011). For long-term mobility decisions such as investment in a car, the consideration of household members will be even more important. Besides direct household members, local friends, and colleagues, there is further growing interest in the geographically wider social networks of individuals as these explain (and cause) a significant increase in the distance travelled by individuals (Frei & Axhausen, 2007). A wider geographical spread in social networks is partly sustained by an increase in the importance of virtual networks such as social media. Psychologists have long been pointing out that there are further networks, that a person might not necessarily be aware of, which shape that person decisions. In many situations, one tends to adapt, in some cases consciously refute, what others are doing. For example, Festinger (1954) and various other social psychologists have long pointed out the role of "social norms" in decision-making. Besides the direct effect of the behaviour of others on a person's choices, certain types of social influences may have an effect on spatial memory (Maddox et al., 2008) which in turn affects certain travel choices (Ramming, 2002).

This chapter reviews the influence of others on a person's mobility decisions. Mobility decisions are define here as the decision dimensions relevant for daily travel decisions (trip patterns, mode choice, route choice) as well as long term decisions (car purchase, residential location choice) that are known to influence travel. The focus in this chapter is in line with what Schmöcker et al.(2014) refer to as "informational mass effects" and what Ben-Akiva et al.(2012) describe as "interaction effect in loose social networks". Both papers emphasize that this effect can lead to decisions that a "classic utility maximization model" cannot predict. In the literature for such mass effects, a wide range of terms is used such as for example, herd behaviour, peer effects, conformity,

or fashion. Informational mass effect is defined as positive influence to adjust one's choices to be in line with observed choices of others. "Observation" might be due to information obtained directly about others' behaviour or indirectly by perceiving an expectation on one's choice. The latter types of effects are commonly referred to as norming effects. In this chapter, the aim is to distinguish different norming effects, in particular descriptive norms versus injunctive norms. Descriptive norms refer to the common behaviour of others (e.g. the majority choices) whereas injunctive norms refer to one's perceptions of the expectations of others regarding the behaviour in question. The focus of the review is on descriptive norms but believe such a distinction is important in order to draw appropriate policy implications as discussed in the conclusions of this chapter.

It is worth noting that this means the scope is limited in several ways. The scope of "influence of others" is reduced to that by (observed) information about the behaviour by others. That is, effects such as response to traffic congestion are not considered. If congestion is observed, one will tend to re-route to options less travelled by others. Furthermore, this chapter excludes the travel decision effects through ITS, advertisements, or campaigns where travellers respond to information by planners, operators, or companies who consciously try to affect a social system. This chapter also excludes the above mentioned large literature on activity based modelling and within-household interactions as far as it only describes the impact of others due to activity coupling. Finally, as the term "mass effects" indicates, this chapter focus the review of social network effects to those that encourage adaptation or conformity of behaviour. In some other cases, social networks might lead one to choose options that distinguish one from others such as groups with perceived lower social ranking.

## 3.2. Psychological Foundations

In this sub-chapter, the psychological motivations underlying the above-defined mass effects are summarized. This is followed by a brief overview of some of the most prominent theories in the field of social psychology that describe the psychological foundations of conformity behaviour. Note that the terms mass effect and conformity are used interchangeably in this chapter to describe the same effect though mass effect is used predominantly to describe the effect of the phenomena and conformity is used to explain the phenomena from a psychological viewpoint.

### 3.2.1. Motivations Underlying Conformity Behaviour

Individuals conform to the behaviour of others for several reasons. Often individuals

rely on the observation of others' behaviour or attitudes and follow that behaviour in new or emergency situations where information from other sources is costly or difficult to collect (Páez & Scott, 2007). Using others as exemplars could reduce the cognitive effort needed to make a decision (McFadden, 2005; 2010).

Furthermore, individuals may feel the need to conform in situations of high peer pressure to maintain social approval and avoid feelings of isolation or simply to identify with a group. This form of conformity is hence similar to the types of conformity discussed by Kelman (1958). He classifies conformity processes into three types: (1) compliance, (2) identification, and (3) internalization. Compliance refers to changing an attitude or behaviour publicly but not privately. An individual may comply to gain favourable reaction or approval from others and avoid punishment or disapproval. Identification refers to the process where an individual adopts and believes in others' attitudes (even though the specific content may be irrelevant) because the individual wants to establish or maintain an identifying (or self-defining) relationship with those others. Internalization refers to the process where the individual privately adopts others' attitudes because they are consistent with his/her value system and are "intrinsically rewarding." Thus, even in the absence of peer pressure, conformity behaviour may satisfy the need to belong to or identify with a certain group. See also Nord (1969) for further discussion of the costs and rewards of conformity framed within a social exchange theory perspective.

### 3.2.2. Psychological Theories of Conformity

This section describes major psychological theories of conformity. The objective of these theories is to explain the aforementioned types of and motivations for conformity in more detail and to show how motivations transfer into actions. The discussion starts by describing work demonstrating the existence of conformity behaviour in experimental studies. This is followed by an overview of some theories describing the psychological processes underlying conformity behaviour, theories describing internalization, and theories describing group dynamics.

#### *A) Demonstration of Existence*

Many psychological research studies on conformity behaviour have been conducted. One of the earliest studies in the literature demonstrating the existence of conformity behaviour (in particular, compliance effect) is by Asch (1951) who studied the conditions that lead individuals to distort their judgments under the influence of group pressure. He describes experiments that show how the influence of majority judgments regarding

line lengths can sway the judgment or perception of an individual in public settings even if the majority judgments are erroneous. Heterogeneity in individuals' reactions was however observed, with some continuing to make independent judgments while others yielding to group pressure. Various experimental variations showed that compliance may be a function of whether the majority decision is unanimous or not, the size of the majority, the magnitude of the error/distortion made by the majority, the clarity of the situation, and the character of the individual.

### *B) Psychological Processes Underlying Conformity Behaviour*

Following the line of work by Asch, several psychologists proposed theories to explain the process of conformity effect. One of the representative theories is the theory of social comparisons by Festinger (1954) which explains conformity mainly in the form of identification. According to this theory, people have an intrinsic drive to compare themselves to others so as to evaluate their opinions and abilities and a tendency to associate with a group whose members are similar in terms of opinions and abilities. Group members will take action to reduce discrepancy among themselves in terms of opinions and abilities (especially the more important or relevant these are, and the more attractive the group is for its members). Thus, there is a drive or pressure towards conformity (arising from the drive to evaluate opinions and abilities) manifested in changing one's own position, or through a social influence process in the case of opinions where some members try to influence others, or through greater restriction of the comparison range. When there is a wide range of variation in opinions or abilities, the composition of the comparison group may change to reduce the variation.

Two other related theories are those of social facilitation (Thorpe, 1956) and behavioural contagion (Wheeler, 1966). Social facilitation occurs when "the performance of a more or less instinctive pattern of behaviour by one member of a species will tend to act as a releaser for the same behaviour in another or in others, and so initiate the same lines of action in the whole group." It is different from conformity and behavioural contagion by the absence of conflict. The theory of behavioural contagion is concerned with behaviour that is perceived by an individual to possibly be associated with negative consequences to its performer, as follows. An individual facing a certain conflict in making a specific decision but no restraints in performing the action performs it only after other members perform the action. According to Wheeler (1966), Asch's conformity model is different from behavioural contagion in that in the former, conflict arises in the individual's mind after hearing the majority decision and the individual needs to resolve the conflict on his own, while under behavioural contagion conflict

exists prior to the appearance of other individuals whose presence contributes to conflict resolution. Wheeler (1966) also discusses various mechanisms that affect behavioural contagion, including the initial strength of the approach and avoidance conditions, the consequences of the behaviour under question to the other members performing it, characteristics of effective other members and of the individual in question, and the restraint conditions.

Another prominent theory is social learning theory, which posits that social context is important for learning and uses the concepts of imitation, differential association, definitions, and differential reinforcement to describe the dynamic nature of the learning process and subsequent behaviour (Akers et al. 1979). The first process that occurs is differential association whereby individuals interact and identify with different groups (such as peer-friendship groups, family, etc.). Initially, individuals imitate models in their groups and thus learn "definitions" (such as norms and orientations) which may be socially reinforced by the group, serving as evaluations of behaviour as good, neutral, or bad. After initial implementation of the behaviour, the consequences of the behaviour and its alternatives – differential reinforcement – (including anticipated reactions of others) determine behaviour in the future.

Finally, a widely used theory in practice in various fields is the theory of reasoned action (Fishbein & Ajzen, 1975; Ajzen & Fishbein, 1980) and the subsequent theory of planned behaviour (TPB) (Ajzen, 1985; 1991). The TPB posits that the immediate antecedent of behaviour is behavioural intentions, which have several determinants that include subjective norm. Subjective norm refers to an individual's perceptions of how important others expect him/her to behave regarding the behaviour in question (i.e. injunctive norm) as well as the individual's motivation to comply with the expectations of those important others. Thus, these theories describe the conformity behaviour process that is assumed to be induced by the important others' expectations.

### *C) Theories Describing Internalization*

Whereas in the previous section the process of conformity is not always clear, in this section, the focus is specifically on conformity theories related to internalization. As mentioned before, internalization refers to the process where an individual conforms because others' opinions are consistent to his/her value system, i.e. these opinions become internalized. One theory describing this process is social identity theory and the related theory of self-categorization (Terry & Hogg, 1996). According to social identity theory, two processes are in operation when people associate themselves with a certain social category (such as gender, team, etc.) or group: categorization, which highlights

within-group similarities and between-group differences, and self-enhancement whereby in-group things are favoured over out-group things. When social identity is salient, a context-specific group norm or group prototype is constructed, which then transforms an individual's beliefs, attitudes, behaviours, etc. to be consistent with the group prototype. The norms then influence individuals through self-categorization. Terry and Hogg (1996) use social identity/self-categorization theories to re-conceptualize subjective norms as used in the theory of planned behaviour so that they refer to the norms of a reference group that is salient for the behavioural context under consideration and with which an individual identifies strongly.

Internalization may also explain why people sometimes conduct undesirable behaviour if their internalized perceptions about the behaviours of others are biased. Social norms theory (Berkowitz, 1997; 2005; Perkins, 1997; 2003) deals with misperceptions of norms in society and their influence on behaviour. Berkowitz (2005) cites that "Misperceptions are formed when a minority of individuals are observed engaging in highly visible problem behaviour (such as public drunkenness or smoking) and when this extreme behaviour is remembered more than responsible behaviour that is more common but less visible (Perkins, 1997). These misperceptions are assumed to be normative and may be spread further in "public conversation" by community members who act as "carriers of the misperception," including those who don't engage in the behaviour (Perkins, 1997)". A number of social norms interventions have been designed to correct misperceptions by providing accurate information about the norm (or normative feedback), particularly in the health domain. The interventions can target three levels of prevention: universal (targeting all members of a population), selective (targeting not yet affected but at-risk members), and indicated prevention (targeted at individuals displaying signs of the problem).

### *D) Theories Describing Group Dynamics*

Finally, this chapter describes some related theories of group dynamics that are derived from conformity effects. In contrast to the above theories, these works focus more on society as a starting point. One of the most frequently used theories is spiral of silence theory (Noelle-Neumann, 1974) which describes the formation of public opinion in society. According to this theory, compliance of attitude and behaviour is a result of fear of isolation or sanctions in the case of dissent, and it is this compliance effect that makes the public opinion the dominating one. This process also renders non-dominating opinions to become downgraded, thus triggering a "spiralling process" which reinforces the dominance of the public opinion.

The theory of spontaneous order (Sugden, 1989) explains the formation of conventions in society and their evolution into norms. According to this theory, conventions refer to rules of behaviour that arise unconsciously and are self-sustaining once established. A convention is essentially an "evolutionarily stable strategy" (which may not be Pareto-efficient) which people benefit from following and will do less well when they deviate from it. Conventions can become norms thanks to the human desire for social approval.

Related to the above, Yamagishi and Suzuki (2007) discuss culture formation as a kind of equilibrium of "frequency-dependent behaviour." That is, people select default decision strategies (and act on those) that fit with the environment they are in, based on the frequency of the situation in their culture where using or not using a certain default strategy has led to desirable or undesirable consequences. Then, "when a critical mass of individuals are committed to similar values and act in concert in similar situations, the individuals will, as a collective, maintain or transform the culture" (Kim & Markus, 1999). For example, when a critical mass of people walks on the left side of a road, this creates an incentive for pedestrians to also walk on the left side (i.e. to conform) so that walking on the left becomes the "cultural state." Yamagishi and Suzuki (2007) use the term "institutions" for a state where incentives reinforce the state.

### *E) Norms Taxonomy*

Schwartz (1977), and Schwartz and Howard (1982) distinguish norms into personal norms and social norms. Personal norms are defined as self-expectation of specific actions in a particular situation, experienced as a feeling of moral obligation while social norms are defined as norms based on group expectations. In addition, the theory of reasoned action (Fishbein & Ajzen, 1975; Ajzen & Fishbein, 1980) and the subsequent TPB (Ajzen, 1985; 1991) mention subjective norm as one of the determinants of behavioural intention. Similarly, Cialdini et al.(1990) distinguish two types of norms: descriptive and injunctive norms. Descriptive norms refer to the common behaviour of others whereas injunctive norms are defined as expectations on oneself, which will hence include the willingness to conform to the expectation of others.

According to Thøgersen (2006), types of injunctive norms can again be distinguished according to how internalized they are which leads to the definition of personal norms and subjective social norms. Thøgersen (2006) mentions that subjective social norms also strongly correlate with descriptive norms, which is a reason why they are not distinguished in the theory of, planned behaviour. In terms of Thøgersen's categorization, norms that is discussed in this dissertation, refers to the most

externalized part of the injunctive norms: subjective social norms. Subjective social norms can be defined as norms based on group expectations (what other people think a person should do). Note that although Thøgersen (2006) categorizes personal norms into two types of norms: introjected and integrated norms, in this dissertation those types of norms are not further discussed. The detail can be seen in Figure 3-1.

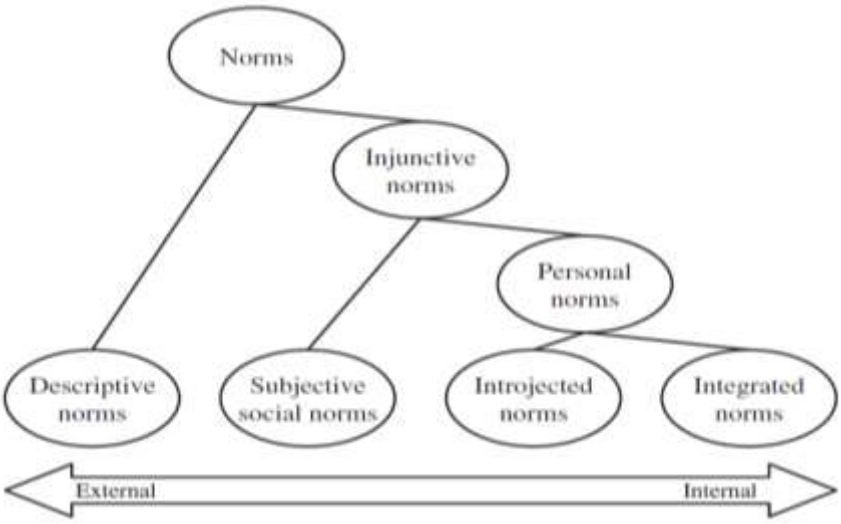


Figure 3-1 Norm Taxonomy. Source: Thøgersen (2006, p. 250)

## 3.3. Empirical Evidence for Social Network Effects: Outside Transportation

In this and the following sub-chapter, some noteworthy studies describing the impact of mass effects on behavior in various disciplines are reviewed. Firstly, examples outside the transportation planning field as social network effects are described, in particular in the form of social norms that have been a long standing research topic. Note that the review in this sub-chapter is not complete. Covering all disciplines in which social network effects are important by far exceeds the scope of this chapter. Recently some popular science books such as "Critical Mass" (Ball, 2004) provide a more complete overview. Instead, some examples that are believed to have direct implications also for transportation planning are chosen.

### 3.3.1. Spread of Products: Bass Model

One of the best known models predicting product sales is based on the seminal paper by Bass (1969). The model has made such a significant impact in marketing science since it could replicate sales of newly developed products such as refrigerators, steam irons, or record players fairly accurately with the model itself being simple. The model divides

the population into “innovators” and “imitators”, or, one might say each person has an innovative and an imitative tendency. Innovators are likely to buy a new product with a certain probability p independent of its market penetration. Imitators’ likelihood to buy a product is based on the product’s market penetration. The more persons have bought the product, the more likely one is to also buy it. The model is formulated as

$$\frac{f(\tau)}{[1 - F(\tau)]} = p + qF(\tau) \tag{3-1}$$

where $f(\tau)$ is the likelihood to purchase at time $\tau$, and p and q are the “innovation” and “imitation” coefficients, respectively. Mahajan et al. (1990) termed p and q coefficients of external and internal influence.

Particularly interesting is that the model does not describe the social network structures in more detail. Bass calibrates the parameters p and q with time series data and finds that q is one or sometimes several magnitudes larger than p. He also uses the model for sales predictions and achieves $R^2$ values for the model fit of 0.7 or higher for 8 out of 11 studies. In subsequent research, the model has been generalized and extended (Bass et al., 1976; Norton & Bass, 1987; Mahajan et al., 1995). Niu (2002) provides a stochastic version of the Bass model clarifying the relationship between the Bass model and “pure birth-process modeling” that is used in a variety of fields, such as modeling epidemics.

Though the Bass study is clearly targeting business strategy implications, there are also possibly relevant implications for transportation policy. It appears there is strong evidence that dynamic processes in a society are susceptible to the influence of some innovators in the society. Influencing some key persons could hence trigger sustainable as well as unsustainable trends. Further research should aim at identifying who such innovators are and whether someone having a strong innovative factor in one decision field is also likely to be an innovator in other aspects. The Bass model calibration results suggest that innovation depends heavily on the particular case study. Bonabeau (2004) finds that people in particular imitate others in the case when information is too plentiful.

### 3.3.2. Tourism and Product Sales: WOM and eWOM

Bass does not further specify how the “internal influence” or imitation effect is passed among population members. In comments on the model, Bass (2004) notes that “word of mouth, learning, contagion and interpersonal communication” have all been used to describe and explain the imitation effect and social network effects could be added to this list as well. Besides product sales, one of the fields where social network effects are

most apparent is tourism. Jalilvand et al. (2011) describe word of mouth (WOM) as one of the most influential sources of information transmission. Similar to the afore described Bass model, they note that opinion leaders are the key players in WOM. One key aspect to become an opinion leader is trustworthiness.

It appears that for example the choice of holiday destinations as well as hotels and which sites to visit is heavily influenced by word of mouth and recently in particular in the form of social media or more generally electronic word of mouth (eWOM). Sparks and Browning (2011) note that customers appear to increasingly rely on the internet for travel choices, and popularity of sites such as e.g. "TripAdvisor" is evidence for these effects and is an example of the significantly reduced effort needed through eWOM to obtain relevant information about one's potential choices. Lee et al. (2011) point out in their review that also for other online businesses eWOM is essential. With data from online stores such as Amazon, they show further that eWOM strengthens "short tails" in sales distribution, i.e. popular products are bought more often and less popular products fade out more quickly.

It is believed that these marketing findings have some further important implications for the importance of social network effects for travel behavior in general. It seems that, despite potentially better information by the service provider being available, travelers will to some degree (understandably) prefer to rely on information obtained from persons in similar situations. For policy providers, this emphasizes the importance of providing targeted, personalized information instead of "global expert information". Chen (2008) reviews online book sales and finds also here "herd behavior". Customers appear to rely more directly on reviews by other readers than on reviews written by experts. Utz et al. (2012) also report through two experimental studies that online consumer reviews are the most important factors determining the trustworthiness of online stores. Findings by Sparks and Browning (2011) further suggest that negatively framed experiences have a stronger effect on customers than positively framed experiences. If transportation policy providers aim to promote sustainable modes, this could suggest that providing negative experiences regarding the unsustainable mode is effective.

### 3.3.3. Health

Repeated information (received by various means including WOM and possibly even eWOM) will be perceived as norms within a culture to which one is likely to adhere. In marketing, "norms" might be seldom introduced except possibly for some large brands such as iPods that have been so successfully marketed that it becomes almost normative

to possess such a product. In such cases, single bad experiences are not likely to alter one's opinion but the (perceived) collective opinion of a group will determine one's behavior. Norms are hence found instrumental for a wide range of repeated behaviors. In this and the following subsection, the evidences for the impact of norms on health and environmental friendly behavior are discussed.

Leveraging normative influences is desirable in situations involving health related consequences where knowledge about the behaviors or attitudes of others may be used to make healthier choices. Two such studies are summarized below, one on alcohol drinking patterns of college students and another on smoking.

### A) College Student Drinking

A number of studies have shown that college students overestimate the extent of drinking by other students. This misperception of others' behavior creates a social norm which justifies excessive drinking. By knowing more accurately the drinking patterns of other students, students may reduce their amount of drinking.

For example, DeJong et al. (2006) report the impact of a social norms marketing campaign designed to correct college students' misperceptions about the prevalence and extent of drinking by other college students. Institutions in the study were divided into treatment (exposed to the social norms campaign) and control institutions. Surveys of drinking patterns using different measures were conducted before and after the social norms campaign. The campaign's message, distributed through various channels, described others' behavior as follows: "x% of XYZ University students have 4 or fewer drinks when they party" or a similar message based on the number of drinks per week. Among the main results of the study is that students in treatment institutions had significantly lower perceptions of student drinking levels and lower alcohol consumption, which suggests that the treatment has changed their social norms. The main policy implication is that the provision of accurate information about others' behavior, in a way that is consistent with a movement towards healthier choices, can change the social norms of students (by correcting their misperceptions) and their behavior in such a way that it is aligned with the norms.

### B) Smoking

In the case of smoking, a social norm may be associated with how acceptable it is to smoke in public in the absence of smoking regulation, considering the reaction of non-smokers who are subjected to passive smoking. An interesting question is whether social norms can change to shift the majority of smokers in a society from being

inconsiderate to becoming considerate smokers.

Nyborg and Rege (2003) examine this issue in relation to the implementation of smoking regulations in Norway prohibiting smoking in public places. The idea is that once non-smokers become accustomed to no smoking in the regulated areas, they become less tolerant (or show greater social disapproval) of smoking even in the unregulated areas, which may drive a shift in social norms of smokers in a way that they become more considerate even in the unregulated areas.

The authors develop a model which predicts whether a smoker will be considerate or not to non-smokers in the unregulated areas, accounting explicitly for the trade-off between two types of cost in the payoff function related to the decision to smoke or not: social disapproval in the case of being inconsiderate and inconvenience cost in the case of being considerate. They also measure empirically shifts in attitudes of smokers and non-smokers towards indoor smoking and find evidence for a shift in social norms after the implementation of the smoking regulation towards considerate smoking behavior. The main policy implication is that public regulations (even if temporary) may be an effective instrument for shifting social norms in a society towards healthier choices by the majority.

### C) Environmental Friendly Behavior

Several environmental psychologists have conducted experiments to investigate the impact of norms on behavior. Goldstein et al. (2008) conducted an experiment in hotels where they informed guests about the percentage of customers who have reused their towel instead of requesting a new one. They replaced the hotels' common signs of appealing to customers' co-operation or environmental consciousness such as "help save the environment by re-using your towel" with messages encouraging customers to follow the behavior of the majority of guests that re-use their towel. By this approach, they could achieve a significantly higher percentage of customers re-using their towel. The effect was even more pronounced if messages were displayed encouraging customers to follow customers that stayed in the same room before. This leads Goldstein et al. (2008) to conclude that "provincial social norms" are particularly effective. Provincial refers to the effect that one tends to follow in particular those that are similar to one, even if the similarity consists purely of the room number in a hotel that one stayed in. The findings are in line with the psychological theories described in Sub-chapter 3.2, in particular with the theory of Festinger (1954). Goldstein et al. (2008) further mention sociological studies such as Deshpandé et al. (1986) that explain that ethnic affiliation can explain behavior.

In a further study, Schultz et al. (2007) provide households with information about the amount of energy they use compared to other similar households. They find that, in line with their hypothesis, households reduce their energy consumption if they become aware that other similar households use less energy than they do. Also here provincial social norms can be used as explanation. The authors further discuss that besides comparing oneself to others, one tends to overestimate the amount of undesirable behavior among others in line with the drinking related studies reported above. As described in a large number of other studies, perceived social norms are also important in explaining other pro-environmental friendly behavior such as e.g. littering or recycling (Cialdini et al., 1990; Harland et al., 1999). Interestingly, Harland et al. (1999) show that accounting for personal norms (expectation towards myself, independent of the behavior of others) and subjective norms (expectation of others about my behavior) as in the theory of planned behavior improves the model fit to explain pro-environmental behavior. Further several studies show in particular the influence of parental expectations. For example, Grønhøj and Thøgersen (2009; 2012) examine parents and adolescents regarding their pro-environmental commitment and find significant correlation, suggesting that parents influence the future societal development not only directly through their own acts, but also indirectly through their children.

The policy implications for transportation planners are fairly clear. Aiming to shift the norms towards the desired behavior is of primary importance as especially Cialdini (2007) argues. If the goal is for example to increase bicycle usage, this might be achieved by providing information that others in the neighborhood use bicycles more than one might think. Further, Jariyasunant et al. (2012) discuss that through new technologies such as mobile phones it becomes increasingly possible to provide persons with detailed information about one's own and others' travel behavior so that it allows people to assess and compare their own behavior for example in terms of its environmental friendliness.

### 3.4. Empirical Evidence: Transportation and Land Use

In this sub-chapter, a number of examples illustrating the influence of social networks and mass effects are presented in particular on various mobility related decisions including long and medium term decisions (residential location, vehicle ownership, mode choice, telecommuting) and short term decisions (parking, driving, riding, and pedestrian crossing behaviours). This list is not exhaustive, and as other authors mention (Fukuda & Morichi, 2007; Páez & Scott, 2007), mass effects could have an

influence on decisions such as the adoption of compressed workweek arrangements at work, illegal car parking, and opposition of road pricing by the public. However, studies addressing mass effects in these contexts were not found.

### 3.4.1. Environmental Friendly Behaviour

Social influences are expected to be important when people make residential location decisions as people may prefer to reside among certain types of social networks in their neighbourhoods (Schelling, 1971). Páez et al.(2008) simulate the residential location decision which could be motivated by the influence of informal support networks (consisting of members with affective ties or relatives and offering support services to each other). Individuals' location decisions are modelled in two periods using a utility maximization framework, where the utilities in the second period are a function of the average shares of the location alternatives chosen in the first period by others in the individual's social network. Different social networks are tested that vary by the number of contacts/neighbours of each node in the network and by clustering of nodes (i.e. "the tendency of two nodes to have common neighbours.") They find that when social influences are accounted for, the distribution of individuals across towns differs markedly from the case where they are ignored, and that the model results are more sensitive to the number of contacts in the social network than to the degree of clustering.

The dynamics of the process of population migration has also been studied in earlier work by Weidlich (1986) at two levels: stochastic and quasi-deterministic. The idea is that individuals associate a utility with every potential region that is a function of the number of people living in that region, among other factors. The solution in terms of how many people will live in each region is not obtained through utility maximization but through the derivation of equations of motion for the probabilities of different states of the system, where a state corresponds to a particular combination of population sizes of different regions. A "master equation" is derived, which is an expression of the probability distribution over the states of the system. Equations of motion are then derived for mean values (assuming a unimodal probability distribution), and the properties of the model are studied analytically and using simulation to determine when metropolitan areas emerge.

### 3.4.2. Vehicle Ownership

One of the most studied areas among the listed mobility choice dimensions is the influence of social networks on vehicle ownership and vehicle type choice.

Goetzke and Weinberger (2012) study social network effects on car ownership. They particularly distinguish endogenous and contextual effects following Manski (1993). Endogenous effects refer to the case where one's behaviour is influenced by the behaviour of others in one's peer group. Contextual effects refer to characteristics (not behaviour) of the peer group that may influence an individual's behaviour. For example, for modelling auto ownership decisions, Goetzke and Weinberger (2012) define endogenous effects as the percentage of households with no auto in the census tract of a given household and contextual effects as the average socio-economic characteristics of other households in the tract.

Goetzke and Weinberger (2012) use New York household survey data and present three models to test the impacts of social networks. The first includes only contextual effects, the second only endogenous effects, and the third both. In order to distinguish both effects, they use a binary probit model with a two-step estimator developed by Newey (1987). They find that the peer effect coefficient (endogenous effect) is highly significant. This suggests that the probability of owning a car is affected by the behaviour of socio-economic peers and physical neighbours, meaning that people have a higher probability to go car-less if they are surrounded by other households who do not have a car. The contextual effects are consistently estimated only when the endogenous effects are controlled for. The authors emphasize that it is important to distinguish between endogenous and contextual effects and to recognize their connection for effective policymaking.

Gaker et al. (2010) study the effect of others on a person's car type choice by computer laboratory experiments with a large number of subjects most of whom are undergraduate students. The results show that the subjects are influenced by the decision of their peers in the experiments, leading the authors to conclude that social norms are amongst the most powerful influences on auto ownership decisions, including whether to buy a car and what type (hybrid or conventional).

For car type choice, there is more evidence for the strong influence of others. In particular, with the advent of hybrid and electric cars, there is current interest in the market spread of these and to what extent this is due to social network effects. Keith, et al. (2012) analyse the market spread of Prius in different parts of the US and discuss the difficulty in distinguishing supply effects and "homophily" from group effects. Supply effects refer to, for example, varying petrol price and density of retailers in different parts of the US. Homophily refers to the fact that people with similar tastes and travel demands will tend to live closer together. Tentative results suggest though that some group effects remain significant even after controlling for the other factors.

Ozaki and Sevastyanova (2011) analyse the market share of Prius in the U.K. They conducted a survey among people who had purchased a Toyoto Prius in the 24 months prior to January 2009 and their results suggest that purchases are related to what people have seen others buy. They discuss that hence campaigns promoting the message that hybrid cars are normal should be more widely employed. Rasouli and Timmermans (2013) study the effect of car reviews and the level of social adoption of electric cars on the intention to buy electric cars through a stated preferences survey. They find that positive reviews increase the utility of the intention to buy an electric car. The level of adoption in different social networks (friends, family, colleagues, and peers) also plays a role in an individual's intention to buy an electric car although the effects are generally non-significant and not consistently monotonic.

### 3.4.3. Mode Choice/Use

One of the earlier studies on voluntary car usage restraint, which incorporates the influence of others' behaviour, is a study by Morikawa (1999) in Nagoya, Japan. Using an ordered probit model, Morikawa models individuals' stated intentions of cooperative car usage restraint as a function of others' cooperation level (which is varied in stated choice experiments) to represent the social norm, a measure of others' utility level, and other factors. He finds that people are willing to behave cooperatively, in this case restrain car usage, if they are aware that others also behave cooperatively. The model suggests that their intentions are affected by the relative utility compared to others to a greater extent than by the modal attributes. Despite these social interaction effects, the author believes that in order to create commitment to cooperative behaviour, some incentives are needed.

Dugundji and Walker (2005) study the effects of interdependence in mode choice decisions among commuters in the Amsterdam area. Similar to other studies described in this section, they include the proportion of others taking a mode as an explanatory variable (field effect). However, their study goes further in that they try to disentangle spatial and social interaction effects. They hence define models with "panel effects", where the panel are not time series observations but describe the connectivity "in a social and/or spatial context". They allow for random variation in the specific panel effects and show that this improves the model fit. They hence conclude that "global field effects" might often not be appropriate, rather the effects can be group specific. As a more general conclusion, one might add that one has to be careful to generalize perceived descriptive norms over too large population groups. Walker et al.(2011) extend the study by discussing the endogeneity in the field effect variable due to its correlation

with unobserved attributes (captured by the error term) that influence both an individual and his/her peer group. Instead of defining panel effect, they aim to capture the endogeneity in the field effect variable through the use of the 2-stage Berry, Levinson and Pakes method. Spatial reference groups are based on postcodes and social reference groups are based on income. As further work, Dugundji and Walker (2005) further emphasize the collection of temporal data to better understand causal relationships in the panel effects.

Goetzke (2008) also estimates spatial interdependence in observed mode choice. He uses home-based work trip data from New York and employs a conditional spatially autoregressive discrete choice model. He controls for the group effect by building a "spatially moving transit mode split average" which is included in the utility function. A problem with this approach is that supply effects (i.e. all living near a metro station will be more likely to use the metro) and mass effects are difficult to distinguish. He therefore includes an additional network effect controlling for car access and finds that the mass effect remains significant. Goetzke (2008) concludes that in the traditional mode choice model approach, if the mode-specific constant term is not allowed to change in space, "as long as the relative utility for using transit in the suburbs is lower than average and, in the central city, higher than average, transit ridership will be overestimated in the suburbs and underestimated in the central city." Related to the aforementioned studies on car ownership, Goetzke (2008) further notes one important difference. Whereas for car ownership peer pressure (or one way contextual effects) are important factors, in the case of mode choice group effects are more likely to be imitation (endogenous effects) only.

Goetzke and Rave (2011) focus on explaining why some cities have a "bicycle culture". The study uses data from a German nationwide survey of travel behaviour. Explanatory variables include individual and trip characteristics as well as municipal characteristics such as bicycling infrastructure and topography. The authors use a 2-step instrumental variable approach similar to Walker et al. (2011). The regression results show that the city specific cycling mode share plays an important role in explaining likelihood of choosing cycling for recreational and, to some extent, shopping trips. No support is found for the hypothesis that the modal share has an impact on cycling to school/work or for errands. The authors argue that therefore approaches to bicycle policy should shift to include also building and supporting bicycle culture and should not exclusively focus on improving infrastructure.

Slightly different from the studies mentioned earlier, Sunitiyoso et al. (2011) study the influence of social interaction and social learning on travelers' behaviour in a

social dilemma context. They use a laboratory experiment with nine students who are given incentives to choose the (for the individual less attractive) bus for commuting. The group receives rewards based on the total number of persons taking this mode. With simulation experiments, they then aim to replicate these results and observe that various types of conformity behaviour appear to be indeed relevant choice mechanisms. In particular, imitating selected individuals and imitating the majority are both possible strategies. They hence discuss the importance of having some "good influence persons" as well as the importance of a critical mass. In Sunitiyoso et al. (2011), they further expand their experiment with an additional feature. This time the experimental groups are allowed to communicate with each other within the group using text messaging (chat services). The results show that communication does not necessarily solve the social dilemma but that individuals learn from others. The learning can be observed in the form of conformity to the majority as well confirmation. Confirmation means that individuals repeat their previous choices unless others change from their previous choice.

Related to travel behaviour, Bamberg et al. (2007) investigate if there is empirical evidence for the assumption that social norms do influence intentions indirectly via their impact on attitude, perceived behavioural control, and personal norm. This research constructs the social norms construct by asking respondents in two German cities about the extent to which people who are important to them think they should use public transport instead of car. They find that in both data sets social norm is strongly associated with personal norm, attitude, and perceived behavioural control but has no direct association with intention.

Thøgersen (2006) shows the correlation between the choice of taking public transport vs. private car for work or shopping trips and subjective social norms. Subjective social norms were constructed by asking the respondents about their agreement with a five-point Likert scale statement "I believe that most of my acquaintances expect that I take the bus or train to work and shopping if the choice is between bus or train and my own car." The result shows that subjective social norms have a strong correlation with commuting behaviour. Closely related, according to Jakobsson et al. (2000), expectations about others' intentions were found to be one determinant of car use reduction.

### 3.4.4. Telecommuting

Social influences also have implications for the design of policies aimed at promoting telecommuting. In the workplace, the prevalence of telecommuting, whether it is

accepted or not as a norm, and knowledge of other employees' telecommuting experiences could matter at various stages of the telecommuting adoption process by employees, including why employees adopt telecommuting, how the arrangement is negotiated, and the process of asking for advice, and can also play a role in defining the costs and benefits of telecommuting (Wilton et al., 2011).

Páez and Scott (2007) simulate the process of adoption of telecommuting using a two time period model. The principal idea is that the decision to adopt telecommuting is influenced by the number of people who have already adopted. The simulation generates the social network of an individual and the choice of telecommuting or going to a conventional workplace based on a discrete choice model. The utility equations include learning effects related to the choice made by the individual in a previous period and the average behaviour of others (adopters vs. non-adopters) in the individual's social network in a previous time period. The authors thus demonstrate the extent of adoption of telecommuting in relation to proximity to other adopters or non-adopters. Issues of sample size needed to reach reliable simulation results and the historical data needs of the model related to who adopted telecommuting and at which point in time are highlighted.

### 3.4.5. Safety/Legal Behaviour

Social influences are often found to be powerful in contexts involving legal and/or safety related behaviours. When people follow the masses and disregard certain laws or engage in risky behaviours, the social norms are associated with negative consequences for society as a whole or for specific individuals, and it becomes important to come up with policies that alleviate or reverse the negative influence of the social norms. In this section, these mechanisms are illustrated in the contexts of illegal parking behaviour, risky pedestrian crossing, driving, and riding behaviours.

#### *A) Parking*

In the case of bicycle parking behaviour near railway stations, individuals often have the choice between parking legally off-street or illegally on-street. When illegal parking is prevalent in a certain area, it becomes a norm, which is undesirable. That is, the larger the proportion of illegal on-street parking, the more likely an individual is to park illegally (Fujii, 2005; Fukuda & Morichi, 2007).

Fukuda and Morichi (2007) study this problem in Metropolitan Tokyo using data from three areas with varying extents of illegal parking behaviour. A discrete choice modelling approach, following the methodology developed in Brock and Durlauf (2001a;

2001b), is used to model the choice of legal or illegal parking. The effect of conformity is quantified by including a "field variable," defined as the average share of people in an individual's social network (defined as other people who park near the train station where the individual parks) who park legally, in the utility. This latter quantity is assessed by means of a survey asking about parking behaviour, and it is found to be a significant predictor of behaviour.

In their model, multiple equilibrium solutions can exist (e.g. inferior and superior, with a middle equilibrium solution denoted as the critical mass) and this is found to be the case in their case study where the three different case study areas are in different equilibrium states. The policy implications of their model consist of quantifying the necessary increase in the frequency of police patrols (an explanatory variable in the model) to increase the utility of off-street parking so that there is a move from the inferior equilibrium solution to the superior equilibrium solution where the majority of people park legally (off-street).

### *B) Pedestrian Crossing Behaviour*

Pedestrian crossing at red lights, or jaywalking, is often observed in urban areas. It may be postulated that observation of other pedestrians jaywalking, who thus set a social norm, would encourage an individual to jaywalk as well. A series of studies based on self-reported intentions data have examined this effect and found evidence for it, as described briefly below.

Zhou et al. (2009) examine conformity in adult pedestrians' crossing behaviour based on a survey conducted in China. The survey presents pedestrian crossing scenarios at traffic lights and asks respondents to state their intention of crossing under such scenarios, which vary by level of conformity with respect to other pedestrians present at the intersections (i.e. other pedestrians either jaywalk or don't). The survey also measures conformity tendency based on a questionnaire developed in Mehrabian and Stefl, (1995) and other psychological variables that are later used in a model based on the theory of planned behaviour (TPB). Among the main findings is that intentions to cross are stronger in the conformity scenario than in the non-conformity scenario, and for respondents with higher conformity tendency. In the TPB regression model, the conformity tendency variable turns out significant as a predictor of intentions in the conformity situation but not in the non-conformity situation. The implications of the results for road safety interventions include informing people that conformity in risky situations (e.g. crossing with others illegally) is unsafe. In another similar study, Zhou and Horrey (2010) study jaywalking of adolescents (middle and high school students)

and find that stronger intentions for jaywalking are reported in conformity situations. One of the policy implications described is to provide stronger emphasis on the safety education of individuals with high conformity tendency.

McGhie et al. (2012) study the contribution of conformity and group identity of a sample of university students in South East Queensland to the problem of drink walking. They design scenarios where a person who is drink walking arrives at a red traffic light and either sees other pedestrians not crossing on red (low conformity) or crossing on red (high conformity), where these other pedestrians are strangers (low group identity) or friends (high group identity) of the person in question. Respondents of the survey state their level of agreement with crossing on red under each scenario (including a baseline scenario where the individual is alone at the intersection). It is found that respondents are most willing to cross on red when in the presence of other friends who are also crossing on red (high conformity, high group identity), and least willing to cross when in the presence of other friends who were not crossing on red. The authors draw policy implications related to "promoting resilience to peer influence and reinforcing the negative consequences associated with following the behaviour of other pedestrians who are drink walking and crossing against a red signal." The authors also note that it is important that public campaigns and the media promote the message that individuals should think about the consequences of illegal crossing behaviour not just on themselves but also on others due to conformity effects.

The study by Gaker et al. (2010) mentioned earlier also evaluates the influence of others' jaywalking behaviour on a given individual's future reported jaywalking behaviour, but the information is presented in a slightly different way compared to the above studies. Different types of information are presented to different students from the University of California, Berkeley, including statistics on fatalities, the law (including amount of fine), citation rates (including amount if fine), and percentage of other Berkeley students that jaywalk (stated positively and negatively). The different types of information are then included in a discrete choice model which predicts whether the individual will improve, worsen, or not change his/her jaywalking behaviour over the next week. It is found that the only type of information that influenced reported intended behaviour (towards more jaywalking) is information about crossing behaviour of peers stated negatively (i.e. x % of students jaywalk). The policy implication mentioned by the authors is that "one should not let people know that they are behaving better than the norm" since the social norm backfired in this case, possibly because the percentage of peers who jaywalk is not insignificant.

### *C) Driving/Riding Behaviour*

Teenage drivers may have social norms or perceptions related to "cool" driving which could result in having them engage in risky driving behaviours. These social norms may be more strongly followed in the presence of teenage passengers in the car. For example, Simons-Morton et al. (2005) examine the influence of the presence of teenage passengers (by gender) on the extent of risky driving behaviour of teenage drivers. Social influences in this case could be direct, when teenage passengers encourage the driver to drive in a risky manner, or indirect, when the driver feels the need to drive in a risky manner as the teenage passenger may view such driving behaviour as desirable or expected. They conduct a study using field observations in proximity to various school locations in the Washington DC area. More risky driving behaviour (measured by speed and headway) is observed for teenage drivers in the presence of a male teenage passenger compared to general traffic. The implications of the study include "the importance of addressing teenage passenger influences in education and policy initiatives" such as "graduated licensing program strategies, driver training, public education, and parental oversight." Other studies have also found that the perceived speeding behaviour of others has an influence on an individual's speeding behaviour (Haglund & Åberg, 2000; de Pelsmacker & Janssens, 2007; Fujii & Abdul Sukor, 2010).

Social influences can also be powerful in the context of riding behaviour, where perceived peer pressure may create the norm that it is cool/normal to ride with an alcohol-impaired driver. Kim and Kim (2012) examine this influence, together with other factors such as sensation seeking and harmful alcohol drinking, on the decision to ride as a passenger with an alcohol-impaired driver (RAID) using a survey conducted in South Korea. Perceived peer pressure is measured through two questions related to beliefs about the prevalence and acceptability of alcohol-impaired driving among peers. Using a structural equations model, a significant effect of perceived peer pressure on RAID behaviour is found, but the indirect effect of gender on RAID through perceived peer pressure is not significant. As policy implications, the authors suggest that prevention efforts should replace "the perceptions of drunk driving or RAID as normal with a realistic understanding of the prevalence and consequences of the deviant behaviour." They also talk about the importance of a social norms media campaign and changing normative perception.

## 3.5. Summary of Data and Modelling Methodologies

With the above review of the literature on mass effects in transportation, in this

sub-chapter the main types of approaches that have been used to model information mass effects on transportation choice behaviour, the type of data required by each approach, the advantages and limitations of each, and some prominent papers that fall under each approach are synthesized. In Table 3-1 the approaches are summarized. From top to bottom, the scale/complexity of the models increases as the analysis shifts from explaining individual behaviour towards predicting society wide impacts.

Table 3-1 Summary of data and modelling approaches for incorporating mass effects in transportation behaviour models

| Approach | Type of Data | Scope/ Advantages | Limitations/ Disadvantages | Prominent Papers |
|---|---|---|---|---|
| Egocentric approaches | Specified surveys | Understand possible influence structure | Network structure gives limited explanation of mass effects | Carrasco et al. (2008), van den Berg et al.(2009), Kowald and Axhausen (2011) |
| Psychological causal models | Laboratory experiments; specific surveys regarding attitudes, norms, and individual choices | Obtain empirical measures of norms; establish associations between norms, other psychological variables, and behaviour | Difficult to disentangle cause and effect; in the case of SP data, stated intentions may differ from actual behaviour; difficult to derive society wide conclusions | De Groot and Steg (2007), Taniguchi and Fujii (2007), Zhou et al.(2009), Gakeret al.(2010) |
| Regression models considering "field effects" | Large data sets about revealed behaviour plus contextual data | Explain society wide distribution of choice | Generally no empirical measures of norms, attitudes, etc.; dynamic network effects cannot be modeled | Fukuda and Morichi (2007), Goetzke (2008), Bhat and Sener, (2009), Walker et al.(2011) |
| Stochastic process models | Survey to define group influence factors or time series data (for calibration) | Explicitly model dynamics, such as "critical points" and probability distributions, making it easier to forecast and analyze what-if scenarios | Limited modelling of complexity in population strategies, partially ignoring possible attitudinal change | Weidlich (2000), Nakayama and Nakayama (2004), Schmöcker et al. (2014) |
| Agent-based simulation | Survey to define agent behaviour | Can model complex agent strategies and dynamics | Stability of results needs to be ensured | Páez and Scott (2007), Sunitiyoso et al.(2011), Ettema et al.(2011) |

One approach that has been used in a few studies is the egocentric approach such as e.g. Carrasco et al. (2008), van den Berg et al.(2009) or Kowald and Axhausen (2011), who additionally use snowball sampling. These contributions attempt to quantify the extent of the social network structure of specific individuals (egos). The network is usually limited to a specific type, such as an affective network or a leisure network. The approach is data intensive as it requires knowing, for every individual surveyed, information about other individuals in his/her social network (such as their socio-economic characteristics) and their ties with the ego (e.g. frequency and nature of interaction). This approach to studying social influences provides a better understanding of the possible influence structure and subsequent activity-travel decisions that are tied to this structure, instead of using reference groups that are preset by the analyst. However, limited insights seem to have been derived regarding mass effects, which explains why reviews of these papers have not been included in the previous sub-chapters. The egocentric approach might have large potential to explain mass effects but it would require representing the overall network and influence structure of a large number of members in society. Moreover, one needs to carefully sample egos and elicit 'appropriate' network members (Carrasco et al. 2008).

