URBAN SUSTAINABLE MOBILITY

edited by
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ECONOMIA E POLITICA INDUSTRIALE

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INTRODUCTION

Sustainable mobility, that is disconnecting mobility from its harmful effects, has been at the heart of the transport policy of all developed economies for several years. It is based on a broad range of policy tools which are and will continue to be crucial to action taken by individual states, which are a vital element in achieving a sustainable transport system. In broad terms, it refers to transport modes and systems of transport planning which are in line with wider concerns of sustainability. One definition of sustainable mobility is given by the Council of Ministers of Transport of the European Union (2001) which defines a sustainable transport system as one that:

- allows the basic access and development needs of individuals, companies and society to be met safely and in a manner consistent with human and ecosystem health, and promotes equity within and between successive generations;
- is affordable, operates fairly and efficiently, offers a choice of transport mode, and supports a competitive economy, as well as balanced regional development;
- limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and uses non-renewable resources at or below the rates of development of renewable substitutes, while minimizing the impact on the use of land and the generation of noise.

This definition is very wide and includes aims that sometimes needs a trade-off policy. Further, our knowledge of the long term interplay between economic development, spatial distribution of economic activities and transport costs is still very partial. Therefore, poor knowledge by economists leaves a lot of room for interpretation by policy makers so we should not be surprised to encounter very different policies.

The key idea of this book is that the full achievement of sustainable mobility aims requires efforts from the demand behavior, the pricing system and appropriate intervention policy. The contribution of this volume takes up relevant policy issues and discuss behavioral, social and economic aspects of sustainable transport, assuming that sustainable transport and mobility system require the co-existence of several different mobility modes. This is unavoidable. Therefore, we are all aware that a balance between modes and means of transport is necessary and, of course, what we need is a policy and a system which avoid discrimination and social exclusion, without compromising the environment. In this framework there is the need to deepen theoretical, methodological and empirical aspects of sustainable transport and mobility, and this is what we try to do in this book. For this reason the first part of the book describes and criticises the various methodological approaches adopted to assess the causal impact of the built environment on travel behavior, and summarizes the empirical findings of those studies (Xinyu Cao, Patricia L. Mokhtarian, Susan L. Handy). Also on the travel behaviour is focused the study of the author Venezia in which a case study is illustrated and it shows that people wishes to use public services, regardless the price, and that clear changes in terms of urban transport policies could help the urban environment to be more sustainable. The key solution, as suggested by the author, is to assume a greater responsibility by a drastic introduction of a tools set which modify the travel behaviour and the modal choice, and the development of sustainable transport systems through a revolutionary change in the transport services supply.

The second part of the book analyses the role of integrated tariffs and service quality as attraction factors which may change the modal split in an urban context. A particular focus is given to integrated tariff systems as a possible instrument to enhance the quality in public transport supply (Graziano Abrate, Massimiliano Piacenza, Giuseppe Sorrenti, Davide Vannoni**),** while the paper by Valeri-Stathopoulos-Marcucci-Gatta highlights the importance of service quality control in the local public transport industry. In particular, they illustrate a method to measuring service quality taking a consumers' perspective into account and they underline the relevance of including service quality control systems into tendering contracts.

Finally, in the third part on intervention policy, Luongo focuses on the definition of the intervention policy and on the actions to carry out in order to try to solve the accessibility problems in urban areas. He remarks that sustainable urban mobility requires the optimal use of transport infrastructures, coordination between different transport modes and the promotion of less polluting modes starting from an extensive and accurate knowledge of the current and potential transport demand.

Elisabetta Venezia

1st part

Travel behaviour

1. EXAMINING THE IMPACTS OF RESIDENTIAL SELF-SELECTION ON TRAVEL BEHAVIOR: METHODOLOGIES AND EMPIRICAL FINDINGS

by *Xinyu (Jason) Cao, Patricia L. Mokhtarian, Susan L. Handy*

1.1. Introduction

Numerous studies have observed that residents of higher-density, mixed-use (“traditional”, “neo-traditional”, or “new urbanist”) neighborhoods tend to walk more and drive less than do inhabitants of lower-density, single-use residential (“suburban”) areas (e.g., Cervero and Duncan, 2003; Crane and Crepeau, 1998; Frank *et al.*, 2006). Based on this considerable evidence, altering land use patterns from the latter to the former has become widely discussed as a means of reducing motorized vehicle travel, and thereby reducing petroleum consumption, air pollution, greenhouse gas emissions (TRB, 2009), and even obesity (TRB-IOM, 2005).

