Transport Policy 69 (2018) 98–105

Contents lists available at ScienceDirect

Transport Policy

journal homepage: www.elsevier.com/locate/tranpol

Urban form, transit supply, and travel behavior in Latin America: Evidence from Mexico's 100 largest urban areas

Erick Guerra[a,*], Camilo Caudillo[b], Paavo Monkkonen[c], Jorge Montejano[b]

[a] Department of City and Regional Planning, University of Pennsylvania, School of Design, 210 South 34th Street, Philadelphia, PA 19104-6311, United States
[b] Centro de Investigación en Ciencias de Información Geoespacial, A.C. (CentroGeo) CONACYT, Contoy 137 Esq. Chemax, Col. Lomas de Padierna, Delegación Tlalpan, CP, 14240, Mexico
[c] Department of Urban Planning, University of California, Los Angeles, 337 Charles E Young Dr E, Los Angeles, CA 90095, United States

ARTICLE INFO

Keywords:
Transit
Urban form
Travel behavior
Mexico
Mode choice

ABSTRACT

This paper examines the relationship between urban form, transportation supply, and individuals' mode choice across Mexico's 100 largest urban areas. After documenting variation in mode choice, urban form, and vehicle ownership, we fit a multinomial logit model to data from 2.5 million commuters who reported a work commute on the 2015 Intercensus. We estimate whether a person commutes by transit, car, or walking/biking as a function of commuters' gender, age, employment status, household income, and seven measures of urban form and transportation supply. Across urban areas, commuters are less likely to drive in dense urban areas where jobs are spatially concentrated jobs and near population centers. Commuters are also less likely to drive in areas with better public transit supply and less roadway. Collectively the measures of urban form are as strongly related to the probability someone commutes to work by car as household income. Population density plays a particularly strongly role with an estimated elasticity four times as strong as recent studies from US urban areas. Taken together, our findings suggest that land use planning and transportation investments can and do influence commute patterns. Recent public policies have almost certainly contributed to increased, rather than decreased driving and associated congestion, pollution, and traffic fatalities.

1. Introduction

Between 1990 and 2010, Mexico's largest 100 urban areas added 23 million new residents, a 53% increase. Nearly all of this new growth has been in densely populated suburban neighborhoods, comprised of informal housing or — more recently — large, dense, publicly-subsidized, and peripherally-located commercial housing developments.[1] The most central neighborhoods have lost population but jobs have become more centrally clustered, partially as a result of the overall shift from manufacturing jobs to services. While urban sprawl is generally characterized by low-density, fragmented, leapfrog, single-use development (Hamidi et al., 2016; Tsai, 2005; Galster et al. 2001), Mexico's recent sprawl is dense and spatially concentrated. Even in single-use development, moreover, residents quickly convert housing units into shops and local businesses.

Shifts in urban spatial structure have likely contributed to the rapid increase in vehicle fleets and vehicle travel in Mexico. Across cities, neighborhoods, and individuals, higher density neighborhoods with better access to jobs are associated with lower rates of motorization (Newman and Kenworthy, 1989; Holtzclaw, 1990; Levinson and Kumar, 1997; Ingram and Liu, 1999; Bento et al., 2005; Ewing and Cervero, 2010; Stevens, 2017). National and local government agencies have attempted to contain sprawl and its associated costs — such as pollution, long and expensive commutes, congestion, and traffic fatalities. For example, the National Housing Commission (Comisión Nacional de Vivienda, CONAVI) recently developed an Urban Growth Containment Program to promote more centralized construction of publicly subsidized housing (for an overview, see Monkkonen and Giottonini (2017)). The Federal government's recently approved 2016 New Human Settlements Law will allow for higher densities and mixed-use development throughout Mexican neighborhoods starting in 2018. Nonetheless, between 1990 and 2010, the vehicle fleet tripled in Mexico's largest 100 largest urban areas.

To inform academic understanding of this issue and contribute to

* Corresponding author.
E-mail addresses: erickg@upenn.edu (E. Guerra), ccaudillo@centrogeo.edu.mx (C. Caudillo), paavo.monkkonen@ucla.edu (P. Monkkonen), jmontejano@centrogeo.edu.mx (J. Montejano).

[1] Since reforms enacted in the early 1990s, INFONAVIT, a subsidized housing provident fund for employed low-to-middle-income households, has sparked a shift from primarily incremental, self-help construction housing market to one based on speculative building and mortgage finance (Monkkonen, 2011).

https://doi.org/10.1016/j.tranpol.2018.06.001
Received 16 August 2017; Received in revised form 20 April 2018; Accepted 1 June 2018

policy debates in Mexico, we examine whether and to what extent measures of urban form and transportation supply correlate with travel behavior across Mexico's 100 largest urban areas. Although there is a large and growing body of literature on the relationship between urban form and travel behavior (see for example (Ewing and Cervero, 2001, 2010; Boarnet, 2011; Stevens, 2017)), little empirical evidence is from Mexico or Latin America. What studies do exist tend to be from large capital cities with metropolitan household travel surveys, such Mexico City (Guerra, 2014b), Santiago de Chile (Zegras, 2010), or Bogota (Cervero et al., 2009). The relationship between urban form and travel behavior may vary substantially in smaller cities and urban areas. For example, even metropolitan Mexico City's most peripheral neighborhoods have high enough population densities to support high-capacity transit like subways or metros (Guerra and Cervero, 2011; Newman and Kenworthy, 2006; Pushkarev et al., 1982). As in other low- and middle-income countries, however, nearly all of Mexico's recent and projected population and economic growth is now occurring outside of its largest cities (United Nations Population Division, 2014). How smaller cities grow will help determine national car ownership levels, total vehicle travel, pollution levels, and traffic safety records. Despite the rapid growth in vehicle fleets, Mexico's urban areas remain highly multimodal, with 49% of residents commuting to work by transit, 28% by car, and 23% commute by foot or bicycle.