Another more common approach is what referred to as psychological causal models, which make use of controlled laboratory experiments or specific surveys designed to explicitly measure attitudes, norms, choices, etc. but not social networks per se. The major advantage of this approach is that, unlike the other approaches, it obtains an empirical measure of the norm (by asking respondents) which could be helpful for modelling. Studies based on the theory of planned behaviour generally fall under this category, as well as some other studies reviewed earlier in this paper (de Groot & Steg, 2007; Taniguchi & Fujii, 2007; Zhou et al. 2009; Gaker et al. 2010). While useful as a tool to describe behaviour and estimate associations between different constructs, it is usually not possible to validate the causalities assumed by the models because most of these datasets are collected cross-sectionally. Since this approach often relies on hypothetical scenarios and stated intentions, it is also limited to the extent that stated intentions may differ from actual behaviour. Finally, it is generally difficult to derive society wide conclusions about the effects of norms on behaviour without explicitly modelling dynamics and feedback in the process of conformity behaviour.

A third and also common approach is to estimate choice models (typically utility maximizing) that generally include a "field effect", i.e. the average share in a population or reference group choosing an alternative, as an additional explanatory variable for predicting the choice of that alternative by a given individual (Fukuda & Morichi, 2007;

Goetzke, 2008; Bhat & Sener, 2009; Walker et al. 2011). The idea is that the greater the share of the population choosing the alternative, the more desirable the alternative is to a given individual. In models considering "choice probabilities within zones," it is hence the correlation between different zones that needs to be modelled. For this Bhat and Sener (2009) use a general copula-approach whereas Walker et al.(2011) estimate correlation with a 2-stage modelling approach. In general, this type of modelling requires large data sets about revealed behaviour and contextual data in order to define different reference groups and derive average shares of the different alternatives for all reference groups. While this method is appealing as it explains society wide distribution of choices, it does not generally directly measure attitudinal and normative indicators that could be useful in enriching the model, and dynamic network effects cannot be modelled. The fact that the method does not require knowledge of the individual's social network simplifies the complexity of data collection but the choice of reference group set by the analyst could be arbitrary. Moreover, the analyst needs to account for the endogeneity resulting from including the average share of an alternative in a certain reference group in the utility of that alternative since this variable might be correlated with the disturbance in the utility if common unobserved factors affect the utility of an alternative for an individual and for his/her reference group as discussed in reference to the work by Walker et al., (2011)[1].

A fourth approach is stochastic process models, which derive ideas from systems analysis in physics (e.g. Weidlich, 2000; Nakayama & Nakayama, 2004). The main idea is to derive probability expressions for the state of a system and their transition dynamics, where a state could refer to the number of people in different population sub-groups (e.g. innovators vs. imitators) choosing different alternatives (e.g. mobility lifestyles). These probabilities may depend on the intrinsic utilities of the alternatives as well as the number of people in each sub-group that have chosen the different alternatives in previous time periods to capture mass effects (Schmöcker et al. 2014). The main advantage of this approach is its potential to investigate a large number of scenarios, explicitly model the interaction dynamics between population groups, and derive probability distributions, which can be used for forecasting the influence of mass effects. However, similar to the above choice models, the approach partially ignores possible attitudinal changes (i.e. changes in individuals' tastes over time) and generally requires difficult to obtain time series data for model calibration.

[1]One way to handle the endogeneity problem is to use the BLP (Berry et al. 1995; 2004) correction method if the endogeneity is at a market level (e.g. at a reference group level), which consists of first estimating a regular choice model with market-specific constants replacing the "field variable" and then accounting for the endogeneity by regressing these constants on the field variable (using e.g. a two-stage instrumental variables approach) and estimating the field variable influence. See for example Walker et al. (2011) for a mode choice application employing endogeneity correction.

Finally, agent based simulation has also been used to test model properties and the effects on behaviour of various social network structures and experimental settings (Páez & Scott, 2007; Sunitiyoso et al. 2011; Ettema et al. 2011). In the absence of resources to collect large amounts of data, simulation offers an alternative approach to study social influences. An advantage of simulation models is that they can test a rich set of agent strategies, in particular more complex strategies than those tested in stochastic process models. Therefore, agent based models are in particular suited to test the effect of individual strategies on the masses in social dilemma situations (Sandholm, 2011). Furthermore, similar to stochastic process models, simulation can be used to represent the evolution of behaviour over time and is hence useful for policy forecasting if data calibration issues can be solved. With detailed simulation, it might also be possible to model the interaction between social network structure itself and mass effects. On the negative side, in many cases one needs to conduct long term and repeated simulations to test if a steady state solution exists with respect to the modelled behaviour (Páez & Scott, 2007; Sunitiyoso et al. 2011). This is particularly a problem when there might be multiple equilibria and the solution is sensitive to some of the input parameters.

To sum up, the approach to use for modelling mass effects in transportation depends on the available resources for data collection and model development as well as the objective of the analysis (e.g. studying model properties vs. calibrating a model). But overall, the research in this area would benefit moving forward with further examples of data collection efforts that measure social norms and social networks and with explicit representation of dynamics in the models.

## 3.6. Discussion and Implications

### 3.6.1. General Policy Implications

In the previous sections, the specific implications of each study (if any) have been described. In this sub-chapter, these implications are summarized into some general policy implications, which is believed that five main, general conclusions can be drawn.

First, it is emphasized that this review illustrates the importance of descriptive norms on decision making regarding transportation. In situations with too little as well as too much information, decision makers have difficulties to weigh pros and cons of options and often imitate others. A number of further psychological explanations that encourage one to imitate others have been described. It is found that descriptive norms have the potential to change the system equilibrium in some cases more than pricing

mechanisms or other policy interventions. As several authors point out, if social influences – in the form of descriptive norms – are ignored, this can lead to significant biases in transportation planning models (Goetzke, 2008; Páez et al. 2008). Ample evidence outside (drinking, energy consumption, littering) as well as within transportation planning (crossing junctions, using bicycles, using PT) have been reviewed to support this observation. This suggests that appealing to descriptive norms can be very successful.

Secondly, in order to achieve changes towards sustainable transportation it will be important to appeal to individuals as well as to the wider environment. Thom (2009) writes that one needs to "create a culture of change". The Australian TravelSmart Programme, that is a typical soft mobility management measure for changing transportation attitude and behaviour, has realized the importance of descriptive and injunctive norms in that it combines personal information about alternative travel modes with general messages through posters or other "mass media" for persons to understand that the surrounding society encourages the change. Norms therefore highlight also the role of organizations such as government (if it is trusted) and employers to promote change as discussed also in the INPHORMM (1999) project. Karash et al.(2008) also highlight the importance of influencing "community normative values" by directing promotional efforts and campaigns encouraging sustainable transportation behaviour towards families rather than just individuals.

Thirdly, messages appealing to injunctive norms directly, i.e. messages about what one should do, appear to be also successful in influencing decision making as for example various "travel feedback programs" show (Taniguchi & Fujii, 2007; Fujii et al. 2009) and as posited in the theory of planned behaviour (Ajzen, 1985; 1991) with respect to the expectations and approval of others (Karash, et al., 2008). However, proving that appealing to injunctive norms has long term and system wide influences, seems more difficult. This might not be because injunctive norms are less important, but rather because a field effect of injunctive norms per se is more difficult to show. Furthermore, as the discussion by Yamagishi and Suzuki (2007) implies, the set of injunctive norms can be regarded as the local culture, which has significant effects on individuals' behaviour and the macroscopic societal situation. We therefore note that the educational social process that influences injunctive norms appears to have potentially large power for policy makers. Fourthly, there appear to be critical or tipping points in many systems. As Goetzke and Weinberger (2012) point out "... as tipping points are reached, new social norms are established thus reinforcing the behaviour through contextual influences as well." The work of cultural psychologists also supports this

point strongly by describing how norms and culture are self-perpetuating each other. This suggests that policy makers should react early to unwanted trends, as retrospective changes are difficult to achieve (such as rising auto ownership levels in developing countries). In addition, Fukuda and Morichi's (2007) results can be interpreted in this way. Regulation and police control can be used to direct the system towards the desired equilibrium. Once an equilibrium is reached, it is difficult to distort this.

As a final point, it appears important for modelling as well as practical applications to recognize that there are different person groups and key persons within a society. The Bass work can be seen as evidence that innovators have a significant impact on society. Further, descriptive norms seem to have more effect on some population groups than others do. As, for example, the study by Van Vugt et al.(1995) points out, distinguishing pro-socials and pro-selfs in a society could help target information provided by policy makers. Pro-socials are much more influentiable by descriptive norms than pro-selfs, as also discussed by Karash et al.(2008) who suggest targeting campaigns encouraging walking and PT use to those with high receptiveness to such campaigns. As the review of the effects of (electronic) word of mouth further shows, through social media and changing social network structures it is becoming more complex though to understand who the key players within a society are; at least key players might also change faster and are not necessarily the obvious ones.

### 3.6.2. Designing Normative Messages

Though changing norms is difficult, it seems that through designing appropriate normative messages the importance of unwanted norms can be weakened; and desired norms can be supported or even created. To weaken existing norms, misperceptions can be emphasized as the study by Kim and Kim (2012) showed. They illustrates that drunk driving or RAID can be reduced by informing people that it is less common than many thought. A second way to reduce the effect of undesired norms is to explain the risks of complying. For example, Zhou et al.(2009) and McGhie et al.(2012) discuss that positive safety effects can arise by explaining to jaywalkers the risks of crossing with others illegally (appealing to injunctive norms). An example of strengthening descriptive norms is to provide residents with more information that the bicycle share in their neighbourhood is higher than often perceived.

As Goldstein et al.(2008) show, in particular if one can appeal to descriptive norms of (in some way) similar persons, this can be a successful strategy. This means that for example PT agencies should provide customized information to travelers (e.g. others

like them) instead of global information about their customers in general. Jariyasunant et al.(2012) apply this principle to some degree by presenting a Smartphone application and web-based interface that provides detailed information about one's own and others' behaviour so that it allows people to assess and compare their own behaviour for example in terms of its environmental friendliness. They provide individuals not only with "global" information about behaviour at a national level but also with "local" information about other individuals in their vicinity.

Some further important issues for designing normative messages are summarized in Cialdini (2003) and Glassman & Braun (2010): A) Considering salience is important. Normative messages should be structured so that they are salient at the time of performing an action. For transportation policy, this would mean that messages could be displayed when people are making transportation decisions. B) A message needs to be credible and presented in a way that people can relate to it. C) A message needs to highlight the benefits of the switching behaviour towards sustainable transportation that it is trying to promote. D) Ideally, descriptive and injunctive norms should be aligned. For example, to encourage PT usage due to environmental reasons if only a minority is doing so, has less persuasive power. In such situations, it might rather be useful to not report the absolute descriptive norm but injunctive norms only or, possibly injunctive norms plus messages showing the increase in PT usage over the last years.

Incentives and injunctive norms can further play a supporting role to avoid the boomerang effect. That is, normative effects might also encourage those behaving better than the average to revert to the norm. To avoid this, the Californian energy provider OPOWER had a successful experience providing households that consume less energy than the average with a reward in the form of a smiley on their bill (Allcott, 2011). Such simple rewards and injunctive norms may in the long term be a more promising way than to aim for people not to know that they behave better than the norm (Gaker et al. 2010).

Several examples where normative messages can be effective are discussed. Schultz et al.(2007) generalize this by discussing the type of choices that can be targeted by normative social influences and come up with four qualities: the choice should have a direct personal benefit, should be made for private purposes, is re-occurring (rather than a one-time action), and should have widespread social approval. Mode switching (e.g. to PT) has the first 3 characteristics, but the fourth is questionable. Although people would approve of others using PT, in most circumstances where PT usage is not the norm, they would not necessarily disapprove if PT is not used. This shows again that injunctive and descriptive norms should work in tandem. One might appeal first to

injunctive norms and only later, once a majority is reached to descriptive norms.

### 3.7. Conclusions

As this review have been tried to show, it is believed that this research area has potentially large applications for achieving sustainable and safe transportation. Its origins are in social psychology, marketing, and other disciplines and mass effects are possibly still under researched within the transportation field despite more recent efforts. Several areas of further research can be pointed out.

There is ample need for more empirical work to show evidence for social network effects within the transportation field as a number of studies reviewed relied on hypothetical scenarios only. Páez et al.(2008) point to the need to verify empirically the connection between location decisions and social influences and note the current scarcity of empirical work due to the difficulty of collecting social network data. In absence of data on social networks, several authors have relied on simulation. Similarly, point to the need for further data collection as well as developing dynamic activity-based models considering changes in the social network structure. Sharmeen et al.(2010) point to the need for further data collection as well as developing dynamic activity-based models considering changes in the social network structure. Especially due to the growing influence of fast changing virtual networks, this might be a topic of growing interest. Panel data can also help better define the causalities between social network structures and transportation behaviour. Connected to this, several authors have pointed to the need to determine which social networks are relevant in a particular behaviour context (Manski C. F., 1993; Brock & Durlauf, 2001; Dugundji & Walker, 2005; Páez et al. 2008) for example by directly asking people in surveys and/or by using egocentric approaches. Egocentric approaches have been developed but the link to mass effects has not yet been tested in detail. Páez & Scott (2007) also mention the need to test different social network compositions with different density and connectivity levels (as opposed to fixing the network).

In the absence of sufficient data, several studies on social network effects remain theoretical or rely on intentions to conduct a certain behaviour as a function of mass influences based on stated preferences data. Many authors acknowledge the limitations of these self-reported intentions. It may be more desirable to study these using revealed preferences data or field observations where possible. For example, Gaker et al.(2010) mention that it is important to analyse the applicability of stated intentions results to real-market settings and the long-term effectiveness of social influences on travel behaviour.

We listed some broad categories of modelling approaches, which all require further research, possibly on the methodologies themselves as well as in terms of case studies. In choice models, separating endogenous mass effects remains a challenge (Manski C. F., 1993; Brock & Durlauf, 2001a) and Schmöcker et al.(2014) mention even more open research areas for stochastic process models to be applicable for transportation policy. Most of the studies mentioned among process modelling as well as simulation are not based on actual data, or if yes, on small laboratory experiments. The limitations of models are broadly described but these might also be refined in further research. For example, it is believed that egocentric approaches are promising if they can be linked to mass effects. Further, there is also scope for "non-mathematical" approaches such as forecasting the impact of mass effects in the form of narratives or "socio-technical scenarios" as in Anable et al.(2012).

In conclusion, it is believed that the role of social norms is an important determinant for the decision to buy a car in the future. This notion is tested in Chapter 6. The objective is to understand further if there is a difference in the role of social norms between different societies, in particular between developing and developed countries. None of the above reviewed studies utilizes samples from developing countries. In some societies, the role of certain social network members such as parents or family members might be stronger than close friends or peers in campus compared to other societies. This will also be explored in more detail in Chapter 5 and Chapter 6.

# Chapter 4

# Role of Attitudes for Car Ownership Decisions of Students in Bandung City

## 4.1. Introduction

This chapter discusses about how attitudes towards cars and other determinant variables influence car ownership, car purchase intentions (car desire), and car upgrading intentions as well as partly discusses peer influences on those intentions. The structure of this chapter is as follows: After this introduction, the second part of this paper discusses first characteristics of the study area, Bandung, Indonesia, before explaining the survey among students regarding their motivation to buy cars. The following part describes first some aggregate statistics before employing principal component analysis (PCA) to extract attitudinal factors that are hypothesized to determine car ownership decisions. These factors are subsequently used for SEM to understand car ownership factors. Then, the discussion continues by using the result of PCA for car desire model. The next part is discussing correlation between peer influence and car upgrading desire. Finally, in the last part of the chapter, some conclusions and implications for transport planning are drawn.

## 4.2. Survey Design and Implementation

### 4.2.1. Study Area

Bandung is located approximately 140 km southeast of Jakarta. The city has a population of around 2.4 million people living in an area of 167.67 $km^2$ that makes it the densest city in Indonesia with 14,283 people/ $km^2$. Bandung has been famous as a fashion city since a long time. Because of its reputation, many visitors come not only from Indonesia (especially Jakarta) but also from overseas, in particular Malaysia and Singapore, mostly for leisure and shopping purposes. This has generated high economic growth and an increase in freight as well as passenger traffic within the city and on motorways connecting Bandung with Jakarta. All of this has added to create severe

traffic congestion within the city. The modal share in Bandung, based on registered vehicles in 2010, is depicted in Figure 4-1, which shows the city, is dominated by motorcycles and private cars.

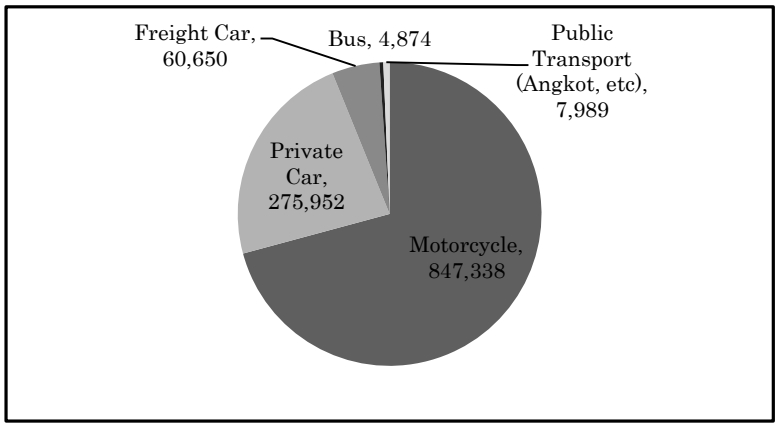


Figure 4-1 Modal Share in Bandung Based on Registered Vehicles in 2010. Source: Statistics of Bandung City (2010)

Private cars make up around 23% of the modal share whereas buses and minibuses constitute less than 1% of the vehicle fleet (Unfortunately, data on person-trips or trip-km by modes are not available). PT in Bandung mainly consists of paratransit in the form of minibuses (Angkot). These have a capacity of 12-14 passengers and operate on fixed routes through various parts of the city (Joewono & Kubota, 2005). Angkot minibuses are allowed to stop everywhere without any restriction. Their departure is not fixed as the operators often wait until the vehicle is nearly full. Pradono et al.(2010) discuss that the PT system in Bandung is not designed to encourage mode choice and Tarigan et al.(2014) reports that nearly 65% of PT users in Bandung have an income nearly equal to or lower than the local standard minimum income level[2] of IDR 939k (IDR 1,000k is about US$100). The PT network does not serve the city well and if residents do not want to, or cannot afford to, purchase cars, they have to either stick to motorcycles or adjust their residential location. Therefore, also for many students relying on PT alone is not a competitive alternative if one does not live very close to campus.

The focus is on undergraduate students. There are 3 state universities and 78 private universities/academies in Bandung (Statistics of Bandung City, 2010). It is obvious that students' economic situation is closely related to the support they obtain

[2]Standard minimum income level also known in Indonesian as *upah minimum propinsi* (UMP). A law issued by the provincial government as a monthly salary guideline for full time employees.

from their families. Intani (2009) reports that the parents of Bandung's public university students all have an income above the local standard minimum wage. The average monthly income of students' parents is IDR 9,443k, i.e. nearly ten times the minimum local income level. Intani (2009) also reports that students' monthly expenditure is on average 1,716k (with a range between IDR 500k- 4,200k). Pradono et al.(2010) target students from two state universities (ITB and UNPAD) and two private universities (UNIKOM and UNISBA) and show that there is no significant difference in the socio-economic profile or modal split between the students from these four universities in Bandung. They report that 41.8% of the students own a car or motorcycle. Van & Fujii (2011) also interviewed students in Bandung and report that 10% own a car (they did not ask for motorcycle ownership). In this study, focus is on students from one university only. This is clearly a limitation but partly due to the Pradono et al.(2010) results, it is believed that the results have wider validity as it will be discussed.

#### 4.2.2. Respondents

The targets of the survey were students of Bandung Institute of Technology (ITB). The survey focused on undergraduates aged between 17 and 23, as students, with the support of their parents, often purchase cars within their four years at university. In Indonesia, 17 is the minimum age to obtain a driving license as well as for buying a car. The majority of the samples were obtained through surveys in classrooms at the end of lectures. Some additional surveys were obtained through randomly approaching students in communal areas. In total exactly 500 complete surveys could be obtained.

#### 4.2.3. Questionnaire design

First, the respondents were divided into two groups according to whether they own a car or not. Car owning respondents were asked 20 questions about their attitudes toward cars. It was emphasized that they should answer considering "cars in general." Respondents were asked to recall their attitudes at the time of purchase as well as to provide their current attitudes. Each question was posed on a seven-point Likert scale with verbally defined endpoints (fully disagree – fully agree).

The first four items: *cars allow to express oneself*, *cars brings prestige*, *cars allow to distinguish oneself from others*, and *cars allow to do adventurous things* are taken with some adjustment from Steg (2005) who finds that they load high in the *symbolic/affective* construct. Four further statements: *cars are cool*, *cars are expensive to own and maintain, cars are fun to have*, and *cars give an arrogant impression* are taken from the attitudinal questions in Van and Fujii (2011) who also classified these

items as *symbolic/affective*. The latter statement did not load as high in Van and Fujii (2011) as the other three factors, possibly because "arrogance" is perceived often negative, whereas "cool" or "fun" have positive connotations.

A further item *cars are comfortable* is used in both Steg (2005) and Van and Fujii (2011) where Steg (2005) classifies this item into her *instrumental* factor in contrast to Van and Fujii (2011), who find that this factor correlates more with the *symbolic/affective* factor. The statements *cars allow one to travel safely*, *cars allow one to pick up or see off others* (Steg, 2005), and *cars are convenient* (2011) are all classified as instrumental factors in the previous research. Further statements taken from Steg (2005) are *cars allow one to travel anytime*, *cars allow one to be independent*, *cars allow one to travel anywhere*, and *cars help one to save time for travel*, which are found to form a factor referred to as *independence*.

Table 4-1 Attitudinal Variables towards Cars Used in Survey (grouping according to the previous literature)

| Symbolic/Affective | Instrumental | Independence | Social Orderliness |
|---|---|---|---|
| Cars allow to express oneself (Steg, 2005) | Cars are comfortable (Steg, 2005; Van & Fujii, 2011) | Cars allow one to travel anytime (Steg, 2005) | Cars are environmentally friendly (Van & Fujii, 2011) |
| Cars bring prestige | Cars allow one to travel safely (Steg, 2005) | Cars allow one to be independent | Cars allow one to care about others |
| Cars allow to distinguish oneself from others | Cars allow one to pick up or see off others | Cars allow one to travel anywhere | Cars are disturbing one's neighbourhood |
| Cars allow to do adventurous things | Cars are convenient (Van & Fujii, 2011) | Cars helps one to save time for travel | |
| Cars are cool (Van & Fujii, 2011) | | | |
| Cars are expensive to own and maintain | | | |
| Cars are fun to have | | | |
| Cars give an arrogant impression | | | |
| Cars are trendy (Weinberger & Goetzke, 2010; 2011) | | | |

As mentioned above, Van and Fujii (2011) propose that there is an additional attitudinal factor referred to as *social-orderliness*. To verify its importance, questions on whether respondents consider that *cars are environmentally friendly*, *cars allow one to care about others*, and *cars are disturbing one's neighbourhood* are also included. A final item *cars are trendy* is included in accordance with Weinberger and Goetzke (2010; 2011) who find that people are influenced in their transportation decision by social peers and neighbours. Table 4-1 summarizes the attitudinal variables and in which literature they have been used before. In the second section of the survey, non-car owners were asked the same attitudinal questions and, to improve comparability, it is emphasized again that answers should be based on their attitude towards "cars in general."

In chapter 3, the influence of peers on car ownership have been discussed. For example, Goetzke and Weinberger (2012) find that probability of owning a car is affected by the behaviour of socio-economic peers and physical neighbours. Schultz et al. (2007) also find that the closer the person group, the stronger might be the influence of expectations. Therefore, car owners were asked to recall how much certain groups of people influenced their decision to buy the car they currently own. The choices were given on a seven-point Likert scale starting with "he/she never talked to me about this car" followed with "he/she suggested me to buy this car" as a middle point, and ended with "he/she strongly recommended me to buy this car".

These groups of people are father, mother, partner, brother, sister, friends, classmate, student association mate, and virtual network. Since they are students, it is assumed that aside from family and probably partner, if they have one, they directly interact a lot with campus mates and virtual network mate, thus friends, classmate, student association mate, and virtual network are incorporated here. They are also asked how certain group of media influences their decision to buy a car. The answer range is also given on a seven-point Likert scale from "no influence at all" to "strong influence." These groups are newspaper, TV commercial, radio commercial, internet commercial, and car expo.

Regarding desire to upgrade cars, several studies have mentioned about car replacement (see Sub-chapter 2.5). According to Marell et al.(2009) psychological factors can influence the decrease in perceived current quality of car (need recognition). The hypothesize is that the decrease in perceived current quality of car can be further brokendown to either satisfaction with current car or also regret with the car bought hence these two variables is incorporated in car upgrading model. Thus the next question for them is "are you satisfied with your car?" the answer range is seven-point

Likert scale from “not at all” until “yes, very much”. The same answer range is also used for another question “do you regret having bought a car?” Finally they have to answer whether they will buy a new car or not in the future.

Non-car owners were asked similar questions regarding their desire to buy a car. In the final sections, all respondents were asked about their travel distance to come to university and their frequency of using PT, “how often do you use PT per week?” Further, a limited number of questions were asked about respondents’ attitudes towards PT in Bandung to verify whether limited PT is a reason for car ownership. These questions are also asked on a seven-point Likert scale. In particular, they are asked for their perception whether PT is fast and reliable, using variables that are referred to in the following, as PT is fast and PT is reliable. Note that students, who do not or only seldom use PT, might answer the PT questions based on what they have heard rather than what they experience. This difference is perceived though as not important for the purposes of this dissertation as both direct as well as indirect experiences will have formed a respondent’s attitudes (Eagly & Chaiken, 1993).

The questionnaire concluded by asking for socio-demographic characteristics including students’ monthly income obtained jointly from parents, scholarships, part time jobs, etc. Five income categories are provided: US$0-50 (IDR 0-500k); US$50-100; US$100-250; US$250-500; and more than US$500, these categories also used by the previous study (Tarigan et al. 2014). Additional information about their parents’ income are not available, but it is believed that the students’ available budget also, to some degree, reflects their parents’ economic status. Only few undergraduate students obtain scholarships and the possibilities to significantly increase one’s income by part-time jobs are limited during the first years of study. Parking availability is not included because in Bandung, as well as other parts of Indonesia it has never been a problem for car owners to find a parking space, as parking restrictions in most places are not enforced. The more detail about the questionnaire can be seen in Appendix A

## 4.3. Descriptive Analysis

### 4.3.1. Socio-demographics and other Explanatory Variables

The majority of the respondents are aged 19-21 ($\mu$=19.83, $\sigma$=2.15). The youngest one is 17, which means all of them are allowed to apply for a car-driving license. As the difference in age between the respondents is minor, it is not used in the subsequent analysis. There are slightly more males in the sample, in line with the overall student composition at ITB. About 134 respondents, or 27% of the sample, are car owners. Based

on the vehicle ownership statistics of students in Bandung discussed in Section 4.1, this seems representative. Table 4-2 illustrates some of the socio-demographic characteristics of the respondents.

Table 4-2 Characteristic of Respondents

| Descriptive Statistic | Male | | Female | | Total | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| Non Car Owner | 206 | 41.2% | 160 | 32.0% | 366 | 73.2% |
| Car Owner | 76 | 15.2% | 58 | 11.6% | 134 | 26.8% |
| Total | 282 | 56.4% | 218 | 43.6% | 500 | 100% |

Figure 4-2 groups the percentage of students owing a car based on income level. The category "more than US$500" only contains four respondents, so that it is combined with the category "US$250-500." Based on the above reported standard minimum income more than 50% of the students are below this. If this is compared with the results of Tarigan et al. (2014) the income distribution seems fairly representative.

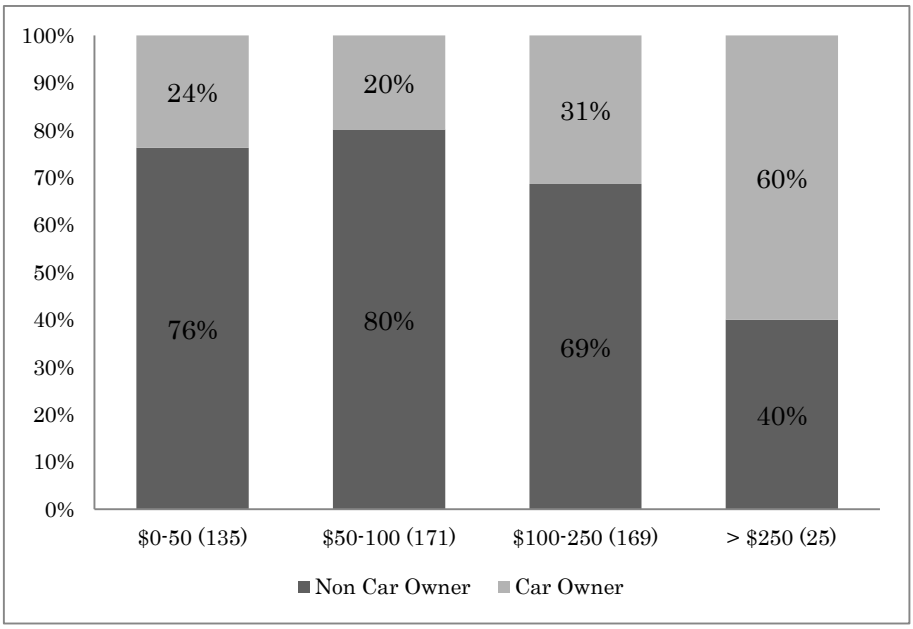


Figure 4-2 Car Ownership Ratio by Income Level (in brackets number of samples)

As one might expect, from the figure it can be seen that the number of car owners does increase with income level, though also low-income students own cars and not all of the students with a higher income own a car. It is further found that many respondents live fairly near the campus (μ=4.4 km, σ=5.1 km, max 30km), reducing the

need to own a car for commuting for some. The respondents, both car owners and non car owners, further answer that they use PT on average 4.93 times per week, though this frequency varies significantly among respondents ($\sigma$=4.9). As expected, respondents rate the service quality as low ("PT is fast": $\mu$=2.75, $\sigma$=1.47; "PT is reliable": $\mu$=2.94, $\sigma$=1.55).

### 4.3.2. Attitudinal Variables

Whether there are significant differences in attitudes towards cars between the car owners and non-car owners is analysed in the sample. Since attitudes variables are ordinal, the Mann-Whitney U test is used. As can be seen from Table 4-3, there are some significant differences between the two groups. Around 14 out of 20 attitudinal variables are significantly different at 5% level; one variable is significantly different at 10% level, while only the answers to five attitudinal questions are not significantly different.

In general, car owners have attitudes towards cars that are more positive. They tend to agree more with the statements that cars allow one to travel anytime, travel anywhere, allow to be independent, and help save time to travel. These are independence reasons valued by car owners and possibly a reason for their eventual purchase of a car.

For the potentially negative images of cars such as cars allow to distinguish oneself from others and cars are expensive to own and maintain, car owners tend to disagree with these statements while non cars owner gives more value to it, which is also expected. Car owners also less agree with cars bring prestige and cars allow to express oneself, possibly because of a negative undertone perceived with these statements. Further, non car owners might overestimate the effect of car ownership on prestige and the possibility of self expression as they will not have had the experience of owning a car themselves.

Surprisingly, the statement cars allow one to pick up or see off others, a positive attribute of cars, is also more agreeable to non car owners than car owners. One might argue that this potential benefit of cars is not utilized as much as non car owners expect, explaining this result. Finally, regarding "direct negative effects" such as cars are environmentally friendly (reversed scale) and cars are disturbing one's neighbourhood non-car owners disagree more to the first statement and agree more to the second statements which is according to the expectations. It is emphasized though that there are various different possible explanations for this effect. Car owners might downplay the negative effects of their driving and/or not be aware of the side effects. Alternatively,

one might argue that non-car owners are truly more aware of the externalities caused by driving. Yet another explanation would be that non car owners use the negative side effects as an excuse or "pretended argument" if they might not be able to afford a car. This projection of a negative image on an item that one currently does not own and can not afford to buy was termed "cognitive dissonance" by Festinger (1957).

Table 4-3 Attitudinal differences between car owners and non-car owners

| Variable | Car Owners (N = 134) | | Non Car Owners (N = 366) | | Mann-Whitney U | |
|---|---|---|---|---|---|---|
| | Mean | Std. Dev | Mean | Std. Dev | | |
| Cars are cool | 5.07 | 1.71 | 5.02 | 1.39 | 23045 | |
| Cars are trendy | 4.43 | 1.53 | 4.54 | 1.36 | 23798 | |
| Cars allow to express oneself | 4.08 | 1.45 | 4.37 | 1.37 | 21775 | ** |
| Cars are giving arrogant impression | 3.24 | 1.74 | 4.01 | 1.58 | 18223 | *** |
| Cars allow to distinguish oneself from others | 3.43 | 1.71 | 4.17 | 1.59 | 18387 | *** |
| Cars are expensive to own and maintain | 5.13 | 1.51 | 5.68 | 1.25 | 19362 | *** |
| Cars are disturbing one's neighbourhood | 2.89 | 1.53 | 3.54 | 1.36 | 18001 | *** |
| Cars bring prestige | 4.17 | 1.61 | 4.61 | 1.48 | 20522 | *** |
| Cars help one to save time for travel | 4.87 | 1.86 | 3.57 | 1.79 | 14982 | *** |
| Cars allow one to travel anywhere | 5.39 | 1.48 | 4.64 | 1.61 | 17980 | *** |
| Cars allow one to travel anytime | 5.26 | 1.61 | 4.11 | 1.75 | 15238 | *** |
| Cars allow one to be independent | 5.43 | 1.46 | 4.69 | 1.40 | 17099 | *** |
| Cars allow one to travel safely | 5.75 | 1.27 | 5.43 | 1.24 | 20301 | *** |
| Cars are comfortable | 5.95 | 1.16 | 5.77 | 1.09 | 21660 | ** |
| Cars allow one to pick up or see off others | 5.68 | 1.37 | 5.97 | 1.03 | 22321 | |
| Cars are fun to have | 5.69 | 1.29 | 5.56 | 1.16 | 22393 | |
| Cars allow one to care for others | 4.07 | 1.52 | 3.60 | 1.43 | 19807 | *** |
| Cars are environmentally friendly | 3.40 | 1.62 | 2.80 | 1.33 | 19184 | *** |
| Cars are convenient | 4.98 | 1.67 | 4.70 | 1.37 | 21247 | ** |
| Cars allow to do adventurous things | 5.27 | 1.61 | 5.10 | 1.49 | 22596 | |

**: $p<0.05$ ***: $p<0.01$

### 4.3.3. Car Upgrading Explanatory Variables

A) Satisfaction and Regret

The mean and standard deviation of satisfaction and regret can be seen in Table 4-4. From the table it can be seen that most of the students are quite satisfied with their current car and most students have few regrets that they bought their current car.

Table 4-4 Descriptive statistic of satisfaction and regret

| Variable | N | Mean | Std. Deviation |
|---|---|---|---|
| Satisfaction with current car | 134 | 5.49 | 1.18 |
| Regret with the car bought | 134 | 1.94 | 1.18 |

B) Peer influence on past car owning decision

For the group influence on past car owning decision, two samples are distinguished. In the first sample a "no" answer is treated as a missing value and these respondents are omitted in the subsequent analysis. For example, one might have no sister, and so might not have answered the question relating to influence of sister. Note that this introduces a bias in the sample towards students from larger families. For the second scenario, the missing value is treated as "no influence" which means that for example no brother is considered as the same as no influence from a brother. The descriptive statistic can be seen in Table 4-5.

Table 4-5 Descriptive statistic of influence group

| Influence Group | Biased Sample | | | Full Sample | | |
|---|---|---|---|---|---|---|
| | N | Mean | Std. Dev | N | Mean | Std. Dev |
| Father | 133 | 4.71 | 1.92 | 134 | 4.68 | 1.94 |
| Mother | 133 | 4.19 | 2.05 | 134 | 4.16 | 2.06 |
| Partner | 108 | 2.12 | 1.68 | 134 | 1.90 | 1.57 |
| Brother | 114 | 3.14 | 2.01 | 134 | 2.82 | 2.01 |
| Sister | 118 | 2.91 | 2.01 | 134 | 2.68 | 1.99 |
| Classmate | 118 | 2.00 | 1.61 | 134 | 1.88 | 1.55 |
| Student Association Mate | 118 | 1.75 | 1.53 | 134 | 1.66 | 1.46 |
| Friends | 118 | 2.34 | 1.89 | 134 | 2.18 | 1.82 |
| Virtual Network | 116 | 1.55 | 1.25 | 134 | 1.48 | 1.18 |
| Newspaper | 124 | 3.60 | 1.72 | 134 | 3.41 | 1.79 |
| TV Commercial | 125 | 3.90 | 1.93 | 134 | 3.70 | 2.00 |
| Radio Commercial | 122 | 2.48 | 1.48 | 134 | 2.35 | 1.47 |
| Car Expo | 128 | 4.76 | 1.89 | 134 | 4.59 | 2.01 |
| Internet Commercial | 124 | 3.77 | 1.90 | 134 | 3.56 | 1.97 |

Based on the table, in both samples it can be seen that father and mother have high values, which means that strong suggestions to buy their current car were given by parents. For partners and siblings, the values are not so high implying that these groups did not give strong suggestion/influence on the decision to buy the current car. However, it is interesting to note that 114 out of 134 answer the question regarding influence of brothers. There is a possibility that many without brother will also have answered, "he/she never talked to me about this car" which is supporting the second sample. At current state, it cannot be confirmed whether they have siblings or not.

As mentioned before, since the respondents are undergraduate students, which are assumed that they directly interact with their classmate and student association mate, hence there is high possibility that these peer groups influence the decision of students to purchase cars. Nevertheless, from the result it can be seen that classmates and student-association mate influence decisions less than friends do. Clear definition about the term friends is not given, while classmate as well as student association mate are clear by definition, but for just friends it can have a wider scope or range from campus until neighbourhood. For virtual network friends, Facebook or Twitter are mentioned as an example, since almost all Indonesian students have a Facebook and/or Twitter account, it is assumed that the influence to purchase car from this virtual network friends is high, but based on the table it can be seen that virtual network friends give low influence.

For commercial sources such as newspapers, TV and internet commercials quite high influence values are reported although still below the mid points. The similarity between these three media is in the visual part, they can see the product and they can read the information about certain types of car, in case of TV, they can listen to the explanation. For radio commercial although they can get many information regarding car, but since it is not visualized, they might not be attracted to it. Car Expo is different from any other media mentioned before; the respondents can actually see the product. They can get information regarding the product and experience it, thus it gives higher influence in the decision to purchase car, as can be seen in the table.

## 4.4. Car Ownership Models

### 4.4.1. Principal Component Analysis

To construct uncorrelated factors of attitudes toward cars, a principle component analysis (PCA) with varimax rotation is performed on the attitudinal variables. PCA is a method of data reduction where in the process it groups correlated variables into

uncorrelated factors (Fabrigar et al., 1999; Wright & Villalba, 2012). At first factors are constructed based on all 20 attitudinal variables and 500 samples. The two variables *cars are convenient*, and *cars allow to do adventurous things* give low loading factors though, so that these two are excluded. All factors with eigenvalues larger than one are selected which are five constructs that explain 57.4% of the variance. The results of the PCA can be seen in Table 4-6.

Table 4-6 Rotated Factor Loadings on Attitudes toward Cars

| | Variables | Symbolic/ Affective (13.2%)[a] | Arrogant Prestige (12.6%) | Independence (12.4%) | Comfort (11.5%) | Social/env. Care (7.6%) |
|---|---|---|---|---|---|---|
| X1[b] | Cars are cool | **0.81**[c] | -0.01 | 0.02 | 0.27 | 0.06 |
| X2 | Cars are trendy | **0.77** | 0.20 | 0.03 | 0.11 | 0.08 |
| X3 | Cars allow to express oneself | **0.57** | 0.11 | 0.14 | 0.04 | -0.09 |
| X4 | Cars are giving arrogant impression | 0.26 | **0.73** | -0.08 | -0.05 | -0.11 |
| X5 | Cars allow to distinguish oneself from others | 0.37 | **0.69** | -0.15 | -0.16 | 0.10 |
| X6 | Cars are expensive to own and maintain | -0.12 | **0.64** | -0.11 | 0.33 | -0.18 |
| X7 | Cars are disturbing one's neighbourhood | -0.06 | **0.58** | -0.03 | -0.22 | -0.18 |
| X8 | Cars brings prestige | 0.47 | **0.53** | -0.22 | 0.15 | 0.18 |
| X9 | Cars help one to save time for travel | 0.13 | -0.19 | **0.76** | -0.10 | 0.02 |
| X10 | Cars allow one to travel anywhere | 0.05 | -0.08 | **0.71** | 0.16 | 0.09 |
| X11 | Cars allow one to travel anytime | 0.04 | -0.20 | **0.71** | 0.12 | 0.21 |
| X12 | Cars allow one to be independent | 0.00 | 0.14 | **0.61** | 0.35 | 0.07 |
| X13 | Cars allow one to travel safely | 0.17 | -0.18 | 0.07 | **0.69** | 0.19 |
| X14 | Cars are comfortable | 0.03 | -0.06 | 0.23 | **0.64** | 0.10 |
| X15 | Cars allow one to pick up or see off others | 0.21 | 0.15 | 0.02 | **0.60** | -0.21 |
| X16 | Cars are fun to have | 0.48 | -0.08 | 0.23 | **0.55** | -0.05 |
| X17 | Cars allow one to care for others | -0.13 | -0.05 | 0.13 | 0.19 | **0.76** |
| X18 | Cars are environmentally friendly | 0.18 | -0.17 | 0.19 | -0.15 | **0.71** |

a. Number inside bracket are total variance explained by each factors; b. Numbering X1 to X18 are used for the subsequent analysis; c. Bold means that the variable in the row is grouped to the respective column factor.

The first factor accounts for 13.2% of the variance. Variables loaded on this factor mostly refer to emotional perceptions such as the car being cool or trendy. Therefore, this factor is named *symbolic/affective* in line with the Steg (2005) study. The second factor accounts for 12.6% of variance and describes negative associations with car

ownership such as cars giving an arrogant impression, being a symbol of prestige and being expensive. Therefore, this factor is named *arrogant prestige*. The third factor (explaining 12.4% of variance) includes attitudes that are grouped as *independence* in the previous research. Variables loaded on the fourth factor (explaining 11.5% variance) are cars allow traveling safely, are comfortable, allow picking up or seeing of others, as well as are fun to have. As comfort and pleasure aspects for the driver as well as other passengers seem to be a central theme here, this factor is referred to as *comfort*. The last factor accounts for 7.6% of variance and includes the two items *cars allow one to care for others* and *cars are environmentally friendly*. These variables were also key variables in Van and Fujii (2011) for their definition of a *social orderliness* factor. However, since the construct is slightly different, to name it *social/env. care* is preferred in the following. These five attitudinal factors along with socio-demographic variables are used for the subsequent analysis to explain car ownership.

### 4.4.2. Car Ownership Models Estimation

The attitudinal factors are extracted using the Bartlett refined method (1937). This method is chosen (instead of using for example weighted means) as it produces unbiased estimates of the true factor scores with sample mean zero and a standard deviation of one (Hershberger, 2005, as cited in DiStefano et al., 2009). The five factors constructed by the above PCA analysis are used as a basis for determining exogenous latent variables for car ownership model. In addition explanatory variables that previously found to be significantly determine car ownership as exogenous variables are incorporated i.e.: PT accessibility that is measured by frequency of using PT and also attitudes towards PT[3];monthly income; and commuting distance (see Table 2-1).

Note that for income, the four point's ordinal scale is used as in Figure 4-2. Though this imposes the assumption of linearity between the categories, this scale is preferred instead of a continuous scale or a dummy coded variable as firstly, the categories have also been only broad and secondly, as discussed above, ideally for a precise income effect model one should have better knowledge of the parents' income situation. Further note that a better model fit is found by using the ordinal category. Needless to say, the ordinal variable is presumed to be strongly correlated with actual income, therefore the ordinal variable is used as substitute of actual continuous income that is more difficult to observe. Table 4-7 shows the descriptive statistic of variables used in the correlation analysis.

[3]The trial to construct a latent variable "attitude to PT" with *PT is fast* and *PT is reliable* and to incorporate this factor into the SEM model has been done before, however, the goodness of fit of the model was low and the construct was not significant.

Table 4-7 Descriptive statistics of five attitudinal factors and socio-demographics

| **Variable (N=500)** | Mean | Min | Max | Standard deviation | Std. Error of Mean |
|---|---|---|---|---|---|
| Symbolic/ Affective | 0.00 | -3.46 | 2.75 | 1.00 | 0.04 |
| Arrogant Prestige | 0.00 | -4.47 | 2.33 | 1.00 | 0.04 |
| Independence | 0.00 | -2.91 | 2.68 | 1.00 | 0.04 |
| Comfort | 0.00 | -5.48 | 2.58 | 1.00 | 0.04 |
| Social/Env. Care | 0.00 | -2.76 | 3.35 | 1.00 | 0.04 |
| Commuting Distance | 4.36 | 0.08 | 30.00 | 5.10 | 0.23 |
| PT is fast | 2.75 | 1.00 | 7.00 | 1.47 | 0.07 |
| PT is reliable | 2.94 | 1.00 | 7.00 | 1.55 | 0.07 |
| Frequency of using PT | 4.93 | 0.00 | 20.00 | 4.90 | 0.22 |
| Monthly Income | 2.18 | 1.00 | 5.00 | 0.90 | 0.04 |

Further, the correlation between these variables is tested and non-significant correlations is found between attitudinal factors and socio-demographics variables except that the construct symbolic affective is, correlated with monthly income and that *social/env. care* is correlated with frequency of using PT.

