

# From Modeling Parking Search to Establishing Urban Parking Policy

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**The paper presents a conceptual view and explicit agent-based model of parking in a city. Driver-agents behave within a high-resolution GIS database of the street network and parking facilities. They drive towards their destination, search for parking, park for a given interval of time, and leave the network. During parking search, driver-agents estimate the availability of parking places, their price, and parking enforcement efforts, and decide whether to park or not. The model is implemented as an ArcGIS C#.NET application and is applied to the Tel Aviv central area.**

## 1 Introduction

Parking policies have a strong impact on the behavior of drivers and, through it, on the functioning of cities. As such, they require careful analysis and evaluation at the level of a single driver. Against this background, we develop a spatially explicit Agent-Based model of parking in the city. The model enables the systematic analysis of the impacts of various policy scenarios, using a set of quantifiable data relevant to policy-makers.

The development of spatially explicit simulations of drivers' parking behavior is still in its infancy. The first attempts in this direction dealt with over-restricted situations of search and choice within an off-street parking lot (Harris and Desouky 1997) or several adjacent street segments (Saltzman 1997). The model of Thompson and Richardson (Thompson and Richardson 1998) goes essentially further and considers driver parking search and choice between on-street and off-street alternatives in a realistic way. However, it still deals with a small abstract grid network of two-way streets. The recent model of Dell'Orco and Teodorović (2005) makes an essential step toward specifying drivers' parking behavior by means of a set of fuzzy rules. It does not account for relative location of parking facilities (and in this sense is not spatial), but the parking choice rules clearly describe how the driver-agent chooses between on-street legal/illegal and off-street parking with low/moderate/high fees based on distance to CBD, previous parking experience and planned parking duration. Using data on actual parking facilities, the model is applied to the city center of Bari (Italy), in order to establish appropriate parking fees.

While the above models provide deep insight into some key questions on parking, they cannot be directly applied to real-world settings and, hence, cannot be used to assess and evaluate real-world policy alternatives. The model developed in this paper aims filling the gap. It provides a realistic framework for investigating drivers' parking search and choice behavior within real cities. While the model is by no means fully developed yet, the first results do show that the approach enables analysis and assessment of a wide variety of parking policy scenarios within real-world settings.

## 2 The Setting: Parking Problems In Urban Settings

Virtually all cities in industrialized countries face parking problems, when defined as an imbalance between demand for and supply of parking, at least in specific areas of the city and during specific time intervals. This imbalance typically occurs around high-density employment centers during workdays or during peak shopping periods around shopping centers. Furthermore, older neighborhoods, especially in European cities, increasingly experience a tension between demand for residential overnight parking and available on-street parking supply.

Without appropriate parking pricing or severely restrictive measures, these types of areas will nearly always experience a situation in which demand for parking exceeds supply during at least part of the day. Moreover, due to synergetic reactions, parking problems in one area tend to spill over in another. For instance, visitors of bars and restaurants may park on-street in a neighborhood, decreasing the probability for local residents to find an on-street place for overnight parking. In reaction, these residents will extend their search area into surrounding neighborhoods, which will, in turn, face a growing imbalance between demand and supply (Shoup 2005).

Policy intervention thus becomes increasingly complex, as measures in one area and for a particular group of drivers (e.g. commuters) may worsen the conditions in another area and for another group of drivers (e.g. local residents or visitors). Since the typical goal of a municipal parking policy will be to guarantee a balance between demand for and supply of parking (i.e. a demand/supply ratio below, but close to, one), relatively small changes in parking demand or supply, due to e.g. increasing car ownership, densification of land uses, or changes in traffic arrangements, can easily result in an increase of the demand/supply ratio to a level above one. The impacts of parking measures thus become extremely difficult to forecast.

This "criticality" of the situation implies that a practically applicable tool for testing policy measures will have to explicitly represent the dynamics of the parking situation, based on precise estimates of demand and supply, at the spatial and temporal resolution at which policy measures could be implemented. Only in this way the 'on-street' competition between drivers looking for parking, each faced with the aforementioned synergetic system reactions, can be accounted for. In