CHAPTER 3

Dynamic Trip Modelling

3.1 Background to the RASTT Model

How can we examine changes in consumer trip behaviour within the retail landscape? One method is to construct a calculus model and look at empirical ‘snapshots’ over time to study changes in shopping trip behaviour. This step is necessary to provide a framework to study shopping in a number of space-time contexts. The retail landscape is translated by abstraction. For example, shopping centres become density points of spatial and temporal demand. When we look at consumer trips through the glasses of mathematical abstraction, the space-time assignment of trip strategies creates particular theoretical behaviours within a retail hierarchy based on this demand. Baker (1994a) has shown that ‘large centre’ behaviour has characteristics not found in lower order planned shopping centres (PSCs) and that this behaviour, not only varies with centre size, but over time. Further, lower order centres may assume the characteristics of a higher order PSC in the pre-Christmas rush. What this means is that time can substitute for floorspace and that behaviour at PSCs is dynamic. There is a time-space connectivity and, implicitly, the existence of a temporal pattern in each and every spatial pattern (Janelle, 1968; 1969). Planned shopping centres are therefore not just points of spatial demand in a classical economic sense, but rather there is a time demand imbedded within the synthesis of what defines ‘retail floorspace’. The corollary of this proposition is that a change in the time boundary will fundamentally affect spatial demand and its allocation by consumers within a retail hierarchy. This is what underlies the retail aggregate space-time trip (RASTT) model that will be developed in this chapter.

The RASTT model was introduced previously to demonstrate the art of model building. Now, we want to look at this model more formally, by reviewing ways of deriving it and checking the robustness of the assumptions. Since the model is based on space and time operators, Equations (2.1) and (2.2) can apply to an individual trip to a shopping centre, to ten thousand shoppers travelling to a mall or millions using the Internet. The scale and order of magnitude of demand are different, but the distributions are very similar. Why? All involve the negative exponential or a gravity function, which does not change because of the invariant nature of the spatial operator ($\partial/\partial x$). The difference is that the Internet involves ‘very weak’ gravity interaction and this should be reflected in very low values of the gravity co-efficient β in Equation (2.3). Therefore, a significant advantage of using this type of model is that it can apply equally to trips to neighbourhood stores, planned shopping centres or to the flow of transactions globally on the Internet. The latter applications will be developed in this study.

The RASTT model treats a shopping centre as a retail laboratory and uses measurable variables. Spatial and temporal variables can be averaged per sample and there are constants such as 'floorspace' and 'trading period per week'. The model is made robust from ensuing empirical relationships rather than from the postulation of normative behavioural assumptions (such as utility maximisation). The hypotheses should be testable and reproducible. Therefore, the advantage of the RASTT model is that it has physical descriptors with minimum assumptions that can be measured through direct observation or a survey instrument. The data comes from large samples of 'face-to-face' interviews, generated relative to stated behaviour on the floorspace of PSCs, rather than longitudinally at residences. The respondents are then aggregated into a relative density function, enabling a space-time differential equation to be constructed in space and time for each centre. The method is another physical view of retail modelling and is an alternative to the entropy-maximising approach of trip assignments. The advantage of the RASTT model is that the assignments are dynamic, that is, there is a direct relationship between trip timing and the trading hours of the mall.

There are other approaches, such as economic modelling, which can be used to look at how trading hours impact on retail markets. Rouwendal and Rietveld (1998) argue that with heterogeneous firms there are situations where restrictions of opening hours increase welfare. They assume time is a continuous variable and that the relevant time intervals are determined exogenously by the kind of product under consideration. We consider time, not as continuous and approaching infinity, but allocated relative to a cycle of events (Monday to Sunday) with a maximum boundary of 168 hours per week. The RASTT model allows for the study of the impact of changing this time boundary on spatial shopping patterns. Ferris (1990) has linked the time spent shopping with the store's location in an economic model and recognised that a household's ability to take advantage of particularities of time and place is a function of the length of time that the stores stay open for business. Using a spatial model of monopolistic competition, Ferris argues that by maximising utility in the households' trade-off between discrete time and inventories of traded goods, the households' demands for retail output will increase with the hours of operation and decrease with longer distances to the nearest store. Further, there is a space-time connectivity, where distance and opening hours are substituted through their effect on shopping time (Ferris, 1990, 183). This same thesis underpins the RASTT model, but here we approach the modelling process by assuming that aggregate consumer shopping time is averaged within the boundary of the fixed centre hours, rather than fixed just over a representative sample of the population. The RASTT model deals with relative densities of shoppers (once again sampled from the floorspace of the mall) and not the assumption that there are a fixed number of consumers (as in Rouwendal and Rietveld, 1998). The RASTT model therefore provides an alternative view to economic modelling and its applications in this study are instructive of its strengths (and weaknesses).