The correlations between these variables (the correlations between attitudinal factors are omitted as these are (near) zero due to construction by PCA) are shown in Table 4-8. The positive significant correlation between symbolic affective and monthly income is understandable indicating that students from the highest income groups might consider it mandatory to own a car. The negative significant correlation between *social/env. care* and frequency of using PT is more difficult to explain. It is suggested that these students either make in general less motorized trips or possibly this correlation supports the above proposed "cognitive dissonance" argument. Some other expected significant correlations can be observed between the socio-demographic variables. It is observed that the higher the commuting distance the lower frequency to use PT. This might reflect the inconvenience of taking longer distance trips with PT in Bandung. The negative significant correlation between commuting distance and monthly income is also expected, as housing near the campus is very expensive.

Table 4-8 Correlation between the five attitudinal factors and socio-demographics

| Variables | Commuting Distance | PT is fast | PT is reliable | Frequency of using PT | Monthly Income |
|---|---|---|---|---|---|
| Symbolic/ Affective | -0.02 | -0.06 | -0.05 | -0.01 | **0.10** |
| Arrogant Prestige | 0.02 | 0.01 | 0.04 | 0.01 | -0.08 |
| Independence | -0.05 | -0.01 | -0.05 | 0.05 | 0.08 |
| Comfort | 0.05 | 0.06 | 0.05 | -0.07 | 0.08 |
| Social/ Env. Care | 0.09 | -0.02 | -0.04 | **-.012*** | 0.04 |
| Commuting Distance | | -0.01 | -0.05 | **-0.16*** | **-0.21*** |
| PT is fast | | | **0.63*** | -0.04 | -0.04 |
| PT is reliable | | | | 0.00 | -0.02 |
| Frequency of using PT | | | | | 0.03 |

Bold p value<0.05; Bold + * p value <0.01

Table 4-8 also shows significant correlation between explanatory variables that might influence car ownership. In order to understand better indirect effects towards car ownership, especially related to income, a structural equation modelling (SEM) analysis is conducted. The model allows to further directly estimates the latent attitudinal constructs[4]. Previous research on car ownership also used SEM as their modelling techniques (Wu et al., 1999; Parkany et al., 2004; Zhao, 2011; Galdames et al., 2011).

SEM is a multivariate regression in which the response variable in one regression equation may become predictor in another equation (Schumacker & Lomax, 2010). This allows to account for correlations and to distinguish direct and indirect effects of exogenous and latent variables on car ownership. Since the dependent variable is a dichotomous outcome (binary discrete choice model), the robust (mean- and variance adjusted) method of Weighted Least Square (WLS) also known as WLSMV (Muthén & Muthén, 1998-2012) is used. In general, this method is preferable to Maximum Likelihood (ML) estimation when the data are severely non-normal distributed (Olssonet al. 2000). Since car ownership is dichotomous, SEM with binary probit regression for these paths towards the main dependent variable is used.

Since in the initial correlation analysis it is found that commuting distance has a negative significant correlation with frequency of using PT and monthly income, path analysis between these three variables is performed in the SEM model. It is

[4]Initially, a binary logistic regression model using car ownership as the dependent variable is conducted (Belgiawan et al., 2011). However, a logistic regression model does not consider correlation between independent variables nor specify indirect paths which is considered important for the model.

hypothesized that monthly income might influence commuting distance since the housing location decision is often determined by income level; apartments closer to the campus area in general have higher prices in Bandung thus commuting distance is treated as endogenous variable and monthly income as exogenous variable. It is also hypothesized that there is an indirect effect of commuting distance via frequency of using PT on car ownership in line with the correlation results.

Three different model specifications are tested, started with the first model (Model 1, p 77-78) which is constructed without indirect paths as in Belgiawan et al. (2011). The R-square is good, however other model fit indicator statistics suggest a low model fit (RMSEA = 0.09; CFI = 0.410; TLI = 0.34; and WRMR = 2.49)[5]. It is further found that the *symbolic/affective* does not explain car ownership in contrast to the previous literature. Instead, *arrogant prestige* is highly significant. Remembering that this construct relates to the negative aspects of *symbolic/affective* the result might hence suggests that *arrogant prestige* is rather the negative than the positive symbolic aspects that influence car ownership. Interestingly *comfort* is not significant, possibly indicating that the student sample concerns less about these aspects.

Based on these observations hence alternative model structures are tested. The second model (Model 2) provides a better model fit (reduced Chi-2/df; RMSEA = 0.04; CFI = 0.90; TLI = 0.87; and WRMR = 1.05). In this model *symbolic affective* and *comfort* as well as PT is fast are omitted since they are not significant in the first model. Further *independence* is treated as endogenous variables influenced by monthly income based on correlations found in Table 4-8. The interpretation is that income level influences the car perception aspects such as save time to travel, can travel anywhere, and can travel anytime, which construct the *independence* factor. All variables are significant except for *social/env. care*. This might suggest that social and environmental aspects might be to some degree important to students but maybe not sufficiently to influence car ownership decisions. Omitting this factor then leads to the final model (Model 3) with the best model fit (RMSEA = 0.04; CFI = 0.94; TLI = 0.92; and WRMR = 0.95). The three different model specifications are shown in Table 4-9.

[5]In general with binary outcomes at N>250, CFI>0.95, TLI>0.95, RMSEA<0.05 and WRMR<1 can be indications of good models (Yu, 2002). CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; RMSEA = Root-Mean-Square Error of Approximation; WRMR = Weighted Root Mean square Residual (WRMR is suitable to evaluate models with non-normally distributed outcomes)

Table 4-9 Car Ownership Models (Model 1, Model 2, Model 3)

| Path | | | Model 1 (n=500) | | Model 2 (n=500) | | Model 3 (n=500) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Est. | t-stat | Est. | t-stat | Est. | Stndz. | t-stat |
| **Latent Constructs** | | | | | | | | | |
| X1 | ← | Symbolic Affective | 1 | | | | | | |
| X2 | ← | Symbolic Affective | 0.87* | 9.03* | | | | | |
| X3 | ← | Symbolic Affective | 0.48* | 8.73* | | | | | |
| X4 | ← | Arrogant prestige | 1 | | 1 | | 1 | 0.71 | |
| X5 | ← | Arrogant prestige | 1.00* | 11.17* | 0.93* | 9.82* | 1.00* | 0.71* | 9.95* |
| X6 | ← | Arrogant prestige | 0.49* | 8.22* | 0.55* | 7.94* | 0.52* | 0.46* | 7.84* |
| X7 | ← | Arrogant prestige | 0.45* | 7.42* | 0.54* | 7.33* | 0.53* | 0.43* | 7.33* |
| X8 | ← | Arrogant prestige | 0.72* | 9.37* | 0.66* | 8.10* | 0.72* | 0.55* | 8.47* |
| X9 | ← | Independence | 1 | | 1 | | 1 | 0.70 | |
| X10 | ← | Independence | 0.77* | 8.41* | 0.74* | 7.54* | 0.71* | 0.58* | 7.56* |
| X11 | ← | Independence | 1.01* | 8.67* | 1.09* | 7.58* | 1.04* | 0.77* | 7.58* |
| X12 | ← | Independence | 0.58* | 8.01* | 0.47* | 6.71* | 0.46* | 0.42* | 6.81* |
| X13 | ← | Comfort | 1 | | | | | | |
| X14 | ← | Comfort | 0.76* | 11.15* | | | | | |
| X15 | ← | Comfort | 0.68* | 10.41* | | | | | |
| X16 | ← | Comfort | 0.99* | 10.28* | | | | | |
| X17 | ← | Social/Env Care | 1 | | 1 | | | | |
| X18 | ← | Social/Env Care | 1.22* | 3.04* | 1.04* | 5.42* | | | |
| **Structural Model (Figure 4-3)** | | | | | | | | | |
| Commuting distance | ← | Monthly income | -1.18* | -4.07* | -1.20* | -3.95* | -1.20* | -0.21* | -3.96* |
| Freq. of using PT | ← | Commuting distance | -0.15* | -3.45* | -0.15* | -3.47* | -0.15* | -0.16* | -3.47* |
| Independence | ← | Monthly income | | | 0.21* | 2.84* | 0.21* | 0.15* | 2.85* |
| Car ownership | ← | Symbolic Affective | -0.04 | -0.70 | | | | | |
| Car ownership | ← | Arrogant prestige | -0.33* | -6.14* | -0.20* | -3.24* | -0.21* | -0.25* | -3.69* |
| Car ownership | ← | Independence | 0.44* | 7.35* | 0.30* | 4.08* | 0.33* | 0.43* | 5.70* |
| Car ownership | ← | Comfort | 0.13 | 1.38 | | | | | |
| Car ownership | ← | Social/Env Care | 0.54* | 3.82* | 0.14 | 0.96 | | | |
| Car ownership | ← | Commuting distance, | 0.02 | 2.08 | 0.02* | 2.14* | 0.02* | 0.11* | 2.14* |
| Car ownership | ← | PT is reliable | -0.09 | -2.35 | -0.09* | -2.35* | -0.09* | -0.14* | -2.35* |

| Path | | | Model 1 (n=500) | | Model 2 (n=500) | | Model 3 (n=500) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Est. | t-stat | Est. | t-stat | Est. | Stndz. | t-stat |
| Car ownership | ← | Freq. of using PT | **-0.05*** | **-3.92*** | **-0.05*** | **-3.92*** | **-0.05*** | **-0.24*** | **-3.92*** |
| Car ownership | ← | Monthly income | **0.26*** | **4.42*** | **0.20*** | **3.30*** | **0.19*** | **0.17*** | **3.19*** |
| Car ownership | ← | PT is fast | 0.02 | 0.58 | | | | | |
| **Indirect effect to Car ownership** | | | | | | | | | |
| Freq. of using PT | ← | Commuting distance | | | | | **0.01*** | **0.04*** | **2.72*** |
| Commuting distance | ← | Monthly income | | | | | *-0.03* | *-0.02* | *-1.85* |
| Frq PT + ComDist | ← | Monthly income | | | | | **-0.01** | **-0.01** | **-2.37** |
| Independence | ← | Monthly income | | | | | **0.07** | **0.06** | **2.59** |
| **Thresholds** | | | **0.83*** | **3.57*** | **0.77*** | **3.72*** | **0.77*** | **0.77*** | **3.72*** |
| **R Square** | | | 0.77 | | 0.47 | | 0.46 | | |
| **Model Fit** | | | | | | | | | |
| Chi-2/df | | | 5.04 | | 1.97 | | 1.71 | | |
| RMSEA | | | 0.09 | | 0.04 | | 0.04 | | |
| CFI | | | 0.41 | | 0.90 | | 0.94 | | |
| TLI | | | 0.34 | | 0.87 | | 0.92 | | |
| WRMR | | | 2.49 | | 1.05 | | 0.95 | | |

Italic p value <0.1; Bold p value<0.05; Bold + * p value <0.01

### 4.4.3. Discussion

In the final model (Model 3) there are significant paths to car ownership from the attitudinal factors *independence* (μ= 0.46, σ=1.32), *arrogant prestige* (μ= 0.00, σ=1.17), PT is reliable as well as from frequency of using PT, commuting distance and monthly income. *Arrogant prestige* is constructed by the five attitudinal variables suggested by the PCA, which are all found significant though the importance of the exogenous variables vary. *Cars allow to distinguish oneself from others, are giving arrogant impression* and *bring prestige* are weighted more than *cars are expensive to own and maintain* and *are disturbing one's neighbourhood*. This result though confirms the chosen construct name, i.e. the perception one conveys to others by owning a car is the central theme for this construct. For *independence*, it is found that travel time related aspects more important in the construct. The structure of the final model (Model 3) is further illustrated in Figure 4-3.

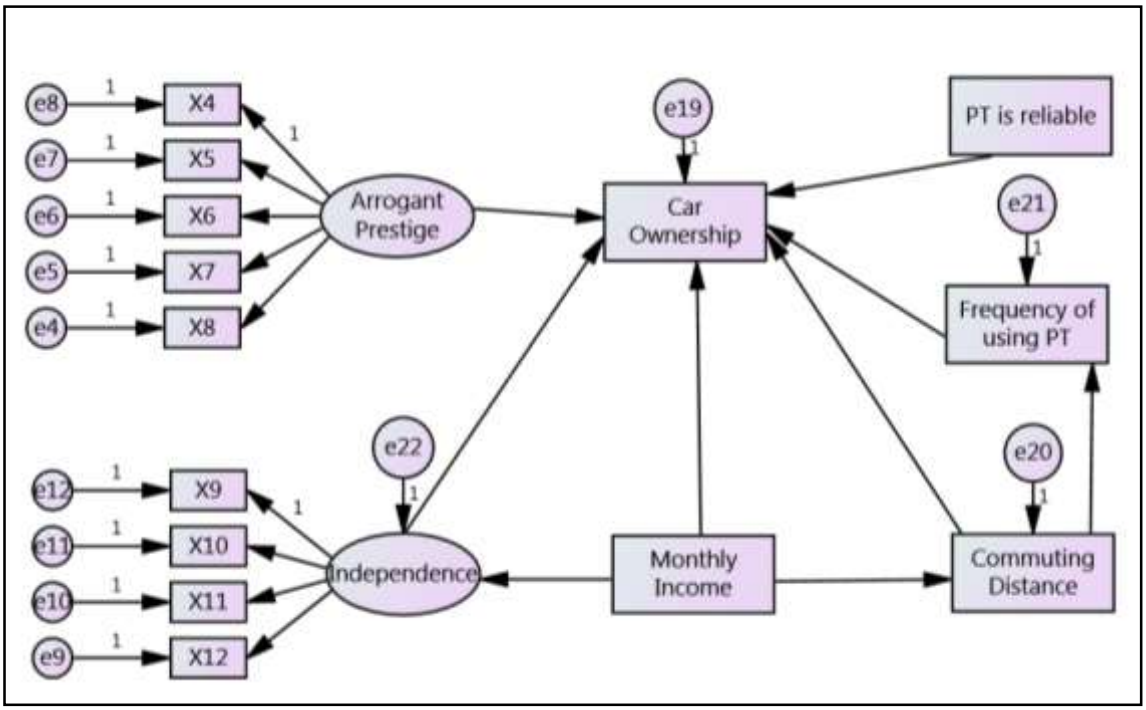


Figure 4-3 Car Ownership SEM Model 3

Income directly and indirectly influences car ownership. The indirect paths are via commuting distance and frequency of using PT with different sign and through *independence*. Though these effects are found to be significant, they are weak effects as the combined indirect effect of monthly income is only 0.03. The path confirms the observation that high-income students, probably especially those with parents out of town, choose to stay near the campus, while the lower income students choose to stay far from campus.

In order to illustrate the estimated effect of income on other variables, a person with all variables at their mean is considered as the reference point. Then monthly income is varied by one and two standard deviations using the results of parameter estimates. Figure 4-4 (a) illustrates the resulting increase in *independence* in terms of standard deviations. It is found that a one standard deviation increase in income results in an increase of 0.14 standard deviations for *independence*. With the same methodology in Figure 4-4 (b) an opposite effect of income on commuting distance is found with larger effect in terms of standard deviation (0.21). In Figure 4-4 (c), it is found that PT is not highly influenced by the combined effect of monthly income and commuting distance. A standard deviation increase in income results in an increase of only 0.33 standard deviations, equivalent to 0.65 trips per month.

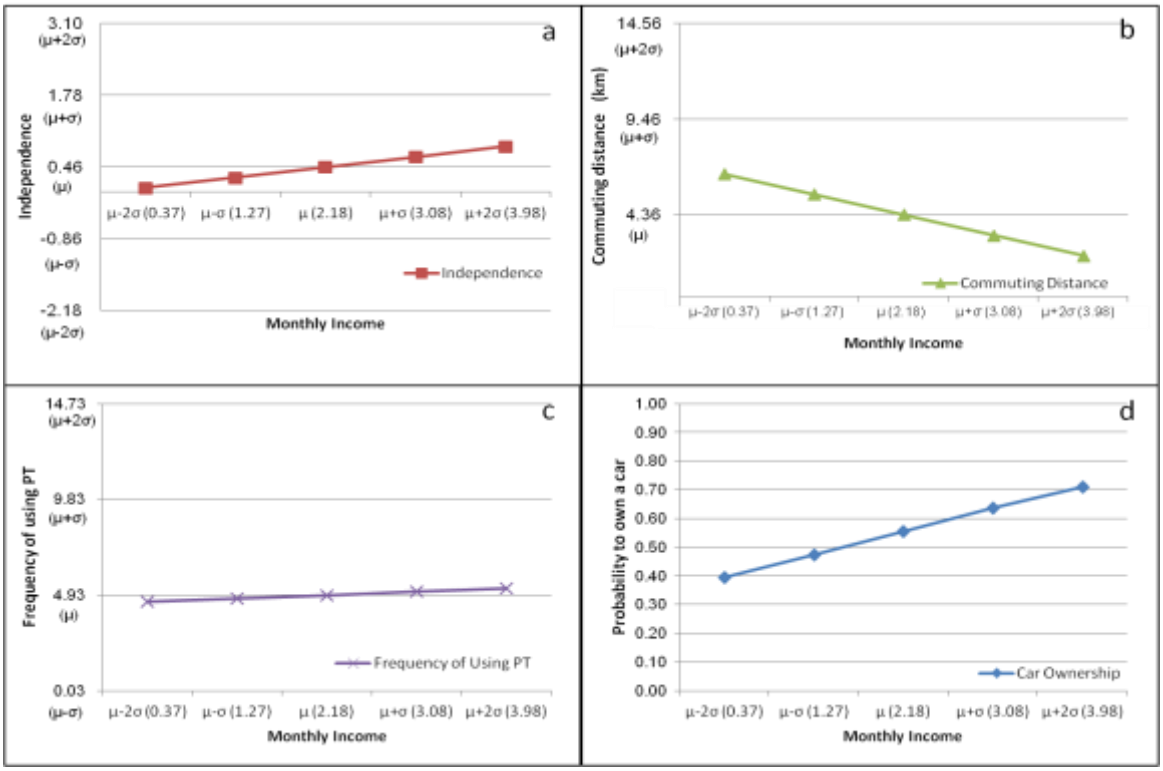


Figure 4-4 Combined effect of monthly income through (a.) Independence; (b.) Commuting distance; (c.) Frequency of using PT; on (d.) Car ownership intention

Finally, Figure 4-4 (d) illustrates the combined effect of income on car ownership considering all direct and indirect paths. That is all variables are at their mean, except for *independence* and commuting distance as well as frequency to use PT, which deviate from their mean according to the estimated influence of income. It is observed that the combined effect of monthly income is quite high. That is, an increase in income by one standard deviation (or 0.90 categories on the 4-point income scale) results in an increase of 7% probability to own a car.

The model suggests that compared to monthly income, commuting distance has less effect on car ownership. It is further found that commuting distance negatively influences PT usage as discussed before. The indirect effect of commuting distance on car ownership via frequency of using PT is again very small (0.01). Frequency of using PT and the perception that PT is reliable both negatively influence car ownership with similar regression weights. This suggests that if PT is perceived more positively, the probability to use PT more and possibly not to own a car is also higher.

It is found that, even controlling for the factors discussed so far, *arrogant prestige* significantly influences car ownership with a negative regression value of -0.21. One might argue that in particular for this variable the causality is not clear. The

interpretation in line with the model structure is that those who project a negative image on cars and car ownership tend to not purchasing one. Another possibility could be again the afore mentioned cognitive dissonance argument. In other words, non-car owners might still desire a car but project a negative image on it as a way to reduce disappointment of not being able to afford one. Which of these two explanations is more likely cannot be fully solved with the current data available.

Independence has a significant positive influence on car ownership. Note that the construct refers to time and space travel flexibility, which hence suggests that "classic utility factors" play a more important role for purchase decisions compared to the other attitudinal factors. The regression weight (0.33) is found to be the highest parameter value among all the significant paths. This result is partly in disagreement with findings from Steg (2005) or Gatersleben (2011), who find that *independence* is less significant compared to symbolic affective. However, one should remember the different PT situation in Bandung, Indonesia, compared to many European cities. Given the current PT conditions in Bandung, one cannot guarantee punctual arrival when using minibuses. When travelling by car, one might also be stuck in congestion; however, at least one does not have the uncertainty of having to wait until a vehicle has collected enough passengers for the driver to decide to depart. Furthermore, as discussed above, the route network is limited.

To further illustrate the importance of attitudes and income Figure 4-5 shows the probability of students owning a car for varying the attitudes in units standard deviation and for different levels of monthly income (also in units of means plus/minus standard deviations). Similar to Figure 4-4 all other parameters have been held constant at their mean sample value. (Note that for *independence* the total effect equals the direct effect on car ownership). Figure 4-5 (a) and 4-5 (b) illustrates the effect of one and two standard deviation increases and decreases in the attitudinal construct and monthly income mean value.

The figures clearly illustrate the relative importance of attitudes. For a "mean person" a standard deviation in *independence* perception increases the probability by nearly 20% whereas a standard deviation increase in income only increases the probability to own a car by about 10%. The impact of Arrogant Prestige is not as large but still an increase in one standard deviation in this attitudinal construct has a larger impact than a standard deviation increase in income.

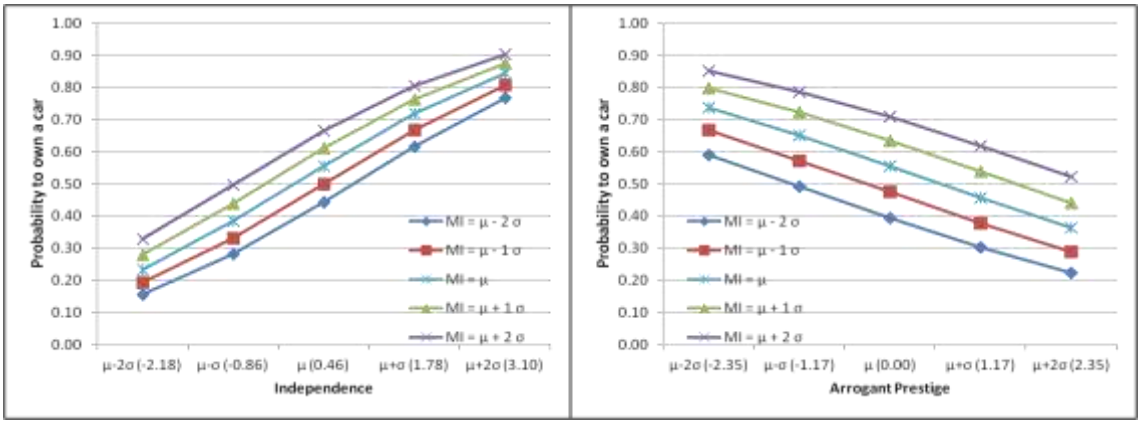


Figure 4-5 Probability to own a car by a change of standard deviation of (a.) Independence; and (b.) Arrogant Prestige

### 4.4.4. Attitudes over Time

From the SEM result, it is found that *arrogant prestige* and *independence* are significantly influence car ownership. While these findings are important for policy implications, it might also important to understand the change of attitudes over time. Note that in sub-chapter 4.2.3, it is discussed that the car owners were asked twice regarding their attitudes towards car. The first is attitudes at the time when they first bought cars and the second is their current attitudes towards car. To measure the difference between their attitudes when first bought car and their current attitudes, a Wilcoxon signed-rank test is used. This test is used to compare related non-parametric data. The result can be seen in Table 4-10.

Table 4-10 Attitudinal Differences of Car Owners between When First Bought Cars and At the Present

| Variable (N=134) | When first bought cars | | At present | | Wilcoxon | |
|---|---|---|---|---|---|---|
| | Mean | Std. Dev | Mean | Std. Dev | signed-rank | |
| Cars are giving arrogant impression | 3.18 | 1.69 | 3.24 | 1.74 | -0.66 | |
| Cars allow to distinguish oneself from others | 3.43 | 1.72 | 3.43 | 1.71 | -0.09 | |
| Cars are expensive to own and maintain | 5.60 | 1.33 | 5.13 | 1.51 | -4.69 | *** |
| Cars are disturbing one's neighbourhood | 3.02 | 1.64 | 2.89 | 1.53 | -1.16 | |
| Cars bring prestige | 3.94 | 1.56 | 4.17 | 1.61 | -2.30 | ** |
| Cars help one to save time for travel | 4.41 | 1.95 | 4.87 | 1.86 | -3.50 | ** |
| Cars allow one to travel anywhere | 5.02 | 1.57 | 5.39 | 1.48 | -3.56 | *** |
| Cars allow one to travel anytime | 4.90 | 1.69 | 5.26 | 1.61 | -2.30 | *** |
| Cars allow one to be independent | 5.38 | 1.52 | 5.43 | 1.46 | -0.69 | |

**: $p<0.05$ ***: $p<0.01$

For brevity, this sub-chapter only discuss the difference between nine variables that construct *arrogant prestige* and *independence*, while other eleven variables are omitted since it is found to be not significantly influence car ownership. Five variables are found to be significantly difference while other four variables are not significantly difference. The result from the test show that there is significant difference in attitude, however since the question were asked at one point in time there is a potential bias that the attitude during first bought is mixed with current attitudes since this is a recalled data. Therefore, the discussion for attitudes over time is not continued in subsequent analysis.

### 4.5. Car Desire Models

In this sub-chapter, factors determining students desire to own a car in the future are further explored. Thus, the samples used in this research are the 366 non car-owners from the same sample used in Sub-chapter 4.4. Three models are performed; the first one is normal car desire model (Model 1, p 85). The dependent variable in this model is whether the respondent desires a car or not, which is performed by binary logistic regression. They are asked about their desire to own a car in five years' time with the assumption that they will already have a job by then. Similar to previous research where attitudes factors are found to significantly influence intention to buy a car (Wu et al., 1999; Galdames et al., 2011) attitudinal factors are also used here, mainly five attitudinal factors from PCA shown in Sub-chapter 4.4 in the car desire model. In addition socio-demographic and PT related aspects are also used as explanatory in the model.

The second model are the luxury car desire model (Model 2). The discussion about luxury cars in the previous literature are only as one of the type for car type choice using MNL (Lave & Train, 1979; Berkovec, 1985; Berkovec & Rust, 1985). Potoglou and Kanaroglou (2008) note that car ownership is more of necessity rather than luxury. Choo and Mokhtarian (2004) give more explanation regarding factors influencing the decision to own luxury car i.e: those who have a stronger dislike for travel are more likely to buy luxury cars; those who are a status seeker are likely to think car as status symbol (symbolic affective) hence more likely to own luxury cars; household income has a positive sign for luxury cars; those who travel long distance prefer luxury cars; and finally urban neighbourhood variables positively influence luxury cars.

Since luxury cars are related to attitudes especially symbolic affective, and also to income and commuting distance, in this dissertation the influence of attitudes, income and commuting distance on desire to own luxury cars are also modelled. In the survey,

students are asked which type of car they would like to buy. The basis for the classification into luxury or normal car is consensus among Indonesians about what brand and price should be regarded as luxury. Normally cars costing IDR 150 M (equivalent with USD 15K) or more are regarded as luxury. This model uses the same sample and same explanatory variables as previous model.

Finally, for the third car desire model (Model 3), factors influencing car desire are explored more, using the desire for luxury car versus desire for normal car as dependent variable. This model use also the same explanatory variables as previous models, however, the sample size is reduced to the 284 respondents who have a desire to own a car. The result of model estimations for three models can be seen in Table 4-11.

For Model 1, all the other variables except for attitudinal variables and income show no significant results. In fact, income turns out to be the most significant variables for desire model. It can be seen clearly in the table that there are no significant results for variables related to PT in Bandung for this model. Three of the five attitudinal factors are significant. It is found that *symbolic/affective* attitudes and social/env care are not significant. Instead, *independence* appears to explain car ownership most. Same as in the car ownership model reported in Sub-chapter 4.4, the "independence" construct includes instrumental as well as *independence* variables suggesting that "utility" factors play a more important role compared to previous attitudinal research.

It is an interesting result that income appears to explain, "desire to own a car" most. The income variable here is the present financial condition for non-car owners. The lower the income, the lower the desire to buy a car. One explanation for the income effect might be that respondents do not distinguish between their current and future financial condition. Another interpretation, in accordance with the literature on the importance of education and past experiences, might be that those with low income have also experienced less car ownership within their families and hence desire less to own a car.

As a significant variable, *arrogant prestige* is further found with a negative sign, i.e. those who do not desire a car tend to think cars give an arrogant impression or that cars bring prestige. The results indicate that car desire and *arrogant prestige* are correlated even controlling for other factors. However, questions remain on the causality between the two. Above regression analysis suggests that the student who has high *arrogant prestige* has less desire. However, it could also be argued that students with strong car desire therefore perceive less *arrogant prestige*. To answer this question is impossible with current analysis but should be investigated in further work with "intervention experiments." Above result could support both causal directions, but at

least rejects a hypothesis that *arrogant prestige* and desire are uncorrelated. While in the car ownership model *comfort* is not found to be significant, it becomes significant in the car desire model. Thus, it confirms the hypothesis that *comfort* is the reason why people desire to buy cars.

Table 4-11 Car Desire Models (Model 1, Model 2, Model 3)

| Variables | Car desire (Model 1) | | Luxury car (Model 2) | | Luxury Vs normal (Model 3) | |
|---|---|---|---|---|---|---|
| | Estimate | t-statistic | Estimate | t-statistic | Estimate | t-statistic |
| Travel Behaviour | | | | | | |
| Commuting Distance | 0.01 | 0.50 | 0.02 | 0.66 | 0.01 | 0.36 |
| PT Usage/ Perception | | | | | | |
| PT is fast | -0.03 | -0.28 | 0.06 | 0.60 | 0.15 | 1.14 |
| PT is reliable | -0.01 | -0.05 | -0.14 | -1.56 | **-0.24** | **-1.98** |
| Frequency of using PT | 0.00 | 0.11 | 0.00 | -0.16 | -0.01 | -0.43 |
| Socio-demographic | | | | | | |
| Monthly Income | **0.59*** | **3.34*** | **0.45*** | **3.08*** | 0.25 | 1.27 |
| Attitudes Toward Car | | | | | | |
| Symbolic/Affective | 0.20 | 1.41 | 0.14 | 1.13 | 0.04 | 0.24 |
| Arrogant Prestige | **-0.37** | **-2.59** | -0.23 | -1.93 | -0.04 | -0.26 |
| Independence | **0.39*** | **2.71*** | **0.41*** | **3.30*** | 0.32 | 1.94 |
| Comfort | **0.31** | 2.17 | 0.11 | 0.92 | -0.13 | -0.74 |
| Social/Env Care | 0.00 | -0.03 | -0.03 | -0.24 | -0.04 | -0.27 |
| Intercept | | | | | | |
| Intercept | 0.34 | 0.67 | -0.11 | -0.24 | 1.22 | 2.07 |
| Model Fit | | | | | | |
| Sample Size (Individuals) | 366 | | 366 | | 284 | |
| -2 Log Likelihood (intercept only) | 389.4 | | 488.855 | | 292.879 | |
| -2 Log Likelihood (final) | 354.8 | | 458.259 | | 282.211 | |
| Hosmer–Lemeshow Statistic | 4.45 | 0.81 | 4.004 | 0.86 | 2.365 | 0.97 |

italic: p<0,1 bold: p<0.05 bold***: p<0.01

For Model 2, except for monthly income which similar to Choo and Mokhtarian (2004) findings, *independence* on 95% level and *arrogant prestige* on 90% level, all the other variables turn out to be not significant in this model. A possible reason for income

significant is that the higher the income the more they have desire to own a luxury car. Students with lower income know that it would be difficult to afford luxury cars while for the higher income level. Regarding findings on the importance of *independence*, a possible conclusion is that the *independence* construct includes instrumental variables suggesting that "utility" factors play a more important role compared to previous attitudinal research. Here it is found that *arrogant prestige* is significant at 90% level with negative sign. This implies that the higher the *arrogant prestige* the less likely non-car owners desire to own luxury cars. This result is in line with the previous discussion and expectation as luxury cars give more of a negative "arrogant" and anti-social image.

Last for Model 3, it can be seen from the results that no variables except for "PT is reliable" on 95% level and *independence* on 90% significance level variables are significant. Regarding *independence*, which was highly significant in the two other models, the result shows that the *independence* of luxury cars is only marginally higher than the *independence* of normal cars. Regarding slightly surprising result of the significance of "PT is reliable" the suggested explanation might be that students satisfied with PT have "less expectation" on the transportation system or general care less about how they travel. This means they also desire less luxury cars less.

### 4.6. Peers Influence to Upgrade Car

Previous sub-chapters have discussed about car ownership for students as well as car desire for non-car owner, now the discussion is continued with car owners desire to upgrade to a new car. In this sub chapter, the first discussion is about peer groups' factors, then correlate them along with other psychological aspects such as satisfaction, and regret with the dependent variable car upgrading desire.

#### 4.6.1. Peer Groups Factors

For the biased sample (see Table 4-5), a PCA with varimax rotation was performed on the 14 influence variables to construct uncorrelated groups of peer influence toward decision to upgrade cars. The results are reported in Table 4-12.

All groups with eigenvalues more than 1 are selected which leaves us with five constructs, which explain 69.4% of the variance. For ease of presentation, only measures that have group loadings larger than 0.5. The first group accounted for 24.99% variance. Variables loaded on this group mostly refer to friends group such as classmate, student association mate, virtual network. Therefore, this group was named Friends. The second group accounts for 13.52% of variance. Variables loaded on this

group partly include audio and visual commercial such as car expo, TV and radio commercial. Therefore, this group was named Audio Visual (AV) Commercial. The third group accounts for 10.74% of variance and include father and mother thus this group is named Parents. The fourth group accounts for 10.67% of variance and include newspaper and internet commercial, thus, this group is named Text Commercial. Finally, the last group accounts for 9.48% of variance and include brother and sister, thus this group is named Siblings.

Table 4-12 Biased Groups PCA

| Influence Groups (N=108) | Friends | AV Commercial | Parent | Text Commercial | Siblings |
|---|---|---|---|---|---|
| Classmate | 0.85 | | | | |
| Student Association Mate | 0.82 | | | | |
| Virtual Network | 0.78 | | | | |
| Friends | 0.78 | | | | |
| Partner | 0.71 | | | | |
| Car Expo | | 0.78 | | | |
| TV Commercial | | 0.78 | | | |
| Radio Commercial | | 0.52 | | | |
| Mother | | | 0.85 | | |
| Father | | | 0.77 | | |
| Newspaper | | | | 0.83 | |
| Internet Commercial | | | | 0.63 | |
| Brother | | | | | 0.80 |
| Sister | | | | | 0.57 |

For full sample, a PCA with varimax rotation was performed on the 14 influence variables to construct uncorrelated groups of peer influence toward decision to upgrade cars. All groups with eigenvalues more than 1 are selected which leaves us with four constructs, which explain 62.4% of the variance. For ease of presentation, only measures that have group loadings larger than 0.5 are reported in Table 4-13.

The first group accounted for 24.5% variance. Variables loaded on this group mostly refer to friends group such as classmate, student association mate, virtual network etc. Therefore, this group is named Friends. The second group accounts for 16.46% of variance. Variables loaded on this group include commercial such as car expo, TV and radio commercial. Therefore, this group is named Commercial. The third group accounts for 10.75% of variance and include brother and sister, thus this group is named Siblings. Finally, the last group accounts for 10.68% of variance and include father and mother thus this group is named Parents.

Table 4-13 Full Sample Groups PCA

| Influence Groups (N =144) | Friends | Commercial | Siblings | Parents |
|---|---|---|---|---|
| Student Association Mate | 0.85 | | | |
| Classmate | 0.85 | | | |
| Partner | 0.76 | | | |
| Friends | 0.74 | | | |
| Virtual Network | 0.69 | | | |
| Internet Commercial | | 0.73 | | |
| Newspaper | | 0.70 | | |
| TV Commercial | | 0.67 | | |
| Car Expo | | 0.57 | | |
| Radio Commercial | | 0.57 | | |
| Brother | | | 0.81 | |
| Sister | | | 0.63 | |
| Mother | | | | 0.89 |
| Father | | | | 0.77 |

### 4.6.2. Correlation of Peers Groups towards Car Upgrading Desire

From the result of the survey, 97 students who have a desire to upgrade their car and 37 students who have no desire to upgrade their car are obtained. The desire to upgrade a car is derived from the question asked to car owners whether they want to buy another car or not. Thus, it is implied that students who answered with "yes" have a desire to upgrade their car. For biased sample, the correlation between desire to upgrade, influence group, satisfaction and regret can be seen in Table 4-14.

Table 4-14 Correlation between Desire to Upgrade, Influence Group, Satisfaction, Regret, Monthly Income and Gender for Biased Sample

| Variable | Influence Group (N=108) | | | | | Satisfy | Regret | Monthly Income | Gender (Male) |
|---|---|---|---|---|---|---|---|---|---|
| | Friends | AV Commercial | Parent | Text Commercial | Siblings | | | | |
| Car upgrading desire | -0.13 | 0.16 | 0.13 | 0.06 | 0.15 | 0.12 | -0.16* | -0.11 | 0.14 |
| Satisfaction with current car | -0.12 | -0.03 | 0.25** | 0.15 | 0.21** | | -0.47*** | 0.11 | -0.05 |
| Regret of having bought a car | 0.14 | -0.06 | -0.18* | -0.12 | -0.07 | | | -0.20* | 0.08 |
| Monthly Income | 0.16 | 0.20 | 0.14 | 0.04 | 0.10 | | | | -0.06 |
| Gender (Male) | 0.14 | -0.12 | -0.09 | 0.02 | -0.03 | | | | |

*: p<0,1 **: p<0.05 ***: p<0.01

As can be seen, car-upgrading desire does not have any significant correlation with any influence group nor with level of satisfaction of current car. However, it has

significant negative correlation with regret of having bought the current car. The level of satisfaction of current car has a significant correlation with the influence group, particularly parent and siblings. This might imply that family influence has a significant correlation on the level of satisfaction on current car.

The level of satisfaction also has strong negative correlation with regret of having bought a car. The regret of having bought the current car has a negative significant correlation with influence groups particularly parents as well as monthly income. Since their parents suggested them to buy a car, probably they have no objection hence regret less. While for monthly income, the higher monthly income means they probably buy cars that are more expensive and hence regret less.

For full sample, the correlation between desire to upgrade, influence group, satisfaction and regret can be seen in Table 4-15.

Table 4-15 Correlation between Desire to Upgrade, Influence Group, Satisfaction, Regret, Monthly Income and Gender for Full Sample

| | Influence Group (N=144) | | | | Satisfy | Regret | Monthly Income | Gender (Male) |
|---|---|---|---|---|---|---|---|---|
| | Friends | Commercial | Siblings | Parent | | | | |
| Car upgrading desire | -0.04 | 0.13 | 0.23*** | 0.07 | 0.12 | -0.16 | -0.11 | 0.14 |
| Satisfaction with current car | -0.06 | 0.18** | 0.18** | 0.17* | | -0.47*** | 0.11 | -0.05 |
| Regret of having bought a car | 0.08 | -0.14 | -0.11 | -0.08 | | | -0.20* | 0.08 |
| Monthly Income | 0.18* | 0.11 | 0.13 | 0.14 | | | | -0.06 |
| Gender (Male) | -0.13 | -0.02 | 0.17* | 0.06 | | | | |

*: p<0,1 **: p<0.05 ***: p<0.01

Car upgrading has a significant correlation with influence groups particularly siblings. It has no significant correlation with level of satisfaction and regret of current car. Level of satisfaction of current car has significant correlation with the influence group particularly commercial; it might imply that commercial influences the higher level of satisfaction with the current car vice versa. Aside from that, level of satisfaction also has positive correlation with siblings and parents group, almost the same as biased sample.

Furthermore, also same as for the biased sample, there is a strong negative correlation with regret. Also in this sample, regret of having bought the current car has a significant negative correlation with monthly income. The higher monthly income means they probably buy more cars that are expensive and hence regret less. Beside with regret, monthly income has significant correlation with influence by friends. It might be said that students with higher income have “less self-confidence” and worry

more about influence of friends. Finally, it is found that male students are more likely to be influenced by siblings possibly because they discuss car purchase decisions more with their siblings.

### 4.7. Conclusions

The objective is to understand factors determining car purchase decisions among younger people in Indonesia. Through a survey among Indonesian students in Bandung, asking for attitudes as well as socio-demographic characteristics, several conclusions are obtained which is believed to have some policy implications and give possibly some hope that, at least to some degree, adequate transport policy could reduce the trend towards a rapid increase in car traffic.

Clearly, with higher GDP and increasing income in South East Asian countries it is expected the modal share of cars to increase. However, it is found that attitudes are important determinants of car ownership and also car desire and that attitudes such as the perception of whether the car is a prestige object and income are not significantly correlated, so that there might be some hope that rapid economic growth might not necessarily mean a motorization development as experienced in Western countries several decades ago. It is found that *independence* related aspects are the most important factor for students to purchase a car as well as to desire to own a car. The result emphasizes that in Bandung and generally, in situations where there are insufficient convenient PT options, such services need to be improved first before one in fact has a choice.

It is further found that *independence* is also positively influenced by monthly income, therefore if monthly income changes also *independence* will. This finding might also have policy implications. With improving economic situations policy makers concerned about increasing car ownership do not only have to deal with the higher affordability of cars but also an increase in perception of how much *independence* a car can bring possibly due to the generally increased financial possibilities to travel. Therefore, also for this reason it will be important to create early on a PT system that can fulfil the more diverse travel needs of rapidly developing countries. Further, the connection between income, commuting distance, and car ownership lead to some obvious policy implications highlighting the need for affordable housing or dormitories near the campus.

The high importance of *independence* might though also imply that possibly the status symbol factor of cars is decreasing, at least for some parts of the population. This interpretation is supported by the findings regarding *arrogant prestige* construct, which

describes negative attitudes one has towards cars. It is found that *arrogant prestige* to be negatively significant, implying that those who think cars are arrogant also tend to not own one or to desire one. Some reservations is discussed regarding causality of this factor that should be explored with further research, but believe that, regardless of this discussion, this result indicates that students start to realize the negative societal effects of the car more. If the negative side effects of cars for the society and city are highlighted, the car might eventually become a kind of "anti-status symbol." In addition, the discussion on *arrogant prestige* and its correlation to behaviour or car desire implies that some campaigns or public education to induce *arrogant prestige* to reduce car ownership might be helpful.

Regarding peer influence groups, constructed by PCA in this dissertation, except for siblings, it is found that these groups might not be the determinant variables for a desire to upgrade to a new car. Note that since these influence groups are constructed by their experience, there is a possibility that they might be determinants if they are constructed from student present situation, however, this should be studied more. Regarding satisfaction level and regret level, it is found from the correlation analysis that satisfaction level has a significant correlation with siblings and parents; while regret level also has slightly negative correlation with parent (family); this might imply that the suggestion from siblings and parents (family) is in accordance with what students need since parents might be the ones who understand better what students need. Therefore, it is recommended that parents should get involved in students "car choice" at this age to avoid later frustration as these young students might otherwise purchase "dream cars" without considering costs and their usefulness.

From these car ownership and car desire models, some general conclusions can be made. Firstly, *independence* factors become the most important factors influencing the decision to own a car and the desire to own a car. This is in contrast to findings by Steg (2005) and is most likely because in Indonesia high frequency and reliable PT modes are in most cities still in their development stage and need significant investments to become really an alternative to private cars, however this findings confirms Steg (2005) suggestion that *independence* is indeed a separate factor influencing car use, in this case car ownership (see Sub-chapter 2.4).

Second, monthly income is important in the car ownership model and car desire models, which is confirming previous research that states income as significant determinants of car ownership (see Table 2-1). The results regarding the importance of monthly income do, further express also some urgency to react fast and invest in attractive alternatives to the private car soon. With given economic trends in

South-East Asia a significant proportion of younger people will keep trading in their motorbikes for normal or even large, expensive cars.

Third, this dissertation finds, however, also potentially positive news that possibly can be used to at least reduce the rapid motorization trend. Arrogant prestige is very significant in almost all the models with negative sign, implying that people start to regard cars as displaying arrogant impressions, which discourage them to purchase cars. This is in line with other findings such as in Van and Fujii (2011) that show that the car is indeed losing some of its status symbol meaning and has become less desirable compared to PT usage for many young people in several Asian countries, in particular Japan; and also Potoglou and Kanaroglou (2008) which state that car ownership is more of necessity rather than status symbol. The result suggests that this trend might have also arrived in Indonesia. Through appropriate environmental education, it might be strengthened and the next generation might make mobility choices more consciously.

Fourth, in general, regarding determinant factors on car upgrading, the important result is that the satisfaction level does not appear to influence the decision to upgrade to a new car, even though it is highly correlated with other variables such as influence and regret. The influence of siblings might hint at other factors such as comparing oneself to others are important factors. This dissertation cannot confirm whether peer influence exists in car owning desire particularly car upgrading desire.

As the survey is focused on young students, one might even connect this to a discussion on values of "Generation Y." For example Newman (2011) argues that "previous generations found freedom and flexibility through the car. But Generation Ys find their freedom and flexibility by staying connected to their friends, family, and workplaces through the various information devices - like their laptops, or i-phones." In how far hence this value shift could be used to encourage PT usage should be further explored. Generally, it is believed that the results suggest besides necessary improvements in the PT system, soft policy measures such as communicative measures discussed in Taniguchi et al.(2007) that aim to change the attitudes of younger people should also be considered as one way in developing countries to control the growth in car ownership and car usage. The research in this chapter is conducted in Indonesia, particularly Bandung context only, to get better insight and to learn more on car ownership and determinant factors that influence it in broader context, car ownership decisions in six other countries (China, Japan, Lebanon, Netherlands, Taiwan, and United States) are studied and discussed in more detail in Chapter 5.

