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Modelling social norms: Case study of students' car purchase intentions

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ABSTRACT

In this paper we aim to quantify the influence of *social norms* on car ownership intention by estimating ordered hybrid choice models (OHCM) with car purchase intention as dependent variable. Our sample consists of 1229 university students from three developed and four developing countries. We construct *subjective social norms* (*SSN*) by interacting the perceived expectation to buy a car with motivation to comply with the expectation. Four approaches to incorporate social norms into OHCM are presented while controlling for other explanatory variables such as attitudes and socio-demographics. From the four estimated models we find that social norms significantly correlate with car purchase intention. Though differently defined in the four models, we find similar parameter estimates in all models, which leads us to conclude that the effect is fairly robust even with simplified definitions. From a model with person-group specific observed SSN, we further find though that group specific influences can differ significantly and that parents and university peers significantly influence car purchase intention.

1. Introduction

Decisions of all kinds, including car purchase decisions, 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 of 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 behavior related decision-making, the theory of reasoned action (TRA) (Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975), the subsequent theory of planned behavior (TPB) (Ajzen, 1985, 2012; Ajzen and Driver, 1991) and the latest Reasoned Action Approach (RAA) (Fishbein and Ajzen, 2010) were developed. These theories posit that the immediate antecedent of behavior (action/decision) is behavioural intentions (intention/motivation), which in turn have 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 behavior in question as well as the individual's motivation to comply with the expectations of those important others.

The importance of "norms" has been reported as instrumental for a wide range of repeated behaviours in research related to health and environmental friendly behavior. In the field of health, we can refer to work on college students drinking (DeJong et al., 2006; Neighbors et al., 2007) and on smoking behavior (Nyborg and Rege, 2003). Several researchers have successfully investigated and explained the effect of norms on environmental friendly behavior such as Goldstein et al. (2008) on hotel towel re-use, Schultz et al. (2007) on house energy reduction, and some on the case of littering and recycling (Cialdini et al., 1990; Harland et al., 1999). Rivis and Sheeran (2003) review several studies that incorporate the influence of norms on several behavioural intentions such as healthy eating, smoking, and drug use. In transportation research, we can also find the positive influence of norms on transportation behavioural intentions as can be seen from a growing body of literature that is reviewed in the next section.

Since there are several ways of defining social norms related factors for transportation modelling, the question remains, which is a better way for modelling social norms as a determinant of transportation behavioural intentions? How many person

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reference groups should we incorporate in order to find the best representation of *social norms*? These are the key questions motivating this paper. We aim to quantify the influence of *social norms* on transportation behavioural intentions, particularly car purchase intentions of students with different model formulations. Though there is a significant body of literature illustrating the effect of norms, our literature review will show that findings are not coherent and that there is no agreement on the best modelling approach for social norms.

We further emphasize that in this paper we discuss desire for "cars in general" though recent literature has been often on attitudes towards alternative fuel vehicles (AFVs). Our choice is conscious as we believe that car ownership itself, independent of whether it is an AFV or not, remains an important policy topic. We explore *social norms* in more detail by developing ordered hybrid choice models (OHCM) with car purchase intention as dependent variable. Our results are limited to a specific population subgroup, undergraduate students. However, besides the estimation results, we believe the more important contribution of this paper is a methodological discussion on how *social norms* might be estimated and modelled.

The structure of this paper is as follows: Section 2 discusses previous research on the role of social norms in transport planning related literature. In Section 3, we discuss different forms of how we formulate our choice models incorporating *social norms*. In Section 4, we describe how the data were collected and include some descriptive analysis of the data. Section 5 then explains the car purchase intention model and in Section 6 we discuss our findings, conclusions and the implications for transport modelling.

2. Literature review

2.1. Social norms and transportation decisions

Norming effects have been described in various studies with different terms such as mass effects, herd behavior, peer effects, fashion or conformity (Abou-Zeid et al., 2013). Though the terms are partly used interchangeably, the former terms mostly include a notion of dynamics and are associated with modelling the spread of behavior. Instead *social norms* is the term mostly used in social psychology to explain the behavior of an individual which is also our focus here. For a more detailed review on the psychological foundations, with a focus on implications for mobility decisions, we refer the reader again to Abou-Zeid et al. (2013). In the remainder of this section, we focus on empirical evidence for the importance of the influence of others for transportation related decisions.

Thøgersen (2006) explores the correlation between mode choice for different trip purposes and subjective social norms. Subjective social norms (SSN) 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 results show that subjective social norms have a strong correlation with commuting behavior. Closely related, according to Jakobsson et al. (2000), expectations about others' intentions were found to be one determinant of car use reduction. Muñoz et al. (2016) propose a number of cycling indicators based on TPB for their bicycle commuting logistic regression model. They construct a "subjective norms" factor by asking 654 respondents from one city in Spain about the approval of certain specific groups on bicycle commuting as well as the importance of those specific groups on the decision to commute by bicycle. They conclude that subjective norms influence bicycle commuting decision.

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 norms. Their research obtains 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. Partially following on from Bamberg et al. (2007), Zhang et al. (2015) utilize the same approach in Shanghai context and find that SSN might have stronger effects on one's intention in the Asian context compared to Western context. Dharmowijoyo et al. (2015) investigate if subjective norms influence the intention to use motorized vehicle/public transport/non-motorized transport for out-of-home activity in the context of Bandung, Indonesia and find positive significant effect.

Also for the usage/ownership of alternative fuel vehicle (AFV), norming effects appear to be important. Jansson (2011) points out that there is a significant difference in perceived personal and social norms between adopters and non-adopters of AFV in Sweden. Personal and social norms were constructed in his paper by using principal component analysis (PCA) using indicators that emphasize on reducing oil/petrol usage and the use of AFV. The research found that the prevailing norms are to use fossil fueled vehicles. Ozaki and Sevastyanova (2011) analyse the Prius market share in the U.K. They used a sample of 1263 individuals who had purchased a Prius in the 24 months prior to January 2009. They construct two social norm factors based on PCA results. The first one is *social orientation* while the other norms factor is *identity* which is constructed from comments in open comments questions that are related to compliance with norms of the social group and the expression of self. Both of the above studies suggest that social norms are important for AFV purchase decisions, though they do not conduct a regression analysis in order to understand the relative importance of norms.

Moons and De Pelsmacker (2012) use intention to use an electric car as dependent variable in the regression model with a sample of 1199 individuals from Belgium. In their regression analysis they include subjective norms of peers and of media. These were constructed by asking several questions related to peers' expectation and media influence related to electric car. They found that those two norms variables significantly influence electric car intention. They do not though distinguish person groups, the role of perceived expectations and the importance of the group for the respondents which we aim to explore in this paper.

In conclusion, there appears to be some evidence that social norms are an important determinant of mode choice and consequently vehicle ownership choice. What the above studies have though not discussed is how best to implement their social norms construct into a "standard" random utility choice model (RUM) framework where one can better control for a wide range of socio-demographics and attitudinal factors (Kim et al., 2014). Some of their studies relied on structural equation modelling which explains correlation but arguably is less suitable for choice prediction. Achieving the formulation of such a RUM framework (Hybrid Choice Model) with different social norm constructs is precisely the objective of the present study. As a background to this, the following section continues this literature review by pointing out different prevailing norms and discusses how they have been measured.

2.2. Types and measurement of norms

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. Similarly, Cialdini et al. (1990) distinguish two types of norms: descriptive and injunctive norms. Descriptive norms refer to the common behavior 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. In terms of Thøgersen's categorization, norms as discussed in this paper refer 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). Thøgersen (2006) mentions that subjective social norms also strongly correlated with descriptive norms, which is a reason why they are not distinguished at first in TPB (Ajzen, 1991).

In TPB subjective norms are defined as the perceived social pressure to perform or not to perform the behavior in question (Ajzen, 1991, p. 188). TPB includes attitudes towards behavior, subjective norms and perceived behavioural control as factors influencing the intention towards a behavior. Ajzen (1991) distinguishes direct and indirect measures of subjective norms (SN). Direct measures, also known as *Global SN*, are assessed by using two Likert scales with respect to behavior: "Most people who are important to me approve/disapprove of my engaging in this activity" (approve-disapprove) and; "Most people who are important in my life think I should engage in this activity" (likely-unlikely). Then a global measure of SN is obtained by averaging responses to the two scales.

