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Effects of built environment on freight consumption

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Abstract

The aim of this study is to examine the relationship between built environment and consumption of consumer products. The study uses the data obtained from a series of surveys conducted in Texas to empirically examine the relationship between tons of consumer products per capita delivered to each tract and built environmental variables such as road density, population density, and block size while controlling for socioeconomic characteristics. The finding of this study will contribute toward the interrogation of the broad effect of policies that are often called "smart growth" in terms of effect on the demand for freight.

Keywords: Freight transportation planning; built environment and freight consumption; consumer products

1. Research problem

According to Bronzini [1] the freight vehicle-miles traveled (VMT) grew 40 percent in the metropolitan areas in the U.S. over the last decade, while the VMT for passenger vehicles increased by only 30 percent over the same time period. It is common to find road segments for which significant share, sometimes over 50%, of traffic during certain time periods of the day are trucks. However, there is little evidence that the planning process, especially land use, in the U.S. cities takes freight into consideration.

Although movements of freight are mostly driven by the private businesses in the U.S., the pubic sector decisions have critical and pervasive effects on the means and efficiency of freight movement in

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several fronts. Firstly, the transportation infrastructure is by and large still being provided, operated, and managed by the public sector. Even in the case of the rail roads that own and operate their infrastructure and vehicles, they must coordinate with municipalities and states to address negative impacts, e.g. rail crossings, noise, fumes, associated with their business activities. Secondly, land use decisions, implemented through regulations and local ordinances, affect the design and management of supply chains, including the placement of facilities. In the U.S., each municipality enjoys near total control over land use decisions, and their decisions often reflect parochial interests that place greater priority on job creation for their own city over regional benefits. Thirdly, land use determines the location and intensity of demand for freight movements. Recently, land use and transportation policies known as Smart Growth have dominated regional and local planning practices in the U.S. The conceptual cornerstone of the Smart Growth, as far as transportation is concerned, is based on the idea that land use and urban design that encourage non-motorized travel lead to less demand for travel by cars, and thus benefit the society. However, in most cases, the impacts of land use and urban design on the flow of goods are not examined, or even considered by the planners or policy makers. The main reason for this shortcoming in the policy realm is the lack of understanding regarding how various goods are shipped and delivered. According to Bronzini, "the goods delivery impacts are viewed as ancillary effects rather than primary planning goals".

Urban density and design can have profound impacts on both the volume and efficiency of freight movements for the "last mile" segment of journey [2], [3], [4]. Also, while many cities strive to gentrify urban core areas with densification and transit-oriented development (TOD), very little attention is paid to the fact that such land use pattern may lead to an increase in the intensity of goods consumption per a unit of land area. Meanwhile, it is also plausible that compact land use pattern reduces the consumption of freight because of the need to reduce inventory space, and thus the overall intensity of freight demand per unit area may actually decreases with density. A study by Kawamura and Lu [5] found that the demand for freight, measured in annual tons per capita or ton-miles per capita, varies significantly among countries. For example, they found that Italy has a considerably lower average annual ton per capita than other European countries and the U.S. They also found that the freight ton-miles per capita for the U.S. was as much as three times greater than those for most of European countries.

Most practical approaches for estimating truck trip generation can be broadly categorized as commodity-based or trip-based [6]. A common method used in the application of the trip-based approach is the use of trip rates, in which the rate of truck trips generated by a site is estimated based on rate(s) that capture the relationship between the truck trip generating potential of the site and the characteristics of the site such as land use, number of employees, floor area, etc. Brogan [7] calculated truck trip-generation rates for 10 land use categories. A more recent effort by Holguín-Veras and López-Genao [8] examined the trip generation rate at the terminals. They found that the rates varied among different parts of the country. Slavin [9] developed a trip-end model that captures the relationship between truck trip-ends and socio-economic activities in the various land uses. He found that there was a statistically significant relationship between the truck trip ends and the characteristics of land uses. Brogan [10] tested the sensitivity of trip-end estimation with respect to various stratification schemes using the regression model. He found that the regression stratified by land use categories provided the best results.

It should be noted that most of the studies were conducted for the purpose of improving the travel demand estimation of truck movements and did not specifically examine the relationship between the generation or consumption of freight by the end user and the land use. To our knowledge, no study has examined the relationship between consumer freight demand and built environment in an empirical manner. This study is a part of a multi-year effort to examine several aspects of the complex relationships between land use and transport of freight. For passenger travel, the relationships between travel behavior and built environment (e.g. land use allocated for different industrial types, density) as well as socioeconomic characteristics have been studied extensively, e.g. Ewing and Cervero [11]. In this paper,