# Chapter 5

# Descriptive Analysis of Students Car Ownership in Developed and Developing Countries

## 5.1. Introduction

The aim of this dissertation especially this chapter is to provide further insight on the reasons for the contrary trends of car ownership growth between developing and developed countries as briefly discussed in Chapter 1. This dissertation however, does not analyse the trends themselves by time-series or age-cohort data; instead, the focus is on young students in seven different countries and their motivations to purchase cars after graduation. This dissertation emphasizes on the role of personal background and the country context, including prevailing social norms influencing mobility decisions of younger people. This has been done by conducting a survey among undergraduate students from seven different countries. The sites are chosen to cover a wide range of countries (and partly due to previously established research connections).

Four of the sites are from Asia. Indonesia is included as a fast developing country with rapidly increasing motorization among younger people. Taiwan is chosen as a more developed Asian country in which currently the motorbike is the dominating mode among younger people. Shanghai is included as a city where the desire to own a car has lately been rapidly increasing especially among younger people (Zhu et al. 2012). Japan is included as a more developed country in which car ownership has been increasing until lately. Beirut, Lebanon, a city in which the car is the dominating mode among all generations is further included. As examples from "Western 1st world countries," this dissertation includes Utrecht, The Netherlands and Berkeley, U.S.A., two cities with very different mobility patterns and spatial organization. By conducting the survey in such diverse countries, it is hoped that the causes of differences among the desire to purchase cars among young people can be explained.

## 5.2. Mobility Context in the Surveyed Countries

Before describing the survey in more detail, this sub-chapter provides an overview on the mobility context in the seven countries in which the students were surveyed. Table 5-1 lists some key factors that describe the motorization level and costs associated with cars in the surveyed countries. The first three columns consist of the three developed countries in the sample, Taiwan is described by IMF as an advanced economic country, and the latter three countries according to IMF are emerging or developing economies (IMF, 2013).

Population growth and also population density as well as number of car per 1,000 people for seven countries have been mentioned briefly in Chapter 1. Other aspects shown in Table 5-1 such as the cost of owning car and mode choice patterns are discussed. The cost of owning a car and using a car is also shown. The most expensive purchase price is in the Netherlands followed by Indonesia and China with the cheapest in Lebanon (Numbeo Doo, 2013). The expensive price of cars in conjunction with purchasing power per capita, partly explains lower car ownership rates especially in Indonesia, even considering low gasoline prices.

Finally, the mode choice patterns are presented for the seven surveyed sites. For Japan, Taiwan, and Indonesia, since the survey was conducted nationwide the nationwide data is also presented. In Japan, the dominant mode share is car at 45% (MLIT, 2007). In Taiwan motorcycle dominates the modal share at 48% (it has the highest motorbike ownership in the world). In Indonesia PT and other modes (primarily non-motorized), dominate the modal share (Statistics Indonesia, 2013). In the other four countries (the Netherlands, U.S.A., China, and Lebanon), the survey only focused on specific cities/regions and hence the mode choice patterns for these specific areas are shown. Seventy-one percent of trips in the Greater Beirut Area are made by private car (Nakkash, 1999).

The modal shares in Berkeley (Metropolitan Transportation Commission, 2006) and Utrecht (Statistics Netherlands, 2013) are dominated by cars. In Shanghai (Urban Construction and Communications Commission, 2010) other modes obtain a share of 54%, where a large percentage of this is walk. These statistics provide a high-level picture of the varying transportation conditions and culture at the different sites, and now this dissertation continue on to the survey results to examine car use with a survey that provides more control over the comparability of results across the sites.

Table 5-1 Context/Statistical Data for the Seven Surveyed Countries

| Variable | Netherlands | Japan | United States | Taiwan | Indonesia | China | Lebanon |
|---|---|---|---|---|---|---|---|
| GDP per capita in 2012,Thousand US$ | 46,010[a] | 46,706[a] | 51,703[a] | 20,335[a] | 3,593[a] | 6,071[a] | 10,310[a] |
| GDP (Purchasing Power Parity) per capita in 2012, Thousand US$ | 41,527[a] | 35,855[a] | 51,703[a] | 38,356[a] | 4,923[a] | 9,055[a] | 15,587[a] |
| Population 1990 (in Thousands) | 14,890[b] | 122,249[b] | 254,507[b] | 20,232[b] | 178,663[b] | 1,165,429[b] | 2,703[b] |
| Population 2010 (in Thousands) | 16,615[b] | 127,353[b] | 312,247[b] | 23,146[b] | 240,676[b] | 1,359,821[b] | 4,341[b] |
| Population density per sq km in 2010 | 400.1[b] | 337.0[b] | 32.4[b] | 639.5[b] | 126.4[b] | 141.7[b] | 417.4[b] |
| Number of cars per 1,000 people in 1990 | 294[c] | 286[d] | 564[d] | 108[j] | 7[d] | 2[d] | ~300[e] |
| Number of cars per 1,000 people in 2010 | 406[c] | 458[d] | 413[d] | 251[j] | 37[d] | 25[d] | ~300-500[e] |
| Car Ownership and Use Costs (US$) 2011 | | | | | | | |
| Purchase price | 31,693[f] | 22,613[f] | 20,000[f] | 20,422[f] | 26,908[f] | 24,640[f] | 19,000[f] |
| Fuel price/liter (Super grade gasoline) | 2.33[g] | 2.00[g] | 0.97[g] | 1.18[g] | 0.47[g] | 1.37[g] | 1.11[g] |
| Fuel price/liter (Diesel) | 1.95[g] | 1.61[g] | 1.05[g] | NA | 0.47[g] | 1.28[g] | 0.94[g] |
| Mode Choice Pattern (reference) | (Utrecht)[c] | [h] | (Berkeley, CA)[i] | [j] | [k] | (Shanghai)[l] | (Beirut)[m] |
| Car | 51% | 45% | 81% | 23% | 8% | 13% | 71% |
| PT | 25% | 16% | 1% | 15% | 33% | 27% | 29% |
| Motorcycle | NA | 19% | 5% | 48% | 16% | 5% | negligible |
| Other (primarily non-motorized) | 24% | 20% | 13% | 14% | 44% | 55% | NA |

Reference: a. IMF (2013) b. UN (2013) c. Statistics Netherlands (2013) d. Oak Ridge National Laboratory (2013) e. Ministry of Environment (2011; 2013) f. Numbeo Doo (2013) g. World Bank (2013) h. MLIT (2007) i. Metropolitan Transportation Commission (2006) j. DGBAS (2013) k. BPS – Statistics Indonesia (2013) l. Urban Construction and Communications Commission(2010) m. Nakkash (1999)

## 5.3. Data Collection Method

### 5.3.1. Respondent

All respondents are undergraduate students from a wide variety of disciplines. The data were collected between January-June 2013. In all countries, the survey was translated into the local language with the exception of Lebanon where the survey was conducted in English, which is the language of instruction at the American University of Beirut (AUB). All responses were gathered via a web-based survey, although the methods to recruit respondents are differed in each country.

In Indonesia, surveying agencies recruited respondents in person on the campuses of the University of Indonesia in Jakarta and the Bandung Institute of Technology. In Japan, the recruitment was via email sent to engineering departments in several universities. In China, the recruitment was via email and through an internet forum in Shanghai with a small incentive in the form of a mobile phone voucher for those who complete the survey. In Berkeley, recruitment was handled by the Experimental Social Science laboratory, and each respondent received financial incentive for participating. In Lebanon, the recruitment was done via email sent to approximately one third of AUB students (chosen randomly). In the Netherlands, recruitment was done via an announcement in a general student newsletter. In Taiwan, recruitment was done via an announcement in a popular Bulletin Board System (Ptt.cc). No financial incentives were used other than in Shanghai and Berkeley.

In total 2,272 undergraduate and graduate students accessed the survey website, of which 1,806 completed the survey. For better cross-site comparability, in this dissertation, only the data from the undergraduate students are reported. Further data cleaning is performed, ignoring incomplete surveys and responses that were completed in fewer than eight minutes, which seems a lower limit to answer all of the survey questions consciously. This results in a sample size of 1,229 used for the analysis below.

### 5.3.2. Questionnaire Design

One of the main objectives of this dissertation is to analyse differences among university students in the seven countries in terms of their stated intentions to buy a car in the future (next ten years), which is measured on a seven-point Likert scale (very unlikely – very likely). This intention can be regarded to be similar to "intention" in TPB (Ajzen, 1985; 1991) since attitudes and norms are used as the explanatory variables. In addition, questions about a wide range of possible determinants of car purchase intentions are asked,

including questions regarding transportation patterns, socio-demographic characteristics, attitudes and perceptions, and norms, each of which is expanded on below. The detail of the questionnaire can be seen in Appendix A.2.

*A) Transportation Patterns.*

These questions aim to understand about students current transportation patterns including car, bicycle, and motorcycle ownership, and how much they use the car for various trip purposes are asked. Those who use car at least twice a week belong to *regular car use* category. In addition, about their intention to use PT more for everyday trips is asked which measured by seven-point Likert scale (very weak – very strong). The students are also asked if they have given a serious thought to whether they can use car less (scale from "not at all" to "very often"). Finally the students are asked to answer three kind of questions (with whom do you most frequently travel, how far do you travel for this trip, and which mode do you use frequently) for commuting trips, shopping activity and leisure activity.

*B) Socio-Demographic Characteristics.*

The students are asked regarding their average income (personal and family), age, gender, as well as their current living situation: whether they live by themselves, with their family or friends and, whether they live in a dormitory or apartment. The income categories are adjusted according to the typical student income in the respective countries.

*C) Attitudes/Perceptions.*

The students are given a range of questions regarding their attitudes/perceptions toward cars and PT. Each question is posed on a seven-point Likert scale with verbally defined endpoints (strongly disagree – strongly agree). The questions are based on surveys used in previous research in particular those studies by Steg, (2005), Van and Fujii (2011), and Belgiawan, et al. (2011). The questions are listed in the Appendix A.2 (in section A) and quite similar with sets of questions in Table 4-1 in the previous chapter.

*D) Social Norms.*

Ranges of questions are asked regarding the influence of others on the students' car purchase intentions. To understand "descriptive norms" respondents were asked about the percentages of family members, close friends, peers, people in their neighbourhood, and people in their province/state that have cars. The response categories were less than 25%, 25-50%, 50-75%, and more than 75%. To measure the perceived "expectation of others to

buy cars" (EOTBC), respondents were asked, "To what extent does each of the following groups (1. Your parents, 2. Your partner, 3. Your family members and relatives, 4. Your close friends, 5. Your classmates, friends and peers at university, 6. People in your neighbourhood, and 7. People in your province/state) expect you to buy a car within the next 10 years?" Responses to this group of questions were measured on a seven-point Likert scale ranging from "they strongly expect me not to buy a car" to "they have no expectation" as middle point and "they strongly expect me to buy a car" as the other end.

Further, the "strength of influence of others to buy a car" factor is measured by asking respondents how important the same seven groups are to their decision regarding buying a car in the future. The responses are measured by seven-point Likert scale (not at all important – extremely important). Finally, to measure "subjective social norms" or "Perceived pressure to buy a car" the respondents are asked to rate their level of agreement with the following statements on a seven-point Likert scale (strongly disagree – strongly agree): "I feel that there is social pressure to have a car here", "Transport modes other than car (walking, bike and PT) are looked down upon", and "The majority of people think that having a car is the right thing to do."

## 5.4. Determinants of Car Ownership Intention

### 5.4.1. Transportation Pattern

#### *A) Peak Car Indices and Mobility Patterns in the Sample*

The aim of this dissertation is to explain variables of interest for the peak car discussion with the available sets of possible explanatory variables. In all sites, more than 90% of students grew up with a car in the household except for Indonesia and China[6], illustrating how prevalent the car has been for most students not only in the most developed countries but also Taiwan and Beirut. Then a number of indices that describe the current mobility pattern is obtained. A car owner is defined as a student who owns a car personally or who has regular access to his/her family car. Table 5-2 describes the past, current, and potential future of vehicle ownership and usage situations of students as reported in the survey.

In all cases, the majority of these "car owning" students (70-90%) are using family cars. The exception is Beirut where one-third of "car-owning" students have their own car. Interesting to note is that the difference between current student car owners and those who grew up with a car is much more significant in developed countries (average car user and owner below 30%) compared to developing countries (average car user and owner

[6]Although the China survey was conducted only in Shanghai, it is found that most of the respondents were not from Shanghai and thus China is used instead of Shanghai in this dissertation.

above 50%). As expected, the percentage of car users (using a car at least two days per week) is slightly higher than the percentage of car owners for all countries. Noteworthy in Beirut and Indonesia are the smaller differences between the percentage of students who grew up with a car at home and the percentage using a car now regularly, whereas in the "1st world" samples from Japan, Berkeley, and Utrecht the difference is very significant. The difference in Taiwan might be explained partly by the reliance on motorcycles.

Table 5-2 Car Ownership, Use, and Intention: Past, Present, and Future

| Variable (number of observations) | Utr (84) | Jpn (142) | Brkly (226) | Twn (139) | Idn (200) | Chn (167) | Brt (271) |
|---|---|---|---|---|---|---|---|
| Past: | | | | | | | |
| Grew up with car (% Yes) | 96.4 | 95.1 | 97.3 | 90.6 | 76.5 | 30.5 | 97.8 |
| Present: Ownership and Transportation Pattern | | | | | | | |
| Regular Car user (%) | 27.4 | 26.1 | 48.2 | 41.0 | 64.5 | 28.7 | 89.7 |
| Regular Car user and owner (%) | 21.4 | 23.9 | 31.4 | 38.8 | 56.5 | 26.3 | 85.6 |
| Regular Car user and non-owner (%) | 6.0 | 2.2 | 16.8 | 2.7 | 8.0 | 2.4 | 4.1 |
| Non-car user (%) | 72.6 | 73.9 | 51.8 | 59.0 | 35.5 | 71.3 | 10.3 |
| Motorcycle owner (%) | 0 | 15.5 | 0.9 | 68.3 | 51.5 | 2.4 | 4.1 |
| Motorcycle or car owner (%) | 21.4 | 33.8 | 31.9 | 79.9 | 78 | 27.5 | 86 |
| Driving license (% have) | 71.4 | 60.6 | 80.5 | 77.7 | 74 | 27.5 | 80.1 |
| Mileage per week (Av. km) | 62.8 | 111.5 | 56.5 | 76.4 | 69.4 | 71.2 | 77.3 |
| Bicycle (% have) | 98.8 | 88 | 27.9 | 66.2 | 51 | 69.5 | 28 |
| Future: Purchase Intentions (How likely are you to buy a car within the next 10 years?) | | | | | | | |
| % have intention | *61.9* | *62.7* | *65.9* | *66.9* | *67.5* | *77.2* | *83.8* |
| Very likely | 9.5 | 17.6 | 21.7 | 14.4 | 18.5 | 26.9 | 38.0 |
| Likely | 10.7 | 18.3 | 25.7 | 15.8 | 36.5 | 31.1 | 28.0 |
| Somewhat likely | 41.7 | 26.8 | 18.6 | 36.7 | 12.5 | 19.2 | 17.7 |
| % have no intention | *38.1* | *37.3* | *34.1* | *33.1* | *32.5* | *22.8* | *16.2* |
| Undecided | 15.5 | 11.3 | 10.2 | 24.5 | 20.5 | 10.8 | 5.2 |
| Somewhat unlikely | 11.9 | 7.0 | 9.7 | 5 | 8.0 | 6.6 | 4.1 |
| Unlikely | 7.1 | 9.9 | 9.7 | 3.6 | 3.0 | 2.4 | 3.3 |
| Very unlikely | 3.6 | 9.2 | 4.4 | NA | 1.0 | 3.0 | 3.7 |

Italic represents that the total percentage of students' response from "very likely to somewhat likely" and the total percentage of students' response from "undecided to very unlikely"

Finally, future car ownership intentions are reported in the lower part of Table 5-2. The responses to the seven-point Likert scale are shown and further converted here in addition the answers into a binary scale by interpreting answers from 1 to 4 as "have no intention" and 5 to 7 as "have intention" (In the following tables, it will return to the seven-point scale). More than 60% of students in all countries have an intention to buy a car in the future. As this is the dependent variable of interest, this table as well as all other tables in the paper is ordered based on this auto intention response. The order of intention to own a car sorts the countries precisely into developed vs. developing countries with Taiwan being in between the two groups. Students in Utrecht, Japan, and Berkeley have the lowest car purchase intentions; and students in Indonesia, China, and Beirut have the highest. This is consistent with the peak auto hypothesis of the developed world as well as increasing auto dependency in the developing world.

B) Current Travel Behaviour Pattern

Travel behaviour patterns are categorized into three categories of activity: commuting to campus (a daily trip); shopping trips (some trips every week); and leisure activities which are carried out less regular. These categories of activities, further are explained based on: the modes being used, the distance travelled and with whom the activity is done. The mode of commuting, shopping and leisure are classified by five modes classification i.e. cars, motorcycle, PT, bicycle and walk, and finally commuting with whom is classified into two categories i.e. alone and with peers.

Among the seven sites, for commuting to campus the highest percentage of using car are students from Beirut, followed by students from Indonesia. For motorcycle, usage of commuting, as expected Taiwan is the first followed by Indonesia. Chinese students use PT more compare to others site followed by Utrecht students. As a cyclist country, Utrecht students together with Japanese students use bicycle more for commuting. The furthest average commuting distance is in Utrecht followed by China, while the shortest distance travelled is in Berkeley case. Contrary, considering only those who "commute alone," the Japanese students travel furthest while Chinese students commute furthest together with friends. The current commuting pattern for seven sites can be seen in Table 5-3.

Table 5-3 Current Commuting Pattern

| Variable (number of observations) | Utrecht (84) | Japan (142) | Berkeley (226) | Taiwan (139) | Indonesia (200) | China (167) | Beirut (271) |
|---|---|---|---|---|---|---|---|
| Mode of commuting | | | | | | | |
| Car (%) | 2.4 | 6.3 | 4.9 | 5.8 | 28.0 | 5.4 | 60.9 |
| Motorcycle (%) | 0 | 7.7 | 0.4 | 41.0 | 24.0 | 0.0 | 1.1 |
| PT (%) | 42.8 | 27.4 | 17.2 | 33.7 | 33.0 | 59.3 | 17.4 |
| Bicycle (%) | 51.2 | 52.8 | 7.1 | 13.7 | 1.0 | 7.8 | 0.7 |
| Walk (%) | 3.6 | 5.8 | 70.4 | 5.8 | 14.0 | 27.5 | 19.9 |
| Commuting distance (km) | 3.44 | 2.63 | 1.74 | 2.79 | 3.30 | 3.32 | 3.24 |
| Commuting with whom | | | | | | | |
| Alone (%) | 89.3 | 94.4 | 84.5 | 79.9 | 77.0 | 59.9 | 59.4 |
| Friends (%) | 9.5 | 4.2 | 13.3 | 17.3 | 18.0 | 35.3 | 19.6 |
| Family (%) | 0.0 | 0.7 | 1.8 | 2.9 | 3.5 | 3.6 | 17.7 |
| Relatives (%) | 1.2 | 0.0 | 0.0 | 0.0 | 1.0 | 0.6 | 1.1 |
| Others (%) | 0.0 | 0.7 | 0.4 | 0.0 | 0.5 | 0.6 | 2.2 |

Focusing on shopping activities, Beirut students use car the most with user percentage higher compared to commuting activity, this is followed by Indonesian students which user percentage almost double compared to commuting activity. Taiwan students use motorcycle more for shopping activity with slightly higher number of user percentage compare to commuting activity, this followed by Indonesian students with slightly lower percentage compare to commuting activity.

For PT usage, Chinese students use PT more with higher percentage compare to commuting activity. For shopping with bicycle, the highest is Utrecht students followed by Japanese students with almost the same share number as commuting activity. Finally for walking for shopping activity, the highest is Berkeley students, more than 50% with exactly the same percentage compare to commuting activity. The furthest shopping distance in average is for Indonesian students while the shortest is Utrecht students. Japanese students and Utrecht students tend to shop alone compare to other countries, however compare to commuting activity, the percentage is lower. Berkeley students travel with friends more for shopping followed by Chinese students, while for shopping with families, Indonesian students is the highest followed by Beirut students. As for shopping with relatives or others, it seems that none of the seven surveyed sites has percentage more than 5%. The current shopping activity patterns can be seen in Table 5-4.

Table 5-4 Current Shopping Pattern

| Variable (number of observations) | Utrecht (84) | Japan (142) | Berkeley (226) | Taiwan (139) | Indonesia (200) | China (167) | Beirut (271) |
|---|---|---|---|---|---|---|---|
| Mode of shopping | | | | | | | |
| Car (%) | 8.3 | 15.5 | 4.9 | 19.4 | 54.5 | 6.6 | 79.0 |
| Motorcycle (%) | 0.0 | 4.2 | 0.4 | 46.8 | 20.5 | 0.0 | 1.8 |
| PT (%) | 20.2 | 24.7 | 17.2 | 21.6 | 23.0 | 70.6 | 4.8 |
| Bicycle (%) | 53.6 | 50.7 | 7.1 | 7.9 | 0.0 | 9.6 | 0.0 |
| Walk (%) | 17.9 | 4.9 | 70.4 | 4.3 | 2.0 | 13.2 | 14.4 |
| Shopping distance (km) | 2.19 | 2.55 | 3.22 | 2.96 | 3.63 | 2.71 | 3.00 |
| Shopping with whom | | | | | | | |
| Alone (%) | 42.9 | 50.0 | 19.9 | 17.3 | 13.5 | 19.2 | 11.8 |
| Friends (%) | 39.3 | 36.6 | 70.8 | 54.7 | 37.0 | 61.1 | 45.8 |
| Family (%) | 15.5 | 11.3 | 8.8 | 25.2 | 45.5 | 19.2 | 39.1 |
| Relatives (%) | 2.4 | 0.0 | 0.4 | 2.9 | 2.5 | 0.6 | 1.8 |
| Others (%) | 0.0 | 2.1 | 0.0 | 0.0 | 1.5 | 0.0 | 1.5 |

For leisure activity using car, similar as the previous two activities, Beirut students is the highest followed by Indonesian students with higher total percentage compare to shopping activity. For motorcycle usage for leisure, Taiwan students is the highest among seven sites, with slightly lower percentage compare to shopping activity. For PT usage, Chinese students are the highest among seven sites, with higher percentage compare to shopping activity but this time followed by Berkeley students, which total percentage more than 50%, higher than that for shopping and commuting activity.

For leisure using Bicycle, Utrecht is still consistently the highest with similar percentage followed by Japanese students with total percentage half of for shopping activities. Last, mode for walking is still dominated by Berkeley students although the percentage is below 10%. The highest Leisure distance is Indonesian students with average 5.30 km and the lowest is Berkeley students with average 3.38 km. The highest percentage of leisure alone is Utrecht students with 21% whereas other sites is 10.1 % for Berkeley and below 10% for other five sites. The highest percentage of leisure with friends is Chinese students with 91%, followed by Berkeley students with 86.7%. For leisure with family, Indonesia students has the highest percentage with 46% followed by Taiwan students with 18%. The current leisure activity patterns can be seen in Table 5-5.

Table 5-5 Current Leisure Pattern

| Variable (number of observations) | Utrecht (84) | Japan (142) | Berkeley (226) | Taiwan (139) | Indonesia (200) | China (167) | Beirut (271) |
|---|---|---|---|---|---|---|---|
| Mode of leisure | | | | | | | |
| Car (%) | 13.1 | 43.0 | 34.1 | 25.9 | 69.5 | 3.6 | 85.6 |
| Motorcycle (%) | 0.0 | 2.8 | 0.0 | 45.3 | 13.5 | 0.0 | 0.7 |
| PT (%) | 26.1 | 27.5 | 54.8 | 19.5 | 16.5 | 87.4 | 6.4 |
| Bicycle (%) | 54.8 | 24.6 | 1.8 | 8.6 | 0.5 | 3.0 | 0.7 |
| Walk (%) | 6.0 | 2.1 | 9.3 | 0.7 | 0.0 | 6.0 | 6.6 |
| Leisure distance (km) | 4.45 | 4.13 | 3.38 | 4.03 | 5.30 | 3.41 | 3.60 |
| Leisure with whom | | | | | | | |
| Alone (%) | 21.4 | 7.0 | 9.7 | 10.1 | 1.5 | 4.8 | 6.6 |
| Friends (%) | 72.6 | 78.9 | 86.7 | 68.3 | 47.5 | 91.0 | 84.1 |
| Family (%) | 3.6 | 11.3 | 2.7 | 18.0 | 46.0 | 4.2 | 7.4 |
| Relatives (%) | 2.4 | 0.0 | 0.0 | 2.2 | 3.5 | 0.0 | 1.1 |
| Others (%) | 0.0 | 2.8 | 0.9 | 1.4 | 1.5 | 0.0 | 0.7 |

In general, the current travel behaviour pattern are as expected especially for commuting and shopping. Students in Utrecht are frequent bicycle users, Beirut students heavily rely on private cars, and Taiwanese students heavily rely on motorbikes. Chinese students are frequent PT users, while Berkeley students are pedestrians. Utrecht figures can also be understood from the fact that many students live independently in the city of Utrecht and use their bikes to commute to the university. Those who live with their parents and commute longer distances often use their transit pass that is provided to all students. Similar to Utrecht, Japanese students use bike for commuting and shopping even though the PT condition is advance. For Berkeley students, the commuting distance and shopping distance is still reachable by walking thus walking is a preferable mode. For Indonesia students, in terms of commuting mode, the mode shares are almost balance, with the highest using PT followed by cars suggesting that their campus is accessible by PT, however the car numbers is double when they are doing shopping activities. This is most likely because Indonesian students consider shopping activity difference from grocery shopping but more like hanging out in the shopping malls thus cars is more preferable.

Difference pattern is shown for leisure activities where most of students use car particularly in Beirut and Indonesia, for Japanese students the highest mode share is cars. While Utrecht students consistent as bike users and Taiwanese students consistent as motorcyclist, Chinese students in Shanghai consistent as PT users for leisure trip. For

Indonesia case, the leisure distance is the longest in average suggesting that student take a longer leisure destination, considering the quality of PT infrastructure it is more preferable to use cars. Berkeley students use PT more for leisure trips suggesting that their travel destination is not reachable by walk thus PT is preferable.

Regarding travel companion, for those activities in the developed counties case, almost all students are solo traveller, but in the developing countries, the percentage of solo traveller is less in Taiwan and Indonesia case and lesser in China and Beirut. Less than 10% students in Utrecht and Japan commute with friends, while the highest percentage of travel with friends is in China with 35.3%. Around 17% of Beirut students commute with family while less than 10% of students in other sites do so. For shopping activity, Utrecht and Japan students are solo traveller, though the percentage is lower than that for commuting activity. More than 50% students in Berkeley, China and Taiwan travel with friends for shopping activities, which is higher than that for commuting activity. As for Indonesia students, most of them shop with their family. For leisure activity, more than 50% students in all sites, except for Indonesia, travel with their friends. Students from developed countries, which in other activities is solo traveller in this, case travel with friends more. In Indonesia case, the percentage of students travel with friends is still the highest followed slightly with travel with family for leisure activity, indicating Indonesian students is more family oriented.

### 5.4.2. Socio-Demographic

In this sub-chapter, the descriptive statistics for socio-demographic characteristics are presented. These characteristics are living arrangement, dwelling unit, age, gender and monthly income (personal and family).

In terms of living arrangement, the majority of students in Indonesia and Beirut and a substantial proportion in Japan and Taiwan live with their families whereas a significantly lower proportion of students live with their families in China, Berkeley, and Utrecht. The average age of students in the sample is between 19-21. In terms of gender, the Japanese, Taiwanese, and China samples are unbalanced, which is a result of the recruitment methods.

Monthly income is specified as a continuous variable. Each category of respective country is transformed into US$ by using the purchasing power parity conversion factor published by the World Bank (2014). Average personal monthly income is, as expected, lowest among Indonesian students while the students with the highest income are those from Beirut followed by Utrecht and Berkeley students. Considering average family income, it is found that families of Berkeley students are the wealthiest followed by

families of students in Japan and Beirut and then in Utrecht. Indonesian families have a significantly lower income, and China is the lowest. Table 5-6 summarizes the socio-demographic characteristics of each site.

Table 5-6 Socio-Demographic Characteristics in the Seven Surveyed Sites

| Variable | Utr | Jpn | Brkly | Twn | Idn | Chn | Brt |
|---|---|---|---|---|---|---|---|
| (number of observations) | (84) | (142) | (226) | (139) | (200) | (167) | (271) |
| Living Arrangement | | | | | | | |
| Living Alone (%) | 6.0 | 55.6 | 4.4 | 13.7 | 24.0 | 2.4 | 5.5 |
| Living with Family (%) | 23.8 | 41.5 | 14.2 | 45.3 | 58.0 | 12.0 | 77.1 |
| Living with Friends (%) | 63.1 | 2.1 | 75.2 | 36.0 | 17.6 | 80.8 | 10.7 |
| Other (%) | 7.1 | 0.8 | 6.2 | 5.0 | 0.4 | 4.8 | 5.7 |
| Dwelling Unit | | | | | | | |
| Dormitory (%) | 22.6 | 7.7 | 5.8 | 36.0 | 6.5 | 89.2 | 11.8 |
| Apartment (%) | 41.7 | 54.9 | 68.1 | 34.5 | 3.0 | 4.8 | 50.2 |
| Other (%) | 35.7 | 37.4 | 26.1 | 29.5 | 90.5 | 6.0 | 38.0 |
| Av. Age | 21.6 | 20.0 | 20.3 | 21.7 | 20.5 | 21.1 | 19.7 |
| Gender split (% male) | 54.8 | 77.5 | 50.4 | 72.6 | 51.5 | 59.9 | 45.4 |
| Av. personal income (US $)* | 696 | 363 | 621 | 555 | 317 | 401 | 972 |
| Av. family income (US $)* | 5,524 | 6,910 | 7,586 | 6,316 | 3,073 | 1,756 | 6.547 |

* based on income group range measured with local currency; ANOVA significant for all variables

### 5.4.3. Attitudes toward car and PT

There are 20 attitudinal variables toward cars obtained from the survey, which the mean and standard deviation of each variables in each countries are reported in Table 5-7. The mean and standard deviation of attitudinal variables toward PT are also reported in Table 5-8.

To understand better "emotional attachment" of students to cars, the attitudinal questions are analysed and grouped with PCA. Based on varimax rotation, four factors with eigen values larger than one could be extracted. These factors are consistent with findings in the literature: Symbolic Affective (explaining 22.3% of the variance) (Steg, 2005; Van & Fujii, 2011), Independence (16.1% of the variance) (Steg, 2005), Negative Aspects of car (9.9% of the variance) (Zhu et al., 2012), and Social/Env. Care (9.4% of the variance) (Chapter 4). The difference in the single questions as well as the country specific factors is statistically significant according to ANOVA analysis.

Table 5-7 Attitudes towards Cars Variables

| Variable (N) | All (1229) | | Utrecht (84) | | Japan (142) | | Berkeley (226) | | Taiwan (139) | | Indonesia (200) | | China (167) | | Beirut (271) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | St.D | Mean | St.D | Mean | St.D | Mean | St.D | Mean | St.D | Mean | St.D | Mean | St.D | Mean | St.D |
| Cars are comfortable | 5.86 | 0.96 | 6.06 | 0.61 | 5.62 | 1.15 | 5.68 | 0.84 | 6.06 | 0.68 | 5.96 | 0.85 | 5.96 | 1.18 | 5.83 | 1.05 |
| Cars allow one to care for others | 4.99 | 1.40 | 5.38 | 1.10 | 4.80 | 1.62 | 5.25 | 1.11 | 5.86 | 0.90 | 4.23 | 1.48 | 4.92 | 1.36 | 4.92 | 1.41 |
| Cars are convenient | 5.90 | 1.06 | 6.04 | 0.78 | 6.23 | 0.90 | 6.22 | 0.79 | 5.64 | 1.05 | 5.29 | 1.23 | 6.02 | 1.13 | 5.92 | 1.02 |
| Cars give freedom to travel anytime | 5.81 | 1.26 | 6.11 | 0.97 | 5.69 | 1.26 | 6.15 | 0.84 | 5.65 | 1.09 | 4.88 | 1.59 | 6.07 | 1.16 | 6.11 | 1.15 |
| Cars are environmentally friendly | 3.04 | 1.42 | 2.64 | 1.25 | 3.08 | 1.31 | 2.91 | 1.21 | 3.72 | 1.38 | 3.02 | 1.18 | 3.70 | 1.79 | 2.53 | 1.32 |
| Cars allow one to travel safely | 4.80 | 1.36 | 4.75 | 1.34 | 5.13 | 1.47 | 4.65 | 1.18 | 5.47 | 1.18 | 5.42 | 1.13 | 4.35 | 1.34 | 4.25 | 1.36 |
| Cars are cool | 4.81 | 1.38 | 3.99 | 1.52 | 4.47 | 1.58 | 5.08 | 1.12 | 4.76 | 1.38 | 4.98 | 1.19 | 4.72 | 1.45 | 4.97 | 1.36 |
| Cars allow one to do adventurous things | 4.72 | 1.68 | 5.42 | 1.36 | 4.23 | 1.68 | 5.70 | 1.08 | 3.25 | 1.56 | 5.27 | 1.19 | 3.57 | 1.73 | 4.98 | 1.55 |
| Cars are disturbing one's neighbourhood | 3.62 | 1.40 | 3.96 | 1.59 | 3.73 | 1.45 | 3.23 | 1.25 | 3.47 | 1.23 | 3.53 | 1.21 | 3.52 | 1.46 | 3.99 | 1.50 |
| Cars allow to express oneself | 4.04 | 1.44 | 3.04 | 1.50 | 3.26 | 1.55 | 4.38 | 1.15 | 4.27 | 1.39 | 4.53 | 1.22 | 4.13 | 1.47 | 3.94 | 1.41 |
| Cars help one to save time when making a trip | 5.37 | 1.35 | 5.45 | 1.18 | 5.60 | 1.27 | 6.04 | 0.89 | 5.19 | 1.27 | 4.33 | 1.57 | 5.48 | 1.27 | 5.45 | 1.24 |
| Cars are giving an arrogant impression | 3.33 | 1.46 | 2.83 | 1.46 | 3.08 | 1.41 | 3.09 | 1.33 | 3.43 | 1.27 | 3.60 | 1.45 | 2.97 | 1.42 | 3.78 | 1.55 |
| Cars allow one to be independent | 5.19 | 1.43 | 5.55 | 1.17 | 3.94 | 1.70 | 5.73 | 1.12 | 4.71 | 1.26 | 5.08 | 1.25 | 4.90 | 1.42 | 5.80 | 1.21 |
| Cars are trendy | 4.39 | 1.34 | 3.85 | 1.28 | 3.28 | 1.51 | 4.68 | 1.09 | 4.27 | 1.22 | 4.49 | 1.19 | 4.38 | 1.37 | 4.90 | 1.19 |
| Cars are useful to pick up or drop off others | 6.00 | 0.99 | 6.13 | 0.71 | 5.75 | 1.27 | 6.25 | 0.74 | 6.22 | 0.87 | 5.84 | 0.89 | 5.82 | 1.21 | 6.00 | 0.98 |
| Cars are fun to have | 5.05 | 1.40 | 4.81 | 1.45 | 4.16 | 1.65 | 5.45 | 1.10 | 4.96 | 1.34 | 5.47 | 1.07 | 4.60 | 1.40 | 5.26 | 1.39 |
| Cars allow one to travel anywhere | 5.40 | 1.36 | 5.82 | 1.22 | 6.11 | 0.98 | 5.44 | 1.16 | 5.94 | 0.90 | 4.95 | 1.45 | 4.86 | 1.63 | 5.26 | 1.37 |
| Cars are expensive to own and maintain | 5.74 | 1.10 | 5.93 | 1.02 | 6.17 | 1.09 | 5.69 | 0.98 | 6.00 | 1.08 | 5.53 | 1.05 | 5.72 | 1.20 | 5.55 | 1.12 |
| Cars allow to distinguish oneself from others | 4.05 | 1.48 | 3.30 | 1.46 | 3.32 | 1.61 | 4.29 | 1.22 | 4.50 | 1.25 | 4.31 | 1.52 | 4.08 | 1.44 | 4.03 | 1.51 |
| Cars bring prestige | 4.11 | 1.56 | 3.36 | 1.36 | 3.97 | 1.79 | 4.22 | 1.28 | 4.24 | 1.41 | 4.52 | 1.46 | 3.86 | 1.58 | 4.14 | 1.72 |

Table 5-8 Attitudes toward Public Transport

| Variables | All (1229) | | Utrecht (84) | | Japan (142) | | Berkeley (226) | | Taiwan (139) | | Indonesia (200) | | China (167) | | Beirut (271) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | St. D | Mean | St. D | Mean | St. D | Mean | St. D | Mean | St. D | Mean | St. D | Mean | St. D | Mean | St. D |
| I get annoyed by long waiting times at stops | 5.14 | 1.55 | 3.92 | 1.75 | 3.99 | 1.63 | 5.23 | 1.40 | 5.21 | 1.38 | 5.68 | 1.18 | 5.19 | 1.52 | 5.59 | 1.39 |
| The service is convenient | 4.06 | 1.70 | 4.90 | 1.42 | 4.23 | 1.76 | 5.08 | 1.27 | 4.42 | 1.54 | 2.99 | 1.32 | 4.36 | 1.44 | 3.26 | 1.77 |
| The vehicles are dirty | 4.65 | 1.65 | 3.45 | 1.61 | 3.11 | 1.46 | 4.73 | 1.39 | 3.98 | 1.27 | 5.61 | 1.04 | 3.86 | 1.35 | 5.91 | 1.20 |
| The drivers drive carelessly | 4.43 | 1.75 | 3.19 | 1.34 | 3.26 | 1.48 | 3.52 | 1.41 | 4.22 | 1.42 | 5.60 | 1.24 | 3.59 | 1.37 | 5.96 | 1.26 |
| I feel unsafe using public transport | 3.92 | 1.82 | 2.51 | 1.65 | 2.58 | 1.31 | 3.36 | 1.41 | 3.70 | 1.31 | 5.10 | 1.27 | 2.80 | 1.23 | 5.51 | 1.60 |
| The service network is confusing | 4.05 | 1.71 | 2.49 | 1.17 | 3.39 | 1.71 | 3.58 | 1.43 | 3.75 | 1.51 | 4.82 | 1.42 | 3.74 | 1.54 | 5.08 | 1.67 |
| The service is efficient | 3.82 | 1.54 | 4.64 | 1.27 | 4.17 | 1.50 | 4.30 | 1.37 | 3.73 | 1.30 | 3.07 | 1.21 | 4.32 | 1.45 | 3.25 | 1.70 |
| The service covers the city area well | 4.23 | 1.66 | 5.01 | 1.39 | 3.85 | 1.73 | 4.76 | 1.41 | 4.47 | 1.65 | 3.63 | 1.44 | 4.85 | 1.44 | 3.65 | 1.78 |
| The service is unreliable | 3.96 | 1.63 | 3.04 | 1.62 | 3.02 | 1.51 | 4.10 | 1.56 | 3.60 | 1.32 | 4.55 | 1.32 | 3.30 | 1.33 | 4.84 | 1.62 |
| I get annoyed by minibuses/buses/shuttles stopping everywhere they like (if applicable where you live | 4.65 | 1.88 | NA | NA | 3.36 | 1.84 | 3.54 | 1.34 | 4.37 | 1.55 | 5.95 | 1.27 | 3.76 | 1.64 | 5.94 | 1.51 |

In Table 5-9, the items loading in the factors in which they load highest are reported (in parentheses) as well the mean values of the responses to the attitude/perception statements loading on the different factors. Note that only variables, which load higher than 0.5 are taken thus only 15 out of 20 variables, are included in the subsequent analysis.

Table 5-9 Mean Values of Responses to Attitude/Perception Statements Loading on the Different Factors in the Seven Surveyed Sites

| Factor | Variable (Factor loading) | All 1229 | Utr 84 | Jpn 142 | Bkly 226 | Twn 139 | Idn 200 | Chi 167 | Brt 271 |
|---|---|---|---|---|---|---|---|---|---|
| Attitudes/perceptions toward car. Respondents were asked whether Cars … | | | | | | | | | |
| Symbolic Affective | …allow to distinguish oneself from others (0.78), …are trendy (0.75), …bring prestige (0.74), …are cool (0.70), …allow to express oneself (0.70), …are fun to have (0.66) | **4.39** | **3.71** | **3.73** | **4.66** | **4.49** | **4.70** | **4.29** | **4.52** |
| Independence | …are convenient (0.80), …give freedom to travel anytime (0.79), …help one to save time when making a trip (0.75), …are useful to pick up or drop off others (0.54) | **5.76** | **5.92** | **5.83** | **6.16** | **5.63** | **5.03** | **5.86** | **5.86** |
| Negative Aspects | …are expensive to own and maintain (0.71), …are disturbing one's neighbourhood (0.67), …are giving an arrogant impression (0.60) | **4.29** | **4.32** | **4.41** | **4.07** | **4.37** | **4.27** | **4.14** | **4.49** |
| Social/Env. Care | …allow one to travel safely (0.81), …are environmentally friendly (0.78) | **3.94** | **3.71** | **4.12** | **3.80** | **4.61** | **4.24** | **4.03** | **3.41** |
| Attitudes/perceptions toward PT (PT) | | | | | | | | | |
| Safety and Reliability | The drivers drive carelessly (0.84), I feel unsafe using PT (0.83), The service is unreliable (0.61), I get annoyed by long waiting times at stops (0.61) | **4.11** | **3.12** | **3.17** | **3.96** | **4.15** | **5.25** | **3.64** | **5.52** |
| Convenience | The service covers the city area well (0.85), The service is efficient (0.80), The service is convenient (0.76) | **4.15** | **4.85** | **4.08** | **4.71** | **4.21** | **3.24** | **4.52** | **3.39** |

ANOVA significant for all variable; bold indicates mean of combined variables in the factor

For symbolic affective, the lowest ratings are those of Utrecht and Japan, which indicates that the car is not perceived as bringing social status in these locations compared to the other countries. For *independence*, the highest overall rating comes from Berkeley followed by Utrecht, Beirut, and China. Indonesia and Taiwan have the lowest rating,

except the variable "cars are useful to pick up or drop off others". This might link to their intensive use of motorcycles, which offer more convenience, freedom, and saving of travel time than cars do.

In terms of *negative aspects*, the rating of the "cars give an arrogant impression" is highest in Beirut and Indonesia, the two countries in the sample in which, arguably, students most need to rely on cars for daily activities. An explanation might be envy among those who cannot afford to buy a car as well as the "misuse" of the car as a status symbol of a few among the students who purchase large, expensive cars. In terms of *social/env. care*, students in all countries tend to disagree that the car is environmental friendly, with the lowest rating given by the Beirut sample, where the transportation sector is responsible for high levels of emissions, which are well beyond standards prescribed by the World Health Organization.

To complement the analysis of attitudes/perceptions towards cars, students are asked about their attitudes/perceptions towards PT (PT) and also here a principal component analysis is conducted from which two factors that refer to as *safety and reliability* and *convenience* are extracted. In addition, here with ANOVA analysis it is found that the PT perceptions of both factors are distinct in all seven countries. The low quality of the PT system in Indonesia and Beirut is reflected in the students' ratings of the system attributes. Utrecht students report the highest ratings of PT.

### 5.4.4. Norms regarding cars

In addition to attitudes/perceptions, the role of norms is investigated. The *descriptive norms* ratings are a reflection of the perceived current car ownership situation in the countries, with higher values denoting higher perception of auto ownership. Beirut in this case is the highest, followed by Berkeley. China is lowest.

*EOTBC* is related to the perceived status value of a car as well as the general perceived need to own a car. In Utrecht, the value is understandably significantly lower than in other samples. Slightly surprising is the high-perceived expectation of others for students to buy a car in Japan and Berkeley. Strength of influence of others might be seen as a measure of "independence." Here it is found again the lowest rating for the Dutch students which possibly reflecting a "more independent Western mind-set." The mean values and standard deviations of the norms statements are shown in Table 5-10.