Indirect measures are derived by multiplying normative belief and motivation to comply. Normative beliefs concern the approval or disapproval of important referent groups of an individual performing a certain behavior. For example: "Most persons who are important to me think I should/should not [description of behavior.]" Responses are often measured on a seven-point Likert scale, with scores from +3 (should, extremely) to −3 (should not, extremely). Motivation to comply is a measure of how likely a person wants to do what other person groups think in terms of whether he/she should perform a certain behavior. Responses are often measured on a seven-point Likert scale, with scores from not at all to very much. Then, responses to each scale would be multiplied and summed if multiple specific referents were included. According to Ajzen (1991), empirical investigations have shown that the best correspondence between measurements of subjective norms and *Global SN* is usually obtained with bipolar scoring of normative belief and unipolar scoring of motivation to comply.

In RAA (Fishbein and Ajzen, 2010), norms are distinguished into *injunctive* and *descriptive*. *Injunctive norms* are similarly measured to the way subjective norms are measured in TPB. *Descriptive norms* instead are measured by asking respondents whether they believe that persons important to the respondent perform the behavior or not. In response to RAA, the newest TPB (Ajzen, 2012) also incorporates *descriptive norms*. Interestingly, Ajzen uses both *Subjective Injunctive Norms* and *Subjective Descriptive Norms* as separate determinants of *intention* (de Leeuw et al., 2015).

Most of the empirical studies on social norms and travel behavior discussed earlier have used direct measures of social norms. Fishbein and Ajzen (2010) note though that the measurement of normative beliefs and hence indirect measures of social norms are important for understanding the potential of behavioural changes. This is one motivation why we employ an indirect measure in this paper.

For indirect measures, Fishbein and Ajzen (2010) note that there is considerable empirical evidence that salient *normative belief* can predict *subjective norms*; however, there is far less compelling evidence that motivation to comply contributes to the prediction of *subjective norms*. Ajzen and Driver (1991) demonstrate that *motivation to comply* can have different effects on behavior depending on the reference group. For example, the correlation between behavior and *subjective norms* with *motivation to comply with friends* is smaller than that without *motivation to comply*. An opposite effect is found regarding the effect of *motivation to comply with siblings*. Therefore, in this paper we construct models with and without *motivation to comply*.

To quantify the effect of norms toward intention there are several methods used in the past. Some studies constructed the indirect norm factor(s) by averaging several variables and used that in the regression analysis. For example in transportation research Dharmowijoyo et al. (2015) and Moons and De Pelsmacker (2012) have done so and for other research disciplines we can refer to Astrom and Rise (2001), Conner et al. (1996), and McMillan and Conner (2003). Other studies instead constructed their norm factor by principal component analysis or factor analysis, e.g. Jansson (2011), Muñoz et al. (2016), and Ozaki and Sevastyanova (2011). Rivis and Sheeran (2003) used meta-analysis to measure the effect of descriptive norm and intention on several behavioural intentions such as healthy eating, smoking, and drug use. They refer to 14 previous studies all of which used either averaging or PCA analysis to construct norms.

In transportation research, there are further few studies that simultaneously construct norms and regress these with intentions in a latent choice framework. Examples are Bamberg et al. (2007), Jakobsson et al. (2000) and Zhang et al. (2015). To the best of our knowledge no study though uses a hybrid choice model framework as proposed in Section 3.

2.3. Reference groups for subjective norms (modal normative belief)

An important model specification decision is which reference groups are defined. In a Fishbein and Ajzen (1975) study on choice between different brands of products (coffee, detergents, potato chips, and gasoline), motivation to comply with five referents (mother, friends, husband, consumer reports, and advertising) is measured. They find that the perceived expectations of women's husbands are of particular importance. In a research study about leisure activities, Ajzen and Driver (1991) mention five referents (friends, parents, boyfriends/girlfriend, brothers/sisters, and other family members) in which respondents have to rate their approval or disapproval of their engaging in a given leisure activity. In the study of cigarette behavior, Primack et al. (2007) use three referents (parents, friends, and most people at my age) to measure subjective norms. For the case of subjective norm for marijuana, Zhao et al. (2006) distinguish two types of referents, authority approval (parents, teacher, and grandparents) and peer approval (close friends, boy/girlfriends, and people of the same age). In travel behavior related research, De Pelsmacker and Janssens (2007) utilise five referents (my best friend, my children/parents, my partner, most people that are important to me, and my passenger) whereas Muñoz et al. (2016) utilise three person groups (my family, my friends, and my co-workers/classmates) for constructing subjective norms.

In conclusion, there is no general consensus on which referents are the most appropriate to use. A useful distinction though is between an inner and outer circle of reference groups also in line with Kahn and Antonucci (1980). Therefore, in this paper we define an inner circle as persons that are commonly viewed as important support providers and recipients such as *parents*; *partner*; *family members and relatives*; *close friends*. The outer circle instead

consists of *peers*; *neighbours*; and *other people in the respondent's province/state*.

With this background on the different definitions of norms and reference groups, in the following we discuss how we measure subjective norms and how we incorporate subjective norms in a hybrid choice model.

3. Ordered hybrid choice model

For this paper, the case study is focused on undergraduate students' car purchase intentions. We measure the main dependent variable, students' stated intentions to buy a car in the future (next 10 years), on a 7-point Likert scale (very unlikely–very likely). We note that this variable is similar to "intention" in the Theory of Planned Behavior (TPB) since we also use attitudes and norms as explanatory variables. We define our dependent variables as "cars in general" and not a specific type of car. We believe that people often choose first to own a car or not, then decide on a different car type. In the car ownership modelling research this is in fact the usual assumption, see for example Xu et al. (2015). We acknowledge that with the increasing spread of alternative fuel vehicles there might be some change and that some people might only consider buying AFVs but in general we would argue that the two-step decision approach is still often true.

To control for socio-demographic characteristics, we asked students about their average personal income, their gender and age. We also asked students about their car ownership and car use patterns. In this section, we describe the measurement of social norms and the other explanatory variables and present several ordered hybrid choice (OHCM) formulations which combine latent variable modelling with discrete choice models (Ben-Akiva et al., 2002a; Walker and Ben-Akiva, 2002).

3.1. Respondents

This sub-section is based on Belgiawan et al. (2014) where we use the same sample. In that paper we provide descriptive statistics and discuss car ownership developments in the countries from which the samples are drawn.

All respondents are undergraduate students from a wide variety of disciplines. The data were collected between January and June 2013 in 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. China, particularly 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 paper includes Utrecht, The Netherlands and Berkeley, U.S.A., two cities with very different mobility patterns and spatial organization.

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 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 emails 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. Since most of the respondents come from outside Shanghai, in the subsequent analysis we use China instead. In Berkeley, recruitment was handled by the Experimental Social Science laboratory, and each respondent received a financial incentive for participating. In Beirut, the recruitment was done via emails sent to approximately one third of AUB students (chosen randomly). In Utrecht, 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 2272 undergraduate and graduate students accessed the survey website, of which 1806 completed the survey. For better cross-site comparability, in this paper 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 in a serious manner. This results in a sample size of 1229 used for the analysis below. For more detail about the surveying methods and contexts of our specific sites, please refer to Belgiawan et al. (2014).

3.2. Subjective social norms

To measure person group specific *expectation of others to buy a car* (e_i), the respondents were asked "To what extent does each of the following groups i (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 7-point Likert scale ranging from −3 (they strongly expect me not to buy a car) to 0 (they have no expectation) as middle point and 3 (they strongly expect me to buy a car) as the other end point. As discussed, this is similar to the bipolar measurement of normative belief in TPB.

Motivation to comply (m_i) is measured by asking respondents how important the same seven groups are to their intention regarding buying a car in the future. The responses are again measured on a 7-point Likert scale, this time ranging from 0 (*not at all important*) to 6 (*very much important*).

In line with the previously discussed literature, we interact expectation with motivation to comply. Our rationale is that the expectations of a certain group only become salient if that group is important to the respondent. For example, if parents have a small positive expectation that their child should buy a car, this weak expectation might in fact be a very important determinant due to the overall influence of parents on their child. Therefore, new variables n_i are constructed as shown in Eq. (1) where $i = 1, \ldots, 7$ denotes the person groups that are shown in Table 3 and that we hypothesize to have different influence on the respondent. We remind that the definition of this variable is similar to what Thøgersen (2006) describes as *subjective social norms*. n_i can take values from −18 (strong expectation and motivation to comply for not buying a car) to +18 (strong expectation and motivation to comply for buying a car).

$$n_i = e_i \cdot m_i \tag{1}$$

Since in the TPB literature subjective norms are defined with and without consideration of motivation to comply, we will in

our model test both the summation of expectations only (Eq. (2)) as well as the sum of the subjective social norms over all reference groups (Eq. (3)).

$$\hat{e} = \sum_{i=1}^{7} e_i \tag{2}$$

$$\hat{n} = \sum_{i=1}^{7} n_i \tag{3}$$

We realize that not all students have complete seven reference groups, i.e. some may have no siblings or some may have no partners anymore. Thus, the summation implies that all else being equal, respondents who experience social pressure from more person groups hold stronger subjective norms.