What is less well understood, however, is the extent to which the observed patterns of travel behavior can be attributed to the residential built environment itself, as opposed to the prior self-selection of residents into a built environment that is consistent with their predispositions toward certain travel modes and land use configurations. For example, residents who prefer walking may consciously choose to live in neighborhoods conducive to walking (as found by Handy and Clifton, 2001), and thus walk more. Therefore, the observed differences in pedestrian behavior in those two types of neighborhoods may be more a matter of residential choice than travel choice. In other words, residential self-selection may be at work. If so, we are likely to overestimate the influence of built environment elements on travel behavior when we adopt land use policies to try to reduce travel, fuel consumption, and emissions. If, for example, someone with an automobile-oriented lifestyle ends up living in a dense, mixed-use neighborhood (perhaps because of financial incentives or because not enough other housing is available to fulfill his preferences), his travel behavior will probably not match that of those who actively want and choose to live in such neighborhoods.

Critics of smart growth policies (e.g. O'Toole, 2009) comment on the price of being wrong (beyond not achieving the expected reduction in vehicle travel), including (1) a diminished collective quality of life through unfulfilled preferences, residential crowding (with a potential loss in privacy, greater stress, and easier transmission of communicable diseases[1]), and lower mobility (arising from higher costs of the automobile, increased traffic congestion, and greater travel times using transit); and (2) the opportunity costs of spending resources on this policy that might have been more effectively deployed on others. Accordingly, it is important to improve our understanding of the role of residential self-selection in the influence of land use on travel behavior, so that our predictions of the travel impacts of land use policies will be as precise and accurate as possible.

In the past few years, this complex issue has been addressed in a variety of ways. This chapter describes and critiques the various methodological approaches adopted to date to assess the causal impact of the built environment on travel behavior, and summarizes the empirical findings of those studies. The organization of this chapter is as follows: Section 2 reviews the prerequisites of causality inference in the context of the built environment and travel behavior. Section 3 analyzes the various methodologies that have been used to address this issue, while Section 4 discusses numerous ways of posing the research question(s) of interest, and highlights the difficulties in actually quantifying the absolute and/or relative extent of the true influence of the built environment on travel behavior. The last section summarizes the review and makes some recommendations for future research.

1.2. Causality requisites

According to the Merriam-Webster online dictionary, causality is defined as "the relation between a cause and its effect or regularly correlated

[1] The preface to TRB-IOM (2005) reminds readers that a century or more ago, lowering settlement densities and segregating residential from industrial and commercial land uses was seen as an enlightened policy for reducing the spread of disease.

events or phenomena". Causality must be inferred, because we can only observe an association between events. The association can be categorized into one (or more) of three principles of connection of events: resemblance, contiguity in time or place, and cause or effect (Hume, 1748). Therefore, association itself is insufficient to establish causality. To *robustly* infer causality, scientific research generally requires at least four kinds of evidence: association, non-spuriousness, time precedence (direction of influence), and causal mechanism (Schutt, 2004; Singleton and Straits, 2005).

Association: The presence of a "statistically significant" relationship between two variables (established, for example, through a t-test, chi-squared test, analysis of variance, or correlation) is often taken as evidence of association. While useful as a general principle, statistical significance does not guarantee even a meaningful association, let alone true causality. The apparent relationship may be spurious (see below), or may simply constitute a Type I statistical error, in which the null hypothesis of no relationship is erroneously rejected due to random variation making the relationship appear to be stronger than it really is. The latter situation may well arise in a given study in which numerous statistical tests are conducted, but is less likely to explain results that persist across a number of independent studies, as is the case for the observed association between the built environment and travel behavior.

On the other hand, while a statistically significant association is often taken to be at least a necessary condition of causality (Singleton and Straits, 2005) if not a sufficient one, this is also not guaranteed to be the case. That is, a weak association does not rule out causality. The causal relationship may be strong for one subgroup of the sample but be diluted when tested across the entire sample; controlling for a third variable may unmask a strong association between the first two (Utts, 1999). Further, an insignificant relationship may be the net outcome of causal forces acting in opposite directions and mostly canceling each other, which is quite a different case than that of no significant forces in either direction.