Table 5-10 Norms Statements in the Seven Surveyed Sites

| Variables | All (1229) | | Utrecht (84) | | Japan (142) | | Berkeley (226) | | Taiwan (139) | | Indonesia (200) | | China (167) | | Beirut (271) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | St.D | Mean | St.D | Mean | St.D | Mean | St.D | Mean | St.D | Mean | St.D | Mean | St.D | Mean | St.D |
| Descriptive Norms (Perceived Car Usage Frequency of Others). Cronbach's Alpha = 0.72 | *2.63* | | *2.40* | | *2.48* | | *2.92* | | *2.39* | | *2.64* | | *1.92* | | *3.08* | |
| Parents | 3.68 | 0.74 | 3.93 | 0.37 | 3.90 | 0.43 | 3.95 | 0.32 | 3.81 | 0.58 | 3.53 | 0.85 | 2.61 | 0.92 | 3.96 | 0.29 |
| Partner | 1.36 | 1.61 | 0.86 | 1.25 | 0.94 | 1.28 | 1.42 | 1.71 | 1.17 | 1.29 | 1.74 | 1.73 | 0.98 | 1.28 | 1.74 | 1.85 |
| Family members | 2.99 | 1.07 | 3.21 | 1.08 | 3.42 | 0.84 | 3.39 | 0.91 | 2.54 | 1.18 | 2.68 | 0.94 | 2.16 | 0.97 | 3.32 | 0.96 |
| Close friends | 2.05 | 1.07 | 1.42 | 0.85 | 1.42 | 0.83 | 2.56 | 1.06 | 1.44 | 0.83 | 2.36 | 0.87 | 1.44 | 0.77 | 2.59 | 1.02 |
| Peers at university | 1.96 | 0.99 | 1.12 | 0.45 | 1.36 | 0.71 | 2.00 | 0.92 | 1.38 | 0.72 | 2.55 | 0.79 | 1.37 | 0.72 | 2.74 | 0.85 |
| People in the neighbourhood | 2.97 | 0.98 | 2.82 | 1.08 | 3.04 | 1.06 | 3.18 | 0.98 | 3.26 | 0.82 | 2.65 | 0.84 | 2.23 | 0.92 | 3.34 | 0.78 |
| People in the province/state | 3.17 | 0.84 | 3.40 | 0.66 | 3.16 | 0.88 | 3.47 | 0.67 | 3.35 | 0.75 | 2.98 | 0.75 | 2.38 | 0.81 | 3.38 | 0.76 |
| Expectation of Others to Buy a car. Cronbach's Alpha = 0.92 | *4.63* | | *3.39* | | *4.80* | | *4.83* | | *4.86* | | *4.75* | | *4.66* | | *5.10* | |
| Parents | 5.22 | 1.54 | 3.17 | 1.47 | 5.54 | 1.61 | 5.31 | 1.40 | 5.08 | 1.37 | 5.43 | 1.15 | 5.29 | 1.46 | 5.50 | 1.52 |
| Partner | 4.75 | 1.42 | 3.38 | 1.25 | 4.20 | 1.64 | 4.67 | 1.31 | 5.00 | 1.33 | 4.92 | 1.16 | 4.99 | 1.26 | 5.18 | 1.41 |
| Family members | 4.93 | 1.39 | 3.22 | 1.17 | 5.12 | 1.54 | 5.00 | 1.26 | 4.93 | 1.23 | 5.10 | 1.12 | 4.87 | 1.27 | 5.25 | 1.42 |
| Close friends | 4.82 | 1.38 | 3.27 | 1.17 | 4.98 | 1.61 | 4.83 | 1.28 | 5.09 | 1.24 | 4.82 | 1.10 | 4.69 | 1.25 | 5.22 | 1.40 |
| Peers at university | 4.68 | 1.31 | 3.44 | 1.11 | 4.89 | 1.55 | 4.73 | 1.26 | 4.87 | 1.18 | 4.59 | 1.00 | 4.57 | 1.18 | 5.00 | 1.36 |
| People in the neighbourhood | 4.39 | 1.20 | 3.65 | 0.95 | 4.32 | 1.52 | 4.58 | 1.22 | 4.45 | 1.06 | 4.31 | 0.92 | 4.13 | 1.00 | 4.76 | 1.27 |
| People in the province/state | 4.41 | 1.23 | 3.63 | 0.94 | 4.56 | 1.50 | 4.69 | 1.20 | 4.57 | 1.10 | 4.10 | 0.95 | 4.07 | 1.08 | 4.79 | 1.30 |

| Variables | All (1229) | | Utrecht (84) | | Japan (142) | | Berkeley (226) | | Taiwan (139) | | Indonesia (200) | | China (167) | | Beirut (271) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | St.D | Mean | St.D | Mean | St.D | Mean | St.D | Mean | St.D | Mean | St.D | Mean | St.D | Mean | St.D |
| Strength of Influence of Others to Buy a Car. Cronbach's Alpha = 0.85 | *4.41* | | *3.70* | | *5.01* | | *4.16* | | *4.52* | | *4.85* | | *4.64* | | *3.98* | |
| Parents | 6.41 | 1.83 | 5.18 | 1.93 | 6.12 | 1.71 | 6.30 | 1.94 | 6.49 | 1.70 | 7.18 | 1.17 | 6.55 | 1.59 | 6.35 | 2.11 |
| Partner | 5.82 | 2.08 | 5.61 | 2.17 | 5.27 | 2.16 | 5.52 | 2.04 | 6.15 | 1.99 | 6.37 | 1.73 | 6.64 | 1.40 | 5.09 | 2.39 |
| Family members | 4.79 | 1.88 | 3.55 | 1.68 | 5.64 | 1.65 | 4.30 | 1.83 | 5.22 | 1.74 | 5.73 | 1.48 | 4.99 | 1.60 | 4.08 | 1.97 |
| Close friends | 4.56 | 1.75 | 4.25 | 1.65 | 5.04 | 1.63 | 4.39 | 1.73 | 4.75 | 1.77 | 4.52 | 1.70 | 4.65 | 1.52 | 4.44 | 1.96 |
| Peers at university | 3.70 | 1.64 | 3.01 | 1.38 | 4.73 | 1.73 | 3.46 | 1.54 | 3.73 | 1.63 | 4.03 | 1.55 | 3.86 | 1.42 | 3.24 | 1.64 |
| People in the neighbourhood | 2.87 | 1.39 | 2.20 | 0.70 | 4.07 | 1.73 | 2.67 | 1.21 | 2.48 | 1.09 | 3.31 | 1.35 | 3.08 | 1.35 | 2.43 | 1.24 |
| People in the province/state | 2.72 | 1.40 | 2.09 | 0.55 | 4.20 | 1.88 | 2.48 | 1.11 | 2.79 | 1.48 | 2.82 | 1.33 | 2.72 | 1.21 | 2.25 | 1.09 |
| Subjective Social Norms (Perceived pressure to buy a car). Cronbach'sAlpha = 0.72 | *3.76* | | *2.85* | | *3.52* | | *3.64* | | *3.59* | | *3.75* | | *4.02* | | *4.95* | |
| I feel that there is social pressure to have a car here | 3.75 | 1.72 | 2.11 | 1.25 | 3.15 | 1.65 | 3.82 | 1.65 | 3.65 | 1.28 | 3.19 | 1.61 | 4.62 | 1.44 | 4.45 | 1.73 |
| transport modes other than car (walking, bike and public transport) are looked down upon | 3.42 | 1.86 | 2.12 | 1.38 | 3.38 | 1.81 | 3.08 | 1.68 | 2.73 | 1.63 | 3.46 | 1.75 | 2.66 | 1.31 | 4.94 | 1.71 |
| the majority of people think that having a car is the right thing to do | 4.60 | 1.50 | 4.31 | 1.41 | 4.03 | 1.47 | 4.04 | 1.68 | 4.37 | 1.43 | 4.59 | 1.23 | 4.78 | 1.34 | 5.46 | 1.27 |

ANOVA significant for all variable; Italic represent mean values of responses to norm statements in the seven surveyed sites.

Finally, regarding *subjective social norms*, the high and low values in Beirut and Utrecht are understandable given the afore discussed context. Utrecht has a good transit system and progressive transportation policies, and using the bicycle for commuting is common (51% reported in Table 5-1). Noteworthy are the relatively high values in Indonesia and China. Together with previous results this might suggest that owning a car is perceived as something one should be able to afford even if "showing the car to others" (as status symbol) is not necessarily a main purpose.

## 5.5. Future Intention

### 5.5.1. Intention to Purchase a Car in The Future

Given the possible explanatory factors discussed in the previous sub-chapter, this sub-chapter aims to relate these variables to car purchase intentions. Table 5-11 shows the mean intentions of car owners to purchase a new/different car and the intentions of non-car owners to purchase a car within the next ten years.

Table 5-11 Car Purchase Intention

| Car purchase intention | Utr (84) | Jpn (142) | Brkly (226) | Twn (139) | Idn (200) | Chn (167) | Brt (271) |
|---|---|---|---|---|---|---|---|
| All Sample Means | 4.55 | 4.62 | 4.92 | 4.99 | 5.24 | 5.42 | 5.65 |
| (Sd.D) ANOVA = 0.00 | (1.47) | (1.86) | (1.79) | (1.23) | (1.41) | (1.51) | (1.57) |
| Car owner Means | 5.00 | 5.15 | 5.45 | 5.13 | 5.33 | 5.48 | 5.74 |
| (Sd.D) ANOVA = 0.02 | (1.68) | (1.52) | (1.52) | (1.40) | (1.37) | (1.47) | (1.53) |
| Non-car owner means | 4.42 | 4.45 | 4.68 | 4.90 | 5.13 | 5.40 | 5.18 |
| (Sd.D) ANOVA = 0.00 | (1.39) | (1.95) | (1.86) | (1.10) | (1.48) | (1.54) | (1.76) |
| Independent t-test car owner and non-car owner | -1.49 | **-2.16*** | **-3.28*** | -1.043 | -0.99 | -0.30 | **-2.08*** |

Italic p value <0.1; Bold p value<0.05; Bold + * p value <0.01

Stronger intentions to buy a car among the students in the developing countries can be observed, and the difference between them and the developed countries is significant (t-test= 7.19; not shown in the table), possibly partly reflecting the higher relative price of cars when considering income and hence that these students cannot yet afford cars. An additional explanation may be found in the quality of PT in Japan and the Netherlands, especially in the urban areas where the current student will likely reside when starting to work. It can further be observed that current car owners have a stronger intention to

remain car owners than the desire of current non-owners to purchase a car. This is the case irrespective of geography though the difference is only significant in Japan, Beirut, and Berkeley.

### *A) Correlation with Transportation Pattern*

Car purchase intentions, regardless of current ownership status, are correlated with the various possible explanatory factors discussed in Sub-chapter 5.4. The correlation start with vehicle (including driving license) ownership/use with intention to buy a car in the future, shown in Table 5-12.

Table 5-12 Single Variable Ordinal Logistic Regression of Car Purchase Intention

| Variable | Utr (84) | Jpn (142) | Ber (226) | Twn (139) | Idn (200) | Chn (167) | Bei (271) |
|---|---|---|---|---|---|---|---|
| Driving License (have) | -0.13 | 0.24 | 0.28 | 0.58 | -0.04 | 0.51 | -0.11 |
| Regular Car Use (regular user) | **1.01** | **0.73** | **1.04** | 0.31 | **-0.66** | 0.13 | **0.98** |
| Car Ownership (car owner) | **1.02** | 0.56 | **0.75** | 0.37 | 0.23 | 0.07 | **0.68** |
| Motorcycle or Car Ownership (motorcycle or car owner) | **1.02** | 0.47 | **0.80** | **0.99** | 0.30 | 0.15 | *0.60* |
| Motorcycle Ownership (motorcycle owner) | NA | 0.22 | 1.05 | 0.55 | -0.05 | 1.37 | -0.55 |
| Bicycle Ownership (bicycle owner) | -1.87 | 0.53 | -0.07 | -0.09 | 0.35 | 0.45 | 0.06 |

Italic p value <0.1; Bold p value<0.05; Bold + * p value <0.01

Since all of the explanatory variables here are binary variables, instead of Pearson correlation, ordinal logistic regression with one explanatory variables is performed to explain the influence of explanatory variables to car ownership intention. It appears that driving license, motorcycle and bicycle ownership do not have significant influence on intention to buy a car. It is found that regular car use significantly influence intention to buy a car in the future in all sites except Taiwan and China. For Indonesia case, it is interesting that regular car use negatively significantly influences car intention. Perhaps due to the severe traffic congestion experienced by the regular car user influences their intention, another thought could be that those who use car have already one and plan to keep using it more than ten years. Car ownership is significant in Utrecht, Berkeley and Beirut, while car or motorcycle ownership variable is significant in the same sites plus Taiwan, however the Beirut case in only at 10% level of significance.

The analysis is continued with correlation between travel pattern variables and Intention to buy a car. As previously discussed in Sub-chapter 5.4.1 the travel pattern is categorized into three main activities: commuting to campus, shopping activity and leisure

activity. For commuting distance and shopping distance, the correlation with car intention is not significant for all sites except for Berkeley and China (commuting) and Utrecht (Shopping) with 10% level of significant. While for shopping distance, it is significant for Indonesia and Beirut case. The correlation between travel pattern variables with intention to buy a car in the future can be seen in Table 5-13.

Table 5-13 Correlation between Travel Pattern Variables and Car Purchase Intention

| Variable | Utr (84) | Jpn (142) | Ber (226) | Twn (139) | Idn (200) | Chn (167) | Bei (271) |
|---|---|---|---|---|---|---|---|
| Commuting distance | 0.18 | 0.05 | *0.12* | 0.12 | 0.01 | *0.14* | 0.06 |
| Shopping distance | *0.20* | 0.06 | 0.07 | 0.13 | 0.07 | 0.06 | 0.10 |
| Leisure distance | -0.10 | 0.01 | 0.05 | 0.11 | **0.18** | 0.10 | **0.13** |
| Categorical Variable (ordinal regression with one variable only) | | | | | | | |
| Commuting with cars (0 = otherwise) | 1.23 | **1.25** | 0.08 | *1.12* | 0.45 | *1.17* | 0.34 |
| Shopping with cars (0 = otherwise) | *1.43* | **1.22** | **0.59** | 0.19 | **0.61** | 0.08 | **0.81** |
| Leisure with cars (0 = otherwise) | 0.58 | **1.05** | 0.48 | 0.58 | 0.19 | -0.56 | **0.77** |
| Commuting alone (0 = otherwise) | -0.60 | 0.01 | 0.30 | **1.07** | **-0.99** | -0.24 | *-0.40* |
| Commuting with peers (0 = otherwise) | 0.23 | 0.19 | -0.18 | **-0.85** | **0.94** | 0.09 | 0.00 |
| Shopping alone (0 = otherwise) | -0.36 | *-0.55* | -0.17 | 0.24 | -0.49 | -0.18 | 0.00 |
| Shopping with peers (0 = otherwise) | -0.20 | *0.51* | 0.06 | 0.17 | 0.04 | 0.02 | 0.12 |
| Leisure alone (0 = otherwise) | -0.18 | **-2.73** | -0.32 | -0.58 | -0.02 | **-1.28** | -0.39 |
| Leisure with peers (0 = otherwise) | 0.37 | **0.98** | 0.13 | 0.46 | -0.19 | **1.04** | *0.55* |
| Commuting, car user who travel with peers (0 = otherwise) | NA | 0.03 | -0.91 | 0.07 | 0.59 | 0.26 | **0.64** |
| Commuting, car owner who travel with peers (0 = otherwise) | 0.46 | 0.03 | 0.07 | -0.85 | **0.76** | 0.06 | **0.50** |
| Commuting, non-car owner who travel with peers (0 = otwise) | 0.63 | -0.03 | -0.45 | **-1.03** | **0.96** | 0.26 | -0.43 |
| Shopping, car user who travel with peers (0 = otherwise) | 1.39 | **1.10** | **0.69** | 0.19 | **0.70** | 0.08 | 0.43 |
| Shopping, car owner who travel with peers (0 = otherwise) | *0.92* | 0.63 | **0.69** | 0.25 | 0.30 | 0.19 | 0.33 |
| Shopping, non-car owner who travel with peers (0=otherwise) | -0.17 | 0.24 | *-0.45* | -0.35 | -0.08 | -0.02 | *-0.58* |
| Leisure, car user who travel with peers (0 = otherwise) | 1.04 | **1.38** | *0.48* | **1.19** | -0.06 | -0.35 | **0.68** |
| Leisure, car owner who travel with peers (0 = otherwise) | **1.03** | *0.67* | **0.61** | 0.29 | 0.21 | 0.15 | **0.68** |
| Leisure, non-car owner who travel with peers (0 = otherwise) | -0.50 | 0.05 | *-0.43* | -0.01 | -0.22 | 0.09 | **-0.73** |

Italic p value <0.1; Bold p value<0.05

Since travel mode in the data is in the form of nominal variables, it is transformed this variables into binary variables which is commuting with cars or otherwise. Commuting with cars is significantly influence intention to buy cars in Japan and two

others developing countries, Taiwan and China, suggesting that in East Asian countries students who commute with cars tend to buy cars. Interestingly in Taiwan and China only, shopping with cars does not influence intention to buy a car in the future while in other five countries, including Japan, shopping with cars is significantly influence car intention. Students in developed countries who shop with cars have intention to buy cars in the future suggesting that they most likely prefer to utilize cars to bring the grocery that is more efficient rather than using PT, for Indonesia and Beirut case, perhaps it is partly because the availability of PT. Significant correlation of leisure with cars are only found in two sites, Japan and Beirut, while in other sites it is not significant.

For travel companion this variable is transformed into two binary variables: travel alone and travel with peers. Regarding commuting with peers, Indonesian students are opposite of Taiwanese students, commuting alone in Indonesia negatively significantly influence car intention which means that those who commute alone do not have intention to buy cars and those who commute with peers is otherwise. Except for Japan (at 10% level), none is significant in regards to shopping alone or shopping with peers, same for leisure activities, Japan is significant but this time followed by China. It might be said here that those who travel with peers tend to buy cars while those who travel alone is otherwise.

New binary variables are also created by interacting between travel by cars and travel with peers to check if these variables have significant correlation with intention to buy car in the future. Finally, whether there is a correlation between binary variables car owner who travel with peers and non-car owners who travel with peers with intention to buy cars in the future, or not, are checked. In Indonesia, car owners and non-car owners who travel with peers, regardless they use car or not intent to buy cars in the future, most likely because it is more convenience to commute with peers especially given the severe traffic congestion in Jakarta and Bandung. While for Taiwanese students non-car owner who commute with peers have less intention to buy cars in the future, partly because of convenience PT or partly because of motorcycle culture. In Beirut, car user and car owner who travel with peers for commuting and leisure tend to buy car in the future, while non-car owner who travel with peers have less intention to buy cars.

In the developed country case, for commuting with peers, there is no significant correlation with intention to buy cars, however for shopping and leisure activities there appears significant correlations. In Berkeley, car owners who shop or leisure with companion tend to buy cars while non-car owners who shop or leisure with peers is otherwise. In Japan, those who shop with peers and use cars regardless own a car or not have intention to buy cars in the future, the same case for leisure with peers. In Utrecht,

car owners who shop or leisure with peers tend to buy cars in the future. In conclusion, only students in Indonesia who are a non-car owners and travel with friends have positive significant intention to buy cars in the future. While shopping with cars is significant in almost all the countries except for Taiwan and China.

### *B) Correlation with Socio-Demographic*

Further socio-demographic variables are correlated with intention to buy a car. Age and gender seem not significantly correlated with the intention to buy a car except in Taiwan (age), however since the age range is not too wide therefore age for this case is not necessarily an important determinant for future car intention. In the developed countries, personal income and family income are not significantly correlated with car purchase intention. In the developing countries, except for Indonesia, it appears otherwise for personal income, it is significantly correlated with future car intention. As for family income, it appears not to be a good explanatory factor for car purchase intentions in Indonesia and China (consistent with Zhu et al. 2012) although it is significant in Taiwan and Beirut. The correlation between socio-demographic variables and intention to buy a car can be seen in Table 5-14.

Table 5-14 Correlation between Socio-Demographic and Car Purchase Intention

| Variable | Utr (84) | Jpn (142) | Ber (226) | Twn (139) | Idn (200) | Chn (167) | Bei (271) |
|---|---|---|---|---|---|---|---|
| Av. Age | 0.00 | 0.02 | 0.01 | **0.17** | 0.09 | 0.08 | -0.01 |
| Av. Income | -0.05 | 0.05 | 0.06 | **0.33*** | 0.13 | **0.21*** | **0.14** |
| Av. Family income | 0.13 | -0.14 | 0.01 | **0.27*** | 0.07 | 0.08 | **0.18** |
| Categorical Variable (ordinal regression with one variable only) | | | | | | | |
| Gender (male) | 0.30 | -0.10 | -0.03 | 0.55 | 0.30 | -0.08 | -0.23 |

Bold p value<0.05; Bold + * p value <0.01

### C) Correlation with Attitudes towards Car and PT

Correlation between attitudes toward car and PT with intention to buy a car in the future are shown in Table 5-15. It is found that among the attitudinal constructs, the symbolic affective factor is significant in various countries, though it is difficult to explain the observed pattern. Students in Utrecht appear most impacted among the students of the seven study sites by the negative car aspects (environmental impacts, costs of maintenance, arrogant image) in their desire to purchase a car. All countries show a positive significant correlation between *independence* and the intention to buy a car in the future except for

Taiwan. The reason is likely to be that Taiwanese students have long enjoyed the mobility and freedom that motorbikes bring to them. Social/Env. Care is important in some countries but the pattern is not seen here. From the magnitude of correlation coefficient, it seems that in the developed countries, attitudes have larger impact than developing countries.

Table 5-15 Correlation between Attitudes toward Car and PT and Car Purchase Intention

| Variable | Utr (84) | Jpn (142) | Ber (226) | Twn (139) | Idn (200) | Chn (167) | Bei (271) |
|---|---|---|---|---|---|---|---|
| Symbolic Affective (Car) | 0.08 | **0.23*** | **0.24*** | **0.26*** | 0.03 | 0.07 | **0.21*** |
| Independence (Car) | **0.34*** | **0.23*** | **0.27*** | 0.13 | **0.16** | **0.21*** | **0.19*** |
| Negative Aspects (Car) | **-0.32** | 0.09 | -0.09 | 0.08 | -0.10 | -0.14 | -0.11 |
| Social/Env. Care (Car) | **0.26** | 0.05 | 0.04 | **0.26*** | 0.00 | 0.12 | 0.09 |
| Safety and Reliability (-) (PT) | 0.05 | 0.05 | **0.21*** | **0.20** | 0.02 | 0.12 | 0.11 |
| Convenience (PT) | -0.21 | -0.06 | -0.07 | -0.05 | -0.01 | -0.09 | -0.07 |

Bold p value<0.05; Bold + * p value <0.01

Further interesting to note is that the perception of PT is only associated with car purchase intentions in Berkeley and Taiwan. The Taiwanese students might believe that a good PT system could replace the need for a car after experiencing the successful PT in Taipei. In other countries, the perception of PT might be too uniform to detect a correlation with car purchase intentions.

### D) Correlation with Norms

Further norms and intention to buy a car are correlated and the result are shown in Table 5-16.

Table 5-16 Correlation between Norms and Car Purchase Intention

| Variable | Utr (84) | Jpn (142) | Ber (226) | Twn (139) | Idn (200) | Chn (167) | Bei (271) |
|---|---|---|---|---|---|---|---|
| Descriptive Norms | **0.34*** | **0.20** | 0.07 | **0.20** | 0.04 | 0.08 | 0.04 |
| EOTBC | -0.20 | **0.25*** | **0.47*** | **0.42*** | 0.14 | **0.23*** | **0.18** |
| Strength of Influence of Others to Buy a Car | 0.12 | 0.19 | **0.20** | 0.07 | 0.06 | 0.05 | **0.35*** |
| Subjective Social Norms | 0.10 | 0.10 | **0.22*** | **0.20** | -0.11 | 0.03 | **0.12** |

Bold p value<0.05; Bold + * p value <0.01

Besides the result from attitudinal variables, another significant finding is the relatively large correlations for the expectation of others regarding car purchase in several samples, in particular Berkeley and Taiwan. In all samples, except Utrecht, It is found in fact a stronger significance of perceived expectations than of *descriptive norms*, i.e. the perceived general car ownership level. In general, it is found that norms other than *descriptive norms* appear less significant among the Dutch students, probably related to a different status of car ownership as discussed previously. For most samples, there is a strong role of expectation of others for the intention to buy a car in the future. This might indicates that the role of expectation of others is an important determinant for the decision to buy a car in the future. Thus in Sub-chapter 5.6 the descriptive analysis of *EOTBC* is discussed.

The impact of social norms is quite difference across countries, and it seems that the impact of social norms cannot be explained by the difference between developed or developing countries, and perhaps the impact of social norms is based on cultural things.

### 5.5.2. Students Future Travel Intention Other than Cars

Before moving to detail discussion about *EOTBC*, the discussion about other students future travel intention are worth mentioning. The first variable that is asked to students is whether they have intention to use PT for commuting which was measured by seven point Likert scale. Whether they have intention to use bicycle or walk more for everyday trips, or not, is also asked and measured by seven-point Likert scale. Finally, whether they have given serious though about use car less or not is asked. The mean and standard deviations (in parenthesis) can be seen in Table 5-17.

Table 5-17 Future Travel Intention Other Than Cars

| Variable | Utrecht (84) | Japan (142) | Berkeley (226) | Taiwan (139) | Indonesia (200) | China (167) | Beirut (271) |
|---|---|---|---|---|---|---|---|
| Intention to use PT more for everyday trips (very weak – very strong) | 2.81 (1.69) | 3.61 (1.92) | 4.25 (1.62) | 4.06 (1.71) | 4.02 (1.66) | 5.17 (1.50) | 3.13 (1.98) |
| Intention to walk and/or use bike more for everyday trips is (very weak – very strong) | 4.51 (1.70) | 5.25 (1.75) | 4.94 (1.58) | 4.14 (1.73) | NA | NA | 3.71 (2.07) |
| I have given it serious thought whether I can use my car less (not at all - very often) | 2.71 (2.20) | 3.04 (1.84) | 3.49 (1.98) | 3.94 (1.68) | 3.72 (1.89) | 3.90 (1.82) | 3.92 (2.21) |

It seems that students in Utrecht, Japan and Beirut have weak intention to use PT for commuting, especially in Utrecht, however if other variables are examined, it seems that the intention to use PT which is weak in Utrecht and Japan can partly be explained by stronger intention to use bicycle or walk more. For Beirut case, weak intention to use PT is also followed by weak intention to use bike or walk more which might be an indication to reduce the use of cars, shown by mean below four for thought whether use car less or not. Berkeley, Taiwan and Indonesia seems indifferent while China students have stronger intention to use PT. For most of the countries, it is found that students are seldom given serious thought of using car less (mean value below four). Note that since these variables are all intentional variables in the future, they are not used as determinants for car ownership intention model.

### 5.6. Descriptive Analysis of EOTBC

In this sub-chapter, the overall responses to the *EOTBC* indicators in the seven countries are described and followed by a description of the correlation of *EOTBC* construct with other variables. Indicators of *EOTBC* for developed countries and developing countries can be seen in Figure 5-1.

In general, it is presumed that students perceive higher expectations by parents, partners, family members, and relatives as the "inner circle of the social network." Arguably, though, close friends and peers at university might have a similar or even stronger influence on the respondents' intentions. People in neighbourhood and people in province/state are also included to represent expectations of the surrounding society.

The midpoint (level 4) expresses "no expectations." Therefore, mean values lower than four indicate a tendency that the group in question expects the respondent to rather not buy a car. It is interesting to see from the figures that students in Utrecht stand out from the rest of the sample. For all groups the values indicate expectations to rather live without a car in Utrecht. These expectations are strongest from family members and close friends. In Japan and Berkeley, the situation is reversed, as there are rather positive expectations to buy a car in the future. Parents, followed by other family members are expecting students to buy cars more compared to people in their neighbourhood or the wider society. Interestingly, the Japanese and the US students perceive expectations from the different person groups very similarly. It would have probably been expected that Japanese students perceive higher expectations from family members than students in Berkeley do.

Also in developing countries, in general the expectations from parents are highest. Only Taiwanese students give a slightly higher rating to the expectations from close

friends, though the difference to expectation from parents is minor. In Beirut, it appears that students perceive similar expectations from almost all groups. This appears coherent though with the car dominated culture of Lebanon. In Sub-chapter 5.5, it is discussed that in Lebanon car ownership is the obvious choice, partly because public transport is insufficient. Interestingly in China and Indonesia, respondents perceive the general expectation by society to own a car much lower than other person groups in their respected countries. This could be due to the general lower car ownership rate in these two countries.

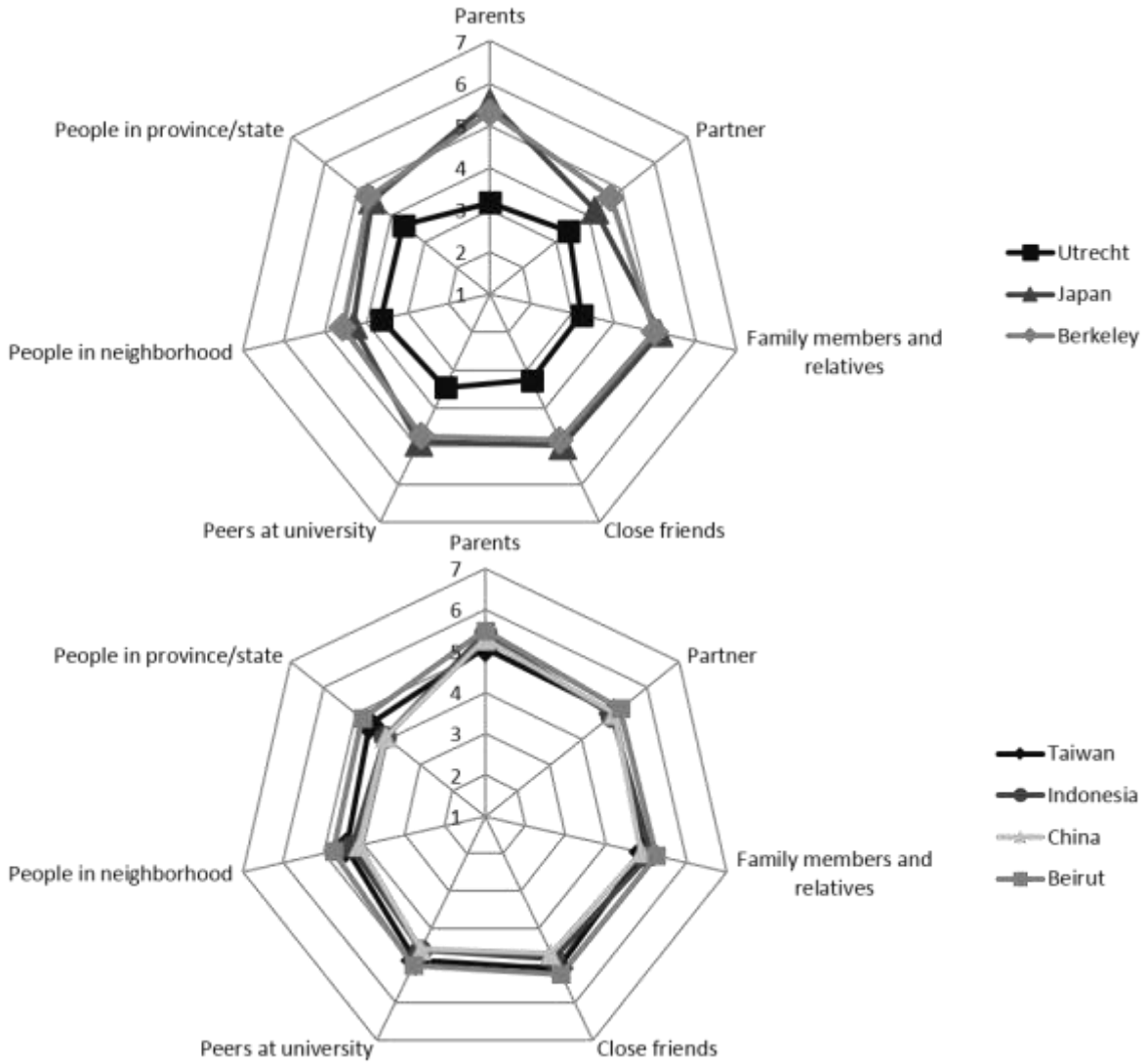


Figure 5-1 EOTBC indicators in developed and developing countries

In the remainder of this sub-chapter, the factor *EOTBC* as estimated by PCA is discussed. This *EOTBC* factor was constructed with the indicators of expectations by the seven different groups. PCA based on the Bartlett refined methods is used to extract factor scores (Bartlett, 1937). This method (instead of using for example weighted means) is chosen as it produces unbiased estimates of the true factor scores with sample mean zero and a standard deviation of one (DiStefano, et al. 2009). Correlation analysis between *EOTBC* with the likelihood to buy a car and other explanatory variables in the seven countries are conducted, the results are shown in Table 5-18.

Table 5-18 EOTBC and its correlation with other variables

| Variable (number of observations) | Utrecht (84) | Japan (142) | Berkeley (226) | Taiwan (139) | Indonesia (200) | China (167) | Beirut (271) |
|---|---|---|---|---|---|---|---|
| Likelihood to buy a car in the future | -0.20 | **0.25** | **0.47** | **0.42** | 0.14 | **0.23** | **0.18** |
| Symbolic Affective | -0.13 | **0.38** | **0.26** | **0.26** | **0.27** | **0.32** | **0.25** |
| Independence | **-0.30** | **0.41** | **0.24** | 0.18 | **0.26** | **0.29** | **0.26** |
| Car Ownership | 0.08 | 0.08 | -0.06 | **0.25** | **0.27** | 0.10 | 0.02 |
| Regular Car User | 0.00 | 0.11 | 0.11 | **0.29** | **0.24** | 0.09 | 0.09 |
| Driving License | 0.14 | 0.00 | -0.05 | 0.10 | 0.11 | 0.11 | 0.06 |
| Family Income | -0.16 | -0.21 | 0.04 | 0.13 | 0.06 | 0.12 | -0.02 |
| Income | -0.11 | 0.14 | 0.08 | **0.29*** | 0.12 | **0.18** | 0.10 |
| Gender (male) | 0.05 | 0.03 | 0.02 | **0.23** | 0.06 | 0.11 | 0.05 |
| Intention to use PT more for everyday trips | 0.19 | 0.03 | 0.10 | **-0.27** | 0.03 | **-0.21** | -0.07 |
| "Have you given it serious thought whether you can use car less?" | 0.13 | 0.07 | 0.04 | **-0.37** | -0.15 | 0.03 | -0.06 |
| Likelihood to buy a car in the future | -0.20 | **0.25** | **0.47** | **0.42** | 0.14 | **0.23** | **0.18** |

Bold p value <0.05; Bold + * p value <0.01

*EOTBC* has positive significant correlation with likelihood to buy a car in the future for all countries except for Utrecht and Indonesia. *EOTBC* further significantly correlates with symbolic affective attitudes in all countries except for Utrecht. This correlation appears reasonable as one might interpret that: The more students perceive a car as a "status symbol," the more they also think others expect them to buy a car, or the higher the expectations, the more they regard the car as a status symbol. *EOTBC* also has significant positive correlation with *independence* in all countries except for Taiwan and Utrecht. For Taiwan, the correlation is not significant but for Utrecht, it is negatively significant. This

finding is difficult to interpret. One explanation might be the generally negative attitudes combined with a strong aim for individualism in the Netherlands; in other words, those who admit that the car brings *independence* will not agree to saying that they have bought the car due to expectations of any kind.

For other explanatory variables such as car ownership and regular car use, they only positively correlate with *EOTBC* in Taiwan and Indonesia. Surprisingly Driving License and Family Income are not significantly correlated with expectations in any of the seven countries and individual Income only positively correlates in Taiwan with expectations. It would have been expected that higher expectations to own a car be also partly reflected in driving license ownership and that those with higher income perceive higher expectations to own a car. Gender is also significant only in Taiwan suggesting that Taiwanese males perceive higher expectations to buy a car.

The last two rows report correlation to two questions that are aimed to reflect general attitudes to PT and how conscious students are about the mode choice options. A negative correlation between *EOTBC* and intentions to use public transport in Taiwan and China is found. This might suggest that car ownership expectations include also reverse expectations on public transport in these countries, whereas in the other five countries, perceived pressure to buy a car and public transport perceptions are mostly decoupled. Similarly, perceptions of whether one could use the car less do not seem to be strongly correlated with *EOTBC*, except in Taiwan. This finding might be in line with the high correlation of *EOTBC* with symbolic affective. That is, the pressure to buy a car is not only perceived due to actual car usage, but also perceived due to the symbolic meaning of the car.

## 5.7. Conclusions

This chapter explains about descriptive analysis of the determinant factors in influencing car ownership intentions in the future. Survey results of undergraduate students in the seven different countries are reported, asking a wide range of questions, including attitudes and norms, as well as future car purchase intentions. In terms of intention to buy cars, there is a significant difference between students of the developing and the developed countries i.e. students in the developed countries having less desire to purchase cars.

Correlation analysis for each of the seven countries is conducted concerning current transportation pattern, socio-demographic aspects, attitudes, and norms. From the result of correlation analysis for current transportation pattern, it is found that regular car use is significantly correlate with car intention in five countries suggesting that this variable might also be important determinants of car intention. Another variable that stands out is

shopping with peers, which is significantly correlate with car intention in five countries. Contrary to previous studies, and Chapter 4 result, commuting distance appears significant only in Berkeley and China case (at 10% level). Regarding socio-demographic aspects, although personal income is highly significant in only three countries, for the subsequent analysis this variable is still included since in most literature and the result of Chapter 4 suggesting the inclusion of this variable. While income levels partially explain purchase intension, several other factors also had positive correlations, such as Symbolic Affective and Independence car attitudes. On the other hand, attitudes/perceptions towards public transit are not very correlated with car intention.

Also noteworthy is that Taiwanese students appear in some points different from the other samples probably due to the tradition of motorcycle usage. In the same way that cycling is an established mode in the Netherlands, this shows that the prevailing "mobility culture" is an important factor when considering global trends. From the Taiwanese sample, the importance of family bonds when predicting car mileage developments in other Asian countries might also be learnt. Low car ownership does not necessarily translate into low mileage in these countries due to family car sharing.

For most samples, there is a strong role of *EOTBC* for the intention to buy a car in the future. Systematic differences between developing and developed countries are not found though, suggesting that the effect of others on purchase decisions needs to be studied carefully across countries. From the descriptive analysis, it is found that Dutch students appear to have a strong desire to be perceived as not-following expectations, whereas in other six countries, especially Lebanon the situation is reversed. To understand more about how significant the determinant factors describe here, influence car ownership intention, in Chapter 6 several ordinal hybrid choice models (OHCM) will be discussed.

# Chapter 6

# Ordered Hybrid Choice Models with Expectation and Subjective Social Norms as Explanatory Factors

## 6.1. Introduction

This chapter discusses explanatory variables of car ownership intention, mainly *expectation of others to buy cars (EOTBC)* and *subjective social norms*. At first, *EOTBC* is modelled as an explanatory variable in an ordered hybrid choice model (OHCM). Then further advanced models that interact *EOTBC* with *strength of influence to buy cars (SOI)* are developed; the interaction factor is named *subjective social norms (SSN)*. There are several alternatives of model specification that will be further discussed in this chapter.

## 6.2. Role of EOTBC in Determining Car Ownership Intention

### 6.2.1. Explanatory Variables

In Chapter 5, it is shown that income, attitudinal factors toward cars such as *Symbolic Affective* and *Independence*, and *EOTBC* have positive correlation with car purchase intentions (Table 5-15 and Table 5-16). In this chapter, this analysis is continued by developing an advanced choice model that aims for controlling for the heterogeneity within samples. Note that only factors which have significant correlation with likelihood to buy a car in at least four countries, plus income (specified as a continuous variable as shown in Table 6-1), are incorporated in the model. Income is significant in only three countries; however, since previous literature (see Table 2-1) and also the car ownership model in Chapter 4 find that income is a determinant of car ownership, it is hypothesized that income is also a determinant of car ownership intention. There are some missing observations in the income variable thus income dummy is introduced in the model (equal to 1 if income is missing and 0 otherwise).

In Chapter 5, two attitudinal constructs and *EOTBC* are estimated using PCA. In this chapter, in order to explicitly model unobserved heterogeneity and estimate the model efficiently, an OHCM which combines latent variable modelling with discrete choice models is constructed (Ben-Akiva, et al., 2002; Walker & Ben-Akiva, 2002). Walker et al.

(2010) have demonstrated that compared to a traditional mode choice model, hybrid choice model fits the data better within a developing countries context. Here the latent variables are not estimated a-priori but the estimation of the latent variable model is done simultaneously with the model predicting the intention to buy a car. The explanatory variables and their coding as well as their measurement are shown in Table 6-1.

Table 6-1 Measurement of Observed Variables, Latent Variables and Indicators

| Variables | | Indicators | | Measurement |
|---|---|---|---|---|
| Latent Variables | | | | |
| $\mathbf{Z}_{ex}$ | EOTBC (Cronbachs' alpha = 0.92) | $I_1$ | Parents | 1 = They strongly expect me not to buy a car; 2 = They expect me not to buy a car; 3 = They have a little bit expectation of me not to buy a car; 4 = They have no expectation; 5 = They have a little bit expectation of me to buy a car; 6 = They expect me to buy a car; 7 = They strongly expect me to buy a car |
| | | $I_2$ | Partner | |
| | | $I_3$ | Family members and relatives | |
| | | $I_4$ | Close friends | |
| | | $I_5$ | Peers at university | |
| | | $I_6$ | People in neighbourhood | |
| | | $I_7$ | People in province/state | |
| $\mathbf{Z}_{sy}$ | Symbolic Affective (Cronbachs' alpha = 0.83) | $I_8$ | Cars are cool | 1 = strongly disagree; 2 = disagree; 3 = somewhat disagree; 4 = neutral; 5 = somewhat agree; 6 = agree; 7 = strongly disagree |
| | | $I_9$ | Cars allow to express oneself | |
| | | $I_{10}$ | Cars are trendy | |
| | | $I_{11}$ | Cars bring prestige | |
| | | $I_{12}$ | Cars allow to distinguish oneself from others | |
| | | $I_{13}$ | Cars are fun to have | |
| $\mathbf{Z}_{in}$ | Independence (Cronbachs' alpha = 0.67) | $I_{14}$ | Cars are convenient | |
| | | $I_{15}$ | Cars allow one to travel anytime | |
| | | $I_{16}$ | Cars allow one to be independent | |
| | | $I_{17}$ | Cars allow one to travel anywhere | |
| Observed Variables | | | | |
| $\mathbf{X}_{rc}$ | Regular Car Use | | | 1: use car at least twice a week; 0: otherwise |
| $\mathbf{X}_{ic}$ | Income | Monthly income is specified as a continuous variable. Each category of each country is transformed into US$ by using the purchasing power parity (ppp) conversion factor published by the World Bank (28). Then the middle point of each category is taken as explanatory variable. The right column shows the categories given to students and the midpoint conversion for Berkeley. | | 1 = US$ 0-500 ➔ US$ 250; 2 = US$ 500 – 1,000 ➔ US$ 750; 3 = US$ 1,000 – 1,500 ➔ US$ 1,250; 4 = US$ 1,500 – 2,000 ➔ US$ 1,750; 5 = US$ 2,000 – 2,500 ➔ US$ 2,250; 6 = US$ 2,500 – 3,000 ➔ US$ 2,750; 7 = More than US$ 3,000 ➔ US$ 3,500 |
| $\mathbf{X}_{id}$ | Income Dummy | | | 1: no answer; 0: otherwise |

There are three latent variables: *EOTBC*, symbolic affective, *independence* and their indicator variables as well as 3 other observed variables: regular car use, income, and income dummy. For measurement of latent variable indicators a seven-point Likert scale is used, for regular car use and income dummy binary outcomes are used. Income is transformed from ordinal categories into continuous measurement based on the midpoint of the income range associated with each of the seven levels (see Table 6-1).

### 6.2.2. Model Formulation

The model framework can be seen in Figure 6-1. In the figure, latent variables are represented as ellipses and observed variables are represented as rectangles; solid arrows represent structural relationships while dashed arrows represent measurement relationships.