3.3. Further explanatory variables

Table 1 summarises the explanatory variables, their coding as well as their measurement. To control for general attitudes toward cars, we pose 10 statements related to "cars in general" to which respondents have to indicate their level of agreement (7-point Likert scale with verbally defined endpoints "strongly disagree" and "strongly agree"). The statements are as follows: *Cars are cool; Cars allow to express oneself*; *Cars are trendy*; *Cars bring prestige*; *Cars allow to distinguish oneself from others*; *Cars are fun to have*; *Cars are convenient*; *Cars allow one to travel anytime*; *Cars allow one to be independent*; *Cars allow one to travel anywhere*.

These questions were used to construct two factors referred to as *symbolic affective* and *independence*. They are based on a number of previous studies where it has been found that attitudinal factors can explain car purchase intentions (Belgiawan et al., 2016; Steg, 2005; Van and Fujii, 2011). *Symbolic affective* was constructed with the first six attitudinal statements above (indicators) and *independence* with the last four.

Other explanatory variables include monthly income and a dummy variable for those respondents who do not provide income information (equal to 1 if income is missing and 0 otherwise). We also have collected information on family income as students' car purchases as well as purchase intentions might be dependent on the parent's financial situation. Since the average family income variable significantly correlates with personal income of the student though, we decided to omit it to minimize multicollinearity. Monthly income is specified as a continuous variable. Each income category of the respective country is transformed into US$ by using the purchasing power parity conversion factor published by the World Bank (2014). We also control for car usage. We define *regular car use* as using the car at least twice a week.

Given the correlation results and various model tests, we fit a model with two latent variables: *symbolic affective* and *independence,* and their indicator variables as well as three other observed variables: regular car use, income, and income dummy for missing income observations. Income is transformed from ordinal categories into continuous measurement based on the midpoint of the income range associated with each of the seven levels. To distinguish among the seven sites, we add site-specific dummy variables into the model.

The following section discusses that depending on the type of norm formulation the norm factor can be treated as latent variable or as observed variable such as total expectation ($\hat{e}$), and total subjective social norms ($\hat{n}$).

3.4. Model formulation with expectation as in TPB

The model framework can be seen in Fig. 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. In this model, similar to TPB, subjective norms is the sum of all referent groups' expectations.

The systematic utility function for the model with total expectations is as follows (the index for an individual is not shown for simplicity):

$$\begin{aligned}\boldsymbol{V} = (&\beta_{as}\boldsymbol{z}_{as} + \beta_{af}\boldsymbol{z}_{af} + \beta_{\hat{e}}\hat{\boldsymbol{e}} + \beta_{rc}\boldsymbol{x}_{rc} + \beta_{w}\boldsymbol{x}_{w} + \beta_{wd}\boldsymbol{x}_{wd} + \beta_{sa}\boldsymbol{x}_{sa} \\ &+ \beta_{sb}\boldsymbol{x}_{sb} + \beta_{sc}\boldsymbol{x}_{sc} + \beta_{sd}\boldsymbol{x}_{sd} + \beta_{se}\boldsymbol{x}_{se} + \beta_{sf}\boldsymbol{x}_{sf})\end{aligned} \tag{4}$$

where $\boldsymbol{\beta}$ are parameters to be estimated. The total utility in the sense used here refers to the latent response underlying the observed response to the car purchase intention question. It is assumed that all latent variables are normally distributed across the population, i.e. $\mathbf{z}_{as} \sim N(0, \boldsymbol{\sigma}^2_{as})$ and $\mathbf{z}_{af} \sim N(0, \boldsymbol{\sigma}^2_{af})$ and are uncorrelated with each other.[1] The $\boldsymbol{\sigma}^2$ terms are the variances of the latent variables which are to be estimated. Further, it is assumed that the error term of the latent response (or utility as in Fig. 1) underlying the dependent variable car purchase intention is independently and identically distributed with: $\varepsilon \sim \text{Logistic}(0, \pi^2/3)$.

The utility is the sum of the systematic utility and the error term as shown in (Eq. (5)), and the measurement model for car purchase intention (likelihood to buy a car) is given by (Eq. (6)) where the τ parameters are thresholds to be estimated.

$$\boldsymbol{U} = \boldsymbol{V} + \boldsymbol{\varepsilon} \tag{5}$$

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

The psychometric indicators for latent variables $\mathbf{z}_{as}$ (Symbolic Affective) and $\mathbf{z}_{af}$ (Independence) are treated as continuous variables and modelled as follows:

$$\boldsymbol{I}_r = \lambda_r \boldsymbol{z}_{as} + \upsilon_r \quad \text{with } r = 1, \ldots, 6 \tag{7}$$

$$\boldsymbol{I}_r = \lambda_r \boldsymbol{z}_{af} + \upsilon_r \quad \text{with } r = 7, \ldots, 10 \tag{8}$$

where $\upsilon_r \sim N(0, \sigma^2_{\upsilon_r})$, $r = 1, \ldots, 10$, where the variances $\sigma^2_{\upsilon_r}$ are to be estimated. It is assumed that the error terms in (Eqs. (7) and (8)) are uncorrelated. The identification of latent variables is ensured by fixing $\lambda_1 = 1$ (for latent variable Symbolic Affective); and $\lambda_8 = 1$ (for latent variable Independence).

The joint probability of the choice and psychometric indicators is given by:

$$\begin{aligned}P(\boldsymbol{y}, \boldsymbol{I}) = &\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} P(y|\boldsymbol{X}, \hat{\boldsymbol{e}}, \boldsymbol{z}_{as}, \boldsymbol{z}_{af}) g_1(\boldsymbol{I}_1|\boldsymbol{z}_{as}) \ldots \\ &g_6(\boldsymbol{I}_6|\boldsymbol{z}_{as}) g_7(\boldsymbol{I}_7|\boldsymbol{z}_{af}) \ldots g_{10}(\boldsymbol{I}_{10}|\boldsymbol{z}_{af}) f_{as}(\boldsymbol{z}_{as}) f_{af}(\boldsymbol{z}_{af}) d\boldsymbol{z}_{as} d\boldsymbol{z}_{af}\end{aligned} \tag{9}$$

where $P(\mathbf{y}|\mathbf{X}, \hat{\mathbf{e}}, \mathbf{z}_{as}, \mathbf{z}_{af})$ is an ordinal logit model. That is, the probability that y takes level m is given as follows:

$$P(y = m) = F(\tau_m - V) - F(\tau_{m-1} - V) \tag{10}$$

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.

[1] In line with most of the literature on hybrid choice models we assume that the latent constructs are orthogonal/uncorrelated with each other (e.g. Ben-Akiva et al., 2002b; Bolduc and Alvarez-Daziano, 2010).

Table 1
Measurement of observed variables, latent variables and indicators.

Variables		Indicators		Measurement
Latent variables				
$\mathbf{z}_{as}$	Attitudes-Symbolic affective (Cronbachs' alpha = 0.83)	I_1	Cars are cool	1 = strongly disagree
		I_2	Cars allow to express oneself	2 = disagree
		I_3	Cars are trendy	3 = somewhat disagree
		I_4	Cars bring prestige	4 = neutral
		I_5	Cars allow to distinguish oneself from others	5 = somewhat agree 6 = agree
		I_6	Cars are fun to have	7 = strongly agree
$\mathbf{z}_{af}$	Attitudes-Independence (freedom) (Cronbachs' alpha = 0.67)	I_7	Cars are convenient	
		I_8	Cars allow one to travel anytime	
		I_9	Cars allow one to be independent	
		I_{10}	Cars allow one to travel anywhere	
$\mathbf{z}_{n}$	Subjective social norms – SSN (Cronbachs' alpha = 0.83)	I_{11}	Parents	−18 = The person group has a strong expectation that the respondent will not buy a car and the group is extremely important; … ; 0 = No expectation or no influence; … ; 18 = strong expectation and strong influence on purchase motivation
		I_{12}	Partner	
		I_{13}	Family members and relatives	
		I_{14}	Close friends	
		I_{15}	Peers at university	
		I_{16}	People in neighbourhood	
		I_{17}	People in province/state	
Observed variables				
$\mathbf{x}_{rc}$	Regular car use			1: use car at least twice a week; 0: otherwise
$\mathbf{x}_{w}$	Income (wages)	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 (2014). Then the middle point of each category is taken as representative of that category. The right column shows the categories given to students and the midpoint conversion for Berkeley		1 = US$ 0–500 → US$ 250 2 = US$ 500–1000 → US$ 750 3 = US$ 1000–1500 → US$ 1250 4 = US$ 1500–2000 → US$ 1750 5 = US$ 2000–2500 → US$ 2250 6 = US$ 2500–3000 → US$ 2750 7 = More than US$ 3000 → US$ 3500
$\mathbf{x}_{wd}$	Income dummy			1: no answer; 0: otherwise
$\mathbf{x}_{sa}$	Utrecht (site a) dummy			1: respondent is from this site; 0: otherwise
$\mathbf{x}_{sb}$	Japan (site b) dummy			
$\mathbf{x}_{sc}$	Berkeley (site c) dummy			
$\mathbf{x}_{sd}$	Taiwan (site d) dummy			
$\mathbf{x}_{se}$	Indonesia (site e) dummy			
$\mathbf{x}_{sf}$	China (site f) dummy			
$\mathbf{x}_{sg}$	Beirut (site g) dummy			
$\hat{\mathbf{e}}$	Total expectation of others to buy cars			−21…; 0; …21
$\hat{\mathbf{n}}$	Total SSN			−126…; 0; …126

