New England University Transportation Center
77 Massachusetts Avenue, E40-279
Cambridge, MA 02139
617.253.0753
utc.mit.edu

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The Impact of Parking Policies on the Long-term Vitality of American Cities

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Principal Investigator:	Norman Garrick	**Co-Principal Investigator:**	Carol Atkinson-Palombo
Title:	Associate Professor	**Title:**	Associate Professor
University:	University of Connecticut	**University:**	University of Connecticut
Email:	Norman.garrick@gmail.com	**Email:**	Carol.atkinson-palombo@uconn.edu
Phone:	860-486-2990	**Phone:**	860-465-7232

Most municipalities in the U.S. set minimum parking requirements in local zoning and building codes *(1)*. These policies assume that the appropriate supply of parking can be determined by estimating the potential demand and aiming to meet that demand. This view is reinforced through the Institute of Transportation Engineer's *Parking Generation* (Institute of Transportation Engineers 2010) and other similar guides that provide estimates of parking demand. However, it typically fails to account for the complex relationships between parking supply and demand. This failure is problematic for many well-documented reasons. Parking is expensive to provide, thereby driving up construction and rental prices; it consumes large amounts of space, thereby limiting development potential; and it often encourages driving *(3)*. This last point—the influence of parking on automobile use—is the primary focus of this study. There is a substantial body of literature describing the many ways that the price and availability of parking influence automobile use and travel behavior. For example, the price of parking at work influences whether employees choose to drive alone *(4–6)*. It also influences where and when people choose to travel for discretionary trips and where they choose to park once they arrive *(7)*. Guaranteed parking at home has been shown to influence whether commuters drive to work, versus taking transit *(8, 9)*.

These studies suggest that minimum parking requirements, public parking provision, and other mechanisms that push citywide parking supplies upward could potentially cause citywide increases in automobile use over time. Prior research has shown that parking supply and automobile use are correlated across different cities and metropolitan areas *(10, 11)*. Cities where parking has increased considerably over time also experienced marked increases in automobile use *(12, 13)*.

The primary question in this study, therefore, is one of causality: do citywide changes in parking actually cause automobile use to increase, or are minimum parking requirements an appropriate response to already rising automobile use? The purpose of this study is to consolidate the available knowledge, contribute original data, and apply a robust, scientifically accepted framework for inferring whether causality exists. In addition to prior research, we rely on data related to parking provision and automobile use for nine U.S. cities in the years 1960, 1980 and 2000, which let us track and analyze considerable changes over time.

Causality has been the subject of numerous prior travel behavior studies—particularly those aiming to parse out the effects of residential self-selection. The most common approaches, in lieu of controlled experimental design, include direct questioning through surveys, statistical models that control for residential location choices, and longitudinal studies, or some combination of those approaches *(14–16)*.

Several studies that relied on household travel surveys controlled for residential location, which the authors considered a treatment effect that explains attitudinal differences *(17–19)*. Several other studies relied on a comprehensive travel survey administered across eight neighborhoods in northern California in 2003. The survey includes information about attitudinal differences, how recently a resident moved and their current location, which allowed the authors to conduct cross-sectional and quasi-longitudinal analyses *(14, 15, 20)*. Similarly, Joh et al. *(21)* relied on the South Bay Travel Survey administered between 2005 and 2007 and controlled for attitudes about walking based on questions asked in the survey.

Since we are interested in understanding changes in parking supply and travel behavior at the city scale over multiple decades, our options for parsing out causality are especially limited. Comprehensive travel surveys and detailed location data are not available. The most consistent source of travel data are from journey to work surveys administered by the U.S. Census Bureau each decade dating back to 1960. Since no reliable database of historical parking supply exists, we are left to develop our own estimates using available aerial photographs. The effort required to develop these estimates limits our potential sample size considerably. The above limitations rule out many common approaches including those involving controlled experiments, direct questioning, or statistical modeling.

Instead, we rely on a widely-accepted general theory of causality, adopted from the field of epidemiology, commonly referred to as the Bradford Hill criteria *(22–25)*. The nine criteria, first presented in a 1965 speech by Sir Austin Bradford Hill, a Professor Emeritus at the University of London, are intended for inferring causality when an association already exists. They are not meant to serve as a checklist or set of rules, but instead to answer the question: "What aspects of that association should we especially consider before deciding that the most likely interpretation of it is causality?" *(22)*. According to Hill, "the decisive question is whether the frequency of the undesirable event B will be influenced by a change in the environmental feature A" *(22)*.
In our case, an environmental feature A refers to parking supply and the undesirable event B refers to automobile use, which is associated with a range of environmental, social, and economic consequences, including traffic congestion, traffic deaths, and pollution. By approaching the question of parking supply and automobile use in this way, we can gain a reasonably definitive answer regarding the potential citywide impacts of parking on travel behavior and make evidence-based recommendations for crafting parking policies to achieve long-term transportation-related goals.

For this study, we combine original data from nine American cities over a period of 40 years with knowledge gained from prior research in order to apply the Bradford Hill causality criteria and better understand the influence of parking provision on automobile use. At the city scale, we find that an increase in parking provision from 0.1 to 0.5 parking spaces per resident and employee is associated with an increase in commuter automobile mode share of roughly 30 percentage points. We also demonstrate that a majority of the Bradford Hill criteria can be satisfied using the available data. While there is some lack of relevant data and research, none of available evidence conflicts with the Bradford Hill criteria. Based on this knowledge, we infer that parking provision in cities is a likely cause of increased driving among residents and employees in those places.

By demonstrating that parking increases contribute to rising automobile use, this research calls into question the underlying justification for minimum parking requirements in urban areas. These requirements, like many transportation policies, employ a predict-and-provide approach through which planners and designers estimate future demand and provide sufficient infrastructure to meet that theoretical demand. Our study suggest than parking has an induced demand effect *(26)*, which should be taken into account and managed accordingly through mechanisms like maximum parking allowances and appropriate pricing.

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