Research in Transportation Business & Management xxx (2013) xxx–xxx

Contents lists available at SciVerse ScienceDirect

Research in Transportation Business & Management

Evaluating selected costs of automobile-oriented transportation systems from a sustainability perspective

Timothy Garceau [a,*], Carol Atkinson-Palombo [a], Norman Garrick [b], Jason Outlaw [b], Christopher McCahill [b], Hamed Ahangari [b]

[a] *Department of Geography, University of Connecticut, 215 Glenbrook Road, Unit 4148, Storrs, CT, 06269-4148, United States*
[b] *Department of Civil and Environmental Engineering, University of Connecticut, 261 Glenbrook Road, Unit 2037, Storrs, CT 06269-2037, United States*

ARTICLE INFO

Article history:
Received 2 November 2012
Received in revised form 31 January 2013
Accepted 12 February 2013
Available online xxxx

Keywords:
Vehicle miles traveled (VMT)
Automobile accident fatalities
Household transportation costs
Greenhouse gas (GHG) emissions

ABSTRACT

This paper uses an existing framework that encapsulates the concept of transportation sustainability to evaluate selected economic, social and environmental costs of automobile-oriented transportation systems as measured by rates of vehicle miles traveled (VMT) at the state-wide scale across the United States. States with higher percentages of commuting using private vehicles have higher rates of VMT per capita, higher carbon emissions, and pay more for transportation at the household level. Surprisingly, higher VMT per capita also corresponds to higher government spending on transportation, which likely reflects the expense of maintaining, repairing and expanding road networks. States with higher automobile-dependency also incurred higher social costs as measured by automobile-related fatalities. States with three times the VMT per capita than other places incurred five times as many fatalities showing that fatality rates are not simply a direct function of the amount of VMT occurring. Together, these metrics provide compelling evidence for the need to think about the impacts of VMT more holistically. These data can inform the global debate about the costs of VMT and provide guidance to those in transportation business and management to formulate cost–benefit analyses that are rooted in a transportation sustainability perspective.

1. Introduction

The growing concern about a variety of transportation-related issues such as fossil fuel dependence, the future trajectory of gasoline prices in a post-peak-oil environment, and the effect of greenhouse gas (GHG) emissions on global climate has motivated a shift in many developed countries towards conceptualizing transportation from a sustainability perspective (Debnath, Haque, Chin, & Yuen, 2011; Janic, 2006; Prillwitz & Barr, 2011). In the United States, in particular, this change comes after more than fifty years of transportation policy focused almost exclusively on automobile travel (Meyer, 2000). Freeway expansion twinned with the mass production of the automobile facilitated the suburbanization of people, jobs and amenities to produce what some numerous critics have described as sprawl (Marshall, 2000). Despite being notoriously difficult to define and measure (Wolman et al., 2005), the concept of sprawl has been linked with a wide variety of negative externalities (Squires, 2002). A large body of evidence about various negative impacts of sprawl has supported the adoption of public policies to reduce it (Badoe & Miller, 2000; Bengston, Fletcher, & Nelson, 2004; Burchell, Downs, McCann, & Mukherji, 2005; Carruthers, 2002; Frank, Andersen, & Schmid, 2004; Stone, 2008). Environmental concerns include the loss of farmland and open space, air and water pollution generated by vehicle emissions, and, more recently, greenhouse gas (GHG) emissions such as carbon dioxide that are widely agreed to be responsible for global climate change (Gonzalez, 2005; Haase & Nuissi, 2007; Nelson, 1990). On the economic front, many have recognized the stark reality that the United States' economic system is structurally dependent on a commodity that it needs to import, whose price is set by forces of supply and demand at the global scale, and whose supply may be dwindling (Gomez-Loscos, Gadea, & Montanes, 2012; Guo & Kliesen, 2005; Klare, 2005; Rafig, Salim, & Bloch, 2009). Another prominent concern of local and regional governments is the cost of maintaining (and sometimes replacing) infrastructure built during the era of freeway construction and expanded thereafter (Parry, Walls, & Harrington, 2007; Shirley & Winston, 2004). Others are concerned about the human cost of automobile dependency, motivated by the fact that motor vehicle crashes are the leading cause of death among those aged 5–34 in the United States (Anderson & Rees, 2011 citing Centers for Disease Control and Prevention, 2010).