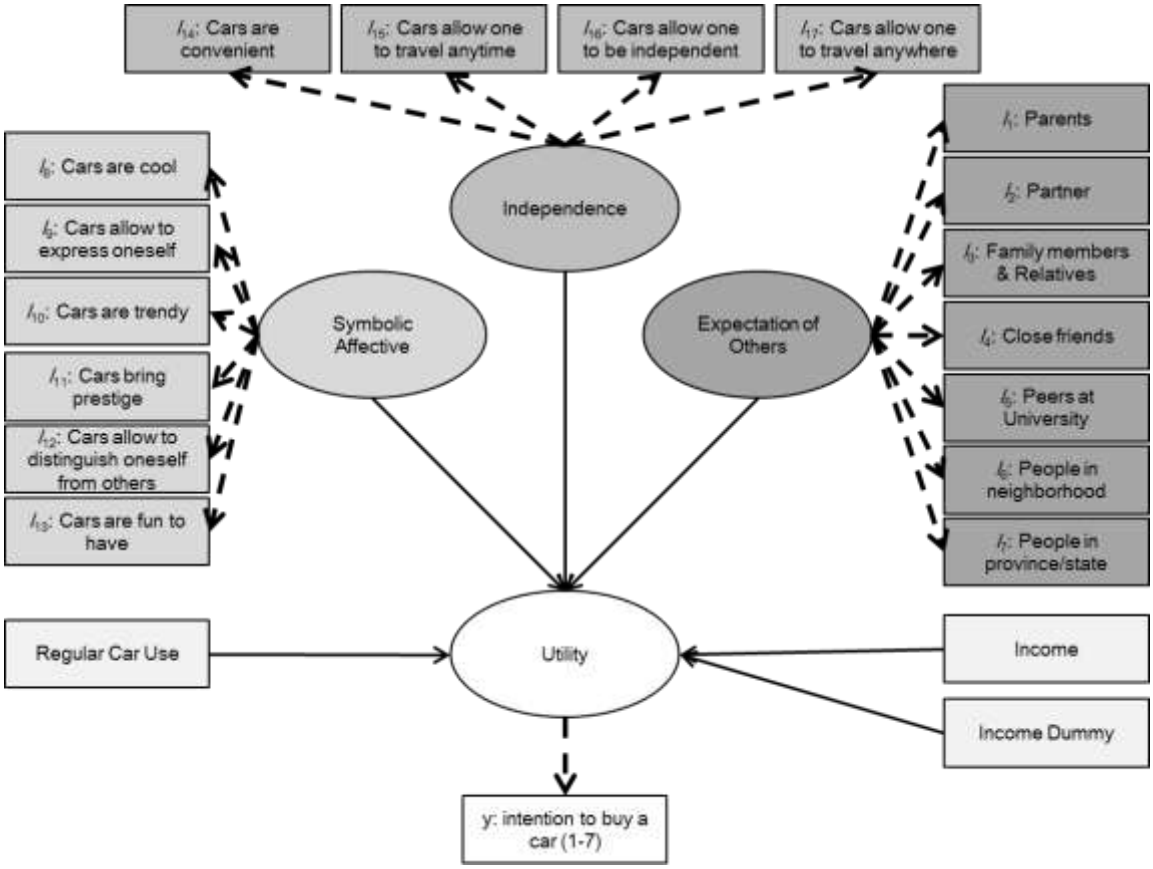


Figure 6-1 Model framework

Mean values of likelihood to buy a car in Table 5-11 suggest that there are some differences in car ownership intentions between the four developing countries, and the three developed countries, that one might claim to be in "peak car." To account for also

possibly different levels of unexplained variance in car ownership intentions between the two groups of countries, a scale parameter is introduced in the utility function:

$$\boldsymbol{V} = \left(\mu_d\ \boldsymbol{\delta}_d + \mu_{nd}\ (1 - \boldsymbol{\delta}_d)\right)\left(\beta_{ex}\boldsymbol{z}_{ex}\ + \beta_{sy}\boldsymbol{z}_{sy}\ +\ \beta_{in}\boldsymbol{z}_{in}\ +\ \beta_{rc}\boldsymbol{x}_{rc}\ +\ \beta_{ic}\boldsymbol{x}_{ic}\ +\ \beta_{id}\boldsymbol{x}_{id}\right) \tag{6-1}$$

where $\boldsymbol{\delta}_{\mathrm{d}}$ is a vector over all N observations that take the value 1 if observation n is from a developed country (i.e. Utrecht, Japan or Berkeley) and 0 otherwise. It is presumed that all latent variables are normally distributed across the population, i.e. $\mathbf{z}_{\mathrm{ex}} \sim \mathrm{N}(0, \boldsymbol{\sigma}^2_{\mathrm{ex}})$, $\mathbf{z}_{\mathrm{sy}} \sim \mathrm{N}(0, \boldsymbol{\sigma}^2_{\mathrm{sy}})$, $\mathbf{z}_{\mathrm{in}} \sim \mathrm{N}(0, \boldsymbol{\sigma}^2_{\mathrm{in}})$. The scale parameters are $\mu_{\mathrm{d}}$ for samples from developed countries, which is fixed at one, and $\mu_{\mathrm{nd}}$ for samples from developing countries, which is estimated. Further, it is assumed that the error terms of the latent response (or utility as in Figure 6-1) underlying dependent variable car ownership intention are independently and identically distributed with: $\varepsilon \sim \mathrm{Logistic}\left(0, {}^{\pi^2}/_{3}\right)$ so that following utility function is obtained:

$$\boldsymbol{U} = \boldsymbol{V} + \boldsymbol{\varepsilon} \tag{6-2}$$

The measurement model for likelihood to buy a car is given by:

$$\boldsymbol{y} = \left\{ \begin{array}{c} 1\ (very\ unlikely)\ if\ -\infty \leq \boldsymbol{U}\ \leq\ \tau_1 \\ 2\ (unlikely)\ if\ \tau_1 \leq\ \boldsymbol{U}\ \leq\ \tau_2 \\ 3\ (somewhat\ unlikely)\ \ if\ \tau_2 \leq\ \boldsymbol{U}\ \leq\ \tau_3 \\ 4\ (undecided)\ if\ \tau_3 \leq\ \boldsymbol{U}\ \leq\ \tau_4 \\ 5\ (somewhat\ likely)\ \ if\ \tau_4 \leq\ \boldsymbol{U}\ \leq\ \tau_5 \\ 6\ (likely)\ \ if\ \tau_5 \leq\ \boldsymbol{U}\ \leq\ \tau_6 \\ 7\ (very\ likely)\ \ if\ \tau_6 \leq\ \boldsymbol{U}\ \leq\ \infty \end{array} \right\} \tag{6-3}$$

The psychometric indicators for latent variable $\mathbf{z}_{\mathrm{ex}}$ (EOTBC), $\mathbf{z}_{\mathrm{sy}}$ (Symbolic Affective) and $\mathbf{z}_{\mathrm{in}}$ (Independence) are modelled as follows:

$$\boldsymbol{I}_r = \lambda_r \boldsymbol{z}_{ex} + \boldsymbol{\upsilon}_r \ \text{ with r = 1, …, 7} \tag{6-4}$$

$$\boldsymbol{I}_r = \lambda_r \boldsymbol{z}_{sy} + \boldsymbol{\upsilon}_r \ \text{ with r = 8, …, 13} \tag{6-5}$$

$$\boldsymbol{I}_r = \lambda_r \boldsymbol{z}_{in} + \boldsymbol{\upsilon}_r \ \text{ with r = 14, …, 17} \tag{6-6}$$

where: $\upsilon_{\mathrm{r}} \sim \mathrm{N}(0, \sigma^2_{\upsilon_{\mathrm{r}}})$, r = 1, …,17. The identification of latent variables is ensured by fixing $\lambda_1 = 1$ (for latent variable EOTBC); $\lambda_8 = 1$ (for latent variable Symbolic Affective); and $\lambda_{15} = 1$ (for latent variable Independence).

The probability of choice and psychometric indicators is given by:

$$P(\boldsymbol{y},\boldsymbol{I}) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} P\left(y|\boldsymbol{X},\boldsymbol{z}_{ex},\boldsymbol{z}_{sy},\boldsymbol{z}_{in}\right) g_1(\boldsymbol{I}_1|\boldsymbol{z}_{ex}) \dots g_7(\boldsymbol{I}_7|\boldsymbol{z}_{ex}) g_8\left(\boldsymbol{I}_8|\boldsymbol{z}_{sy}\right) \dots g_{13}\left(\boldsymbol{I}_{13}|\boldsymbol{z}_{sy}\right) \tag{6-7}$$
$$g_{14}(\boldsymbol{I}_{14}|\boldsymbol{z}_{in}) \dots g_{17}(\boldsymbol{I}_{17}|\boldsymbol{z}_{in}) f_{ex}(\boldsymbol{z}_{ex}) f_{sy}\left(\boldsymbol{z}_{sy}\right) f_{in}(\boldsymbol{z}_{in}) d\boldsymbol{z}_{ex} d\boldsymbol{z}_{sy} d\boldsymbol{z}_{in}$$

where $\mathrm{P}\left(\mathbf{y}|\mathbf{X},\mathbf{z}_{\mathrm{ex}},\mathbf{z}_{\mathrm{sy}},\mathbf{z}_{\mathrm{in}}\right)$is an ordinal logit model. That is, the probability that $y$ takes level $m$ is given as follows:

$$P(y = m) = F(\tau_m - V) - F(\tau_{m-1} - V) \tag{6-8}$$

where $F$ is the cumulative distribution function of the logistic distribution, $\boldsymbol{g}$ are the probability density functions for the indicators $\boldsymbol{I}$ and $\boldsymbol{f}$ the probability density functions of the latent constructs. The above model is estimated using simulated maximum likelihood estimation with 10,000 Halton draws in Python Biogeme (Bierlaire & Fetiarison, 2009).

### 6.2.3. Car Purchase Intention Model

In Table 6-2 three models are reported, the first with all observations while the other two only use samples from developed countries and developing countries, respectively. Table 6-2 shows the estimation results of three models corresponding to the above formulation.

The latent variable *EOTBC* appears to significantly influence the likelihood to buy a car in the future in all three models. For all observations the magnitude of the coefficient of *EOTBC* is higher than the other latent variables, symbolic affective and *independence* suggesting that *EOTBC* is more influencing the likelihood to buy cars compared to attitudes. Those currently driving are also likely to continue driving and to purchase cars. Further income is found to be positively significant, suggesting that the current income (which might be just a small budget obtained from parents) does not only influence the car ownership status but also the future intentions to purchase cars even though undergraduate students might be able to earn very different incomes in the future. Possibly, similar to regular car usage, this also indicates the role of habits gained early (Fujii & Gärling, 2003).

For the case of developed countries, the magnitude of the coefficient of *EOTBC* remains constant but Independence and Regular car use become even more important. Symbolic affective and income become insignificant. For the case of developing countries, the magnitude of the coefficient of *EOTBC* also remains constant. It is also noted that $\mu_{nd}$ is not significantly different from 1 (t-stat <1.96) indicating that there is no significant difference between developed and developing countries in terms of the unobserved variances.

Table 6-2 Car Purchase Intention Models (Model 1, Model 2, and Model 3)

| Variable | | All Observations | | Developed Countries | | Developing Countries | | t-test for |
|---|---|---|---|---|---|---|---|---|
| | | Estimate | Robust t-stat | Estimate | Robust t-stat | Estimate | Robust t-stat | coefficient difference |
| **Latent Variables** | | | | | | | | |
| EOTBC | | **0.41** | **4.90** | **0.40** | **4.50** | **0.38** | **4.26** | 0.14 |
| Symbolic Affective | | **0.22** | **2.73** | *0.21* | *1.63* | 0.14 | 1.54 | 0.48 |
| Independence | | **0.23** | **2.91** | **0.62** | **2.47** | **0.24** | **3.07** | 1.14 |
| **Latent Variables Standard Deviations** | | | | | | | | |
| σ EOTBC | | **1.22** | **20.68** | **1.31** | **16.57** | **1.10** | **17.95** | 1.25 |
| σ SymbolicAffective | | **0.92** | **18.22** | **0.95** | **13.36** | **0.92** | **14.70** | 0.25 |
| σ Independence | | **1.08** | **18.13** | **0.80** | **8.03** | **1.20** | **18.41** | **-2.05** |
| **Observed Variables** | | | | | | | | |
| Regular Car Use | | **0.61** | **4.90** | **0.79** | **4.35** | **0.31** | **2.10** | *1.85* |
| Income (US$) | | **0.31** | **2.92** | 0.15 | 0.72 | **0.46** | **3.01** | -1.02 |
| Income Dummy | | 0.27 | 1.63 | 0.22 | 0.65 | *0.34* | *1.62* | -0.23 |
| **Scale Parameter** | | | | | | | | |
| μnd | | 1.00 | 0.15 | | | | | |
| **Threshold** | | | | | | | | |
| $\tau_1$ | | **-3.10** | **-17.35** | **-2.79** | **-10.36** | **-3.55** | **-13.88** | 1.37 |
| $\tau_2$ | | **-2.08** | **8.11** | **-1.63** | **6.58** | **-2.63** | **4.82** | 0.82 |
| $\tau_3$ | | **-1.37** | **9.58** | **-0.95** | **6.67** | **-1.80** | **6.80** | -0.78 |
| $\tau_4$ | | **-0.54** | **13.25** | **-0.32** | **7.59** | **-0.77** | **10.68** | **-2.21** |
| $\tau_5$ | | **0.51** | **17.69** | **0.92** | **11.31** | **0.21** | **13.42** | 1.37 |
| $\tau_6$ | | **1.82** | **19.43** | **2.17** | **10.26** | **1.58** | **16.45** | -0.49 |
| **Measurement Equations for Latent Variables** | | | | | | | | |
| **EOTBC** | | | | | | | | |
| Parents | $\lambda_1$ | 1 (fixed) | | 1 (fixed) | | 1 (fixed) | | |
| | $\sigma_1$ | **1.04** | **26.83** | **1.15** | **17.79** | **0.95** | **21.72** | 1.42 |
| Partner | $\lambda_2$ | **0.90** | **22.87** | **0.80** | **11.81** | **0.95** | **28.07** | -1.04 |
| | $\sigma_2$ | **0.99** | **24.92** | **1.10** | **15.76** | **0.86** | **26.49** | *1.79* |
| Family members and relatives | $\lambda_3$ | **1.02** | **37.00** | **1.00** | **24.43** | **1.04** | **34.81** | -0.27 |
| | $\sigma_3$ | **0.77** | **24.29** | **0.84** | **15.57** | **0.72** | **19.17** | 1.09 |
| Close friends | $\lambda_4$ | **1.09** | **25.03** | **1.08** | **15.20** | **1.09** | **25.40** | -0.04 |
| | $\sigma_4$ | **0.63** | **14.99** | **0.63** | **6.54** | **0.63** | **21.65** | 0.06 |
| Peers at university | $\lambda_5$ | **1.02** | **21.48** | **1.03** | **14.42** | **1.01** | **19.07** | 0.16 |

| Variable | | All Observations | | Developed Countries | | Developing Countries | | t-test for |
|---|---|---|---|---|---|---|---|---|
| | | Estimate | Robust t-stat | Estimate | Robust t-stat | Estimate | Robust t-stat | coefficient difference |
| | $\sigma_5$ | **0.61** | **20.02** | **0.56** | **9.80** | **0.64** | **19.35** | -0.70 |
| People in | $\lambda_6$ | **0.80** | **17.25** | **0.78** | **10.98** | **0.85** | **15.42** | -0.46 |
| Neighbourhood | $\sigma_6$ | **0.78** | **23.12** | **0.88** | **14.09** | **0.70** | **17.94** | 1.53 |
| People in | $\lambda_7$ | **0.76** | **15.83** | **0.74** | **10.41** | **0.81** | **13.28** | -0.42 |
| province/state | $\sigma_7$ | **0.89** | **25.37** | **0.92** | **14.59** | **0.83** | **18.73** | 0.70 |
| **Symbolic Affective** | | | | | | | | |
| Cars are cool | $\lambda_8$ | 1 (fixed) | | 1 (fixed) | | 1 (fixed) | | |
| | $\sigma_8$ | **1.05** | **34.76** | **1.06** | **23.01** | **1.02** | **24.29** | 0.33 |
| Cars allow to express oneself | $\lambda_9$ | **1.00** | **15.17** | **1.01** | **9.18** | **0.92** | **11.72** | 0.47 |
| | $\sigma_9$ | **1.12** | **36.03** | **1.13** | **20.45** | **1.13** | **29.37** | 0.03 |
| Cars are trendy | $\lambda_{10}$ | **0.99** | **19.47** | **0.97** | **10.66** | **0.94** | **17.67** | 0.20 |
| | $\sigma_{10}$ | **1.09** | **35.95** | **1.08** | **20.92** | **0.95** | **28.66** | 1.00 |
| Cars bring prestige | $\lambda_{11}$ | **1.25** | **16.71** | **1.11** | **12.34** | **1.28** | **12.20** | -1.01 |
| | $\sigma_{11}$ | **1.08** | **30.97** | **1.07** | **21.06** | **1.08** | **22.86** | -0.04 |
| Cars allow to distinguish | $\lambda_{12}$ | **1.27** | **16.13** | **1.15** | **10.26** | **1.28** | **12.11** | -0.56 |
| oneself from others | $\sigma_{12}$ | **0.95** | **26.27** | **1.00** | **17.10** | **0.94** | **20.17** | 0.48 |
| Cars are fun to have | $\lambda_{13}$ | **0.91** | **18.03** | **1.04** | **12.88** | **0.82** | **13.08** | 1.48 |
| | $\sigma_{13}$ | **1.13** | **38.60** | **1.10** | **21.91** | **1.13** | **30.68** | -0.17 |
| **Independence** | | | | | | | | |
| Cars are convenient | $\lambda_{14}$ | **0.70** | **16.58** | **0.75** | **6.76** | **0.68** | **15.39** | 0.44 |
| | $\sigma_{14}$ | **0.77** | **27.09** | **0.60** | **12.31** | **0.83** | **22.81** | *-1.94* |
| Cars allow one to travel | $\lambda_{15}$ | 1 (fixed) | | 1 (fixed) | | 1 (fixed) | | |
| anytime | $\sigma_{15}$ | **0.70** | **13.31** | **0.69** | **7.68** | **0.74** | **11.91** | -0.29 |
| Cars allow one to be | $\lambda_{16}$ | **0.50** | **9.08** | **0.74** | **5.67** | **0.47** | **8.00** | 1.45 |
| independent | $\sigma_{16}$ | **1.33** | **36.31** | **1.45** | **21.71** | **1.23** | **31.49** | 1.33 |
| Cars allow one to travel | $\lambda_{17}$ | **0.66** | **13.38** | **0.72** | **7.29** | **0.63** | **11.54** | 0.58 |
| anywhere | $\sigma_{17}$ | **1.17** | **34.02** | **1.02** | **19.54** | **1.23** | **29.02** | -1.29 |
| **Model statistics** | | | | | | | | |
| Sample size | | 1229 | | 452 | | 777 | | |
| Final log-likelihood | | -32593.598 | | -12228.083 | | -19996.591 | | |
| Estimated parameters | | 47 | | 46 | | 46 | | |
| Final gradient norm | | 5.85E-05 | | 1.33E-03 | | 8.36E-04 | | |

Italic p value <0.1; Bold p value<0.05

To further test whether there is a difference in the models for developed and developing countries, the likelihood ratio test in Eq.(6-9) (Ben-Akiva & Lerman, 1985) is used.

$$-2\left[\mathcal{L}_N(\hat{\beta}) - \sum_{g=1}^{G} \mathcal{L}_{N_g}(\hat{\beta}^g)\right] \tag{6-9}$$

The model estimated on all observations is the restricted model, while the unrestricted model consists of the two models for developed and developing countries. The test statistic (737.85) is higher than the chi-square value (61.67) suggesting there is a statistically significant difference between developed and developing countries. The result of the likelihood ratio test suggests further exploration of the importance of and the reason for the difference, which is done by exploring the t-statistic for the difference between the coefficients in developed and developing countries for each variable using Eq.(6-10). The result are shown in the last column of Table 6-2.

$$\frac{\hat{\beta}_k^1 - (\hat{\mu}_{nd}\hat{\beta}_k^2)}{((N^1(N^1-1)var(\hat{\beta}_k^1) + N^2(N^2-1)var(\hat{\mu}_{nd}\hat{\beta}_k^2))/(N^1+N^2-2))^{1/2}\left((N^1+N^2)/(N^2N^1)\right)^{1/2}} \tag{6-10}$$

Where $N^1$ is the number of observation for the first model, in this case the developed countries, while $N^2$ is the number of observation for the other model, in this case the developing countries. Eq.(6-10) assumes equal variance of the samples and was formulated following Fujiwara (1993, p. 67) and modified considering product of scale variable and beta (for developing countries). The variance of $(\hat{\mu}_{nd}\hat{\beta}_k^2)$ is obtained using Eq.(6-11) taken from Daly et al. (2011) below.

$$(\hat{\beta}_k^2)^2 var(\hat{\mu}_{nd}) + (\hat{\mu}_{nd})^2 var(\hat{\beta}_k^2) + 2\hat{\mu}_{nd}\hat{\beta}_k^2 Cov(\mu_{nd}\hat{\beta}_k^2) \tag{6-11}$$

where $var(\mu_{nd})$ and $Cov(\mu_{nd}\hat{\beta}_k^2)$ are obtained from Python Biogeme model output.

It can be seen that there is no significant difference between explanatory variables that influence car purchase intention in the developed $(\hat{\beta}_k^1)$ and developing countries $(\hat{\mu}_{nd}\hat{\beta}_k^2)$(t-stat <1.96), although there is a significant difference between parameters of regular car use (10%), and σ Independence.

In constructing *EOTBC*, for the model with all observations, the λ values for close friends, family members and peers are all close to one, whereas for the wider population (people in neighbourhood and in state) lower values are observed. This suggests that even though the perceived expectation of parents might be rated highest by the respondents, this does not necessarily translate into stronger car purchase intentions than the influence of peers or close friends. In addition, for the models estimated separately for developing

and developed countries, similar λ values are observed and it is found that not all of the λ parameters are statistically significantly different except for partners. The standard deviations of the measurement errors of the indicators (σ parameters) are also estimated. For the indicators of the *EOTBC* variable, it is found that the largest variance is that of the rating of the expectation of parents and the lowest for the rating of the expectation of close friends and peers which indicates that the expectation of peers is perceived more uniformly. In addition, here, statistically significant differences between the developing and developed country σ parameters for three variables: parents, partner, and people in neighbourhood are found.

In summary, the $\beta$ estimates for latent and observed variable parameters are found to be similar in developing and developed countries. However, the models themselves are statistically significantly different. It is found that the variances of the latent constructs as well as variances in some measurement equations show different magnitudes.

### 6.2.4. Country Specific EOTBC Parameters

In order to test whether the previous models overlook differences in *EOTBC* among the seven countries, in the subsequent model (OHCM model 4) a model with country specific $\beta_{ex}$ is constructed as in the following:

$$\boldsymbol{V} = \left(\mu_d\ \boldsymbol{\delta}_d + \mu_{nd}\ (1 - \boldsymbol{\delta}_d)\right)\left(\beta_{sy}\boldsymbol{z}_{sy} + \beta_{in}\boldsymbol{z}_{in} + \left(\boldsymbol{\delta}_c\beta_{c,ex}\boldsymbol{z}_{ex}\right) + \beta_{rc}\boldsymbol{x}_{rc} + \beta_{ic}\boldsymbol{x}_{ic} + \beta_{id}\boldsymbol{x}_{id}\right) \quad (6\text{-}12)$$

where $\boldsymbol{\delta}_c$ is a dummy variable equal to 1 if the observation is from country $c$ and 0 otherwise, and $\boldsymbol{\beta}_{ex}$ is now a vector of estimated parameters for each country $c$. Otherwise, the specification of this model is identical to the previous three models except that this model is estimated using simulated maximum likelihood estimation with now 15,000 instead of 10,000 draws to increase the confidence in the model and to account for the increased number of parameters. It is observed that the $\beta$ estimates for none of the three observed variables, nor for Independence and Symbolic Affective attitudes are statistically significantly different from the first model (Table 6-2, all countries). The same holds true for threshold estimates and measurement indicators. Therefore, for brevity, only the country specific *EOTBC* parameters are reported in Table 6-3.

It is observed that the estimate of the coefficient of *EOTBC* varies substantially among the seven countries. *EOTBC* is not significant in Utrecht, Indonesia and China while it is for the other four countries. Specifically for Berkeley, a much higher parameter is found. The non-significance in Utrecht is maybe not very surprising given the findings that in general expectations are rated lower.

To understand the findings in Table 6-3 more, some additional exploratory analysis is further made by running the above models also for two sites (Utrecht and Berkeley) separately, even though the sample size for individual countries is low and therefore there are some model stability issues. It is found that in that case the *EOTBC* parameter for Utrecht even becomes negative, highlighting the previous observation that among Dutch students there is a strong desire not to "conform to the mass". The Berkeley only model confirms a high *EOTBC* parameter and gives a much higher *independence* rating. An explanation might be the correlation between the two constructs.

Table 6-3 Car Purchase Intention Model with 7 Countries, EOTBC Parameters only (Model 4)

| Name | Parameter Estimate | Robust t-test |
|---|---|---|
| EOTBC_Utrecht | 0.16 | 1.41 |
| EOTBC_Japan | **0.43** | **2.29** |
| EOTBC_Berkeley | **0.82** | **6.91** |
| EOTBC_Taiwan | **0.33** | **2.79** |
| EOTBC_Indonesia | 0.08 | 0.66 |
| EOTBC_China | 0.17 | 1.39 |
| EOTBC_Beirut | *0.24* | *1.91* |
| **Model statistics** | | |
| Sample size | 1229 | |
| Final log-likelihood | -32564.95 | |
| Number of estimated parameters | 53 | |
| Final gradient norm | 7.43E-04 | |

Italic p value <0.1; Bold p value<0.05

### 6.2.5. Discussion

*EOTBC* is found to be an important explanatory variable for car ownership intentions. The models suggest that there is a direct effect though one might argue that the effect of expectations is mediated through other causalities not included in the OHCM. For example, it is found that *EOTBC* correlates with attitudes towards car (Table 5-18). In line with Bamberg et al. (2007) one might argue that *EOTBC* influences one's attitudes towards car. Though this argument appears plausible, note that one might also argue the opposite, i.e. general public attitudes towards the car will influence personal attitudes towards the car and hence perceived expectations. This causality including modelling of paths or interactions between the latent constructs is left as an important further work.

There are no findings from the models that *EOTBC* is more important in developing or developed countries. There appears to be more variance in developed countries, in line with above observations on the strong differences in attitudes and perceived expectations between students in Utrecht and Berkeley. Students in Utrecht appear to be different from students in other developed countries in the model. It is interesting that compared to Japan and Berkeley, they seem to perceive that their society in the Netherlands expects them not to buy a car suggesting that the norms in the Netherlands are more anti car compared to norms in Japan or the US where students think that society has expectations of them to buy a car.

It has been shown that socio-demographic factors do not correlate well with *EOTBC*; there is no significant difference between the effects of income level on students' perceptions of *EOTBC*, and there is no significant difference between males and females in terms of *EOTBC*. It is suggested therefore that one important further research direction is to find better ways to explain how perceived expectations are built up. It is found that in general students rate the perceived expectations of parents highest, closely followed by perceived expectations from peers. The OHCM suggests further that the influence of peers on *EOTBC* construct is the highest among all groups.

## 6.3. Role of Subjective Social Norms (SSN) in Determining Car Ownership Intention

### 6.3.1. SSN Variable and Factor Construct

To explain more how perceived expectations are built up, the trial to interact variables of *EOTBC* with *strength of influence of others to buy a car (SOI)* is performed. In OHCM Model 1-4, the importance of other groups were ignored. There is a possibility that one group has strong expectations, however if that group is not important to the person, then the expectation of that group would not be important to the purchase intention. For example if the parents group has higher expectation to buy a car than close friends but the strength of influence of close friends is the highest then there is a possibility that close friends variables has higher influence on intention to buy a car. Therefore the new variables are constructed as *EOTBC* ($I_{1..7}$) times *SOI* ($I_{17...24}$), as shown in Eq. (6-13).

$$I_{k+24} = I_k \cdot I_{k+17} \text{ for k =1,....,7} \tag{6-13}$$

These new interaction variables explain the strength of influence on students to conform to the expectation of others. Since the definition of this variables is similar to what Thøgersen (2006) describes as *subjective social norms*, which is the most externalized of injunctive norms, these new variables are called *subjective social norms* ($I_{k+24}$). The

measurement as well as the coding for *EOTBC*, *SOI*, and *subjective social norms* (*SSN*) can be seen in Table 6-4.

Table 6-4 Measurement of EOTBC, SOI and SSN

| Variables | | Indicators | | Measurement |
|---|---|---|---|---|
| $\mathbf{z}_{ex}$ | EOTBC (Cronbachs' alpha = 0.92) | $I_1$ | Parents | -3 = They strongly expect me not to buy a car; -2 = They expect me not to buy a car; -1 = They have a little bit expectation of me not to buy a car; 0 = They have no expectation; 1 = They have a little bit expectation of me to buy a car; 2 = They expect me to buy a car; 3 = They strongly expect me to buy a car |
| | | $I_2$ | Partner | |
| | | $I_3$ | Family members and relatives | |
| | | $I_4$ | Close friends | |
| | | $I_5$ | Peers at university | |
| | | $I_6$ | People in neighbourhood | |
| | | $I_7$ | People in province/state | |
| $\mathbf{z}_{so}$ | SOI (Cronbachs' alpha = 0.85) | $I_{18}$ | Parents | 0 = not at all important;...; 6 = extremely important. |
| | | $I_{19}$ | Partner | |
| | | $I_{20}$ | Family members and relatives | |
| | | $I_{21}$ | Close friends | |
| | | $I_{22}$ | Peers at university | |
| | | $I_{23}$ | People in neighbourhood | |
| | | $I_{24}$ | People in province/state | |
| $\mathbf{z}_{sn}$ | SSN (Cronbachs' alpha = 0.83) | $I_{25}$ | Parents | -18 = Peers strong expectation on not buying a car is extremely important;....; 0 = Peers expectation is not at all important (and they also have no expectation to buy a car);.....; 18 = Peers strong expectation on buying a car is extremely important. |
| | | $I_{26}$ | Partner | |
| | | $I_{27}$ | Family members and relatives | |
| | | $I_{28}$ | Close friends | |
| | | $I_{29}$ | Peers at university | |
| | | $I_{30}$ | People in neighbourhood | |
| | | $I_{31}$ | People in province/state | |

As noted before *EOTBC* and *SOI* are measured on a seven point scale as shown in Table 6-4. Note that the measurement of *EOTBC,* compared to Table 6-1, is transformed from a scale from 1 to 7 into a seven-point Likert scale starting from -3 (strongly expect not to buy a car) to 3 (strongly expect to buy car) with 0 as a middle point (have no expectation). For SOI the measurement is a seven-point Likert scale starting from 0 (not at all important) to 6 (extremely important).

The reason to transform *EOTBC* from all positive values to 0 as middle point and to have negative values is to show that a negative value means an expectation <u>not</u> to buy a car. Moreover, since *SOI* variables have no negative values then the higher positive value

of interaction effect means that there is a strong tendency to conform to the expectation to buy a car, while higher negative value of interaction effect means that there is a strong tendency to conform the expectation to not buy a car in the future.

In the last row of the table, the coding and measurement of each category of *SSN* as product of *EOTBC* and *SOI* is also presented. The highest negative measurement is -18, which represent strong and important expectation on not buying a car. Conversely the highest positive measurement is 18 with the middle point is 0, which represent that either that expectations are not important or that there is no positive or negative expectation.

### 6.3.2. Descriptive Analysis of SSN factors

The mean and standard deviation of each of the seven SSN indicators can be seen in Table 6-5. All samples combined, it can be seen that parents is the most influential followed by family members, partner and close friends. Peers at university, people in the neighbourhood, and people in state/province appear to have weaker influence on intention to buy car.

Table 6-5 Descriptive Statistics (means and standard deviation) of SSN

| Variables | All (1229) | Utrecht (84) | Japan (142) | Berkeley (226) | Taiwan (139) | Indonesia (200) | China (167) | Beirut (271) |
|---|---|---|---|---|---|---|---|---|
| SSN Parents | 5.70 | -3.24 | 7.75 | 5.86 | 4.88 | 7.25 | 6.57 | 6.03 |
| | (7.56) | (5.87) | (7.24) | (7.51) | (7.17) | (6.26) | (7.03) | (7.71) |
| SSN Partner | 2.74 | -2.10 | 2.14 | 2.25 | 3.45 | 3.58 | 4.35 | 2.98 |
| | (5.85) | (5.29) | (5.20) | (5.11) | (6.38) | (5.79) | (6.11) | (5.71) |
| SSN Family Members | 3.08 | -1.55 | 5.28 | 2.70 | 2.84 | 4.17 | 3.17 | 2.92 |
| | (5.31) | (3.52) | (6.54) | (4.61) | (5.02) | (5.15) | (4.72) | (5.31) |
| SSN Close Friends | 2.55 | -1.51 | 3.92 | 2.33 | 3.09 | 2.51 | 2.29 | 3.20 |
| | (4.88) | (3.99) | (5.75) | (4.38) | (4.99) | (4.15) | (3.98) | (5.30) |
| SSN Peers at University | 1.59 | -0.50 | 3.63 | 1.29 | 1.56 | 1.67 | 1.39 | 1.51 |
| | (3.64) | (2.25) | (5.15) | (3.01) | (3.71) | (3.33) | (3.14) | (3.50) |
| SSN Neighbourhood | 0.67 | -0.08 | 1.83 | 0.71 | 0.28 | 0.74 | 0.38 | 0.61 |
| | (2.59) | (0.39) | (4.08) | (2.29) | (1.69) | (2.55) | (2.32) | (2.62) |
| SSN Province/State | 0.64 | -0.02 | 2.60 | 0.49 | 0.53 | 0.43 | 0.22 | 0.42 |
| | (2.55) | (0.22) | (4.59) | (1.70) | (2.18) | (2.49) | (1.54) | (2.32) |
| SSN factor (Cr's Alpha = 0.83) | **2.42** | **-1.29** | **3.88** | **2.23** | **2.38** | **2.90** | **2.62** | **2.52** |

ANOVA significant for all variable; bold indicates mean of combined variables in the factor; standard deviation is in parenthesis

It is interesting to see that only in the Utrecht case, all the mean values are negative which indicates that the influence of others on intention to not buy cars is high. In Japan and Indonesia, the mean value of *SSN parents* is the highest compared to other sites, In Taiwan it appears that the influence of parents to buy a car is the lowest among seven countries followed by Berkeley. In Japan, Berkeley and Indonesia, family members influence is the second most important while in Taiwan and China, partner is the second most important. In Beirut, close friends appear to be the second most important influence to buy cars in the future.

In the bottom part of Table 6-5, the means of the *SSN* factors over all seven indicators for all countries are shown. The Cronbach's alpha for *SSN* factors is very high (0.83) suggesting that this factor is reliable. It is shown that Japanese students regard influence of others highest compared to students in other sites, followed by Indonesian students. Though this variables has not entered the model yet, it is interesting to note that for developed country case, Japanese students regard the influence of others the highest, while Utrecht students regard the influence of others the lowest. In developing country case, the highest mean value for *SSN* is Indonesian while Taiwan is the lowest *SSN* value.

### 6.3.3. Correlation with Intention to Buy Car in the Future

In this sub chapter, the *SSN* for each category is correlated with intention to buy cars in the future, which can be seen in Table 6-6. *SSN parents* is significantly correlated with intention to buy cars in all sites except for Indonesia and Utrecht, the last one has negative significant correlation with intention to buy cars. In Berkeley and Beirut, all categories are significantly correlated with car intention, while in Utrecht only two categories, parents and close friends are significant. Interesting to see that in Japan and Indonesia, compared to close friends, peers at university significantly influence car intention suggesting that in both countries what other thinks in their social environment, in this case university, is important. In all sites except for Utrecht, students regard their partner as significantly influencing car ownership intention.

In the lower part of Table 6-6, it can be seen that the *SSN* latent construct significantly influences car intention in all sites, suggesting that this factor is an influential determinant of car intention. This result can be explained when discussing the results of car purchase intention model using the second *SSN* formulation. In the last row of Table 6-6, it can be seen that the interaction between latent constructs of *EOTBC* and *SOI* is only significant in the developing countries, with a noteworthy magnitude for the China sample, suggesting that the more Chinese students listen to others the less likely

they are willing to buy cars. This result can also be considered when discussing the results of the car purchase intention model using the third *SSN* formulation.

Table 6-6 Correlation between SSN and Car Purchase Intention

| Factor and Variables | Utrecht (84) | Japan (142) | Berkeley (226) | Taiwan (139) | Indonesia (200) | China (167) | Beirut (271) |
|---|---|---|---|---|---|---|---|
| SSN Parents | *-0.18* | **0.18** | **0.33*** | **0.52*** | 0.10 | **0.22*** | **0.24*** |
| SSN Partner | -0.12 | **0.27*** | **0.23*** | **0.39*** | **0.23*** | **0.22*** | **0.18*** |
| SSN Family Members | -0.18 | **0.26*** | **0.27*** | **0.39*** | 0.08 | 0.12 | **0.17*** |
| SSN Close Friends | **-0.26** | 0.09 | **0.33*** | **0.43*** | 0.12 | **0.22*** | **0.17*** |
| SSN Peers at University | -0.15 | **0.19** | **0.29*** | **0.35*** | **0.19*** | 0.07 | **0.17*** |
| SSN Neighbourhood | -0.11 | 0.11 | **0.14** | 0.10 | **0.14** | -0.12 | **0.13** |
| SSN Province/State | -0.03 | 0.12 | **0.19*** | 0.13 | 0.09 | 0.02 | *0.12* |
| SSN latent construct (PCA) | **-0.24*** | **0.24*** | **0.37*** | **0.47*** | **0.18** | **0.17** | **0.23*** |
| Interaction between EOTBC latent (PCA) and SOI latent (PCA) | -0.01 | 0.00 | -0.11 | **0.18** | *0.14* | **-0.20*** | 0.10 |

Italic p value <0.1; Bold p value<0.05; Bold + * p value <0.01

### 6.3.4. SSN Model Formulation

There are three options to formulate *SSN* in order to model the influence of it on intention to buy cars in the future using OHCM. All of the three formulation are discussed below.

#### *A) First SSN Formulation*

In this formulation each of the seven category variables is included as exogeneous variable in the model. This formulation suggests hence that the *SSN* of different persons is also perceived separately by the respondent, as shown in Figure 6-2. As can be seen in the figure, the path of each of the seven *SSN* categories (Table 6-5) directly influences to the utility factor. Then the parameter of each *SSN* is estimated using OHCM. The disadvantage of this formulation is that the correlation between the SSN indicators is not accounted for (multi-colinearity problem).

To partly resolve this problem not all of the seven categories will be used in the model. Because of multi-colinearity consideration, only several observed *SSN* variables will be used in the model. The test for an appropriate selection from the seven possible *SSN* constructs is done by using simple ordinal logistic regression incorporating three observed variables of regular car use, personal income, and income dummy plus two latent variables

of symbolic affective and *independence*. The two latent attitude variables are in this model in fact observed variables obtained from Table 5-9.

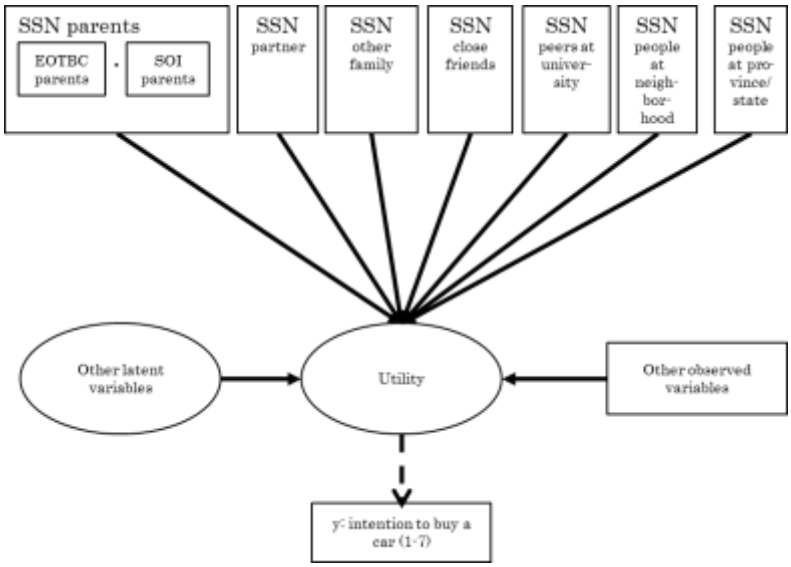


Figure 6-2 Car intention model with SSN first formulation

The result of the models can be seen in Table 6-7. Although control for other explanatory variables is done in these models, for simplicity only the results of *SSN* are shown. The test starts with *SSN Parents* since previous research such as Grønhøj and Thøgersen (2009; 2012) show that parents significantly influence intention. Close friends is then incorporated, as it is hypothesized that outside family circle, close friends might have more influence. It is found that for all samples close friends significantly influence intention (10%) but for developed and developing countries there is no significant result.

Further, in the second test, partner is incorporated into the model as it is likely that partners are important. It is found that after incorporating partner, close friends become insignificant in the three models. The most interesting finding is that parents become insignificant in developed countries when partner enters the model suggesting that students in developed countries regard partner more than parents.

Since close friends are found to be insignificant that variable is removed and only parents and partner are used for the third observation. It is found that both variables are significant. For the developed countries parents now become significant if close friends is removed from the model but it can be seen that the magnitude for partner is higher in developed countries while in developing countries it is the opposite.

The test is continued by entering peers at university in the model. The findings are peers at university is insignificant in all samples and developing countries, but it is

significant in developed countries. This might suggest that regarding intention to buy a car, there is a possibility that students in the developed countries perceive that their peers at university regard them more highly by having a car, and the magnitude is higher than partner is. Still in the developed country case, parents become insignificant if peers at university enters the model. At this point, given the result of first and fourth tests shown in Table 6-7, this dissertation argues that peers at university is more important than close friends is for car ownership intention.

Table 6-7 SSN Ordinal Logistic Regression Tests

| Variables | All samples (N = 1229) | | Developed Countries (N = 452) | | Developing Countries (N = 777) | |
|---|---|---|---|---|---|---|
| | estimate | t-stat | estimate | t-stat | estimate | t-stat |
| First test | | | | | | |
| SSN parents | **0.05** | **5.37** | **0.03** | **2.42** | **0.05** | **4.16** |
| SSN close friends | *0.02* | 1.84 | 0.03 | 1.53 | 0.03 | 1.63 |
| Second test | | | | | | |
| SSN parents | **0.03** | **3.99** | 0.02 | 1.59 | **0.04** | **3.35** |
| SSN close friends | 0.01 | 0.55 | 0.02 | 1.02 | 0.01 | 0.68 |
| SSN partner | **0.04** | **4.09** | **0.05** | **2.55** | **0.03** | **2.37** |
| Third test | | | | | | |
| SSN parents | **0.04** | **4.59** | **0.03** | **2.33** | **0.04** | **3.83** |
| SSN partner | **0.05** | **4.41** | **0.05** | **2.77** | **0.04** | **2.76** |
| Fourth test | | | | | | |
| SSN parents | **0.03** | **4.00** | 0.02 | 1.37 | **0.04** | **3.48** |
| SSN partner | **0.04** | **3.95** | **0.04** | **2.35** | **0.03** | **2.25** |
| SSN peers at university | 0.02 | 1.46 | **0.05** | **2.11** | 0.03 | 1.24 |
| Fifth test | | | | | | |
| SSN parents | **0.03** | **4.07** | 0.02 | 1.37 | **0.04** | **3.51** |
| SSN partner | **0.04** | **3.99** | **0.04** | **2.35** | **0.03** | **2.32** |
| SSN peers at university | *0.03* | *1.83* | **0.05** | **1.99** | 0.04 | 1.58 |
| SSN people at neighbourhood | -0.03 | -1.24 | -0.00 | -0.07 | -0.04 | -1.07 |
| Sixth test | | | | | | |
| SSN parents | **0.05** | **5.77** | **0.03** | 2.29 | **0.05** | 4.57 |
| SSN peers at university | **0.04** | **2.51** | **0.06** | 2.60 | **0.05** | 2.06 |

Italic p value <0.1; Bold p value<0.05

In the fifth test also *people in the neighbourhood* is entered. Here it is found that there is no significant difference with the previous model, except that in all sample cases, peers at university becomes more significant (10%). People in the neighbourhood is not significant in the model.

When partner is removed for the sixth test, it is found that peers at university becomes significant in the three models. These findings might suggest that in all models, peers at university is more important than close friends is. One thought might be that close friends accept who students are but peers at university are not close to students, therefore students are more concerned that peers at university respect them or regard them better by owning a car. There is a possibility by looking at the magnitude, that being acknowledged by others in one's social environment (in this case university) is as important as acknowledgement by parents. Note that people in the neighbourhood seems not to significantly influence car intention. Then people in the neighbourhood is removed and it is found that parents and peers at university significantly influence car intention. The magnitude of parents is not changed from the previous model, but the magnitude of peers at university is changing in all models; for all sample and developing countries, it becomes smaller but for developed countries it remains unchanged. The removal of people in the neighbourhood changes the magnitude of peers at university.

In summary, to incorporate parents and peers in university is preferred since it represents two social situations, inner circle, and outer circle of students. Although partner appears to be significantly correlated with future car intention, since less than 50% of students for all sites, except for Indonesia and Beirut[7], partner is not incorporated in this model.

### *B) Second SSN Formulation*

For the second formulation, a single latent construct *SSN* ($\mathbf{z}_{sn}$) is constructed by using the seven group specific indicators shown in Table 6-4. The interpretation for this formulation is that the respondent perceives one *SSN* as a decision factor. Further advantages of this specification are taking into account of multi-colinearity, and having high Cronbach alpha, as shown in Table 6-5. To better understand the formulation, it can be seen in Figure 6-3. It is shown in the figure that, the *SSN* factor is constructed by seven observed variables of *SSN* in Table 6-5. The latent variable of *SSN* directly influences the latent factor of utility. In this method, the model estimation is performed simultaneously using OHCM.

[7]The percentage of students that have partner in each site: Utrecht (35.7%), Japan (39.4%), Berkeley (45.1%), Taiwan (49.6%), Indonesia (55.5%), China (41.3%), Beirut (51.2%)

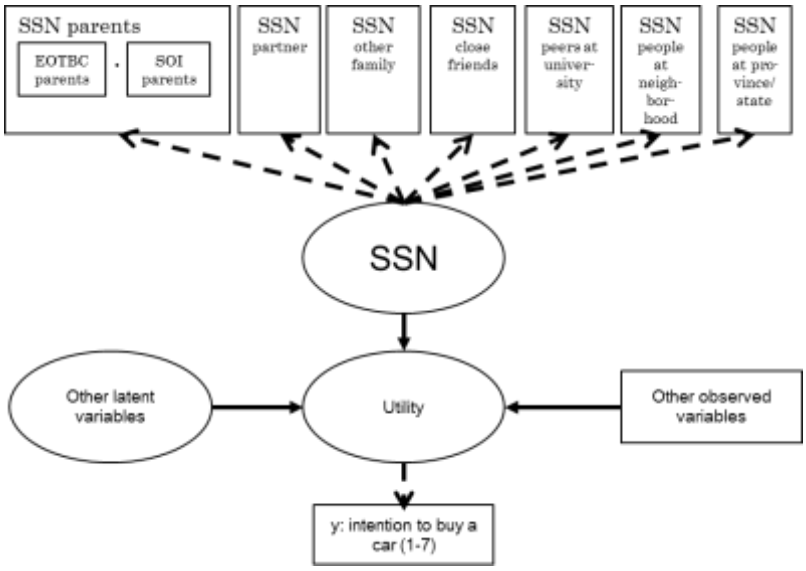


Figure 6-3 Car intention model with SSN second formulation

### *C) Third SSN Formulation*

Finally for the last formulation, the latent variable of *EOTBC* constructed by the seven indicators ($I_1$ – $I_7$), and also the latent variable of *SOI* constructed by seven indicators ($I_{18}$ – $I_{24}$) are interacted and the interaction is used as a latent variable that influences the latent variable of utility. This formulation is shown in Figure 6-4.