This paper is the first to examine the relationship between individual travel behavior and urban form across multiple Mexican cities. To do so, we rely on Mexico's 2015 Intercensus, which provides the first national snapshot of how residents commute to work. We match the data to measures of urban form for Mexico's 100 largest urban areas. Together, these 100 cities and their suburbs account for 64% of the national population and 86% of the employed population. Due to the spatial resolution of the data, we rely on metropolitan level measures of urban form, as in Bento et al.'s (2005) study of the relationship between urban form, mode choice, and vehicle travel in US metropolitan areas in 1990. While this approach misses some of the nuances of how local neighborhood form influences travel behavior, it likely prevents biased parameter estimates from residential self-selection.

We organize the remainder of this paper as follows. Section 2 summarizes and describes the study's data and modeling approach. We pay particular attention to describing the construction of urban form metrics used in the analysis and their expected relationship to travel behavior. Section 3 presents the results of our mode choice models and Section 4 examines the strength of relationship between our measures of urban form, transit supply, and commute mode choice. Section 5 discusses implications for public policy and Section 6 concludes.

2. Data and modeling approach

We estimate whether someone commutes to work by transit, active modes (i.e., walk or bike), or car, as a function of age, income, education, and information about the urban area where the commuter resides. We use the Mexican National Population Council's National Urban System definition of urban areas, which includes all major cities and surrounding suburbs (Consejo Nacional de Población, 2018). As in Bento et al. (2005), commuter information like age and gender vary at the individual level while measures of urban spatial structure like population density and jobs-population balance vary at the metropolitan level.

The Intercensus does not provide information on the neighborhood where respondents reside or work.[2] Thus this analysis ignores the way that differences in the built environment influence travel behavior at the neighborhood level, as in the studies reviewed in recent meta-analyses (Ewing and Cervero, 2010; Stevens, 2017). This limitation has one substantial benefit, however, in that estimates of the relationship between urban form and travel behavior are unlikely to be biased by residential self-selection (for a review of the self-selection problem, see (Handy et al., 2005; Cao et al., 2009; Mokhtarian and Cao, 2008)). Residents may choose to live in a neighborhood that suits their travel preferences but are much less likely to change metropolitan areas based on preferred travel behavior. Nineteen in twenty adults in our sample lived in the same metropolitan area in 2010 as in 2015 and just 2% had moved from one metropolitan area to another (authors' calculation using INEGI (2015)).

The 2015 Mexican Intercensus provides the first-ever national data detailing how Mexicans commute to work and school. Prior to 2015, the national statistics agency asked only one transportation-related question on the Census: whether households had one or more cars. Prior to 2000, there were no transportation-related questions on the Census at all. Although data are available at the household level, spatial resolution is only available down to the municipality and more populous localities. The largest urban area, Mexico City, includes nearly 80 municipalities. Most small metropolitan areas include just one. In Mexico's 100 largest urban areas, the sample includes data collected from 7.2 million individuals, including 2.5 million commuters, in 1.9 million households collected in March 2015. We exclude respondents who did not report commuting to work from our sample, as well as 408,756 respondents who did not report their mode of travel.

Table 1 summarizes the variables used in the models and the expected relationship to commute choices. In the following sections, we provide additional details on mode choice, car ownership, transit supply, and our measures of urban spatial structure in Mexico's 100 largest urban areas. According to the Intercensus, 63% of commuters were men, with an average age of 38 and a monthly household income of 12,800 pesos (around $1000 USD in 2015). Roughly a third of commuters had completed junior high school, with another 23% having completed high school, and 22% having completed college or a higher degree. Just over half of the sample work in the informal sector, according to Suárez, Murata, and Campos's (2016) estimation procedure. This multi-criteria approach characterizes informal workers as those who are: self-employed or day-laborers; not professionals; not involved in healthcare, finance, telecommunications, government-owned industries, or other heavily regulated sub-sectors; and not benefitting from employer-sponsored healthcare or retirement funds.

For the 114,461 residents who did not report household income and 1364 who did not report age, we set income or age to zero and added a dummy variable to indicate missing data. Unreported educational attainment is included with lower educational attainment in the reference category.

2.1. Mode choice to work

In Mexico's largest urban areas, 49% of residents commute to work by transit, 28% commute by car, and 23% commute by foot or bicycle. Fig. 1 plots the distributions of mode share across the 100 urban areas as three kernel-smoothed histograms. Public transit is the most common way for people to access work and accounts for between 12% and 67% of trips in each urban area. Public transit mode share includes buses, minibuses, microbuses, minivans, workplace shuttles, and all types of taxis (shared or unshared), in addition to trains, metro, and bus rapid transit (BRT). In some cities, such as Tijuana, shared taxis are particularly important to the public transportation system. In northern cities with a high share of employment in large factories, such as Juarez and Chihuahua, worker shuttles are particularly important and support around a quarter of all work commutes. Only 1% of commuters relied entirely on a mass rapid transit (MRT) system like BRT or rail. Another 3%, mostly in Mexico City, relied on a combination of MRT and some other transit mode, such as a bus or minibus.

Driving (including cars, light-duty trucks, and motorcycles) is the next most common mode and accounts for between 9% and 62% of

[2] The national statistics agency (INEGI) turned down our request for neighborhood-level geographic data.