3.5. Alternative formulation with total SSN

The second model that we propose here is similar to the first model above. We replace the variable expectation ($\hat{\mathbf{e}}$) with Total SSN ($\hat{\mathbf{n}}$) as can be seen in Eq. (11).

$$\boldsymbol{V} = (\beta_{as}\boldsymbol{z}_{as} + \beta_{af}\boldsymbol{z}_{af} + \beta_{\hat{n}}\hat{\boldsymbol{n}} + \beta_{rc}\boldsymbol{x}_{rc} + \beta_{w}\boldsymbol{x}_{w} + \beta_{wd}\boldsymbol{x}_{wd} + \beta_{sa}\boldsymbol{x}_{sa} + \beta_{sb}\boldsymbol{x}_{sb} + \beta_{sc}\boldsymbol{x}_{sc} + \beta_{sd}\boldsymbol{x}_{sd} + \beta_{se}\boldsymbol{x}_{se} + \beta_{sf}\boldsymbol{x}_{sf}) \quad (11)$$

The model framework can be seen in Fig. 2 below. Total SSN is the sum of SSN across person groups. The variable enters the model as an observed variable.

3.6. Alternative formulation with SSN as observed variables

In the above formulation one observed *SSN* variable is constructed by summing up the expectations from different population groups *i*. Alternatively, in line with our discussion on distinguishing inner and outer person groups, we also test a model as shown in Fig. 3 where we treat the n_i for a reference group *i* as an observed variable with only one observed variable for each group. The decision to include only one observed variable for each group is to minimize multicollinearity.

3.7. Alternative formulation with SSN as latent variables

The fourth model is similar to the other three models except that the SSN variable here is a latent one. For this model, a single latent construct SSN ($\mathbf{z}_n$) is constructed by using the seven group specific indicators shown in Table 1. The interpretation for this formulation is that the respondent perceives one SSN as a norm factor. A further advantage of this specification is that it takes into account the correlation among responses to the various reference group questions through their joint dependence on one latent construct. The formula of this model is shown in Eq. (12) below:

$$\boldsymbol{V} = (\beta_{as}\boldsymbol{z}_{as} + \beta_{af}\boldsymbol{z}_{af} + \beta_{n}\boldsymbol{z}_{n} + \beta_{rc}\boldsymbol{x}_{rc} + \beta_{w}\boldsymbol{x}_{w} + \beta_{wd}\boldsymbol{x}_{wd} + \beta_{sa}\boldsymbol{x}_{sa} + \beta_{sb}\boldsymbol{x}_{sb} + \beta_{sc}\boldsymbol{x}_{sc} + \beta_{sd}\boldsymbol{x}_{sd} + \beta_{se}\boldsymbol{x}_{se} + \beta_{sf}\boldsymbol{x}_{sf}) \quad (12)$$

where it is assumed that all latent variables are normally distributed across the population, including $\mathbf{z}_n \sim N(0, \boldsymbol{\sigma}_n^2)$, and are uncorrelated with each other. The psychometric indicators for latent variables $\mathbf{z}_n$ (SSN) are treated as continuous variables and modelled as follows:

$$\boldsymbol{I}_r = \lambda_r \boldsymbol{z}_n + \boldsymbol{\upsilon}_r \quad \text{with } r = 11, \ldots, 17 \quad (13)$$

where $\upsilon_r \sim N(0, \sigma^2_{\upsilon_r})$, $r = 11, \ldots, 17$, where the variances $\sigma^2_{\upsilon_r}$ are to be estimated. It is assumed that the error terms in (Eq. (13)) are