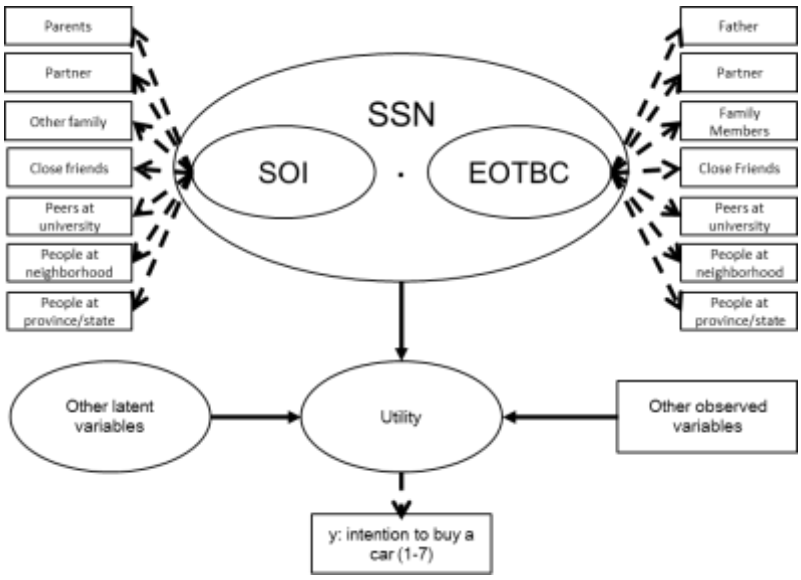


Figure 6-4 Car intention model with SSN third formulation

In this method, the model is estimated simultaneously using OHCM. The argument for performing this method is that by interacting *EOTBC* and *SOI* as one latent variable influencing the decision to buy a car, one can measure whether this student is a social person or anti-social. If the magnitude of this latent variable is significantly high, it can be interpreted that students really listen to others; likewise if the magnitude is significantly low or even not significant, it might be interpreted that students do not listen to others in their decision to buy a car in the future.

### 6.3.5. Car Purchase Intention Models with SSN and Travel Pattern

#### *A) Estimation and Results for First Formulation*

The formula for OHCM with group specific *SSN* observed variables (Model 5, p148) is shown below:

$$\boldsymbol{V} = \left(\mu_d\ \boldsymbol{\delta}_d + \mu_{nd}\ (1 - \boldsymbol{\delta}_d)\right)\left(\beta_{sy}\boldsymbol{z}_{sy} + \beta_{in}\boldsymbol{z}_{in} + \beta_{rc}\boldsymbol{x}_{rc} + \beta_{ic}\boldsymbol{x}_{ic} + \beta_{id}\boldsymbol{x}_{id} + \beta_{snp}\boldsymbol{x}_{snp} + \beta_{snu}\boldsymbol{x}_{snu}\right) \quad (6\text{-}14)$$

where all parameters and variables are the same with all samples model in Table 6-2 except that there is no *EOTBC* variables and there are two additional variables of *SSN parents* ($\boldsymbol{x}_{snp}$) and *SSN peers at university* ($\boldsymbol{x}_{snu}$).

This model, as well as all of sub-sequent OHCM models are estimated each using simulated maximum likelihood estimation with 10,000 Halton draws in Python Biogeme (Bierlaire & Fetiarison, 2009). The result for this model is shown in the second column of Table 6-8. The result is as expected, all variables that are found to be significant in Table 6-2 remain significant, while the *SSN parents* parameter magnitude is higher than *SSN peers at university* suggesting that students listen more to parents.

In the previous model in Table 6-3, the differences in *EOTBC* among seven countries have been shown. This time OHCM is estimated with *independence* country specific ($\boldsymbol{\delta}_c\beta_{c,in}\boldsymbol{z}_{in}$) to check whether there is a difference between attitude variable *independence* that is found to be significant in both developed and developing countries. In the subsequent model, the formula is shown below:

$$\boldsymbol{V} = \left(\mu_d\ \boldsymbol{\delta}_d + \mu_{nd}\ (1 - \boldsymbol{\delta}_d)\right)\left(\beta_{sy}\boldsymbol{z}_{sy} + \left(\boldsymbol{\delta}_c\beta_{c,in}\boldsymbol{z}_{in}\right) + \beta_{rc}\boldsymbol{x}_{rc} + \beta_{ic}\boldsymbol{x}_{ic} + \beta_{id}\boldsymbol{x}_{id} + \beta_{snp}\boldsymbol{x}_{snp} + \beta_{snu}\boldsymbol{x}_{snu}\right) \quad (6\text{-}15)$$

The result of this model (Model 6) can be seen in the third column of Table 6-8. It is shown that only in Utrecht (10%), Berkeley and China, the *independence* parameter is significant.

Table 6-8 Car Purchase Intention Models with SSN First Formulation (Model 5, Model 6, and Model 7)

| Variable | All sample (Model 5) | | Country specific (Model 6) | | With travel dist. (Model 7) | |
|---|---|---|---|---|---|---|
| | Estimate | Robust t-test | Estimate | Robust t-test | Estimate | Robust t-test |
| **Latent variables** | | | | | | |
| Symbolic affective | **0.19** | **2.55** | *0.13* | *1.78* | **0.22** | **2.88** |
| Independence | **0.17** | **2.90** | NE | | **0.17** | **2.90** |
| Independence Utrecht | NE | | *0.42* | *1.65* | NE | |
| Independence Japan | NE | | 0.40 | 1.32 | NE | |
| Independence Berkeley | NE | | **0.66** | **2.55** | NE | |
| Independence Taiwan | NE | | 0.07 | 0.99 | NE | |
| Independence Indonesia | NE | | 0.06 | 0.86 | NE | |
| Independence China | NE | | **0.25** | **2.18** | NE | |
| Independence Beirut | NE | | 0.10 | 0.94 | NE | |
| **Latent variables standard deviation** | | | | | | |
| σ Symbolic affective | **0.92** | **20.36** | **0.91** | **20.35** | **0.92** | **20.36** |
| σ Independence | **1.10** | **21.59** | **1.09** | **20.47** | **1.11** | **21.67** |
| **Observed Variables** | | | | | | |
| SSN parents | **0.04** | **5.02** | **0.03** | **3.91** | **0.04** | **4.99** |
| SSN peers at university | **0.03** | **2.19** | **0.03** | **2.28** | **0.04** | **2.42** |
| Regular car use | **0.53** | **4.23** | **0.42** | **3.13** | **0.47** | **3.93** |
| Income (US$) | **0.32** | **3.55** | **0.31** | **3.65** | **0.34** | **3.58** |
| Income dummy | 0.22 | 1.50 | 0.18 | 1.48 | 0.19 | 1.28 |
| Commuting distance (km) | NE | | NE | | **0.09** | **3.31** |
| Shopping distance (km) | NE | | NE | | 0.02 | 0.46 |
| Leisure distance (km) | NE | | NE | | 0.00 | -0.10 |
| **Scale parameter** | | | | | | |
| $\mu_{nd}$ | 1.24 | | 1.54 | | 1.19 | |
| **Model statistics** | | | | | | |
| Sample size | 1229 | | 1229 | | 1229 | |
| Final log-likelihood | -21772.729 | | -21767.354 | | -21765.662 | |
| Estimated parameters | 34 | | 40 | | 37 | |
| Final gradient norm | 1.10E-02 | | 7.99E-04 | | 2.60E-03 | |

Italic p value <0.1;Bold p value<0.05; NE (not estimated)

Further, those two models are expanded by incorporating commuting distance ($\boldsymbol{x}_{cd}$), shopping distance ($\boldsymbol{x}_{sd}$), and leisure distance ($\boldsymbol{x}_{ld}$) as explanatory variables, with formula shown in Eq.(6-16). below:

$$\boldsymbol{V} = \left(\mu_d\ \boldsymbol{\delta}_d + \mu_{nd}\ (1 - \boldsymbol{\delta}_d)\right)\left(\beta_{sy}\boldsymbol{z}_{sy} + \beta_{in}\boldsymbol{z}_{in} + \beta_{rc}\boldsymbol{x}_{rc} + \beta_{ic}\boldsymbol{x}_{ic} + \beta_{id}\boldsymbol{x}_{id} + \beta_{snp}\boldsymbol{x}_{snp} + \beta_{snu}\boldsymbol{x}_{snu} + \beta_{cd}\boldsymbol{x}_{cd} + \beta_{sd}\boldsymbol{x}_{sd} + \beta_{ld}\boldsymbol{x}_{ld}\right) \quad (6\text{-}16)$$

It can be seen in the last column of Table 6-8 (Model 7) that the inclusion of travel distance variables shows that commuting distance significantly influences car intention while the other two travel variables do not appear to be significant. This is consistent with the result in Chapter 4 which finds commuting distance is a significant determinant of car ownership.

### *B) Estimation and Results for Second Formulation*

In this second formulation, for the first time an OHCM that treated *SSN* as explanatory latent variables is estimated according to Eq.(6-17).

$$\boldsymbol{V} = \left(\mu_d\ \boldsymbol{\delta}_d + \mu_{nd}\ (1 - \boldsymbol{\delta}_d)\right)\left(\beta_{sn}\boldsymbol{z}_{sn} + \beta_{sy}\boldsymbol{z}_{sy} + \beta_{in}\boldsymbol{z}_{in} + \beta_{rc}\boldsymbol{x}_{rc} + \beta_{ic}\boldsymbol{x}_{ic} + \beta_{id}\boldsymbol{x}_{id}\right) \quad (6\text{-}17)$$

where all parameters and variables are the same as the OHCM in Table 6-2 second column except that there is no *EOTBC* variables and there is one additional factor (SSN). It is presumed that all latent variables including *SSN* are normally distributed across the population, i.e. $\boldsymbol{z}_{sn} \sim N(0, \boldsymbol{\sigma}_{sn}^2)$. Since factor of *EOTBC* is replaced by *SSN*, the psychometric indicators for latent variable $\boldsymbol{z}_{sn}$ (SSN) are modelled as follows:

$$\boldsymbol{I}_r = \lambda_r \boldsymbol{z}_{sn} + \boldsymbol{\upsilon}_r \text{ with r = 25, …, 31} \quad (6\text{-}18)$$

where: $\upsilon_r \sim N(0, \sigma_{\upsilon_r}^2)$, r = 25, …,31. The identification of latent variables is ensured by fixing $\lambda_{25} = 1$ (for latent variable SSN).

The result of this model (Model 8) is shown in the second column of Table 6-9. From the result, it is shown that all of the variables that are significant in the previous model with *EOTBC* as well as previous model with *SSN* observed variables remain significant. *SSN* is also found to be significant in the model suggesting that students consider strength of influence of perceived expectation in deciding whether to buy or to not buy a car in the future.

Table 6-9 Car Purchase Intention Models with SSN Second Formulation (Model 8, Model 9, and Model 10)

| Variable | All samples (Model 8) | | Country specific (Model 9) | | With travel dist. (Model 10) | |
|---|---|---|---|---|---|---|
| | Estimate | Robust t-test | Estimate | Robust t-test | Estimate | Robust t-test |
| **Latent variables** | | | | | | |
| SSN | **0.08** | **4.69** | NE | | **0.08** | **5.00** |
| SSN Utrecht | NE | | 0.05 | 1.43 | NE | |
| SSN Japan | NE | | **0.07** | **1.99** | NE | |
| SSN Berkeley | NE | | **0.18** | **5.09** | NE | |
| SSN Taiwan | NE | | **0.08** | **3.11** | NE | |
| SSN Indonesia | NE | | 0.02 | 0.76 | NE | |
| SSN China | NE | | 0.04 | 1.30 | NE | |
| SSN Beirut | NE | | **0.06** | **2.28** | NE | |
| Symbolic Affective | **0.24** | **2.77** | **0.19** | **2.12** | **0.24** | **2.84** |
| Independence | **0.20** | **2.76** | **0.18** | **2.54** | **0.19** | **2.86** |
| **Latent variables standard deviations** | | | | | | |
| σ SSN | **5.44** | **22.05** | **5.45** | **22.05** | **5.44** | **22.08** |
| σ Symbolicaffective | **0.91** | **20.44** | **0.91** | **20.42** | **0.91** | **20.44** |
| σ Independence | **1.09** | **20.14** | **1.09** | **20.13** | **1.09** | **20.19** |
| **Observed variables** | | | | | | |
| Regular car use | **0.63** | **4.85** | **0.54** | **3.50** | **0.50** | **3.78** |
| Income (us$) | **0.33** | **3.22** | **0.30** | **3.44** | **0.34** | **3.42** |
| Income dummy | 0.26 | 1.57 | *0.25* | *1.79* | 0.22 | 1.36 |
| Commuting distance (km) | NE | | NE | | **0.10** | **3.34** |
| Shopping distance (km) | NE | | NE | | 0.03 | 0.68 |
| Leisure distance (km) | NE | | NE | | 0.00 | -0.01 |
| **Scale parameter** | | | | | | |
| $\mu_{nd}$ | 1.04 | | 1.30 | | 1.13 | |
| **Measurement equations for latent variables** | | | | | | |
| **SSN** | | | | | | |
| Parents $\lambda_{25}$ | 1 (Fixed) | | 1 (Fixed) | | 1 (Fixed) | |
| Parents $\sigma_{25}$ | **5.53** | **26.73** | **5.52** | **26.68** | **5.53** | **26.75** |
| Partner $\lambda_{26}$ | **0.68** | **16.21** | **0.68** | **16.19** | **0.68** | **16.21** |
| Partner $\sigma_{26}$ | **4.69** | **34.78** | **4.69** | **34.85** | **4.69** | **34.81** |
| Family members and relatives $\lambda_{27}$ | **0.79** | **26.46** | **0.79** | **26.47** | **0.79** | **26.47** |
| Family members and relatives $\sigma_{27}$ | **3.40** | **19.58** | **3.39** | **19.53** | **3.40** | **19.59** |

| Variable | | All samples (Model 8) | | Country specific (Model 9) | | With travel dist. (Model 10) | |
|---|---|---|---|---|---|---|---|
| | | Estimate | Robust t-test | Estimate | Robust t-test | Estimate | Robust t-test |
| Close friends | $\lambda_{28}$ | **0.78** | **12.19** | **0.78** | **12.20** | **0.78** | **12.20** |
| | $\sigma_{28}$ | **2.77** | **8.56** | **2.77** | **8.57** | **2.77** | **8.56** |
| Peers at university | $\lambda_{29}$ | **0.56** | **11.48** | **0.55** | **11.45** | **0.56** | **11.49** |
| | $\sigma_{29}$ | **2.25** | **17.89** | **2.25** | **17.87** | **2.25** | **17.92** |
| People in neighbourhood | $\lambda_{30}$ | **0.27** | **6.86** | **0.27** | **6.85** | **0.27** | **6.87** |
| | $\sigma_{30}$ | **2.20** | **17.68** | **2.20** | **17.70** | **2.20** | **17.68** |
| People in province/state | $\lambda_{31}$ | **0.23** | **5.90** | **0.23** | **5.90** | **0.23** | **5.90** |
| | $\sigma_{31}$ | **2.26** | **16.96** | **2.26** | **16.96** | **2.26** | **16.96** |
| **Model statistics** | | | | | | | |
| Sample size | | 1229 | | 1229 | | 1229 | |
| Final log-likelihood | | -45009.757 | | -45000.657 | | -45002.031 | |
| Estimated parameters | | 47 | | 53 | | 50 | |
| Final gradient norm | | 1.20E-04 | | 1.65E-04 | | 2.50E-03 | |

Italic p value <0.1; Bold p value<0.05; NE (not estimated)

In order to test whether the previous models overlook differences in *SSN* among the seven countries, in the subsequent analysis, a model with country specific *SSN* $(\boldsymbol{\delta}_c\beta_{c,sn}\boldsymbol{z}_{sn})$ is estimated as in the following:

$$\boldsymbol{V} = \left(\mu_d\ \boldsymbol{\delta}_d + \mu_{nd}\ (1-\boldsymbol{\delta}_d)\right)\left(\beta_{sy}\boldsymbol{z}_{sy}\ +\ \beta_{in}\boldsymbol{z}_{in}\ +\ \left(\boldsymbol{\delta}_c\beta_{c,sn}\boldsymbol{z}_{sn}\right)\ +\ \beta_{rc}\boldsymbol{x}_{rc}\ +\ \beta_{ic}\boldsymbol{x}_{ic}\ +\ \beta_{id}\boldsymbol{x}_{id}\right) \quad (6\text{-}19)$$

The results of this model (Model 9) can be seen in the third column of Table 6-9. The results show that for country specific SSN in developed country, except for Utrecht, *SSN* appears to be significant. In the developing countries, only in Beirut and Taiwan case *SSN* is found to be significant.

It was already mentioned before that the lowest mean intention to buy a car is in Utrecht while the highest is in Beirut. Judging by the negative value of *EOTBC* and *SSN* in Utrecht it seems that Dutch students appear to have a strong desire to be perceived as not-following expectations. Thus, if Utrecht case which seems already in "peak car" state is omitted, it seems that looking at country specific *SSN*, the significant ones, there is a tendency that the country with higher GDP (Table 5-1) has higher *SSN* estimate, starting from Beirut, Taiwan, Japan, and Berkeley. Moreover, it might be interpreted that at this point the GDP and probably infrastructure in Indonesia and Taiwan is not high/advanced enough to trigger the significance of *SSN*.

Further, in the next model, travel distance is incorporated to check whether it significantly influences car intention or not. The model formulation is as follows:

$$\boldsymbol{V} = \left(\mu_d\ \boldsymbol{\delta}_d + \mu_{nd}\ (1 - \boldsymbol{\delta}_d)\right)\left(\beta_{sn}\boldsymbol{z}_{sn} + \beta_{sy}\boldsymbol{z}_{sy} + \beta_{in}\boldsymbol{z}_{in} + \beta_{rc}\boldsymbol{x}_{rc} + \beta_{ic}\boldsymbol{x}_{ic} + \beta_{id}\boldsymbol{x}_{id} + \beta_{cd}\boldsymbol{x}_{cd} + \beta_{sd}\boldsymbol{x}_{sd} + \beta_{ld}\boldsymbol{x}_{ld}\right) \quad (6\text{-}20)$$

The formulation is similar to Eq.(6-16) except that *SSN* is treated as latent variable instead of two observed variables. The result of this model (Model 10) can be seen in the fourth column of Table 6-9. The result is also similar to the model estimated using Eq.(6-16) in that only commuting distance and not shopping or leisure distance is found to be significant. This result supports the previous findings that commuting distance is indeed a determinant of car ownership intentions.

*C) Estimation and Results for Third Formulation*

The formula for the car intention model is now as follows (OHCM model 11):

$$\boldsymbol{V} = \left(\mu_d\ \boldsymbol{\delta}_d + \mu_{nd}\ (1 - \boldsymbol{\delta}_d)\right)\left(\beta_{sn}\boldsymbol{z}_{ex}\boldsymbol{z}_{so} + \beta_{sy}\boldsymbol{z}_{sy} + \beta_{in}\boldsymbol{z}_{in} + \beta_{rc}\boldsymbol{x}_{rc} + \beta_{ic}\boldsymbol{x}_{ic} + \beta_{id}\boldsymbol{x}_{id}\right) \quad (6\text{-}21)$$

where all parameters and variables are the same as OHCM Model 1 except that *SSN* factor is a result from the interaction of latent construct *EOTBC* and latent construct *SOI*. It is presumed that all latent variables including *SOI* are normally distributed across the population, i.e. $\boldsymbol{z}_{so} \sim N(0, \boldsymbol{\sigma}_{so}^2)$. Since the other latent variables except *SOI* are the same as Model 1 (Table 6-2), the psychometric indicators for *EOTBC* are also the same as Model 1, while the psychometric indicators for latent variable $\boldsymbol{z}_{so}$ (SOI) are modelled as follows:

$$\boldsymbol{I}_r = \lambda_r \boldsymbol{z}_{so} + \boldsymbol{\upsilon}_r \text{ with r = 18, …, 24} \quad (6\text{-}22)$$

where: $\upsilon_r \sim N(0, \sigma_{\upsilon_r}^2)$, r = 18, …,24. The identification of latent variables is ensured by fixing $\lambda_{18} = 1$ (for latent variable SOI).

Since this model does not converge and there is no estimation that can be obtained, the result of this model is not reported. Therefore, in the subsequent discussion of this chapter, only the result from the first and second formulation are discussed.

## 6.4. Country Comparison of Attitudes and Norms

The final discussion on influence of attitudes and norms towards car ownership is done by comparing parameter estimates related to attitudes (*independence*) and norms

(*EOTBC* and *SSN*) between Indonesia and other developing and developed countries. This is done since one of the objective state in Chapter 1 is to compare the results of role of attitudes and norms between Indonesia and other countries in order to propose policies to control the number of car ownership in Indonesia. This is shown in parameter estimates of Indonesia and other countries which are tested as to whether there is significant difference between them using the t-test (see Eq.(6-10)). The result of the *t*-test is shown in the last column of Table 6-10.

Table 6-10 Comparison between Indonesia and Other Countries in Term of Parameter Estimate of Attitudes and Norms

| Variables | | Indonesia | | Other Countries | | t-test difference |
|---|---|---|---|---|---|---|
| | | Estimate | Robust t-test | Estimate | Robust t-test | between parameters |
| Taiwan | Independence[1] | 0.06 | 0.86 | 0.07 | 0.99 | 0.10 |
| | EOTBC[2] | 0.08 | 0.66 | **0.33** | **2.79** | 1.42 |
| | SSN[3] | 0.02 | 0.76 | **0.08** | **3.11** | 1.57 |
| China | Independence[1] | 0.06 | 0.86 | **0.25** | **2.18** | 1.47 |
| | EOTBC[2] | 0.08 | 0.66 | 0.17 | 1.39 | 0.53 |
| | SSN[3] | 0.02 | 0.76 | 0.04 | 1.30 | 0.50 |
| Beirut | Independence[1] | 0.06 | 0.86 | 0.10 | 0.94 | 0.29 |
| | EOTBC[2] | 0.08 | 0.66 | *0.24* | *1.91* | 0.89 |
| | SSN[3] | 0.02 | 0.76 | **0.06** | **2.28** | 1.05 |
| Japan | Independence[1] | 0.06 | 0.86 | 0.40 | 1.32 | 1.27 |
| | EOTBC[2] | 0.08 | 0.66 | **0.43** | **2.29** | 1.64 |
| | SSN[3] | 0.02 | 0.76 | **0.07** | **1.99** | 1.16 |
| Utrecht | Independence[1] | 0.06 | 0.86 | *0.42* | *1.65* | *1.83* |
| | EOTBC[2] | 0.08 | 0.66 | 0.16 | 1.41 | 0.40 |
| | SSN[3] | 0.02 | 0.76 | 0.05 | 1.43 | 0.65 |
| Berkeley | Independence[1] | 0.06 | 0.86 | **0.66** | **2.55** | **2.12** |
| | EOTBC[2] | 0.08 | 0.66 | **0.82** | **6.91** | **4.36** |
| | SSN[3] | 0.02 | 0.76 | **0.18** | **5.09** | **3.55** |

Italic p value <0.1; Bold p value<0.05; Note: 1. Taken from Table 6-8; 2. Taken from Table 6-3; 3. Taken from Table 6-9

The discussion starts with a comparison of Indonesian and Taiwanese students. Possibly because are Asian island nations and motorcycle focused countries, there seems to be no significant difference in terms of parameter estimates for Independence, *EOTBC*, and *SSN* between Indonesian students and Taiwanese students. Furthermore, compared

to China and Lebanon, both rapidly developing countries, there seems to be no significant difference between those parameters.

When comparing Indonesia with Japan, a developed Asian island nation, it seems that there is no significant difference between parameter estimates of *independence*, *EOTBC*, and *SSN*. The significant difference is found (10%) when comparing *independence* factor of Indonesia and Utrecht; the parameter estimate for *independence* is more significant in Utrecht suggesting that Dutch students perceive car as giving *independence* to travel more than Indonesian students do. Lastly, significant difference for all variables is found when Indonesia is compared to Berkeley. Students in Berkeley perceive the car as giving more *independence*, listen more to others' expectation and consider more the significance of influence of expectation of others when deciding to buy a car in the future.

## 6.5. Conclusions

The last objective of this dissertation has been to explore the role of attitudes and norms on car ownership motivations in more detail between developed and developing countries in order to propose policies to control car ownership in developing countries particularly Indonesia.

In line with the objective, this chapter can be concluded with mentioning several findings as follows: At first through OHCM which incorporates *EOTBC*, it is found that attitudes, especially symbolic affective and *independence*, appear to significantly influence likelihood to buy cars in the future in all samples; however, when broken-down into developed and developing countries, symbolic affective becomes less significant and not significant whereas *independence* remains significant. Another important finding is that *EOTBC* appears to significantly influence car ownership intention. Other explanatory variables such as regular car use and income are also confirmed as determinants of car ownership intention.

Second, through OHCM that incorporates first *SSN* formulation, it is found that all significant variables found in previous OHCM estimation remain significant here. *SSN parents* is found to be significant suggesting that in terms of future car intention, students consider what their parents expect them to do as important influence. Further, *SSN peers at university* is found to be significant, suggesting that in terms of likelihood to buy cars, students also consider what they think their peers expect in order to be acknowledged or being respected by their peers.

Third, through OHCM that incorporates second *SSN* formulation, it is found that again, all significant variables such as attitudes, which are found to be significant in previous OHCM estimation, remain significant here. *SSN* as one latent variable

significantly influences car ownership intention suggesting that students perceive how strong the influence of others in expecting them to buy a car as one decision factor which determines car intention.

Fourth, when comparing parameter estimates of the *independence* factor between Indonesia and other countries, it is found that Indonesia has the lowest coefficient compared to other countries. One explanation might be that severe traffic congestion causes the lower coefficient of attitudes towards car. People spend more time in traffic jam hence the variable "cars are convenient" and "cars help one to save time when making a trip" might be scored very low.

Fifth, when comparing parameter estimates of *EOTBC* and *SSN* factor between Indonesia and other countries, it is found that again those variables are the lowest in Indonesia. Perhaps there is instead a high expectation to buy motorcycles compared to buying a car.

Sixth, looking only at the correlation analysis between *SSN parents* and car intention in Table 6-6, Indonesia result of *SSN* is the lowest compared to other countries which might be because motorcycle is playing an important role, though this notion is contradictory with the findings from Taiwan, also a motorcycle dominated country where *SSN* is found significant.

Finally, to wrap up all the models and results obtained as well as the analysis, general conclusion, policy recommendation as well as shortcomings and future recommendations will be discussed further in the last chapter of this dissertation.

# Chapter 7

# Conclusions

## 7.1. Summary of Findings

The overall objective of this thesis, i.e. explaining car ownership motivations of young people, has been broken down into five tasks. These are: 1) To understand the factors determining car ownership among students in Bandung, Indonesia. 2) To analyse the differences among university students in the seven countries i.e. Netherlands (Utrecht), Japan, United States (Berkeley), Taiwan, Indonesia, China, and Lebanon (Beirut), in terms of their car ownership motivations. 3) To explore the role of attitudes and social norms on car purchase intentions in more detail between developed and developing countries. 4) To explain more about how perceived expectation are built up, by proposing several formulations of how *subjective social norms* (interaction between *expectation of others to buy cars* and *strength of influence of others*) influence car purchase intentions. 5) To compare the results of attitudes and norms between Indonesia and other countries in order to propose policies to control the number of car ownership in Indonesia (see Sub-chapter 1.2).

To accomplish the first objective, an SEM model-using a sample of 500 undergraduates of ITB Bandung is estimated with binary dependent variable car ownership, resulting in two attitudinal variables, *independence* and *arrogant prestige,* found to be significant determinants that influence car ownership. Further, commuting distance, PT is reliable, frequency of using PT and personal income are also found to be significant determinants of car ownership. Details of this discussion can be seen in Chapter 4.

The second objective has been accomplished by correlating several potential determinant factors with the ordinal dependent variable likelihood to buy cars in the future (car purchase intention) for each of the seven countries. The lowest car purchase intention is found in the Netherlands, followed, from the lowest to the highest, by Japan, USA, Taiwan, Indonesia, China, and Lebanon. Interestingly the order of these countries confirmed the "peak car" discussion where people in the developed countries seem to use car less. From the correlation analysis it is found that from four factors of attitudes towards car (*symbolic affective*, *independence*, *negative aspects* and *social/env. care*) and

two factors of attitudes towards PT (*safety and reliability* and *convenience*), only two factors of attitudes towards cars, *symbolic affective* and *independence* significantly correlate with car intention in most countries. From the correlation analysis it seems that in the developed countries, attitudes have a larger impact on car ownership intentions than in developing countries.

In the reminder, the thesis has then focused on the role of social norms as the literature review emphasized the potential importance of such norms. From the four constructed social norm factors (*descriptive norms, expectation of others to buy cars-EOTBC, strength of influence of others to buy cars-SOI,* and *subjective social norms*), only *EOTBC* is found to significantly correlate with car purchase intention in most countries. *EOTBC* has a relatively larger similarity between countries while the other three factors have different impacts on car purchase intentions between the seven countries. Thus, it seems that the impact of social norms on car purchase intention cannot be explained by the difference between developed or developing countries, and perhaps the impact of social norms is based on cultural issues rather than economic development. The other variables that are found to significantly correlate with car purchase intention are personal income and regular car use. The discussion can be seen in Chapter 5.

In Chapter 6, the third objective is accomplished by estimating ordinal hybrid choice models (OHCM) of car purchase intention. The explanatory variables are those that are found to be correlated with car purchase intention in Chapter 5. From the first group of OHCM models that are estimated for four models (see Table 6-2 and Table 6-3) i.e. all samples model (Model 1, p129), developed countries model (Model 2), developing countries model (Model 3), and country specific *EOTBC* model (Model 4, p 133), it is found that social norms factor (*EOTBC*), attitudinal factors (*symbolic affective* and *independence*) and other variables (regular car use, personal income) significantly influence car intention in all samples (Model 1). *EOTBC* has a larger influence (higher coefficient estimate) on car purchase intentions than symbolic affective and *independence*. In the case of developed countries (Model 2), the magnitude of the *EOTBC* coefficient remains consistent with the aggregate samples (Model 1) but *independence* and regular car use have higher coefficients. In developing countries (Model 3) the magnitude of the coefficient of *EOTBC* also remains consistent with the aggregate samples (Model 1) but the coefficients for *independence* and regular car use are low. *EOTBC* has the highest influence on Berkeley students, but no influence on car ownership intentions for students from Utrecht, Indonesia and China (Model 4).

To accomplish the fourth objectives, three formulations of *subjective social norms* (*SSN*) are introduced. *SSN* is introduced as interaction factor between *EOTBC* and *SOI*.

Seven person groups are defined that might influence a person's purchase intentions (*parents, partner, family members and relatives, close friends, peers at university, people in neighbourhood, people in the province/state*) For the first *SSN* formulation, each group (see Figure 6-2) is interacted separately and enters the OHCM as observed variable. In the second formulation, each peer group is also interacted separately but enters the OHCM as one construct of latent variable (see Figure 6-3). As for the last formulation, the latent variable of *EOTBC* is interacted with latent variable of SOI and enters the model as one latent variable.The first formulation of *SSN* is further used for the second group of OHCM (see Table 6-8) that is estimated for three models i.e. all samples model (Model 5, p144), country specific *independence* model (Model 6), and the model with three distance variables inclusion (Model 7). In the last model three distance variables are commuting distance, shopping distance, and leisure distance. The second formulation of *SSN* is also further used for the third group of OHCM (see Table 6-9) that is all samples model (Model 8, p146), country specific *SSN* model (Model 9), and model with three distance variables inclusion (Model 10). The three distance variables mentioned here are similar with Model 7.

Using the fist formulation of *SSN*, it is found that *SSN parents* and *SSN peers at university* significantly influence car intention (Model 5). In the second formulation of *SSN* OHCM, it is also found that *SSN* significantly correlates with car intention (Model 8). All other variables, symbolic affective, *independence*, personal income and regular car use are found to be significant in both *SSN* formulations. Adding three travel distance variables in all *SSN* formulation OHCM, it is found that only commuting distance is significantly influence car intention. From the result of the OHCM model of *SSN* second formulation, it is found that social pressure is important in Japan, Berkeley, Taiwan and Beirut context (Model 9). Another important finding is that Indonesia has the smallest impact of social pressure.

This dissertation concludes that the comparison of parameter estimate of OHCM in regards to attitudes (*independence*) and norms (EOTBC and SSN) between Indonesia and other developing countries show no significant difference (see Table 6-10). Further, comparison of the same parameter estimate between Indonesia and other developed country such as Japan shows no significant difference. However, comparison with other developed countries case like Utrecht and Berkeley, show that in Utrecht, *independence* is significantly different. While comparing Indonesia with Berkeley (other developed country case) shows that all parameter estimates are found to be significantly different.

Finally, from all of the respective findings, the general conclusion of this dissertation can be made as follow: This research found strong evidence that attitudes and norms

significantly influence car ownership motivations. The summary of this dissertation can be seen in more detail in Figure 7-1.

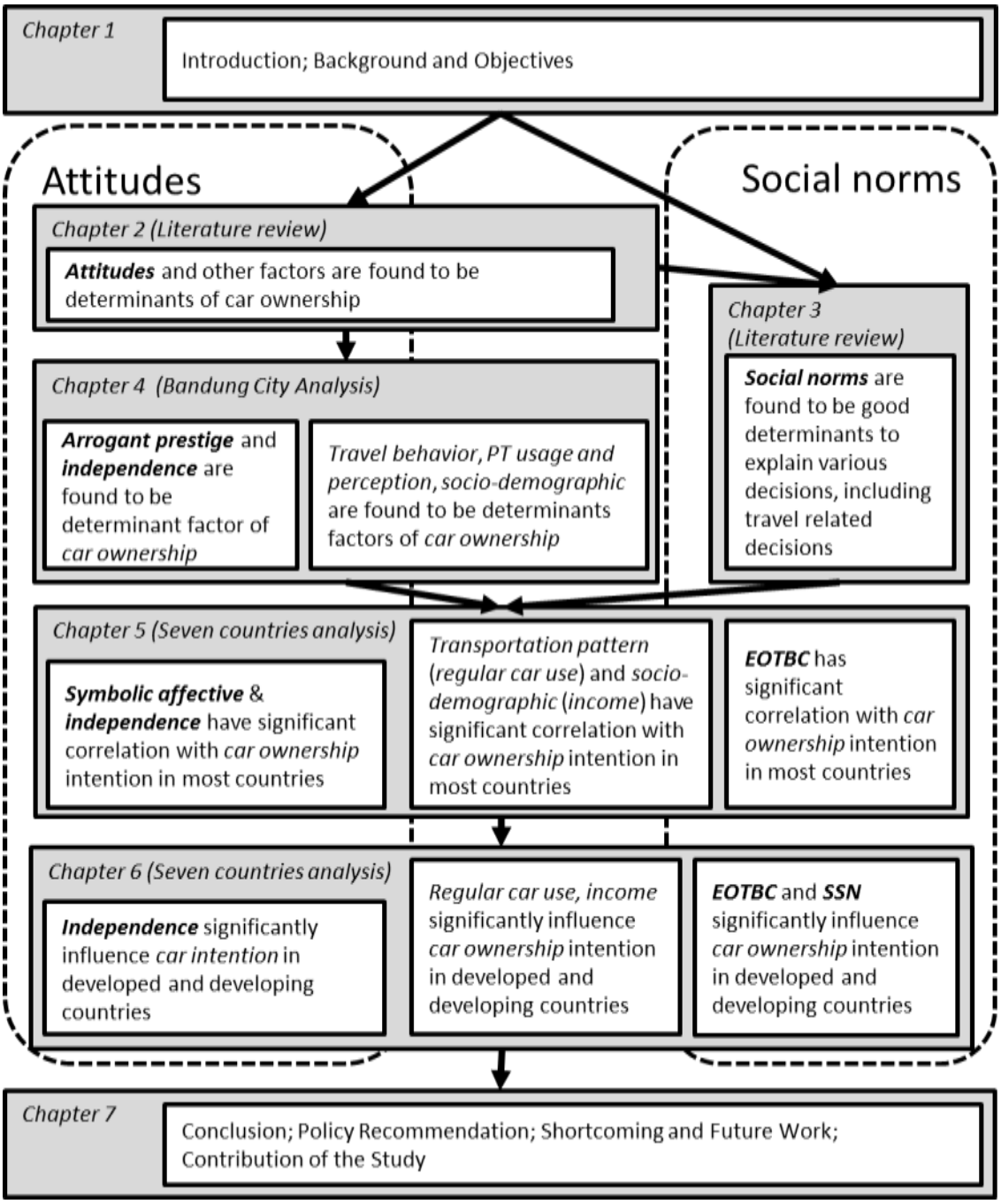


Figure 7-1 Summary of the dissertation

## 7.2. Implication for Policy and Planning

From the general conclusion above, some policy implications related to significant influence of attitudes and social norms on car purchase intentions can be explained. Through a survey among Indonesian students in Bandung, asking for attitudes as well as socio-demographic characteristics conclusions have been obtained which are believed to have some policy implications and give possibly some hope that, at least to some degree, adequate transport policy could reduce the trend towards a rapid increase in car traffic.

The findings, in Chapter 4, that perception of whether the car is a prestige object and income are not significantly correlated, suggests that there might be some hope that rapid economic growth might not necessarily mean a motorization development as experienced in Western countries several decades ago. The findings related to the significance of *independence* emphasizes that in Bandung and generally in situations where there are insufficient convenient public transport options, such services need to be improved first before one in fact has a choice.

Further, the positive influence of monthly income toward *independence* suggests that if monthly income changes then also *independence* will. This finding might also have policy implications in which policy makers concerned about increasing car ownership do not only have to deal with the higher affordability of cars but also an increase in perception of how much *independence* a car can bring possibly due to the generally increased financial possibilities to travel. Therefore, also for this reason it will be important to create early on a public transport system that can fulfil the more diverse travel needs of rapidly developing countries.

Still related to the results from Bandung, the significance of *arrogant prestige*, which is negative, suggests that if the negative side effects of cars for the society and city are highlighted, the car might eventually become a kind of "anti-status symbol." Thus, it implies that some campaigns or public education to induce *arrogant prestige* to reduce car ownership might be helpful.

By broadening the scope from one country to seven countries (three developed and four developing countries), in Chapter 5, it is found that there is a significant difference between developing and developed countries with students in the developed countries having less desire to purchase cars. To control the number of cars in developing countries, it might be good to study from the developed countries experience. Attitudes have a larger impact on car purchase intention in the developed countries thus changing attitudes in the developed countries might have larger impact than changing attitudes in the developing countries, but still it is important for policy makers to change attitudes in the developing countries, since it is significantly correlate with car purchase intentions. Related to

*independence* factor, noteworthy is that Taiwanese students appear in some points different from the other samples (Table 5-15) probably due to the tradition of motorcycle usage. In the same way that cycling is an established mode in the Netherlands, this shows that the prevailing "mobility culture" is an important factor when considering global trends.

As it appears difficult to find a pattern in which (type of) countries social norms are more important, it seems important to study the cultural differences to influence the change in the norms. As in general norms appear important though, what can be concluded from the literature review and the findings presented here is in line with research by Bamberg et al (2011). In their research about self regulation theory, Bamberg et al. (2011) mentioned that the fear of social sanctions for not fulfilling the expectations of others (social norms) may increase people's felt obligation to bring their behaviour more in line with identity-related self-standards (personal norms); therefore, making social norms salient is an important first step. Taking this together with the findings in Chapter 6, highlights the need to firstly make young people aware of the expectations they face, if one wants to reduce car ownership.

Looking at the significant results of *EOTBC* (Table 6-3) and *SSN* (Table 6-9) for Taiwan case, and comparing those results with insignificant results in Indonesia, another Asian island nation with motorcyclist culture, one can hypothesise that social norms become more important with the increase of income. Therefore, it is suggested that if in the future, GDP and transportation infrastructure are improved in Indonesia, the *EOTBC* and *SSN* might become significant determinants of car purchase intention. If that happens and social norms become more important, possibly the Netherlands can be a good example for policy makers in Indonesia and other countries where students appear to have decoupled perceived expectations from attitudes towards car. (Our Dutch findings might though also be an example that shows that one cannot change social norms unless the public transport has a sufficient quality). Based on these findings, it is suggested that expectations of others and *SSN* should be addressed in soft policy measures such as "mobility management".

### 7.3. Shortcomings of Study and Recommendations for Future Work

While "explorative," this study made use of a detailed, individual level, cross-cultural survey of a wide variety of drivers of auto use and provided insight into the cultural differences and future trends of auto ownership.

Since the focus of this dissertation is Indonesia, it is worth mentioning about the generally low model fit for models with data from Indonesia in Chapter 6, whereas the data in Chapter 4, also from Indonesia appear to explain car ownership better. To confirm

whether this is a sample issue or a general finding, perhaps the data collection way should be reviewed. Whereas the data in Chapter 4 were collected mainly through surveys in classrooms at the end of lectures, the data in Chapter 6 used were collected by surveyors using a method of approaching the respondent in campus area and interviewing them. For other six countries, the respondents answer the questionnaire directly from the website while for Indonesia case, the respondents were interviewed. One critical note, however, that it might be better to avoid personal interviews since in some culture the tendency to give honest response especially regarding norms might be hindered by the fear of impression that the person might be "too reliant on others too much."

This dissertation also tries to explain past experience that influence car ownership, by asking the respondents about their attitudes when first bought car and their current attitudes. By doing so, it is hoped that the way attitudes change over time can be explained through past experience, since it seems impossible to do so given the current cross-sectional data to forecast future attitudes change. The brief discussion in Chapter 4 shows that, it might seem difficult to ask such recall-questions. Partly because the way the questions are asked or it might be because a psychological determinants cannot be captured by recalling past experience. Future study needs to consider the way to ask this kind of questions or different methods to capture changes in attitudes.

Further, it might be important for future study to incorporate panel data that capture changes in attitudes, changes in norms and observing those changes over time. These changes might be throughout life events for example, getting married, graduation, having a child, getting a job, moving to a new house. Does car ownership changes during those life events precede by changes in attitudes and finally change in norms? It might be interesting to answer those questions using sufficient panel data.

One might argue that current purchase intentions do not necessarily reflect future car purchase, especially if students change their lifestyle after graduation. Therefore, this dissertation does not claim that the findings should be directly translated into regression models for demand forecasting even for this cohort. However, it is believed that current intention might be one important determinant explaining future intention. It is also acknowledged that the different sampling methods across the different countries/cities might contribute to potential self-selection bias. Therefore, more representative samples from a wider population segment including from different cultures are needed for future research. Additional quantitative or qualitative surveys might further aim to investigate the social-cultural background of respondents in more detail. Unfortunately current data sets do not allow to trace the respondents in 5-10 years to see whether they have actually

behaved according to their intentions and/or whether their attitudes and perceived norms have changed.

The present models in this dissertation do not take uncertainty of other developments into account, for example what if there are changes in demographic situations over time, changes in traffic condition, changes in mobility conditions and changes in policy. Future research might incorporate this uncertainty of other developments. The idea related to this uncertainty and dynamics are presented in Figure 7-2 below.

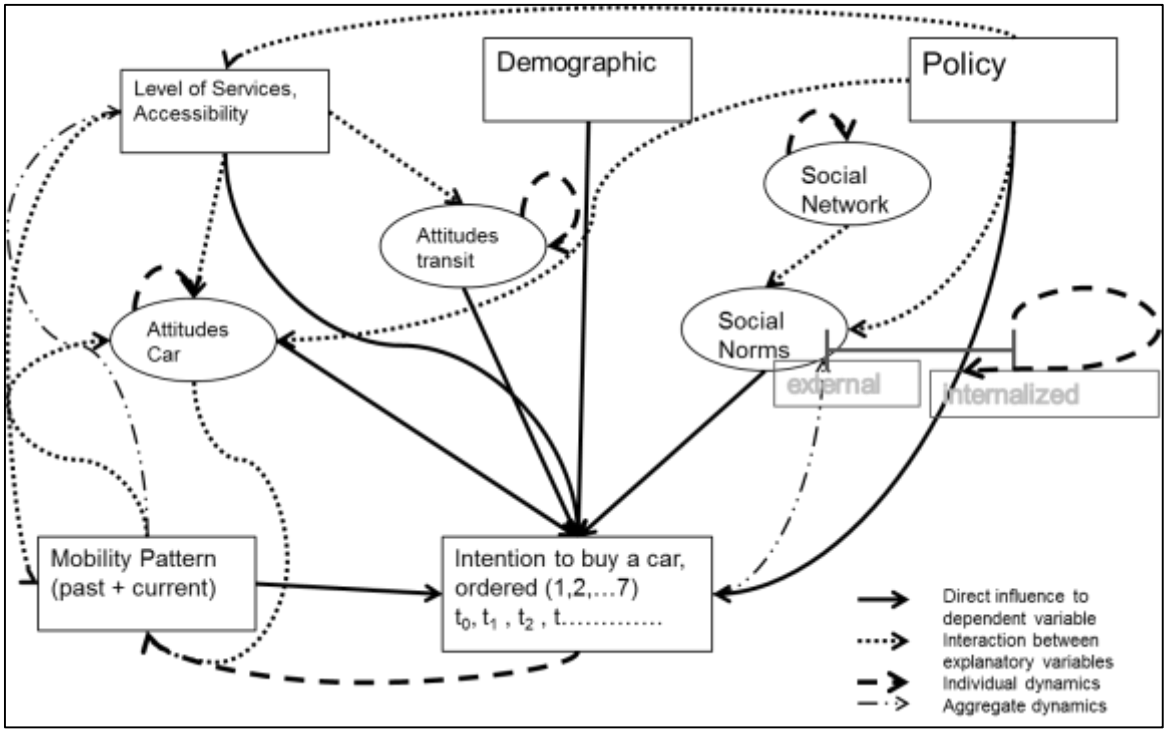


Figure 7-2 Pooled data model and dynamics

As shown in above figure, car purchase intention is hypothesised to be influenced directly at the individual level by three latent variables (attitudes toward cars, attitudes toward PT, and social norms) and four observed variables (policy, demographic situation, level of services + accessibility, and mobility pattern). Over time, the individual car purchase intention defines individual mobility pattern. Individual mobility pattern influences and is influenced by attitudes toward car, and it dynamically and collectively translates into aggregate levels of services. Aggregate levels of service variables influence individual attitudes towards car, and transit as well as mobility pattern while this variable is influenced by policy. Individual attitudes dynamically change over time, especially attitudes towards car are influenced by policy change.

As for social norms factor, dynamic changes in individual car purchase intention collectively forming social norms factor, where this external factor over time being internalized by individual as well as receive influence from policy change and individual social network (which also changes over time). In the end, policy is hypothesised to have a major impact directly and indirectly toward individual car purchase intentions. However, this hypothesis cannot be tested given current data sets, thus future research may consider incorporating policy aspect into the model while also paying attention to acceptability of the policies themselves. Kim (2013) has shown that acceptability is important in implementing transportation related policy, as well as factors that influence acceptability.