One of the most challenging aspects of automobile-oriented transportation systems is the creation of a vicious cycle between land-use and transportation (Colvile et al., 2004; Pardo, 2011, Chapter 4; Rodrigue, Comtois, & Slack, 2009). The Congestion Index, produced by the Texas Transportation Institution (TTI), is one of the most prominent metrics used to evaluate the performance of transportation systems. This indicator, which compares the time taken for a journey in peak versus off-peak hours, has been used to monetize the amount of time spent in traffic, and provided support for freeway expansion. Despite its popularity, this

* Corresponding author. Tel.: +1 509 570 8516; fax: +1 860 486 1348.
E-mail address: timothy.garceau@uconn.edu (T. Garceau).

2210-5395/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.rtbm.2013.02.002

metric is rather limited because it captures only one aspect of a transportation system—the time spent in traffic (Cortright, 2010). New freeways tend to induce demand which produces rather than relieves congestion (Noland & Lem, 2002). The resultant expansion of the transportation network has enabled development to take place at more distant locations which has resulted in people having to drive more to access the same places. In the United States, drivers accumulate approximately three billion miles each year—a twelve-fold increase from 1945—accruing more of what Kooshian and Winkelman (2011) have described as "empty miles" (U.S. Department of Transportation, Federal Highway Administration, U. S. DOT FHWA, 2012).

Fundamentally rethinking the objective of transportation policy in the United States so that it prioritizes the creation of accessibility for people rather than providing mobility for vehicles is not new. Well before the national freeway system expanded across the United States, social commentators such as Jane Jacobs (1961) and Lewis Mumford (1963) raised concerns about the damage that freeway construction could inflict on the fabric of cities. Their ideas have been embraced by proponents of new urbanism who promote the creation and restoration of diverse, walkable, compact, vibrant, mixed-use communities composed of the same components as conventional development, but assembled in a more integrated fashion, in the form of complete communities. These contain housing, work places, shops, entertainment, schools, parks, and civic facilities essential to the daily lives of the residents, located within easy walking distance of each other. New Urbanists also promote the increased use of trains and light rail rather than the creation of more highways and roads (Calthorpe, 1993; Congress for the New Urbanism, 2001). The interrelationship between transportation and land-use is also a prominent theme in many smart growth and sustainable development policies that have been adopted at regional, state-wide, and local scales (Bengston et al., 2004; Carruthers, 2002; U.S. EPA, 2012b). While many subtle and not so subtle differences exist between these emerging planning paradigms (Talen, 2005), all of these approaches rest upon the fundamental idea that transportation needs to be considered in a broad context instead of the rather compartmentalized approaches to public policy where one agency deals with transportation policies, and other agencies deal with impacts of that transportation policy, such as air and water pollution.

The federal government in the United States has recently acknowledged that policies relating to transportation, housing, and the environment need to be integrated across multiple government agencies (U.S. EPA, 2012a). The emphasis on Sustainable Communities by the US Department of Transportation (DOT), Housing and Urban Development (HUD) and Environmental Protection Agency (EPA) that focuses on issues of transportation and sustainability is one sign of the first tentative steps being taken to reframe transportation in a broader context. Some have pointed out that the concept of sustainability, as it is currently posed, is still somewhat nebulous (Blanco, 2012; Dixon & Fallon, 1989; Drexhage & Murphy, 2010; Stirling, 1999). While true, the fact remains that this discussion of sustainability signals an important change in focus at the federal level.

