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研究課題名(和文) 社会的相互作用を考慮した自動車購入と機関選択に関する経年効果分析

研究課題名(英文) Trend Effects in Vehicle Purchase and Travel Decisions

研究代表者

Schmoecker J. D. (Schmoecker, Jan-Dirk)

京都大学・工学(系)研究科(研究院)・准教授

研究者番号：70467017

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研究成果の概要(和文)：本研究は、「集団効果」に着目した交通機関選択について解析を行った。まず、自分だけでなく他人の決定結果を考慮した自動車保有に関する意思決定モデルについて、その取りやめ行動と規範モデルの内容を検討した。調査は、日本・インドネシアなど7カ国を対象に行い、各国の学生間で動機付けの仕方に差異があることを示した。

次に、意思決定モデル内の非対称性を持つコスト関数について、より一般的な知見を得ることを目的とした。結果として、集団効果を考慮した潜在的行動研究について、ネットワークモデリングと社会心理学の両研究を考慮した、現在進めている共同研究へと繋がっている。

研究成果の概要(英文)：This research looked at "mass effects" within mobility decisions from various perspectives. Firstly, a main focus has been on modeling car ownership decisions of individuals and the influence of others in terms of "injunctive norms" as well as "descriptive norms". A survey among students in Indonesia as well as a second international survey was conducted among students from seven countries. The results illustrate the motivational differences among students in different countries. Secondly, another focus has been on modeling more generally asymmetric cost functions in decision making. This research has led to a publication titled "Dynamic Process Model of Mass Effects". The results illustrate potential population dynamics considering mass effects. Possibly the main achievement of this research has been to establish connections between network modeling and social psychology. The research has further led to some on-going research collaborations that promise further research outcomes.

研究分野：工学

科研費の分科・細目：土木計画学・交通工学

キーワード：交通計画

1 . 研究開始当初の背景

Whereas transportation planners commonly predict the negative impacts of mass transportation, there is increasing empirical evidence of the existence of positive mass effects, whereby increased use of a mode by the ‘mass’ will generally increase its attractiveness for future travellers. Recently this has been sometimes reflected in terms of the role of social networks as a stimulus for travel behaviour decisions. That is, from a transport policy-maker’s perspective, one persuades a few to change their behaviour initially in order to encourage a larger number of people to follow later. This has two clear implications: (a) the problem is inherently dynamic, the relevant forecasting question is: ‘how does demand change with time?’, not ‘what is the demand?’ and (b) the decision of an individual at any point in time is dependent on the prior decisions of other individuals.

2 . 研究の目的

The purpose of this research is therefore twofold. Firstly, to find ways to “quantify” the effect of mass effects in decision making. This has strong links to social psychology where the role of social norms has been emphasized. In particular the role of descriptive norms and injunctive norms for mobility related decisions need to be quantified. The first term describes the influence of observation of what others are actually doing on one’s behaviour, whereas the latter term describes the influence of perceptions what one should do. As an example for this, the research focuses on car purchase intentions for students. The role of attitudinal factors and social norms in intentions is to be qualified. To understand the context related importance of these factors data samples are obtained from various countries. In particular it is investigated whether there are potential differences between developed and developing countries.

Secondly, the research aims to propose a potential approach for representing such mass effects among travellers through an extension of existing travel demand forecasting methods. Connected to this, such an approach should then be used to explore the dynamics of such mass effects in some hypothetical scenarios.

3 . 研究の方法

To achieve the first objective firstly an extensive review has been conducted that reviews evidence for the importance of norms. Based on this review, modeling approaches for studying

mass effects and their data requirements are synthesized, highlighting the advantages and limitations of each. The review concludes with a discussion of the importance of leveraging the power of mass effects for designing transportation policies aiming at promoting sustainable and safe mobility, and of challenges for future work in this area. This review and the resulting recommendations have been published as a review paper (see publication [5] in Section 5).

To quantify the importance of norms further an international survey was conducted. Undergraduate students were asked questions related to attitudes, norms and socio-demographic factors as well as the likelihood to buy a car in the future. In total 1229 samples from seven countries were obtained: The Netherlands (N=84), Japan (N=142), United States (N=226), Taiwan (N=139), Indonesia (N=200), China (N=167) and Lebanon (N=271). The data, in particular norms, were correlated with likelihood to purchase cars.

The methodology regarding the second objective, exploring the population wide dynamics of mass effects, is based on more “abstract” modeling of choice between “mobility lifestyles”. Although the approach can be readily applied to the choice between any number of mobility lifestyles, for any number of ‘population groups’ (as defined below), in order to communicate the key ideas the research was restricted to the simplest case, of the choice between two mobility lifestyles, for two population groups. These two mobility lifestyles are denoted by c (broadly for car) and t (for transit) and the two population groups by λ and ϕ . λ stands for the “leading” population group and ϕ for the “following”, but one might more generally interpret λ as innovators as in marketing research; that is to say, those who are more willing or find it easier to experiment with new forms of mobility. Followers are more likely to be influenced by the decisions of others and often make up the mass of the population.