Nonspuriousness: A nonspurious relationship between variables refers to an association that cannot be explained by a third-party (extraneous or antecedent) variable. If a third-party variable happens to cause both a "dependent" variable and an "explanatory" variable, a statistically significant association may exist even if the explanatory variable inherently has nothing to do with the dependent variable. Therefore, to infer causality, we should eliminate rival hypotheses that can explain the observed association between variables (Singleton and Straits, 2005). The land use–transportation literature offers evidence of possible spurious relationships between the built environment and travel behavior. As an example, in the 1995 Nationwide Personal Transportation Survey, it was found that low income households were disproportionately likely to reside in high-density urban areas, and that they were much more likely to walk than their higher-income counterparts (Murakami and Young, 1997). In this case, household income can be a cause of both residential choice and travel behavior, and hence this rival hypothesis weakens the inference of causality between the latter two variables. To establish non-spuriousness in a nonexperimental study, an appropriate method is to show that the relationship still holds when all third-party variables are controlled for (statistical control). In reality, of course, we are seldom able to control for all variables, but we should account for as many variables as possible (Singleton and Straits, 2005).

Time precedence (direction of influence): To infer causality, a cause must precede its effect in time, or at least the direction of influence must be from a cause to an effect (Singleton and Straits, 2005). A causal relationship is "a relationship in which a change in one event forces, produces, or brings about a change in another" (Singleton and Straits, 2005, p. 20). Therefore, a panel study showing that changes in built environment characteristics at one point in time are associated with changes in travel behavior at a later time will offer more direct evidence of a causal link from the built environment to travel behavior than cross-sectional analysis can. Sometimes, however, an anticipatory travel choice may precede residential choice; for example, those moving to suburban neighborhoods may acquire one more car shortly before they relocate. Thus, although this travel choice is still a result of the residential change, the temporal order of observed choices is reversed, complicating efforts to identify the direction of causality even when dynamic data are available.

For cross-sectional data, it can be even *more* difficult to tell whether the choice of the built environment precedes travel choice or travel choice precedes residential choice. For example, it is evident that highly-walkable neighborhoods are significantly associated with a large amount of pedestrian travel (e.g., Cervero and Duncan, 2003). A common inference from this association is that the influence is from the built environment to travel behavior through an intervening variable – travel costs. This is a strong causal mechanism from the perspective of transportation economics, as discussed later in this section. Alternatively, however, as mentioned in the Introduction, this association may mean that individuals who walk a lot intentionally choose a highly-walkable neighborhood in which to live. In this case, travel attitudes (walking preferences) are likely to confound this direction of influence.

As shown in Figure 1, travel attitudes may act as either antecedent or intervening factors in the associations between the built environment and travel behavior. Figure 1a illustrates a potentially spurious relationship between walkable neighborhoods and walking behavior, which can be addressed by controlling for walking preference. In Figure 1b, a large amount of walking (which may or may not have very much to do with the built environment) may stimulate or reinforce an individual's preference for pedestrian travel, which may in turn encourage her choice of highly-walkable neighborhoods. In other words, walking behavior (in that model) is likely to be a proxy for walking preference. If we explicitly account for the influence of walking preference, the influence of the walking behavior on the choice of walkable neighborhood is likely to diminish. Further, an individual's current travel behavior is not a logical indicator of her previous walking preference and residential choice (it may well be correlated with prior attitudes that *are* true antecedents of residential choice, but since the degree of that correlation is unknown, using current behavior as a proxy for past attitudes is in effect assuming what one needs to prove).

Therefore, when only cross-sectional data on the built environment and travel behavior are available, but not attitudes (as is the case in many studies), the influence from the (previously-chosen) built environment to (presently-chosen) travel behavior is generally inferred more strongly than that from travel behavior to the built environment. In that situation, two roles of walking preference can be distinguished. Travel attitudes may again serve as an intervening variable but in the other direction, as shown in Figure 1c. In particular, if travel attitudes are measured at the current time, these attitudes may be more a function of prior residential choice than the reverse (Chatman, 2005). If we fail to take that into account, we may overstate the influence of travel attitudes. Alternatively, as shown in Figure 1d, the built environment may have a primary and direct influence on travel behavior while travel attitudes may be secondary or irrelevant to this link, as most