In conclusion, the analysis may also be extended to population segments other than students. As mentioned above, while this study analysed the intentions to own a car in the future, it is unclear to what extent there will be a gap between these intentions and the actual car purchase decisions. Future analyses should therefore examine current car ownership and use decisions, as well as examine both daily travel patterns and long distance recreational travel to better capture the extent of changes in car use in both developed and developing countries.

Finally, a short note on software usage. Three software packages were used to complete this dissertation: SPSS, Mplus and Python Biogeme. SPSS was used to perform PCA, logistic regression and correlation analysis. This software is useful at the first stage of data processing, however the disadvantage of this software is that it can not be used for simultaneous modelling such as SEM or OHCM. The second software, Mplus, is perhaps the most powerful statistical software package to date; it can perform maximum likelihood and WLSMV SEM simulation very fast. This software is used in Chapter 4 to run car ownership SEM model. The disadvantage of this statistical package is that it is difficult to estimate scale parameter for two different contexts in one model. Python Biogeme, was used for the OHCM estimation in Chapter 6, the advantage of this software is that it is very intuitive in which the researcher can write their own utility function to run the model, however this software is very time consuming when it comes to larger data.

## 7.4. Contribution of the Study

There are three significant contributions from this dissertation. First, this study is the first one that compares role of attitudes and norms that influence car intention with a sample from a range of countries. In doing so, three developed countries, one semi developed countries and three developing countries are incorporated in this study. By doing international comparison, hopefully some important aspects that relate to car ownership intention can be transferable from developed countries to the less developed countries.

These aspects are especially in terms of attitudes and norms. As shown in Chapter 6 there are significant differences between Berkeley (developed country case) and Indonesia for *independence*, Expectation of others to buy cars, and *subjective social norms* factors. These findings can be employed and be considered by Governments of Indonesia or other developing countries in planning and implementing policies to reduce car ownership. The central governments might implement a nationwide policy given general attitudes and norms of their citizens, while local governments can implement policies that are more specific considering special characteristics of their respective place.

Related to the first contribution, the second contribution of this dissertation is "problem specific", as the thesis explains determinant factors of car ownership decisions among Bandung students and also the role of attitudes and norms within Indonesia and other six countries context using Ordinal Hybrid Choice Model. Especially in testing factors related to subjective norms. As mentioned in Chapter 3, there is ample need for more empirical work to show evidence of social network effects within the transportation field as a number of studies reviewed in Chapter 3 relied on hypothetical scenario only. It is also noted in Chapter 3 that it is important for modelling and practical to recognize that there are several person groups and key persons in society. This dissertation classify person groups into seven groups as well as collected data regarding perceived expectation for each student in respect to the seven person groups. The findings highlight the importance of each of mentioned person group in influencing the decision of students regarding car ownership.

Third and finally, this dissertation makes a methodological contribution. In this research, three ways of formulating how *subjective social norms* influence car intention are introduced here. The three formulations of *SSN* describe an understanding of how persons can be influenced by their peers through several ways. As mentioned above, this dissertation can contribute not only to car ownership research, but also for broader topic in the field of transportation and outside transportation.

It is believed that the *SSN* formulations introduced here can be utilized in a wide range of studies that incorporate norms as factors influencing behaviour such as marketing, tourism, health, environmental friendly behaviour. For example studies about energy conservations, nowadays the world experiencing crisis of energy, while some people might realize about this some might ignore this situation. In some population, at first it will be tested whether individuals perceive others surrounding them as expecting them to care about energy crisis or not. This test partly might give information about the energy norms in the society. Second, the *strength of influence of others* is tested to check whether one will adjust their behaviour, co-operate according to the expectation of others or not.

The appropriateness of the three *SSN* formulations can be explored further in this situation. Finally some policy can be proposed based on the result of the model.

While in the field of transportation, *SSN* formulations might be utilized for studies such as residential location choice, mode choice, telecommuting, and safety behaviour. By understanding the way *SSN* influencing a decision through several formulations, researcher can propose at what stage that related to norming effect an intervention or policy should be implemented in order to alter or modify behaviour and intention in the future. One specific example related to transportation field is perhaps a "bike to work" policy. While it is true that in the developing countries, especially Indonesia context, the PT situation might not be as advanced as in the developed countries, but bicycle might be an alternative to use for commuting. It can avoid traffic congestion, and perhaps if more people expect others to use bicycle more, then there is possibility that others might listen to that expectation.

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# Appendix A.

## 1. Questionnaire for Chapter 4

TRAVEL BEHAVIOR ANALYSIS LABORATORY
Graduate School of Engineering Kyoto University, JAPAN

NO : ☐☐☐☐

# QUESTIONNAIRE FORM

## CAR USAGE AND OWNERSHIP

The purpose of this study is to understand why students use cars and why they decide to buy one. All information given by the respondents will be kept confidential and is not used for any commercial purposes.

Please read each question carefully. Note that, depending on whether you own a car, you do not have to answer Part A or B of the questionnaire respectively.

Thank you for your cooperation.

**FOR CAR OWNERS**

**SECTION A – ATTITUDE TOWARD CARS**

If you do not own a car please move to SECTION B

Please answer the following questions

We would like to know how you think about **CARS IN GENERAL**. We would especially like to know how your impression about cars in general changed from the time when you bought your car and your impression now. Therefore for Q1 please remember the time at the time when you decided to buy your first car.

| No | | Q.1 At the time when I bought my first car, I thought cars..... | | | | | | | Q.2 Now, that I already own a car, I think cars.... | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fully disagree ← | | | | | | → Fully agree | disagree ← | | | | | | → agree |
| 1. | .....are comfortable. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. | .....allow one to care for others. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. | .....are convenient. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. | .....allow one to travel anytime. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5. | .....are environmentally unfriendly. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6. | .....allow one to travel safely. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 7. | .....are cool. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 8. | .....allow to do adventurous things. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 9. | .....are disturbing one's neighborhood. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 10. | .....allow to express oneself. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 11. | .....helps one to save time for travel. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 12. | ..... are giving arrogant impression. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 13. | .....allow one to be independent. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 14. | .....are trendy. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 15. | .....allow one to pick up or see off others. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 16. | .....are fun to have. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 17. | .....allow one to travel anywhere. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 18. | .....are expensive to own and maintain. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 19. | .....allow to distinguish oneself from others. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 20. | .....brings prestige. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

Q.3. What kind of car do you own now?

1. Brand _____ (e.g: Honda, BMW, etc)
2. Type _____ (e.g: Jazz, Kijang etc)
3. Total Passenger _____persons
4. Machine Size _____cc
5. When did you buy it _____
6. How much did you pay for it _____ (approximately)

Q.4. Have you been suggested by somebody to buy your car? (please refer to below column)

| No | People who engaged with you | He/she never talked to me about this car ← | | | He/she suggested me to buy this car | | | He/she strongly recommended me to buy this car → |
|---|---|---|---|---|---|---|---|---|
| 1. | Father | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. | Mother | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. | Partner (Girlfriend/Boyfriend/Spouse) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. | Brother | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5. | Sister | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6. | Grand Parents | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 7. | Other Relatives | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 8. | Neighbor | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 9. | Classmate | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 10. | Student Association Mate | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 11. | Lecturer | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 12. | Friends | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 13. | Online Friend (facebook, twitter, blog,etc) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 14. | Advertisement (Salesman) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

Q.5. Are there other sources that influenced you to buy your car?

| No | Sources | Influence ← | | | neutral | | | Strong Influence → |
|---|---|---|---|---|---|---|---|---|
| 1. | Newspaper | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. | TV Commercial | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. | Radio Commercial | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. | Car Expo | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5. | Commercial on Internet | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6. | Other_____ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

Q.6 Who bought your car? _____ _____

Q.7 How did you pay for your car? (cash, installments, credit, etc) _____year

Q.8 In total, how much do you use your car per week? (rough estimate) ca. _____km/week

Q.9 What percentage of your monthly income is spent for fuel? ca. _____%

Q.10 What percentage of your monthly income is spent for maintaining your car? ca. _____%

Q.11 Are you satisfied with your car?

Not at all ← ☐ ☐ ☐ ☐ ☐ ☐ ☐ → Yes, very much

Q.12 Do you regret having bought a car?

Not at all ← ☐ ☐ ☐ ☐ ☐ ☐ ☐ → Yes, very much

**Section A is Finished, Please skip Section B and go to Section C**

**FOR NON CAR OWNERS**

**SECTION B – ATTITUDE TOWARD CARS**

**Please answer the following questions**

Q.1 How do you think about cars in general?

| No | I think cars..... | Fully disagree | | | neutral | | | Fully agree |
|---|---|---|---|---|---|---|---|---|
| 1. | .....are comfortable. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. | .....allow one to care for others. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. | .....are convenient. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. | .....allow one to travel anytime. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5. | .....are environmentally unfriendly. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6. | .....allow one to travel safely. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 7. | .....are cool. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 8. | .....allow to do adventurous things. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 9. | .....are disturbing one's neighborhood. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 10. | .....allow to express oneself. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 11. | .....helps one to save time for travel. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 12. | ..... are giving arrogant impression. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 13. | .....allow one to be independent. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 14. | .....are trendy. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 15. | .....allow one to pick up or see off others. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 16. | .....are fun to have. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 17. | .....allow one to travel anywhere. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 18. | .....are expensive to own and maintain. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 19. | .....allow to distinguish oneself from others. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 20. | .....brings prestige. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**Section B is Finished, Please Go to Section C**

## SECTION C – DESIRE TO UPGRADE

Please answer the following questions

Q.1. Do you have a motorcycle?

☐ Yes ☐ No ➔ please move to Question 3

Q.2. What kind of motorcycle do you own?

1. Brand _____ (e.g: Honda, Suzuki, etc)
2. Type _____ (e.g: Tiger, Ninja etc)
3. Machine Size _____cc
4. When did you buy it _____
5. How much did you pay for it _____ (approximately)

Q.3. What type of vehicle do you hope to buy in the next 5 years?

1. ☐ Car ☐ Motorcycle
2. Brand _____ (e.g: Honda, BMW, etc)
3. Type _____ (e.g: Xenia, Karimun, Kijang, Tiger, etc)
4. Passenger Size _____person
5. Machine Size _____cc
6. How much do you expect to spend? ca. Rp. _____

Q.4 Why do you desire to buy this particular vehicle?

| No | I think this vehicle will..... | Fully disagree ← | | | neutral | | | → Fully agree |
|---|---|---|---|---|---|---|---|---|
| 1. | .....be comfortable. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. | .....allow me to care for others. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. | .....be convenient. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. | .....allow me to travel anytime. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5. | .....be environmentally friendly. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6. | .....allow me to travel safely. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 7. | .....be cool. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 8. | .....allow me to do adventurous things. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 9. | .....not be disturbing my neighborhood. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 10. | .....allow me to express myself. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 11. | .....help me to save time for travel. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 12. | .....not give arrogant impression. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 13. | .....allow me to be independent. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 14. | .....be trendy. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 15. | .....allow me to pick up or see off others. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 16. | .....be fun to have. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 17. | .....allow me to travel anywhere. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 18. | .....be affordable to own and maintain. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 19. | .....allow to distinguish myself from others. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 20. | .....bring prestige. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

Q.5. Have you had a discussion with somebody about this desired vehicle? (please refer to below column)

| No | People who engaged with you | He/she never talked to me about this car | | | He/she suggested me to buy this car | | | He/she strongly recommended me to buy this car |
|---|---|---|---|---|---|---|---|---|
| 1. | Father | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. | Mother | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. | Partner (Girlfriend/Boyfriend/Spouse) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. | Brother | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5. | Sister | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6. | Grand Parents | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 7. | Other Relatives | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 8. | Neighbor | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 9. | Classmate | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 10. | Student Association Mate | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 11. | Lecturer | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 12. | Friends | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 13. | Online Friend (facebook, twitter, blog,etc) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 14. | Advertisement (Salesman) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

Q.6. Are there other sources that give you information about this vehicle?

| No | Sources | No Influence | | | neutral | | | Strong Influence |
|---|---|---|---|---|---|---|---|---|
| 1. | Newspaper | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. | TV Commercial | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. | Radio Commercial | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. | Car Expo | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5. | Commercial on Internet | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6. | Other_____ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**Section C is Finished, Please Go to Section D**

## SECTION D – TRAVEL BEHAVIOR

Please answer the following questions

Column A indicates your current status. Column B indicates your status just before you bought a vehicle (car or motorcycle). If there is no change then just put [v] in column (B). If you do not own a car or motorcycle then you do not need to answer column (B)

| No | Question about your commute to University | (A) Present | (B) Just before you bought your current vehicle |
|---|---|---|---|
| Q.1. . | How do you commute to university? (* Walk, Car, Motorbike, PT, Car Pooling, other.....) * Please choose the first letter | | |
| Q.2. | With whom do you usually commute to campus? (Alone, Family, Relatives, FRiends) | | |
| Q.3. | How often do you commute? (Everyday, three times a week, once a week) | | |
| Q.4. | What time usually do you depart from home to university? | | |
| Q.5. | What time usually do you leave university? | | |
| Q.6. | How far do you travel from home to campus? | km | km |
| Q.7. | How long does it take you to travel from home to campus? | | |

| No | Question about your weekends activity | (A) Present | (B) Just before you bought your current vehicle |
|---|---|---|---|
| Q.8. | Where do you usually go on weekends? | | |
| Q.9 | What modes do you mostly use for weekend activities? (Walk, Car, Motorbike, PT, Car Pooling, Other.....) | | |

| No | Question about your other weekdays activities | (A) Present | (B) Just before you bought your current vehicle |
|---|---|---|---|
| Q.10. | Where do you usually go shopping? | | |
| Q.11 | Where do you go after campus activities finished? | | |

**Section D is Finished, Please Go to Section E**

## SECTION E – PUBLIC TRANSPORT PERCEPTION

**Please answer the following questions**

Q. 1. What do you think about current Public Transport (PT) in Bandung?

| I think current PT in Bandung is..... | Totally disagree ← | | | neutral | | | → Fully agree |
|---|---|---|---|---|---|---|---|
| .....Cheap | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| .....Fast | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| .....Reliable | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| .....Convenient | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| .....Offers good route alternatives | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

Q.2. Is it possible for you to commute using public transport?

| Not at all ← | | | Fairly o.k. | | | → Yes, it's very easy by PT |
|---|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

Q.3. How often do you use public transport per week? _____

Q.4. Do you think that you would use PT more if it would improve?

| Definitely no ← | | | maybe | | | → Definitely yes |
|---|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

Q.5. Do you have any comments on PT or the current traffic conditions in Bandung?

**Section E is Finished, Please Go to Section F**

## SECTION F – DEMOGRAPHIC

**Please answer the following questions.**

| No | Question | (A) Present | (B) When you bought your current vehicle |
|---|---|---|---|
| Q.1. | Please state your age | year | year |
| Q.2. | What is your monthly income (rough estimation)<br>Please chose between one of these 5 options and circle it | Rp.0-Rp.500,000 | Rp.0-Rp.500,000 |
| | | Rp.500,000-Rp.1,000,000 | Rp.500,000-Rp.1,000,000 |
| | | Rp.1,000,000-Rp.2,500,000 | Rp.1,000,000-Rp.2,500,000 |
| | | Rp.2,500,000-Rp.5,000,000 | Rp.2,500,000-Rp.5,000,000 |
| | | >Rp.5,000,000 | >Rp.5,000,000 |
| Q.3. | How many hours per week do you work? Indicate an hours per week (Indicate 0 for no job) | | |
| Q.4. | Where do you live? (area, post code) | | |
| Q.5. | House status (Private, Rent, Boarding house, Dormitory, Other) | | |
| Q.6. | With whom do you stay? (Alone, Family, Relatives, FRiends) | | |
| Q.7. | What student association or activity units do you belong to? (If you don't belong to any indicate 0). | | |
| Q.8. | How often do you visit your student association or unit activity room? (give answer in times per week) | | |
| Q.9. | Sex (Male/Female) | | |
| Q.10. | Where do you come from?<br>(hometown/province) | | |
| Q.11. | Since when do you have a driving license? | Type A (4 Wheel) | |
| | | Type C (2 Wheel) | |

**This is the end of the questionnaire.** If you have any other comments about car ownership, driving or this questionnaire in general, please use below space.

***Thank you for your support!***

## 2. Questionnaire for Chapter 5-6

This questionnaire shown here is one of the examples in English version

# Car Usage and Ownership Survey

## INTRODUCTION

CAR USAGE AND OWNERSHIP SURVEY

Information about This Survey

This research study is being conducted by researchers at the American University of Beirut, University of California – Berkeley, and Kyoto University to understand car purchase and usage decisions of university students across different cultures. Since the study is cross-cultural, certain questions or terminology may be inapplicable in your context. The information we collect from you will help us suggest ways to improve transportation services and alternatives to the car in the future.

The survey is expected to take about 10 minutes to complete. Your participation in this study is completely voluntary. The survey is anonymous and data collected will be kept strictly confidential. Only aggregated results will be used in any report on the survey.

The opportunity to take part in the survey has been sent to all AUB students. For any questions about your rights as a research subject, you may contact the Institutional Research Board at the American University of Beirut at 01-350000 Extension 5440.

For further information about the study itself, you may contact:

Professor Maya Abou Zeid

Civil and Environmental Engineering

ma202@aub.edu.lb

Your experience is important to us! If you are willing to fill out this survey, please click on the "Next" button below.

I understand that by clicking on the "Next" button below, I will be agreeing to participate in the survey. I also understand that I may refuse to participate or withdraw from the survey without penalty or other consequences

.

## INTRODUCTION

***1. What is your current status?**

- ◯ Undergraduate Student
- ◯ Master Student
- ◯ Doctoral Student
- ◯ Other (please specify)

## INTRODUCTION

Page 1

## Car Usage and Ownership Survey

***2. In what year in school/university are you now?**

- ◯ First year
- ◯ Second year
- ◯ Third year
- ◯ Fourth year
- ◯ Higher

***3. In which country are you studying right now?**

- ◯ Indonesia
- ◯ Japan
- ◯ Korea
- ◯ Lebanon
- ◯ Mainland, China
- ◯ Taiwan
- ◯ United States
- ◯ Other (please specify)

## SECTION A – ATTITUDE TOWARD CARS

In this section, we would like to know how you think about CARS IN GENERAL.

## Car Usage and Ownership Survey

***4. I think in general cars.....**

| | Strongly Disagree | Disagree | Somewhat Disagree | Neutral | Somewhat Agree | Agree | Strongly Agree |
|---|---|---|---|---|---|---|---|
| are comfortable | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| allow one to care for others | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| are convenient | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| give freedom to travel anytime | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| are environmentally friendly | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| allow one to travel safely | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| are cool | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| allow one to do adventurous things | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| are disturbing one's neighborhood | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| allow to express oneself | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| help one to save time when making a trip | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| are giving an arrogant impression | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| allow one to be independent | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| are trendy | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| are useful to pick up or drop off others | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| are fun to have | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| allow one to travel anywhere | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| are expensive to own and maintain | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| allow to distinguish oneself from others | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| bring prestige | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

## SECTION B – CAR & OTHERS

In this section, we would like to know what other people around you think about owning a car.

***5. Did you grow up with a car at your house?**

◯ Yes

◯ No

## Car Usage and Ownership Survey

***6. What percentages of people in these categories have a car?**

| | Less than 25% | 25-50% | 50-75% | More than 75% |
|---|---|---|---|---|
| Your family members and relatives (excluding your parents) | ◯ | ◯ | ◯ | ◯ |
| Your close friends | ◯ | ◯ | ◯ | ◯ |
| Your classmates, friends & peers at university | ◯ | ◯ | ◯ | ◯ |
| People in your neighborhood | ◯ | ◯ | ◯ | ◯ |
| People in your province/state | ◯ | ◯ | ◯ | ◯ |

***7. Does your partner (girlfriend/boyfriend/spouse) have his/her own car mostly for his/her personal use?**

◯ Yes

◯ No

◯ Not applicable

**8. To what extent, does each of the following groups expect you to buy a car within the next 10 years? (if it is not applicable, please leave it empty)**

| | They strongly expect me not to buy a car | They expect me not to buy a car | They have a little bit expectation of me not to buy a car | They have no expectation | They have a little bit expectation of me to buy a car | They expect me to buy a car | They strongly expect me to buy a car |
|---|---|---|---|---|---|---|---|
| Your parents | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Your partner | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Your family members and relatives | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Your close friends | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Your classmates, friends & peers at university | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| People in your neighborhood | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| People in your province/state | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

## Car Usage and Ownership Survey

**9. Please rate on a scale per 1 - 7, how important the following groups are to your decision regarding buying a car in the future**

| | |
|---|---|
| Your parents | ☐ |
| Your partner | ☐ |
| Your family members and relatives | ☐ |
| Your close friends | ☐ |
| Your classmates, friends & peers at university | ☐ |
| People in your neighborhood | ☐ |
| People in your province/state | ☐ |

***10. Please rate your level of agreement with the following statements. In my city,.....**

| | Strongly Disagree | Disagree | Somewhat Disagree | Neutral | Somewhat Agree | Agree | Strongly Agree |
|---|---|---|---|---|---|---|---|
| It is a no brainer to have a car | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I feel that there is social pressure to have a car here | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| transport modes other than car (walking, bike and public transport) are looked down upon | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| the majority of people think that having a car is the right thing to do | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I think people should use cars less | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I feel guilty having a car | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

***11. Please rate your level of agreement with the following statements.**

| | Strongly Disagree | Disagree | Somewhat Disagree | Neutral | Somewhat Agree | Agree | Strongly Agree |
|---|---|---|---|---|---|---|---|
| It is important for me to be similar to others in my community | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I tend to rely on others when I have to make an important decision quickly | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I prefer to make my own way in life rather than find a group I can follow | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

## SECTION C - YOUR TRAVEL PATTERNS AND EXPERIENCES

In this section, we would like to ask a few questions about your travel patterns and experiences.

## Car Usage and Ownership Survey

**12. What do you think about the current public transport (bus, service) in the place you live?**

| | Strongly Disagree | Disagree | Somewhat Disagree | Neutral | Somewhat Agree | Agree | Strongly Agree |
|---|---|---|---|---|---|---|---|
| I get annoyed by long waiting times at stops | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| The service is convenient | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| The vehicles are dirty | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| The drivers drive carelessly | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I feel unsafe using public transport | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| The service network is confusing | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| The service is efficient | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| The service covers the city area well | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| The service is unreliable | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I get annoyed by minibuses/buses/shuttles/service stopping everywhere they like (if applicable where you live) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

***13. Is it possible for you to commute to/from university using public transport (PT)?**

☐

***14. Please consider your most common commuting, shopping and leisure trips.**

| | With whom do you most frequently travel? | How far do you travel for this trip (one way)? | Which transportation mode do you most frequently use? |
|---|---|---|---|
| Commuting to university | ☐ | ☐ | ☐ |
| Shopping activity | ☐ | ☐ | ☐ |
| Leisure activity | ☐ | ☐ | ☐ |

***15. My intention to use public transport more for everyday trips is.....**

☐

***16. My intention to use bike or walking more for everyday trips is.....**

☐

***17. I have given it serious thought whether I can use my car less.**

☐

## SECTION D – FUTURE DECISIONS

In this section, we would like to know your thoughts about buying a car in the future.

## Car Usage and Ownership Survey

**18. Do you have a dream car you would like to own in the future?**

- ◯ No
- ◯ Yes (please specify model/brand)

***19. Now realistically, and assuming you will buy a car in the future, please rate how likely you are to buy the following type of car for your next car.**

| | Very unlikely | Unlikely | Somewhat unlikely | Undecided | Somewhat likely | Likely | Very likely |
|---|---|---|---|---|---|---|---|
| Small | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Mid-size | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Large | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Luxury | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Sports | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Hybrid | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Electric | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

***20. Assuming that you will continue to live in the city you are living now, how likely are you to buy a car in the next 10 years (even if you already have one)?**

[ ]

## SECTION D – FUTURE DECISIONS

***21. At what point in time do you think you will buy it? (Please tick one of the following answers)**

- ◯ before graduation
- ◯ immediately after graduation
- ◯ within 2 years after graduation
- ◯ more than 2 years after graduation

***22. What would happen to your current car? (Please tick one of the following answers)**

- ◯ Currently I do not have any car
- ◯ I might sell it when I buy a different car
- ◯ I will keep it regardless of when I buy my next car
- ◯ I might sell it before I buy a new car
- ◯ I might sell it probably two years or more after I buy a new car

## Car Usage and Ownership Survey

**23. Do you already have a specific brand and type of car in mind you want to buy in the future? (not a dream but realistically)**

Brand (e.g: Honda, Toyota, etc)

Type (e.g: Civic, etc)

## SECTION E - YOUR CURRENT CAR OWNERSHIP AND USAGE

In this section, we would like to know about your current car ownership and usage.

***24. Do you use a car regularly (at least two days per week) either as driver or passenger?**
**(Please tick one of the following answers)**

- ◯ Yes, as a driver
- ◯ Yes, as a passenger
- ◯ No, I do not have access to a car
- ◯ No, even though I have access to a car

## SECTION E - YOUR CURRENT CAR OWNERSHIP AND USAGE

***25. How satisfied are you with the car you use regularly?**
**(if you use more than one car regularly, please refer to the car you use most of the time)**

- ◯ Very dissatisfied
- ◯ Dissatisfied
- ◯ Somewhat dissatisfied
- ◯ Neither satisfied not dissatisfied
- ◯ Somewhat satisfied
- ◯ Satisfied
- ◯ Very satisfied

***26. Who is the owner of the car you use regularly? (Please tick one of the following answers)**

- ◯ My car and for my personal use only
- ◯ My car but occasionally my family uses it
- ◯ My family car
- ◯ My friend/colleague whom I share a house with
- ◯ My friend/colleague whom I do not share a house with
- ◯ My partner

## Car Usage and Ownership Survey

***27. Who bought this car?**

- ◯ Me
- ◯ My Family
- ◯ Other (please specify)

***28. Can you specify this car that you use regularly?**

Brand (e.g: Honda, Toyota, etc) _____

Type (e.g: Civic, etc) _____

In which year was it bought? _____

How much did it cost? _____

***29. Do you regret having bought this type of car?**

- ◯ Not at all
- ◯ No
- ◯ Not really
- ◯ Indifferent
- ◯ Yes, a little bit
- ◯ Yes
- ◯ Yes, very much

***30. Do you regret having bought a car at all?**

- ◯ Not at all
- ◯ No
- ◯ Not really
- ◯ Indifferent
- ◯ Yes, a little bit
- ◯ Yes
- ◯ Yes, very much

**31. In total, how much do you use this car per week? (rough estimate in km or miles)**

km _____

miles _____

## SECTION F - INFORMATION ABOUT YOU (FINAL SECTION)

The following questions are to ensure that we have a representative sample of university students in each country of

study.

**32. What is your gender?**

- ◯ Female
- ◯ Male

**33. Please state your age and nationality**

Age _____

Nationality _____

***34. What is your own personal monthly budget/income?**

**If in US$, please choose between one of these following categories**

- ◯ US$ 0-500
- ◯ US$ 500 – 1,000
- ◯ US$ 1,000 – 1,500
- ◯ US$ 1,500 – 2,000
- ◯ US$ 2,000 – 2,500
- ◯ US$ 2,500 – 3,000
- ◯ More than US$ 3,000
- ◯ Decline to answer
- ◯ If in other currency, please provide estimate: _____

## Car Usage and Ownership Survey

***35. What is approximately your total monthly family income? (rough estimation of your income plus that of parents/siblings or spouse)**

**If in US$, please choose between one of these following categories**

- ◯ US$ 0 – 1,500 (annual: US$ 0 – 18,000)
- ◯ US$ 1,500 – 3,000 (annual: US$ 18,000 – 36,000)
- ◯ US$ 3,000 – 4,500 (annual: US$ 36,000 – 54,000)
- ◯ US$ 4,500 – 6,000 (annual: US$ 54,000 – 72,000)
- ◯ US$ 6,000 – 7,500 (annual: US$ 72,000 – 90,000)
- ◯ US$ 7,500 – 9,000 (annual: US$ 90,000 – 108,000)
- ◯ US$ 9,000 – 10,500 (annual: US$ 108,000 – 126,000)
- ◯ US$ 10,500 – 12,000 (annual: US$ 126,000 – 144,000)
- ◯ More than US$ 12,000 (annual: more than US$ 144,000)
- ◯ Do not know / Decline to answer
- ◯ If in other currency, please provide estimate:

**36. In what type of dwelling unit do you currently live?**

- ◯ Dormitory
- ◯ Apartment
- ◯ Single family house
- ◯ Other (please specify)

**37. What is the address of your current residence? (town/city)**

**38. With whom do you currently live?**

- ◯ Alone
- ◯ Friends
- ◯ Family
- ◯ Relatives
- ◯ Partner

**39. Including yourself, how many persons live in the house where you currently live (if dormitory, include only people living in your unit)?**

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## Car Usage and Ownership Survey

***40. Do you have a motorcycle?**

- ◯ Yes
- ◯ No

***41. Do you have a bicycle?**

- ◯ Yes
- ◯ No

***42. Do you have a driving license?**

- ◯ Yes
- ◯ No

**43. Where do you come from?**
**(hometown)**

town/city

country

**44. Please specify the town/city and country of your high school.**

town/city

country

**45. This is the end of the questionnaire. If you have any other comments about car ownership, driving or this questionnaire in general, please use the space below.**

# Appendix B.

## 1. Legend

| Code | Variables | Code | Variables | Code | Variables |
|---|---|---|---|---|---|
| Y1 | Car Ownership | f1 | Symbolic affective | f2 | Arrogant prestige |
| f3 | Independence | f4 | Comfort | f5 | Social/Env Care |
| x1 | Cars are cool | x9 | Cars help one to save time for travel | x17 | Cars allow one to care for others |
| x2 | Cars are trendy | x10 | Cars allow one to travel anywhere | x18 | Cars are environmentally friendly |
| x3 | Cars allow to express oneself | x11 | Cars allow one to travel anytime | x41 | Commuting Distance |
| x4 | Cars are giving arrogant impression | x12 | Cars allow one to be independent | x42 | PT is Reliable |
| x5 | Cars allow to distinguish oneself from others | x13 | Cars allow one to travel safely | x43 | Frequency of using PT |
| x6 | Cars are expensive to own and maintain | x14 | Cars are comfortable | x44 | Monthly Income |
| x7 | Cars are disturbing one's neighbourhood | x15 | Cars allow one to pick up or see off others | x45 | PT is fast |
| x8 | Cars brings prestige | x16 | Cars are fun to have | | |

## 2. MPlus Model Specification for Section 4.3 Model 1

```
INPUT INSTRUCTIONS
VARIABLE:
    NAMES ARE y1 x1 x2 x3 x4 x5 x6 x7 x8 x9 x10 x11 x12 x13 x14 x15x16 x17 x18 x41 x42 x43 x44 x45;
    USEVARIABLES y1 x1-x18 x41 x42 x43 x44 x45;
    CATEGORICAL y1;
ANALYSIS:ESTIMATOR IS WLSMV;MODEL = NOCOVARIANCES;
MODEL:f1 BY x1 x2 x3;f2 BY x4 x5 x6 x7 x8;f3 BY x9 x10 x11 x12;f4 BY x13 x14 x15 x16; f5 BY x17 x18;x41 ON x44;x43 ON x41;y1 ON
f1 f2 f3 f4 f5 x41 x42 x43 x44 x45;f1 BY x1@1;f2 BY x4@1;f3 BY x9@1;f4 BY x13@1;f5 BY x17@1;x42 WITH x44@0; x42 WITH x45@0;x44
WITH x45@0;
OUTPUT:MODINDICES (ALL); STANDARDIZED(ALL);
```

## 3. MPlus Model Specification for Section 4.3 Model 2

```
INPUT INSTRUCTIONS
VARIABLE:
    NAMES ARE y1 x1 x2 x3 x4 x5 x6 x7 x8 x9 x10 x11 x12 x13 x14 x15x16 x17 x18 x41 x42 x43 x44 x45;
```

```
    USEVARIABLES y1 x4-x12 x17 x18 x41 x42 x43 x44;
    CATEGORICAL y1;
ANALYSIS:ESTIMATOR IS WLSMV;MODEL = NOCOVARIANCES;
MODEL:f2 BY x4 x5 x6 x7 x8;f3 BY x9 x10 x11 x12;f5 BY x17 x18;x41 ON x44;x43 ON x41;f3 ON x44;y1 ON f2 f3 f5 x41 x42 x43 x44;
f2 BY x4@1;f3 BY x9@1;f5 BY x17@1;x42 WITH x44@0;F3 WITH F2;F5 WITH F3;F5 WITH F2;
OUTPUT:MODINDICES (ALL); TECH5; STANDARDIZED(ALL);
```

### 4. MPlus Model Specification for Section 4.3 Model 3

```
INPUT INSTRUCTIONS
VARIABLE:
    NAMES ARE y1 x1 x2 x3 x4 x5 x6 x7 x8 x9 x10 x11 x12 x13 x14 x15x16 x17 x18 x41 x42 x43 x44 x45;
    USEVARIABLES y1 x4-x12 x41 x42 x43 x44;
    CATEGORICAL y1;
ANALYSIS:ESTIMATOR IS WLSMV;MODEL = NOCOVARIANCES;
MODEL:f2 BY x4 x5 x6 x7 x8;f3 BY x9 x10 x11 x12;x41 ON x44;x43 ON x41;f3 ON x44;y1 ON f2 f3 x41 x42 x43 x44;f2 BY x4@1;f3 BY
x9@1;x42 WITH x44@0;F3 WITH F2;
OUTPUT:MODINDICES (ALL); TECH5; STANDARDIZED(ALL); SAMPSTAT;
```

# Appendix C.

## BIOGEME Model Specification (OHCM Model 1)

```
# OHCM All variables model specification

from biogeme import *from headers import *from loglikelihood import *from statistics import *from distributions import *

#Parameters to be estimated# Arguments:# - 1 Name for report; Typically, the same as the variable.#- 2 Starting value.# - 3 Lower bound.# - 4 Upper bound.# - 5 0: estimate the parameter, 1: keep it fixed.

### Parameters of the choice modelB_Symb = Beta('B_Symb',0.218995,-10000,10000,0 )B_Indpnd = Beta('B_Indpnd',0.255928,-10000,10000,0 )B_Eoa = Beta('B_Eoa',0.407211,-10000,10000,0 )B_RegularCarUse = Beta('B_RegularCarUse',0.666033,-10000,10000,0 )B_Inc = Beta('B_Inc',0.203608,-10000,10000,0 )B_Inc_dum = Beta('B_Inc_dum',0.299434,-10000,10000,0 )

### Parameters of the latent variable model: Variable SYMBAFFb_sigma_Symb = Beta('b_sigma_Symb',0.916906,0.0001,10000,0 )# Cars are coolb_lambda07 = Beta('b_lambda07',1,-1000,1000,1 )b_sigma07 = Beta('b_sigma07',1.03584,0.0001,1000,0 )# Cars allow to express oneselfb_lambda10 = Beta('b_lambda10',0.989911,-1000,1000,0 )b_sigma10 = Beta('b_sigma10',1.12174,0.0001,1000,0 )# Cars are trendyb_lambda14 = Beta('b_lambda14',0.98645,-1000,1000,0 )b_sigma14 = Beta('b_sigma14',1.08169,0.0001,1000,0 )# Cars bring prestigeb_lambda20 = Beta('b_lambda20',1.23642,-1000,1000,0 )b_sigma20 = Beta('b_sigma20',1.08574,0.0001,1000,0 )# Cars allow to distinguish oneself from othersb_lambda19 = Beta('b_lambda19',1.25091,-1000,1000,0 )b_sigma19 =Beta('b_sigma19',0.956128,0.0001,1000,0 )# Cars are fun to haveb_lambda16 = Beta('b_lambda16',0.896763,-1000,1000,0 )b_sigma16 = Beta('b_sigma16',1.13501,0.0001,1000,0 )

### Parameters of the latent variable model: Variable INDPNDb_sigma_Indpnd = Beta('b_sigma_Indpnd',1.11033,0.0001,10000,0 )# Cars are convenientb_lambda03 = Beta('b_lambda03',0.681371,-1000,1000,0 ) b_sigma03 = Beta('b_sigma03',0.779286,0.0001,1000,0 )# Cars allow one to travel anytimeb_lambda04 = Beta('b_lambda04',1,-1000,1000,1 )b_sigma04 = Beta('b_sigma04',0.690067,0.0001,1000,0 )# Cars allow one to be Independentb_lambda13 = Beta('b_lambda13',0.498062,-1000,1000,0 )b_sigma13 = Beta('b_sigma13',1.32985,0.0001,1000,0 )# Cars allow one to travel anywhere

b_lambda17 = Beta('b_lambda17',0.647844,-1000,1000,0 )b_sigma17 = Beta('b_sigma17',1.171,0.0001,1000,0 )

### Parameters of the latent variable model: Variable EOAb_sigma_Eoa = Beta('b_sigma_Eoa',1.18348,0.0001,10000,0 )# Your parentsb_lambda21 = Beta('b_lambda21',1,-1000,1000,1 )b_sigma21 = Beta('b_sigma21',1.03195,0.0001,1000,0 )# Your partnerb_lambda22 = Beta('b_lambda22',0.894012,-1000,1000,0 )b_sigma22 = Beta('b_sigma22',0.993016,0.0001,1000,0 )# Your family members and relativesb_lambda23 = Beta('b_lambda23',1.02054,-1000,1000,0 )b_sigma23 = Beta('b_sigma23',0.762703,0.0001,1000,0 )# Your close friendsb_lambda24 = Beta('b_lambda24',1.08095,-1000,1000,0 )b_sigma24 = Beta('b_sigma24',0.630965,0.0001,1000,0 )# Your classmates, friends &amp;amp; peers at universityb_lambda25 = Beta('b_lambda25',1.00871,-1000,1000,0 )b_sigma25 = Beta('b_sigma25',0.615401,0.0001,1000,0 )# People in your neighbourhoodb_lambda26 = Beta('b_lambda26',0.798586,-1000,1000,0 ) b_sigma26 = Beta('b_sigma26',0.780527,0.0001,1000,0 )# People in your province/stateb_lambda27 = Beta('b_lambda27',0.753078,-1000,1000,0 )b_sigma27 = Beta('b_sigma27',0.884525,0.0001,1000,0 )
```

#Attitude structural modelomega_Symb = bioNormalDraws('omega_Symb')omega_Indpnd = bioNormalDraws('omega_Indpnd') omega_Eoa = bioNormalDraws('omega_Eoa')SYMBAFF = b_sigma_Symb * omega_Symb INDPND = b_sigma_Indpnd * omega_Indpnd EOA = b_sigma_Eoa * omega_Eoa

#Attitude measurement equations

####SYMBAFF# Cars are coolQ1_7_dev = Q1_7 - 4.8096013019M07 = b_lambda07 * SYMBAFF L07 = likelihoodregression(Q1_7_dev,M07,b_sigma07)# Cars allow to express oneselfQ1_10_dev = Q1_10 - 4.0398698129M10 = b_lambda10 * SYMBAFFL10 = likelihoodregression(Q1_10_dev,M10,b_sigma10)# Cars are trendyQ1_14_dev = Q1_14 - 4.8096013019 M14 = b_lambda14 * SYMBAFFL14 = likelihoodregression(Q1_14_dev,M14,b_sigma14)# Cars bring prestigeQ1_20_dev = Q1_20 - 4.1147274207M20 = b_lambda20 * SYMBAFFL20 = likelihoodregression(Q1_20_dev,M20,b_sigma20)# Cars allow to distinguish oneself from othersQ1_19_dev = Q1_19 - 4.051261188M19 = b_lambda19 * SYMBAFFL19 =likelihoodregression(Q1_19_dev,M19,b_sigma19)# Cars are fun to haveQ1_16_dev = Q1_16 - 5.0471928397M16 = b_lambda16 * SYMBAFFL16 = likelihoodregression(Q1_16_dev,M16,b_sigma16)

####INDPND# Cars are convenientQ1_3_dev = Q1_3 - 5.8991049634M03 = b_lambda03 * INDPNDL03 = likelihoodregression(Q1_3_dev,M03,b_sigma03)# Cars allow one to travel anytimeQ1_4_dev = Q1_4 - 5.8120423108 M04 = b_lambda04 * INDPNDL04 = likelihoodregression(Q1_4_dev,M04,b_sigma04)# Cars allow one to be Independent Q1_13_dev = Q1_13 - 5.1936533767M13 = b_lambda13 * INDPNDL13 = likelihoodregression(Q1_13_dev,M13,b_sigma13) # Cars allow one to travel anywhereQ1_17_dev = Q1_17 - 5.4011391375M17 = b_lambda17 * INDPNDL17 = likelihoodregression(Q1_17_dev,M17,b_sigma17)

####EOA# Your parentsQ2_1_dev = Q2_1 - 5.21521175453759M21 = b_lambda21 * EOAL21 = (Q2_1==0) * 1.0 + (Q2_1!=0) * likelihoodregression(Q2_1_dev,M21,b_sigma21)# Your partnerQ2_2_dev = Q2_2 - 4.74769230769231M22 = b_lambda22 * EOA L22 = (Q2_2==0) * 1.0 + (Q2_2!=0) * likelihoodregression(Q2_2_dev,M22,b_sigma22)# Your family members and relatives Q2_3_dev = Q2_3 - 4.92732049036777M23 = b_lambda23 * EOAL23 = (Q2_3==0) * 1.0 + (Q2_3!=0) * likelihoodregression(Q2_3_dev,M23,b_sigma23)# Your close friendsQ2_4_dev = Q2_4 - 4.82127288578901M24 = b_lambda24 * EOA L24 = (Q2_4==0) * 1.0 + (Q2_4!=0) * likelihoodregression(Q2_4_dev,M24,b_sigma24)# Your classmates, friends & peers at universityQ2_5_dev = Q2_5 - 4.67985927880387M25 = b_lambda25 * EOAL25 = (Q2_5==0) * 1.0 + (Q2_5!=0) * likelihoodregression(Q2_5_dev,M25,b_sigma25)# People in your neighbourhoodQ2_6_dev = Q2_6 - 4.39004524886878 M26 = b_lambda26 * EOAL26 = (Q2_6==0) * 1.0 + (Q2_6!=0) * likelihoodregression(Q2_6_dev,M26,b_sigma26)# People in your province/stateQ2_7_dev = Q2_7 - 4.41429880843264M27 = b_lambda27 * EOAL27 = (Q2_7==0) * 1.0 + (Q2_7!=0) * likelihoodregression(Q2_7_dev,M27,b_sigma27)

tau1 = Beta('tau1',-3.0499,-10000,10000,0,"$¥tau_1$")delta1 = Beta('delta1',1.02522,0,10000,0,"$¥delta_1$")delta2 = Beta('delta2',0.712719,0,10000,0,"$¥delta_2$")delta3 = Beta('delta3',0.830886,0,10000,0,"$¥delta_3$")delta4=Beta('delta4',1.05567,0,10000,0,"$¥delta_4$")delta5 = Beta('delta5',1.30849,0,10000,0,"$¥delta_5$"); tau2 = tau1 + delta1; tau3 = tau2 + delta2; tau4 = tau3 + delta3; tau5 = tau4 + delta4; tau6 = tau5 + delta5

mu_dev = Beta('mu_dev',1,0,10000,1)mu_nondev = Beta('mu_nondev',1,0,10000,0)

# Choice model#[Utilities]U = mu_dev * DEVCOUNT * B_Symb * SYMBAFF + mu_dev * DEVCOUNT * B_Indpnd * INDPND +

mu_dev * DEVCOUNT * B_Eoa * EOA + mu_dev * DEVCOUNT * B_RegularCarUse * RegularCarUse + mu_dev * DEVCOUNT * B_Inc * Inc + mu_dev * DEVCOUNT * B_Inc_dum * Inc_dum + mu_nondev * NONDEVCOUNT * B_Symb * SYMBAFF + mu_nondev * NONDEVCOUNT * B_Indpnd * INDPND + mu_nondev * NONDEVCOUNT * B_Eoa * EOA + mu_nondev * NONDEVCOUNT * B_RegularCarUse * RegularCarUse + mu_nondev * NONDEVCOUNT * B_Inc * Inc + mu_nondev * NONDEVCOUNT * B_Inc_dum * Inc_dum

ChoiceProba = { 1: 1-logisticcdf(U-tau1),2: logisticcdf(U-tau1)- logisticcdf(U-tau2),3: logisticcdf(U-tau2)- logisticcdf(U-tau3), 4: logisticcdf(U-tau3)- logisticcdf(U-tau4),5: logisticcdf(U-tau4)- logisticcdf(U-tau5),6: logisticcdf(U-tau5)- logisticcdf(U-tau6),7: logisticcdf(U-tau6) }

# The choice model is a logit, with availability conditionscondchoiceprob = Elem(ChoiceProba,LIKELIHOODTBCAR)

# Probability of choice and indicatorscondprob = condchoiceprob * L07 * L10 * L14 * L20 * L19 * L16 * L03 * L04 * L13 * L17 * L21 * L22 * L23 * L24 * L25 * L26 * L27

# Estimation#Iterator on draws for Monte-Carlo simulationdrawIterator('drawIter')

# Integration by simulationprob = Sum(condprob,'drawIter')

# Defines an iterator on the datarowIterator('obsIter')

# Define the likelihood function for the estimationBIOGEME_OBJECT.ESTIMATE = Sum(log(prob),'obsIter')BIOGEME_OBJECT.PARAMETERS['optimizationAlgorithm'] = "CFSQP"; BIOGEME_OBJECT.PARAMETERS['cfsqpMaxIter'] = "3000"; BIOGEME_OBJECT.PARAMETERS['NbrOfDraws'] = "10000"; BIOGEME_OBJECT.PARAMETERS['numberOfThreads'] = "4"; BIOGEME_OBJECT.PARAMETERS['moreRobustToNumericalIssues'] = "1"; BIOGEME_OBJECT.PARAMETERS['RandomDistribution'] = "HALTON"