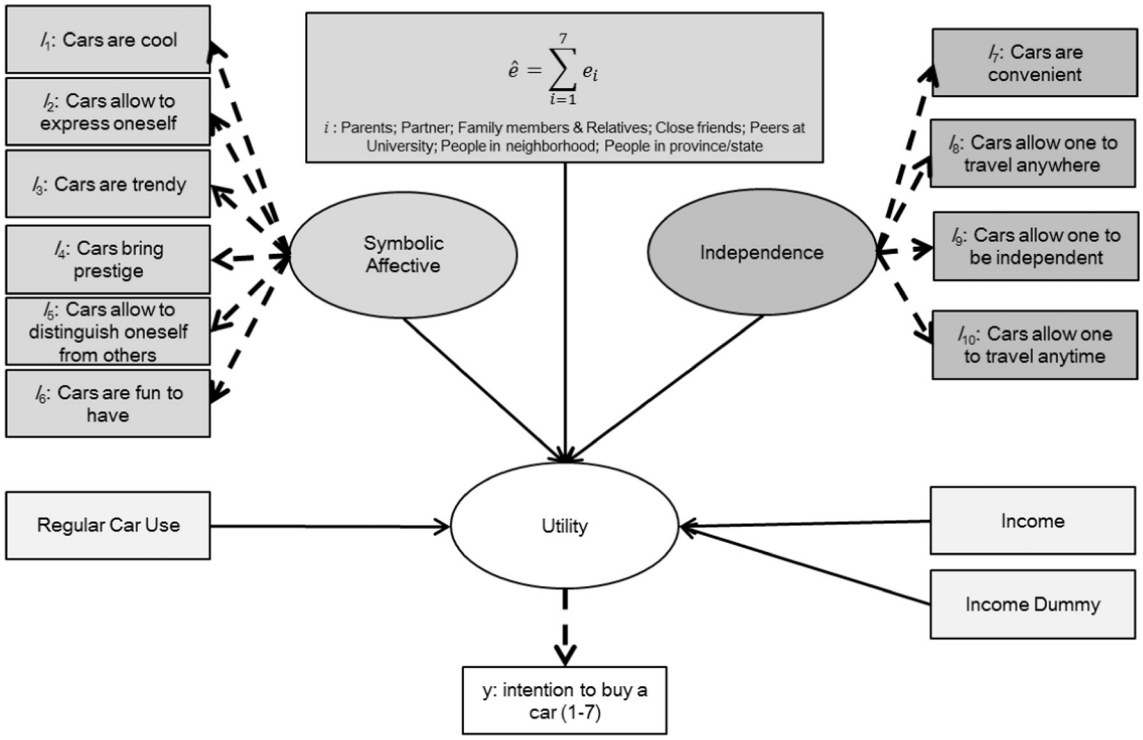

Fig. 1. Car intention model with total expectations as observed variable

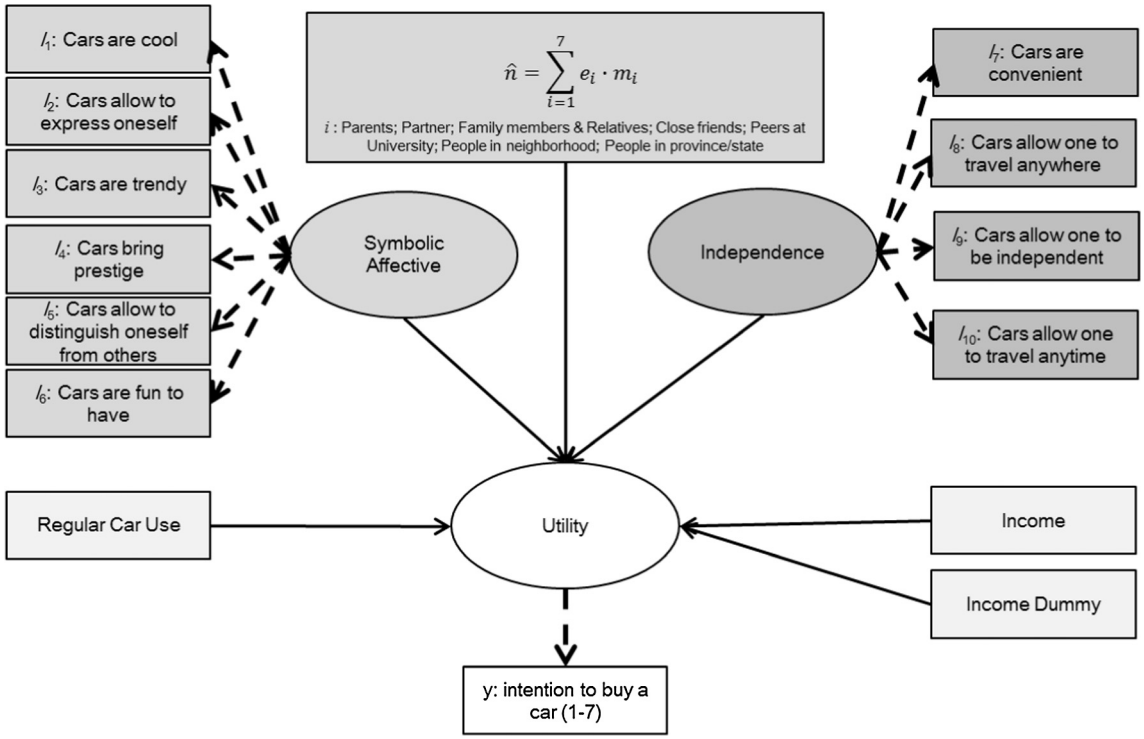

Fig. 2. Car intention model with total SSN as observed variable.

uncorrelated. The identification of latent variables is ensured by fixing $\lambda_{11} = 1$ (for latent variable SSN).

To better understand the formulation, it can be seen in Fig. 4 below where the SSN factor is constructed by seven observed measures of SSN. The latent variable of SSN directly influences the latent utility.

4. Descriptive analysis of students' car purchase intentions

4.1. Aggregate survey statistics

In Table 2 we present aggregate statistics of the survey results for the seven sites where it was conducted. In general, the respon-

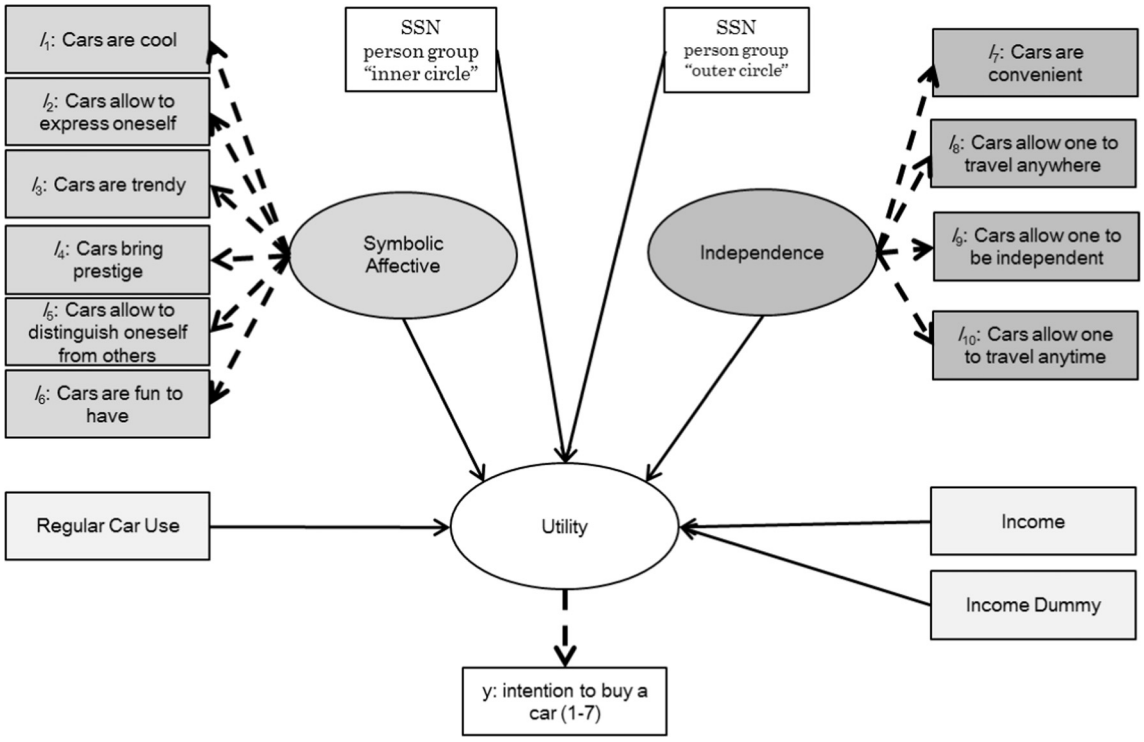

Fig. 3. Car intention model with group specific SSN as observed variables.

dents are in their earlier twenties with an overrepresentation of males, especially in Japan and Taiwan, due to the sampling method used. More than 50% of our respondents in all locations have a driving license with the exception of students in China. Note that age, gender and driving license have no significant correlation with intention to buy a car in the future. Therefore, these variables are omitted in our subsequent models.

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. The majority of the students (more than 50%) in each country are non-regular car users except for Beirut and Indonesia.

For *symbolic affective*, we calculated the mean value of six indicator variables ($I_1, \ldots, I_6$) and report their average in the table. As can be seen, 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 locations. For *independence*, we utilize the same procedure for the four indicator variables ($I_7, \ldots, I_{10}$). The highest overall rating comes from Berkeley followed by Utrecht, Beirut, and China. Indonesia and Taiwan have the lowest rating. This might link to the intensive use of motorcycles in the latter two locations, which offer more convenience, freedom, and saving of travel time than cars do.

Expectation of others 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. Motivations to comply (m_i) might be seen as a measure of "independence." Here it is found again that the lowest rating is for the Dutch students which possibly reflects a "more independent Western mind-set."

In the last row, we present the dependent variable, which is car purchase intentions. We report the mean and standard deviation from responses to the 7-point Likert scale question. The order of intention to own a car sorts the locations 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 (Kuhnimhof et al., 2013; van der Waard et al., 2013) as well as increasing auto dependency in the developing world (Belgiawan et al., 2016; Zhu et al., 2012).

4.2. Subjective social norms

We show the result of interaction between expectation with motivation to comply for each person group and country in Table 3. All samples combined, it can be seen that parents are most influential followed by family members, one's partner and close friends. This result shows that students perceive higher expectations by parents, partners, family members, and relatives as the "inner circle of the social network."

Outer circle consists of peers at university, people in the neighbourhood, and people in state/province which appear to have weaker influence on the intention to buy a car. It is interesting to see that only in the Utrecht case, all the mean values are negative which indicates that there is rather a (weak) influence of others motivating these students not to buy cars. 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 the six locations with positive values. 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 group.

In the last row of the table, we show the sum of SSN for the seven person groups for each site. We also calculate the average from the seven indicators combined ($I_{11}, \ldots, I_{17}$) and show the result for each country as well as its correlation with the dependent variable. Looking at the latent construct *SSN* combined over all groups, Japanese students regard the influence of others highest. For all samples the correlation between *SSN* and the intention

