Chapter 2

A Life of Preference: Evolution of Research from Spatial Interaction Modelling to Discrete Choice Modelling

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2.1 Introduction

One of the challenges for space preference research identified by Dr. Gerard Rushton was to discover spatial choice rules that are independent of the local spatial configuration of alternative destinations. During the 1960s and even the early 1970s, it was common for those analyzing spatial behavior of shoppers, for example, to fit a linear regression model equivalent to an unconstrained gravity model. Each observation of the dependent variable in this model was the trip volume from a given origin to a given destination, and the independent variables described only characteristics of the given destination and its distance from that origin. Such a model effectively assumes that the spatial arrangement of other destinations has no bearing on the value of the dependent variable.

The challenge of this misspecification eventually turned Rushton to the work of mathematical psychologists studying choice behavior [1]-[3]. The method of paired comparisons was at the heart of his key paper on space preferences [4]. The other key feature of this paper was the use of a Kruskal’s [5] nonmetric multidimensional scaling program to derive an interval scale of preferences for location types, based on paired comparisons' proportions inferred from consumers' choices of one location type over others.

It was the rise of mainframe computers in the early 1960s that enabled mathematical psychologists to write iterative nonmetric multidimensional scaling algorithms for the scaling of individuals' perceptions. But, in addition to using programs written by them, we were writing our own, which for me at least, meant sitting for hours in noisy labs filled with IBM keypunch machines and preparing decks of punch cards to submit to the operator of the university's mainframe computer. Every so often at Michigan State University a notice would alert that a limited number of users could use the computer overnight. As soon as we heard of this we would sign up for these nights and often be there into the wee hours getting very fast turnaround on our jobs. All of these would run in a couple of seconds on a modern laptop.

After my 'exchange' year at MSU, I returned to McMaster University in the summer of 1968 and completed my dissertation in early 1971 [6], effectively under Gerry's supervision, though officially under that of the professor who replaced him. This made me Gerry's first doctoral student to graduate.

2.2 Spatial and Environmental Choice Modelling

Despite Rushton's [4] key paper, leading journals continued to accept papers that estimated parameters in spatial interaction models that were biased by the geometry of interaction opportunities. This prompted me to offer the editor a criticism of a paper published in *Economic Geography* in 1973. It concluded by saying that aside from Rushton's paper, there were few papers in geography explicitly addressing the problem of estimating parameters in spatial choice models [7]. The article prompted two useful papers by Cesario [8] [9], the latter in response to Michael Goodchild's comments to the editor about the former. Goodchild during the 1970s was both writing about spatial choice modeling and supervising a doctoral thesis [10] on the topic at Western University, formerly the University of Western Ontario.

Meanwhile, in 1974 I was struggling with how to estimate multiple parameters for destination attributes in probabilistic spatial choice models. This is effectively the probabilistic component of Wilson's [11] production-constrained gravity model in his family of spatial interaction models.

The approach I took beginning in 1973 to estimate weights for multiple destination attributes was a compromise that involved not estimating a distance deterrence effect. The specific question addressed was what factors other than distance affected the attractiveness of U.S. states to interstate migrants. I computed the relative proportion of U.S. interstate migrants moving to one state rather than another equidistant state, thereby eliminating the role of distance in the choice. Also, in order to factor out the effect of state population, migration numbers were standardized by origin and destination state population. Using 1960 U.S. Census data this provided sufficient paired comparison proportions to use a nonmetric MDS algorithm [12] to derive a scale of state attractiveness, independent of state population and distance. The regional structure that emerged was very clear with the warmer western states at the top of the scale and Appalachian states at the bottom [13]. Two-thirds of the variance in attractiveness scores was explained by two climatic factors, one pollution factor, state urbanization and density, and the non-white population percentage.

At the same time as the above study, a similar one was being conducted on revealed and stated preferences for 23 Vermont ski resorts, using license plate data at these resorts for revealed preferences and interviews with skiers for the stated preferences [14]. The method used to infer revealed preferences from license plate data was taken from the aforementioned dissertation of Goodchild's student [10]. Both papers offered insights into ways of extracting information about the antecedents of locational preferences. But neither satisfactorily encompassed both the effect of distance and destination attributes in a single model such as a production-constrained gravity model.

2.3 General Linear Modelling

My foray into recreational travel modeling had resulted in an invitation to meet a British geographer who was visiting Parks Canada, a department in the Canadian federal government that was coordinating the Canadian Outdoor Recreation Demand Study. That meeting led me to spend half of a sabbatical leave at the Tourism and Recreation Research Unit attached to the Geography Department at Edinburgh University. I had agreed to design a household survey of day-trip travel behavior in the summer of 1976. It was at the Unit that I began a long and fruitful collaboration with its mathematical statistician, Mike Baxter. He was intrigued by gravity models in their various guises.

Working with a production-constrained gravity model, we initially used our own Newton-Raphson optimization algorithm to estimate a set of destination attractiveness parameters and two parameters in a distance deterrence function. Baxter then wrote an in-house piece showing that the estimation problem was much more easily solved by applying a multinomial extension of the logit regression model [15].

