Modeling individual discrete continuous consumption decisions

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Andrea Pellegrini

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Thesis Committee:

Prof. Rico Maggi, supervisor, Università della Svizzera italiana

Prof. Patrick Gagliardini, internal examiner, Università della Svizzera italiana

Prof. Kay W. Axhausen, external examiner, ETH Zürich

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Multiple-discrete continuous models represent the most comprehensive and realistic framework to explore individuals' preferences and choices, unifying two different types of processes (discrete and continuous choices). The objective of this PhD thesis, consisting of three papers, is to investigate the determinants of individuals' discrete-continuous decisions in a setting in which these decisions are interconnected.

Chapter 1: The relationship between length of stay and land transportation mode in the tourism sector: a discrete-continuous framework applied to Swiss data

The first paper of my dissertation studies the interdependence between mode choice and length of stay in the context of domestic trips in Switzerland, developing a single discrete-continuous choice model (Hanneman, 1984; Dubin and Macfadden, 1984). The state-of-the-art in estimating a single discrete continuous choice model consists in a two-stage approach. In a first stage, it is assumed that consumers select the alternative with the highest utility from a set of mutually exclusive choices. In a second stage, this choice is inserted in a linear regression model to analyze individuals' continuous decision. Nevertheless, modeling these decisions in a two-stage design implies that the estimates are consistent but not efficient. The proposed method consists in a simultaneous estimation of the parameters (representing both discrete and continuous choices) and ensures consistent and efficient estimates. This methodology has been applied to model tourists' travel decisions. Specifically, tourists are assumed to choose either private car or train as the means of transport to reach their holiday destinations. A log linear regression framework analyzes the determinants influencing the number of days spent at destination (the continuous variable) conditional on a discrete choice probability. In the continuous equation, a correlation parameter is included in order to capture the interconnection between the choice of travel and the duration of stay. This parameter accounts for the stochasticity within the discrete and continuous choices as well as it ensures that the estimates are unbiased.

Keywords: Discrete continuous decisions, Length of stay, Land transportation mode

Chapter 2: Understanding tourists' expenditure patterns: a stochastic frontier approach within the framework of multiple discrete-continuous choices

The second paper of my dissertation extends the single discrete continuous choice model developing a MDCEV model to analyze tourists' expenditure patterns. Adoption of the MDCEV methodology allows one to assess two types of decisions which are interrelated: first, whether or not to allocate money on a specific category of expenditure and, second, deciding the amount to spend for each category of expenditure. An important aspect of the MDCEV model is that the assessment of expenditure behavior is done simultaneously for multiple and diverse categories of expenditure which are non-mutually exclusive choice options. In this way, researchers are able to explicitly recognize tourist's preference concerning different products or activities and account for the substitution effect between different expenses. Another important aspect addressed in this paper is related to the tourists' expenditure budgets. It is commonly assumed in tourism literature that an agent (an individual or a group of individuals) sets an expense budget which, during the course of the holiday, is allocated to tourism/leisure activities, services and products. In this setting, the actual amount of money an agent predetermines to spend is unobserved and hence the budget remains latent from an econometric perspective. The common practice in the literature (Divisekera 2010, Wu, Zhang and Fujiwara 2011, Lee, Wonsok, Funck and Jordan 2015, Ferrer and Coenders 2016) is to consider the sum of expenses an individual or a travel party sustains during a holiday as travel budget. In reality, the budget is something endogenous and unobservable: the sum of travel expenses simply returns the total amount of travel expenditures while a travel budget is something that theoretically can be totally spent, partially saved or exceeded. The main innovation proposed in this paper is to apply a Stochastic Frontier (SF) regression to estimate the travel budget. In general, the SF approach is employed to determine the maximum production level that can be achieved given a vector of production inputs. In the context of MDC literature, Pinjari, Augstin, Imani, Sivaraman, Eluru and Pendyala (2016) interpret the frontier as the subjective maximum expenditure individuals are willing to incur, and the difference between the estimated frontier and the actual total expenditure is utilized to identify *an essential outside good*, which can be interpreted as expenditure for unobserved goods and services, outside the observed categories. This is of relevance in a tourism context because part of the expenditure related to consumption decisions is made only once the tourist is sojourning at destination. Following this approach, this paper contributes to the stream of literature investigating tourists' expenditures by employing a joint SF-MDCEV approach which accounts for multiple discrete continuous expenditure decisions. Moreover, the adoption of SF represents a step forward in the consideration of individual travel budget when tourist expenditures and spending behaviour are investigated.

Keywords: Multiple discrete continuous choices, Stochastic Frontier regression, Travel budget, Tourist expenditure behavior

Chapter 3: A multiple discrete continuous model of time-use that accommodates complementarity and substitution patterns along with time and money constraints

The third paper of my dissertation proposes a random utility maximization (RUM) model that can potentially (a) accommodate non-additive preferences allowing for complementarity and rich substitution patterns, (b) integrate money and time constraints into a single economic constraint, (c) and allow for corner solutions as determinants of individual time-use and goods consumption decisions. To date, most MDC choice models have employed an additively separable utility function, preventing the empirical structure from allowing for rich substitution and complementarity patterns in consumption. Lee and Allenby (2009) develop a non-additively separable utility function (NAS) which assumes that goods within the same group are substitutes, whilst goods in diverse groups are complements. Nevertheless, this structure does not account for multiple consumption decisions within each category, implying that consumers may select only one good for each category. Bhat, Castro and Pinjari (2015) propose a N-AS utility function within the MDCEV framework. Such a utility includes interaction parameters that allow the marginal utility of a good k to depend on the quantities consumed of other goods and capture second order interactions. Positive and negative interaction parameters capture complementarity and substitution effects, respectively. The underlying assumption of most MDC choice frameworks, including the one developed by Bhat, Castro and Pinjari (2015), is that consumers maximize utility subject to a single linear binding constraint (the constraint is binding due to the assumption of an increasing utility function). Nevertheless, in most consumption decisions individuals may face multiple constraints, such as monetary availability, time availability or space availability. Ignoring multiple constraints will lead researchers to deriving wrong conclusions and misleading policy evaluation because of the underestimation of price and/or time sensitivity of the consumers (Satomura, Kim and Allemby, 2011). To address this issue, the proposed research framework assumes that consumers maximize utility subject to time and money constraints, along with rich substitution and complementarity effects in consumption. The time constraint is expressed as the sum of consumption time and time assigned to work, whilst the monetary constraint is defined as the sum of non-work income and work income. By integrating the time spent at work into the monetary budget constraint, the two separate constraints collapse into a single economic constraint, named the full income constraint (Becker, 1965). By doing so, consumers can convert time into commodities by allocating less time to consumption and more to work.

Keywords: Complementarity and substitution patterns, Multiple constraints, Multiple discrete continuous decisions