In response to this changing discourse, researchers have expanded efforts to develop approaches to measure the broader impacts of transportation that are implied by the terms sustainability and livability (Centre for Sustainable Transportation (CST), 2005; Ewing, 1995; Litman, 2012; Mihyeon & Amekudzi, 2005; Zheng, Atkinson-Palombo, McCahill, O'Hara, & Garrick, 2011). In this paper, the framework for transportation sustainability created by Zheng et al. (2011) is utilized as the theoretical foundation for quantifying and comparing three considerations of costs associated with VMT (one for each of the three domains of sustainability—economy, society, and environment) using data at the state-wide scale across the United States. It is important to mention that although methods do exist to express impacts such as deaths associated with traffic fatalities and GHG emissions in monetary terms, data in this paper are presented in their original units because these are compelling reflections of VMT impacts in their own right. In addition, it is also pertinent to point out that the indicators used in this paper are not the only possible indicators for each domain. Rather, there are many other economic, social and environmental impacts that could be measured and will hopefully be incorporated into future research.

The data highlight the very important point that, despite resistance to target VMT for reductions (e.g. Moore, Staley, & Poole, 2010), VMT incurs costs in all three domains of sustainability. Whether or not these costs are sufficiently high to generate broad-based support for investment in alternative policies is for the public to decide. The goal of this paper is to present the data so that it can be used in the public debate about the costs associated with transportation policies that support further expansion, or conversely, contraction of VMT. The core questions to be answered by this paper are: how do VMT and level of automobile-dependence interrelate, what are some of the costs associated with VMT, and how do they vary across states with different levels of VMT/automobility? While VMT growth has tapered off in the United States, the findings may be of use to transportation policy-makers elsewhere in the world, especially in those places where VMT is expanding.

The remainder of the paper comprises three additional sections containing a literature review which provides the foundation for discussing the role of VMT in the transportation sustainability debate; the data, including analysis and results; and a discussion of our findings that focuses on their implications for managerial practice and contributions to the scholarly debate about transportation sustainability.

2. Literature review

In this review, the various strands of literature are woven together to provide a very brief narrative of how transportation policy has emerged and evolved from the beginning of the automobile era until the present day. In the interest of space, a broad picture is painted that will hopefully provide a concise background of how and why transportation sustainability has become prominent in contemporary policy debates, and why the amount of VMT and its costs are foundational to these debates.

2.1. The automobile era and trajectory of VMT

The automobile era in the United States was enabled by the combination of mass production of the automobile, the Servicemen's Readjustment Act of 1944 that provided low interest, zero down payment home loans for servicemen returning from WWII, the Housing Act of 1949 that enabled the Federal Government to spend $13.5 billion on urban redevelopment and slum clearance between 1953 and 1986, and the 1956 Federal Highways Act that launched the construction of a national interstate network comprised of 47,182 miles of roadways as of 2010 (U.S. DOT, FHWA, Office of Highway Policy Information, 2011). Since 1945, the vehicle ownership rate in the United States has risen steadily from 222 per 1000 people to 828 per 1000 people, as of 2009 (U.S. Department of Energy (DOE), 2010). A fleet of approximately 240 million vehicles in the United States (as of 2010) cover almost three trillion miles a year, a quarter of which takes place on the interstate system (U.S. DOE, 2012). From 1945, VMT per capita has more than quadrupled from 1650 to just below 10,000 as of 2010, outstripping the growth in vehicle ownership rates. The rate of growth of VMT per capita has varied over time. An overall upwards trend has been punctuated with sharp periods of decline corresponding to recessions, particularly those associated with the first and second oil shocks in 1973–74 and 1979–80 (see Fig. 1). Growth rates have declined over the decades from an average of 4.3% from 1945 through the end of the seventies, to 2.3% in the eighties, 1.7% in the nineties, and barely any growth during the 2000s (0.1% from 2000 through 2010). Some suggest that this tapering off in VMT growth indicates that a peak level of car mobility may have been achieved (Millard-Ball & Schipper, 2011). Other explanations include higher gasoline prices, the global recession of 2007, and the aging of the population (Currie & Phung, 2008; Metz, 2012). Evidence is