This was the beginning of my introduction to generalized linear models (GLMs) and how they could be used to estimate the parameters of the production-constrained gravity model among others. The necessary statistical software package had been developed by the Royal Statistical Society's Working Party on Statistical Computing in 1974 and publicised the following year as GLIM, Generalized Linear Interactive Modeling [16]. "GLIM was notable for being the first package capable of fitting a wide range of generalized linear models in a unified framework, and for encouraging an interactive, iterative approach to statistical modeling" [17].

Using GLIM, it was easy to show that the simple gravity model, the doubly-constrained entropy-maximizing and the production-constrained trip distribution models were all simple variants of a general equation. Indeed, by treating origin-destination trip volumes as a Poisson random variable, we were able to show that different mathematical forms of production-constrained trip distribution models yielded very similar or identical maximum likelihood estimates of parameters when fitted to data [18].

2.4 Discrete Choice Modelling

By the early 1980s there were still grounds for modeling aggregate spatial interaction data where, for example, variety seeking behavior was likely, as in the case of tourism and recreation travel. Nevertheless, there was a growing interest in discrete choice modeling as it related to many choice situations. Within geography and beyond, one of the leaders in a branch of this field concerned with stated preference and choice was another of Rushton's doctoral graduates, Jordan Louviere.

About 1984 I began co-supervising an Austrian graduate student at McGill University, Wolfgang Haider, who was interested in tourist destination choice behavior in the Caribbean. I was familiar with Louviere's work on discrete choice experiments and the fractional factorial design of choice sets to present to subjects. With invaluable assistance from Louviere and his research colleague, Don Anderson, a statistician, Haider provided them with ten attributes, each with three levels, for which they provided him with an appropriate fractional design from which to construct choice sets [19].

Haider went on to do ground-breaking research while working as a research scientist for the Ontario Ministry of Environment at the Centre of Northern Forest Ecosystem Research in Thunder Bay, Ontario. Using discrete choice experiments with input from Louviere, Anderson and others, he presented potential recreational fishers with choice sets describing imaginary remote fly-in wilderness destinations in Northwest Ontario. The orthogonal designs included images of lakes that had been digitally manipulated to reflect different levels of landscape alteration due to forestry activity [20]. He subsequently continued his research at Simon Fraser University where he is professor in the School of Resource and Environmental Management.

By the second half of the 1980s I had decided to reorient my research on spatial choice behavior into fields with a more explicit 'environmental' focus. I mounted a survey of Montrealers' reported levels of recycling behavior. This was in the early 1990s when domestic curbside recycling was in its infancy in Montreal. For each of five classes of recyclables (paper, cardboard, glass, cans and hard plastics), a binomial logit regression of the choice to be a high or low recycler revealed the decision was influenced by the egoistic factor (perceived inconvenience of recycling that class of object), and belief that household members wanted the respondent to recycle it. In contrast, altruism as measured by the strength of their belief that recycling helped the environment, did not play a role. Personal utility and the moral influence of valued others were the deciding factors [21].

In 1993 the opportunity arose to conduct a substantial piece of stated discrete choice research on car-borne commuters in Montreal, funded by an Environment Canada initiative that supported academic research on economic instruments for environmental sustainability. The challenge was to estimate the likely effectiveness of policies aimed at reducing solo-driver commuting in conventional cars in the metropolitan area. There were two sets of customized discrete choice experiments administered to 900 respondents: One was on how choice might be affected by manipulating the relative commuting cost or travel time of driving alone compared to ridesharing and using transit. The other more complex experiment was designed to discover the relative demand for less polluting and zero-emission vehicles compared to conventional ones, depending not only on differences in their performance and market cost characteristics, but also in travel cost and travel time characteristics that could be manipulated by public policy. A detailed report of the findings [22] was followed by papers on results of the first experiment [23] and the second [24] [25].

2.5 Conclusion

In 2003 I began supervising my last doctoral student, Zachary Patterson. He was prompted by environmental considerations to investigate what might influence shippers to move freight between major cities by a less polluting and congesting mode than tractor-trailer. Specifically, using a contextual stated preference survey he wanted to discover the influence of defined variables and factors on their choice between road-only and intermodal transport. The latter included specialized scheduled freight trains with rapidloading flatbed rail wagons designed to piggyback truck trailers. With funding support to his co-supervisors from Transport Canada and the Railway Association of Canada, Patterson was able to design a web-based stated preference survey based on a fractional factorial design to discover what factors influence the modal choices of various types of shippers in the Windsor-Quebec City Corridor [26].

Following the successful defense of his dissertation in 2006, he spent two years in Switzerland working on integrated transportation land-use modeling at Michel Bierlaire's Transport and Mobility Laboratory, Ecole polytechnique fédérale de Lausanne. After a further two years as a modeling specialist with Montreal's Metropolitan Transport Agency, he won a prestigious federally-funded Canada Research Chair, Tier 2. Seeing a talented researcher like Zak Patterson continue the study of preference and choice in socially important areas of spatial and environmental analysis is further testament to Gerry Rushton's far-reaching geographical and intellectual legacy. In addition to his own long and illustrious career, he has been responsible for igniting intellectual curiosity and inquiry both directly in his own graduate students and through them in further generations of scholars.

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