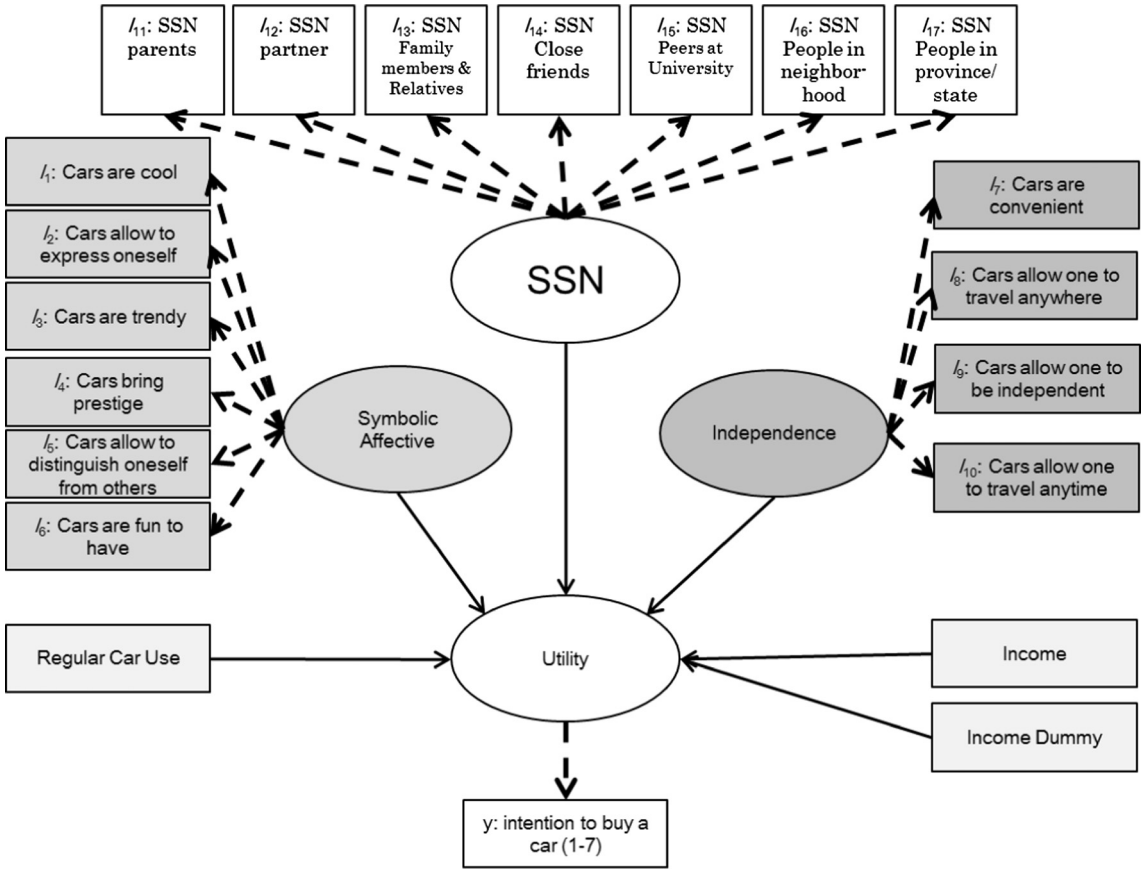

Fig. 4. Car intention model with SSN as latent variable.

Table 2
Aggregate survey statistics (mean and standard deviation).

Variable (number of observations)	All (μ (σ)) (1229)	Cor. coeff.[a]	Utr (84)	Jpn (142)	Brkly (226)	Twn (139)	Idn (200)	Chn (167)	Brt (271)
Age	20.5 (1.83)	−0.00	21.6	20.0	20.3	21.7	20.5	21.1	19.7
Gender split (male)	0.57 (0.50)	−0.02	0.55	0.78	0.50	0.73	0.52	0.60	0.45
Driving license (have)	0.69 (0.46)	0.02	0.71	0.61	0.81	0.78	0.74	0.28	0.80
Personal income (US $/1000)[b]	0.52 (0.61)	**0.11**	0.70	0.36	0.62	0.56	0.32	0.40	0.97
Income dummy	0.12 (0.33)	0.04	0.00	0.11	0.07	0.03	0.33	0.03	0.16
Regular car user	0.53 (0.50)	**0.22**	0.27	0.26	0.48	0.41	0.65	0.29	0.90
Symbolic Affective	4.41 (1.43)	NA	3.71	3.73	4.66	4.49	4.70	4.29	4.52
Independence	5.57 (1.28)	NA	5.92	5.83	6.16	5.63	5.03	5.86	5.86
Expectation of others[c]	0.67 (1.30)	NA	−0.56	0.80	0.78	0.75	0.67	0.66	0.87
Motivation to comply[c]	2.22 (1/72)	NA	1.52	2.69	1.99	2.45	2.62	2.40	1.86
Likelihood to buy a car	5.15 (1.62)	NA	4.55	4.62	4.92	4.99	5.24	5.42	5.65

[a] Correlation with the dependent variable.
[b] Based on income group range measured with local currency.
[c] Mean over all person groups bold: p value < 0.05.

to buy a car is significant. We obtain positive coefficients for all locations except for Utrecht. This might indicate that Dutch students have a strong desire to be perceived as not following expectations. Significant correlation in the case of Japan and Taiwan might indicate that the culture in these locations is more collective compared to the more individualistic Dutch culture. We find though that for China, also a more collective society, the correlation is significant only at 10% level and instead for Berkeley we observe a surprisingly high positive correlation. Therefore, simple explanations based on collective versus individual cultures do not explain the effect of uncontrolled correlation between *SSN* and car purchase intentions well.

The results of the correlation of *SSN* do not give a clear pattern between developed and developing countries. Thus, at this point, we might say that the impact of social norms is based on cultural issues rather than economic development. To investigate this further, we run a series of ordinal logistic regression models with car purchase intentions as dependent variable and firstly total expectations, $\hat{e}$, and, in a second series of models, with total SSN, $\hat{n}$, as independent variables. Table 4 then shows the results of subsequent *t*-tests as to whether there is a difference in parameter estimates between two locations. Negative values indicate that parameter estimates for locations on the vertical axis are higher.

We observe that in most cases country specific differences are significant. We find that in Utrecht estimates are persistently lower than in other locations, i.e. that expectations and norms are less important to explain intentions. We find further some differences between parameter estimates $\hat{e}$ and $\hat{n}$, e.g. in comparing Japan

Table 3
Descriptive statistics (mean and standard deviation) of SSN.

Variables	All (1229)	Utrecht (84)	Japan (142)	Berkeley (226)	Taiwan (139)	Indonesia (200)	China (167)	Beirut (271)
Person group								
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)
Combined								
Total SSN ($\hat{n}$)	16.97	−9.00	27.15	15.62	16.63	20.33	18.36	17.66
	(24.15)	(16.63	(26.99)	(20.83)	(23.98)	(22.73)	(20.41)	(24.87)
SSN (average)	2.42	−1.29	3.88	2.23	2.38	2.90	2.62	2.52
Correlation with dependent variable	**0.23**∗	**−0.24**∗	**0.24**∗	**0.37**∗	**0.47**∗	**0.18**	**0.17**	**0.23**∗

Bold: p value < 0.05; Bold + ∗: p value < 0.01.

and Berkeley we find that perceived expectations are less influential in Japan but that the effect of total SSN appears not to be different. One might speculate as to the reasons for such differences; with the data available to us currently we do not seem to be able to come up with a consistent hypothesis though. It would require a different (possibly qualitative) study to understand how cultural differences regarding expectations transform into purchase intentions. In the study present here our focus remains on which modelling approach in general appears to best explain the influences of others on purchase intentions.

4.3. SSN person group determination

As discussed in Section 3.6 and shown in Fig. 3, in the model with observed SSN factors, we are looking for two groups that could represent the "inner circle" and "outer circle" of influence. Furthermore, as will be shown in the estimation results, we find strong correlation between the seven SSN factors, given additional reason to only select a reduced number if the factors are treated as observed variables.

In line with Table 3 and after initial model tests, which we omit for brevity, we found that SSN related to neighbours and general people in the province are not significant and hence appear to be not good indicators. Further, when controlling for other factors, we observe that *SSN close friends* has similar, though weaker, influence than *SSN peers at university*, possibly because one does not perceive as much need to compete with friends than with peers. *SSN partners* have been found to be significant, though only few undergraduates have partners so that we prefer to also drop this group from our model. In conclusion, in the model with group specific observed SSN we decided on *SSN parents* and *SSN peers at university* as representative groups since parents are being influential and in the "inner circle" of the respondents whereas peers at university can be seen as an "outer circle" that still exerts significant pressure on students. Details and further discussion can be found in Belgiawan (2015).

5. Estimation results

In this section we discuss the results of the four models which we divide into: sum of person groups, group specific, and latent factor. All of the models are estimated using simulated maximum likelihood estimation with 10,000 Halton draws in Python Biogeme (Bierlaire and Fetiarison, 2009). We have also tested the model with different number of draws as well as different starting values to ensure convergence and stability of the results. For better interpretation, we standardize the parameter estimates for latent and observed variables. Following Long (1997, p.128), the standardized value, β_x^s is obtained as follows:

$$\beta_x^s = \frac{\sigma_x \beta_x}{\sigma_{y^*}} \tag{14}$$

where σ_x denotes the standard deviation of variable or factor x, while σ_{y^*} denotes the standard deviation of the intention to buy a car. The results of the four models can be seen in Table 5. The standardized value is reported in parenthesis. Note that the standardized value is calculated only for the statistically significant variables. We also report the robust t-test results in the table.