For these two population groups, then choice probabilities and utilities of choice are defined as:

$$p_i(u) = (1 + \exp(-u_i))^{-1} \quad (i = 1,2)$$

$$u_i(y) = \xi_i - \alpha_i(1 + \beta(y_1 + y_2))^{-1} + \gamma_i(d_1 - y_1 + d_2 - y_2)^\eta + \kappa_{i1}y_1 + \kappa_{i2}y_2$$

In above specification the utility functions includes following five terms:

- An alternative-specific constant ξ_i which specifies group i 's perceived advantage of

lifestyle A over B in terms of 'intrinsic utility'.

- A 'consequential mass effect', whereby increased total adoption of the transit-oriented lifestyle A (as measured by y_1+y_2) leads to economies-of-scale.
- A 'negative mass effect', whereby increased total adoption of the car-oriented lifestyle B (as measured by $d_1-y_1+d_2-y_2$) leads to congestion which gives a higher negative utility for lifestyle B.
- Two terms reflecting an 'information mass effect', whereby those in group i will tend to positively imitate the lifestyle-adoption of leaders (as measured by y_1) and followers (as measured by y_2).

The choice probabilities are then used to defined transition probabilities between mobility states. That is it is considered that those with a perceived high utility for the other mode, might change their state. The formulated dynamics correspond to a version of logit dynamics in the evolutionary game theory literature but have also similarity to the master equation approach described in the book "Sociodynamics" by Weidlich. For more details the reader is referred to publication [3] in Section 5.

4 . 研究成果

Regarding the first objective we illustrate the existing of mass effects through norms both through the literature review as well as with our own data. In particular, regarding car purchase decisions, we find for most samples that there is a strong role of expectation of others for the intention to buy a car in the future. This has some important implications for understanding the effectiveness of transport policies. We do not find though a systematic difference between developing and developed countries, suggesting that the effect of others on purchase decisions needs to be studied carefully across countries. The work has raised a number of further work issues, including how "expectations" can be appropriately modeled in discrete choice models. This is currently being continued in follow-up research.

Regarding the second research the dynamics of mass effects has been illustrated among others with a series of graphs. Exemplary below two figures show the difference in the mobility states over time for different initialization points. Highlighted is the situation in which at the beginning of the time all members of population groups use mode c (car). For the given

parameter settings in this case over time not much change can be expected. In figure 2 instead the κ parameter from above utility function was increased. The figure shows that at the beginning very few followers change the mode, but after a significant number are "persuaded" to change their decision. Also this research is currently being continued by investigating the stochastic properties of the population distribution in more detail.

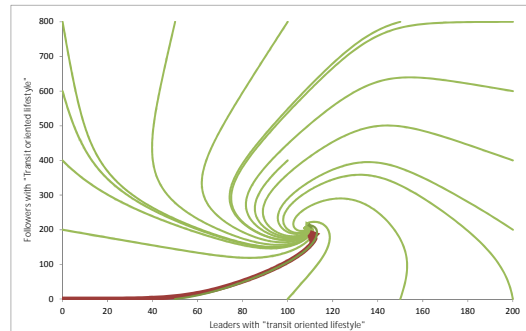


Figure 1 Base Scenario

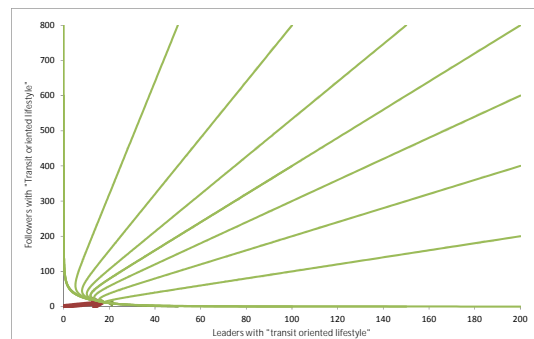


Figure 2 with consideration of mass effect

5 . 主な発表論文等

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- [2] Belgiawan, P.F., Schmöcker, J.-D., Abou-Zeid, M., Walker, J., Lee, T.-L., Ettema, D. and Fujii, S. (In press). Car Ownership Motivations among Undergraduate Students in China, Indonesia, Japan, Lebanon, Netherlands, Taiwan, and U.S.A. Presented at the 93rd Annual Meeting of the Transportation Research Board. Washington D.C., U.S., January 2014 and accepted for publication in Transportation.
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- [5] Abou-Zeid, M., Schmöcker, J.-D., Belgiawan, P.F. and Fujii, S. (2013). Mass Effects and Mobility Decisions. *Transportation Letters*, 5(3), 115-130.
- [6] Belgiawan, P.F., Schmöcker, J.-D. and Fujii, S. (2012). Explaining The Desire to Own a Car among Indonesian Students. Presented at 第 32 回交通工学研究発表会 (Japan Society of Traffic Engineers Proceedings.)