Firstly looking at our control variables income and regular car use across the models, we observe that these variables have the expected coefficient signs and the coefficient magnitudes are similar across models. Regular car use appears to be more highly correlated with the dependent variable than income, which is understandable given that we aim to explain purchase intentions not actual purchase. We also incorporate site specific dummy variables with Beirut as the reference. In the first model, four sites are significant while Indonesia and China are not. For the other three models, only China is not significantly different from Beirut. All the significant coefficients are negative indicating that compared to Beirut, students in the other six locations are less likely to buy a car in the future.

Based on the standardized value, for the first model, *total expectations* is the most influential factor (standardized value = 0.27). If we do not compare with site-specific dummy variables, the second most influential factor is *independence* followed by *regular car use*. *Income* is the least influential factor, while *symbolic affective* is slightly more influential than *income*. For the second model, *total SSN* is the most influential factor (standardized value = 0.28) while the effects of the other explanatory variables seem similar to those in the first model. This result indicates that the influence of expectation is almost equal to the influence of the norm which means that the inclusion of *motivation to comply* gives little power to the prediction of intention, similar to what is discussed in RAA (Fishbein and Ajzen, 2010).

Table 4
T-test for difference in parameter estimates $\hat{e}$ and $\hat{n}$ between locations towards car purchase intention.

Locations	Japan		Berkeley		Taiwan		Indonesia		China		Beirut	
	$\hat{e}$	$\hat{n}$	$\hat{e}$	$\hat{n}$	$\hat{e}$	$\hat{n}$	$\hat{e}$	$\hat{n}$	$\hat{e}$	$\hat{n}$	$\hat{e}$	$\hat{n}$
Utrecht	**4.05**	**4.33**	**5.44**	**5.16**	**5.12**	**5.46**	**3.18**	**3.72**	**3.66**	**3.86**	**4.07**	**4.64**
Japan			**2.01**	1.42	**2.25**	**2.40**	−0.26	−0.97	−0.13	−0.15	−0.37	−0.02
Berkeley					0.50	1.04	**−2.16**	**−2.47**	**−2.11**	−1.52	**-2.74**	*−1.67*
Taiwan							**−2.25**	**−3.33**	**−2.27**	**−2.36**	**−2.88**	**−2.65**
Indonesia									0.15	**−2.31**	−0.03	1.05
China											−0.22	0.14

Bold: p value < 0.05; Italic: p value < 0.01.

Looking at the third model, we observe that SSN, particularly *SSN parents*, is the most influential variable, followed by regular car use. Note that in this model, *SSN peers at university* is the least influential variable for car purchase intention, together with *Income*. Judging also by the lower value of the influence of *symbolic affective*, it seems that rather than peer pressure, family expectations are more important. In the fourth model, we see that the latent factor of SSN is the most influential (standardized value = 0.29). The effects of the other explanatory variables are similar to those of the first and second model. In constructing SSN, all estimated λ values are below the λ value for parents (fixed at 1), which is in line with the third model where we observe that parents are most influential. The λ values further reflect the inner/outer circle classification with the inner circle being more influential. The standard deviations of the measurement errors of the indicators (σ parameters) are also estimated. It is found that $\sigma_{parents}$ is largest, suggesting that parental expectations are not perceived homogenously though.

At the bottom of the table we provide the pseudo R^2 information for each model which was calculated using the initial log-likelihood (L(0)) and the final likelihood for the choice-only component of the total likelihood. The L(0) is the log-likelihood at zero for a model with thresholds only. For the comparison of the R-squared across models, the L(0) should be the same for all models to have a consistent comparison. Therefore, we use the L(0) of the first model as the base value. From the result of pseudo R^2, the model with latent SSN is not necessarily expected to perform better in terms of goodness of fit of the choice (intention) model because it optimizes the estimated parameters over both the intention indicators and the SSN indicators while the other models do not optimize over SSN indicators. From the pseudo R^2 result (Nagelkerke's) we find that for the three models without SSN latent factor, the variance in intention explained is around 20% while in the one with SSN latent factor around 14% variance in intention is explained.

We expect though that the norm identified by the latent model should be the most precise estimate since we estimate errors for each observed variable. Therefore, SSN of the latent model is predicted to be most correlated with intention. We only find very limited effect of this though. The standardized coefficient for SSN in our latent model is 0.29 which is similar to the effect of Total SSN (0.28) in the second model and Total expectation (0.27) in Model 1. This suggests that the "simple" (at least computationally) definition of norms as in the first models gives similar results to the model with latent definition of norms.

In conclusion, we found that all the parameters for the four models seem quite stable and similar indicating that those four models can be utilized to incorporate social norms in explaining car ownership intentions. Whether as observed variable or as latent variable, the influence of the social norms factor remains stable.

6. Conclusions

This paper focused on the role of social norms for car purchase intentions of young students as the literature review emphasized the potential importance of such norms. Different possible definitions and formulations based on literature drawn from social psychology are discussed and compared, which to our knowledge has not been done before. Furthermore, previous studies discussing the effect of norms mostly relied on descriptive studies or modelling of norms within structural equation models which control for far less explanatory variables.

Instead, we estimate ordinal hybrid choice models (OHCM) with four formulations of social norms. In three of them social norms are modelled as interaction factor between *expectation* and *motivation to comply*, while one uses the *sum of expectations*. 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 one's neighbourhood, people in the province/state).

From the four models we find that attitudinal factors (symbolic affective and independence) and other variables (regular car use, personal income) significantly influence car purchase intention. Total of expectation and total of SSN also significantly influence car purchase intention. In the model with two group specific observed SSN, we find similarly that SSN parents and SSN peers at university significantly influence car purchase intention. Using the latent SSN construct, it is found that SSN significantly correlates with car purchase intention. Taking all these results together, there is strong evidence that social norms significantly influence car ownership motivations. Partly auto or non-auto culture as well as collective vs. individualistic culture (consider Japanese correlation between SSN and car purchase intention reported in Table 3) can explain expectations, but there seem to be more factors that we cannot explain.

Given the limited sample size from each of the seven sites, we believe that this study makes primarily a methodological contribution in showing different ways to formulate and estimate social norms that one might choose in the future depending on the problem, data and modelling software available.

In our application, comparing the four models, we can see that the strength of norms factors, the standardized version, is almost equal across all models. In other words, estimating a latent SSN with group specific error terms does not appear to increase the correlation of the resulting norms term with purchase intention significantly. If we build the theoretically less satisfying terms "Total expectation" or "Total SSN" by simply summing up the perceived expectations or perceived pressure by different influence groups, we obtain a similar result. Therefore, we might conclude that (a) latent modelling of norms does not add much to our understanding compared to simpler model formulations and (b) that it is sufficient to include only a few key person groups reflecting the influence of people close to the person (inner circle) and the wider community the respondent is embedded in (outer circle), as also supported by the highest pseudo R^2. This might be good news for future research attempting to include norms in other studies on decisions concerning fairly large investments such as car purchase. We

Table 5
Car purchase intention models.

Variable		Sum of person groups				Group specific		Latent	
		Expectations		Social norms		Social norms		Social norms	
		Est. (stdz)	*t*-test	Est. (stdz)	*t*-test	Est. (stdz)	*t*-test	Est. (stdz)	*t*-test
Latent variables									
Symbolic affective		**0.21 (0.12)**	2.77	**0.22 (0.13)**	2.92	**0.24 (0.13)**	3.12	**0.22 (0.13)**	2.94
Independence		**0.24 (0.16)**	3.13	**0.22 (0.15)**	2.96	**0.22 (0.15)**	2.97	**0.25 (0.16)**	3.29
SSN		NE		NE		NE		**0.09 (0.29)**	6.28
Latent variables standard deviations									
σ Symbolic Affective		**0.91**	20.36	**0.91**	20.36	**0.92**	20.36	**0.91**	20.43
σ Independence		**1.10**	21.09	**1.10**	21.20	**1.10**	21.20	**1.08**	19.90
σ SSN		NE		NE		NE		**5.44**	22.11
Observed variables									
Total expectations		**0.06 (0.27)**	6.90	NE		NE		NE	
Total SSN		NE	NE	**0.19 (0.28)**	7.13	NE		NE	
SSN parents		NE	NE	NE		**0.04 (0.21)**	4.97	NE	
SSN peers at university		NE	NE	NE		**0.05 (0.11)**	2.70	NE	
Regular car use		**0.49 (0.15)**	4.17	**0.49 (0.15)**	4.16	**0.51 (0.16)**	4.33	**0.49 (0.15)**	4.15
Income (10^{-3} US$)		**0.30 (0.11)**	2.56	**0.28 (0.11)**	2.47	**0.30 (0.11)**	2.63	**0.29 (0.11)**	2.46
Income dummy		0.21	1.20	0.19	1.05	0.21	1.18	0.20	1.11
Site-specific dummy (Beirut as reference)									
Utrecht (σ = 0.25)		**−0.53(−0.08)**	−2.28	**−0.64(−0.10)**	−2.83	**−0.58(−0.09)**	−2.50	**−0.70(−0.11)**	−3.08
Japan (σ = 0.32)		**−0.73(−0.14)**	−3.26	**−0.93(−0.18)**	−4.17	**−0.90(−0.18)**	−4.00	**−0.94(−0.18)**	−4.16
Berkeley (σ = 0.39)		**−0.74(−0.18)**	−4.02	**−0.75(−0.18)**	−4.04	**−0.75(−0.18)**	−4.01	**−0.76(−0.18)**	−4.03
Taiwan (σ = 0.32)		**−0.67(−0.13)**	−3.60	**−0.72(−0.14)**	−3.91	**−0.66(−0.13)**	−3.61	**−0.72(0.14)**	−3.89
Indonesia (σ = 0.37)		−0.25	−1.35	**−0.40(−0.09)**	−2.11	−0.40	−2.10	*−0.37(0.08)*	−1.91
China (σ = 0.34)		0.13	0.65	0.02	0.11	0.05	0.25	0.06	0.27
Threshold									
τ_1		**−3.30**	−13.44	**−3.35**	−13.76	**−3.30**	−13.43	**−3.66**	−14.90
τ_2		**−2.27**	8.12	**−2.32**	8.07	**−2.27**	8.08	**−2.63**	8.08
τ_3		**−1.55**	9.64	**1.75**	9.64	**−1.55**	9.63	**−1.91**	9.64
τ_4		**−0.72**	13.28	**1.55**	13.29	**−0.71**	13.30	**−1.08**	13.28
τ_5		**0.36**	17.73	**1.92**	17.77	**0.37**	17.74	**0.01**	17.72
τ_6		**1.70**	19.39	**2.42**	19.35	**1.71**	19.38	**1.35**	19.31
Measurement equations for latent variables									
Symbolic affective									
Cars are cool	λ_1	1		1		1		1	
	σ_1	**1.03**	34.05	**1.03**	34.03	**1.03**	34.01	**1.04**	34.39
Cars allow to express oneself	λ_2	**0.99**	15.28	**0.99**	15.28	**0.99**	15.29	**0.98**	14.90
	σ_2	**1.12**	36.03	**1.12**	36.03	**1.12**	36.05	**1.13**	35.15
Cars are trendy	λ_3	**0.98**	19.67	**0.98**	19.67	**0.98**	19.67	**0.98**	19.72
	σ_3	**1.08**	34.92	**1.08**	34.92	**1.08**	34.92	**1.09**	35.39
Cars bring prestige	λ_4	**1.23**	16.87	**1.23**	16.87	**1.23**	16.87	**1.25**	16.99
	σ_4	**1.09**	31.65	**1.09**	31.64	**1.09**	31.65	**1.08**	31.51
Cars allow to distinguish oneself from others	λ_5	**1.25**	16.30	**1.25**	16.29	**1.24**	16.29	**1.25**	16.28
	σ_5	**0.96**	27.22	**0.96**	27.22	**0.96**	27.25	**0.96**	27.27
Cars are fun to have	λ_6	**0.90**	18.35	**0.90**	18.35	**0.90**	18.36	**0.91**	18.13
	σ_6	**1.13**	38.28	**1.13**	38.27	**1.13**	38.26	**1.13**	38.31
Independence									
Cars are convenient	λ_7	**0.68**	15.42	**0.68**	15.44	**0.68**	15.44	**0.70**	16.67
	σ_7	**0.77**	26.57	**0.77**	26.74	**0.77**	26.74	**0.77**	26.61
Cars allow one to travel anytime	λ_8	1		1		1		1	
	σ_8	**0.66**	11.85	**0.66**	11.81	**0.66**	11.81	**0.70**	13.77
Cars allow one to be independent	λ_9	**0.49**	9.39	**0.49**	9.37	**0.49**	9.38	**0.50**	9.47
	σ_9	**1.33**	36.89	**1.33**	36.89	**1.33**	36.89	**1.33**	36.59
Cars allow one to travel anywhere	λ_{10}	**0.64**	14.13	**0.64**	14.09	**0.64**	14.10	**0.66**	14.43
	σ_{10}	**1.17**	35.02	**1.17**	35.01	**1.17**	35.02	**1.16**	34.53
Subjective social norms									
Parents	λ_{11}	NE		NE		NE		1	
	σ_{11}	NE		NE		NE		**5.53**	26.84
Partner	λ_{12}	NE		NE		NE		**0.68**	16.20
	σ_{12}	NE		NE		NE		**4.69**	34.83
Family members	λ_{13}	NE		NE		NE		**0.79**	26.48
	σ_{13}	NE		NE		NE		**3.40**	19.63
Close friends	λ_{14}	NE		NE		NE		**0.78**	12.22
	σ_{14}	NE		NE		NE		**2.77**	8.56
Peers at university	λ_{15}	NE		NE		NE		**0.56**	11.51
	σ_{15}	NE		NE		NE		**2.24**	17.95
People in Neighbourhood	λ_{16}	NE		NE		NE		**0.27**	6.87
	σ_{16}	NE		NE		NE		**2.20**	17.68
People in province/state	λ_{17}	NE		NE		NE		**0.23**	5.91
	σ_{17}	NE		NE		NE		**2.26**	16.98

(*continued on next page*)

Table 5 (*continued*)

Variable	Sum of person groups				Group specific		Latent	
	Expectations		Social norms		Social norms		Social norms	
	Est. (stdz)	*t*-test	Est. (stdz)	*t*-test	Est. (stdz)	*t*-test	Est. (stdz)	*t*-test
Model statistics								
Sample size	1229		1229		1229		1229	
Estimated parameters	38		38		39		52	
Halton draws number	10,000		10,000		10,000		10,000	
Log-likelihood (L(0))	−2178.02		−2178.02		−2178.02		−2178.02	
Log-likelihood (L(1))	−2044.96		−2043.78		−2044.65		−2089.28	
McFadden R^2	0.061		0.062		0.061		0.041	
Cox and Snell R^2	0.195		0.196		0.195		0.134	
Nagelkerke's R^2	0.200		0.202		0.201		0.138	

Bold = p value < 0.05; Italic p value < 0.10; NE = Not estimated; in the parenthesis is the standardized value.

emphasize though that these conclusions require confirmation through further studies with different samples.

We point out further that the stable standardized coefficient values for the respective norm related terms give us some confidence in the relative importance of social norms compared to other factors influencing choice. We obtain a consistent estimate for the standardized value of the coefficient of the variable regarding social influence of around 0.2–0.3 in all four models. This value is the largest among all our explanatory variables in all four models.

Due to limited sample sizes we did not estimate country specific norming effects in our OHCM. From the correlation analysis we observe that this might be worth doing though if larger samples can be obtained. We find significant positive correlations between norms and car purchase intentions in all samples except for Utrecht. Dutch students appear to have a strong desire to be perceived as not following expectations, which does not seem unrealistic as it suggests that the Dutch have a strong desire to be perceived as "unique individuals". Looking at correlation between social norms and car purchase intention, it seems that the impact of social norms on car purchase intention cannot be explained by differences between developed and developing countries. We also conducted further tests with separate models for developed and developing countries and did not find any differences.

Due to our limited sample, our policy recommendations remain vague though. Possibly, very tentatively we suggest that the Utrecht case can be a good example for policy makers in the developing countries, as in Utrecht, 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 system 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". We acknowledge that our sample is too limited to be confident to generalize any specific recommendations.

Finally, we acknowledge that current purchase intentions do not necessarily reflect future car purchase, especially if students change their lifestyle after graduation. Therefore, this paper 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 purchases. The study has some further shortcomings that one could only address though if the data collection would be repeated. We acknowledge that the different sampling methods across the different locations might contribute to potential self-selection bias. We also acknowledge that the different areal coverage of samples in the sites, i.e. our Dutch sample uses observations from Utrecht only, whereas our Japan sample is drawn from across the country, could have had an influence on the result. Therefore, more representative samples from a wider population segment including from different cultures are preferable. 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 made choices according to their intentions and/or whether their attitudes and perceived norms have changed.

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