



Hitting the sweet spot: Variability in commute lengths and vehicle emissions across a diverse state



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ABSTRACT

In this paper we consider travel across Virginia and identify sustainability “sweet spots” where commute lengths and vehicle emissions per mile combine to maximize green travel in terms of total CO₂ emissions associated with commuting. The analysis is conducted across local voter precincts (N = 2373 in the state) because they are a useful proxy for neighborhoods and well-sized for implementing policy designed to encourage sustainable travel behavior. Virginia is especially appropriate for an examination of variability in sustainable travel behavior and technologies because the state’s transportation, demographic, and political patterns are particularly diverse and have been changing rapidly. We identify four Virginia precinct-based sustainability clusters: Sweet Spots, Emerging Sweet Spots, Neutral and Non-sustaining. A model of demographic differences among the clusters shows that sustainability outcomes, understood in terms of both local commute behavior and vehicle emissions, are significantly associated with the diverse demography and politics of the state. We also look at changes in transportation sustainability and socio-demographic trends within the clusters over the past half-decade, showing that differences in sustainability and demographic metrics are actually accelerating within the state over time. We conclude with a discussion of the implications of the differences among the clusters for developing and implementing effective transportation sustainability policies across the state.

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1. Introduction

In this paper we consider travel sustainability across Virginia and identify sustainability “sweet spots,” where low commute lengths and low vehicle CO₂ emissions per mile intersect, resulting in especially green commute behavior. Maximizing sustainability requires a multiplicity of sometimes loosely linked components of the transportation system to operate in concert, leading to the lowest possible emissions for a given location. We examine how sweet spots and clusters of less sustainable travel are distributed across the state, and how they have been changing over time. Virginia is a useful place for examining difference and changes in travel sustainability because of its diverse and rapidly shifting demographic and settlement patterns, spanning from urban to rural populations and from politically conservative to more liberal over the past

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decade. While according to the 2009 National Household Travel Survey commutes comprise only 28% of all passenger vehicle miles traveled (U.S. Department of Transportation, 2011), this remains the largest proportion of any single trip purpose and an important contributor to overall personal travel sustainability.

Sustainability sweet spots have previously not been applied to a transportation context. However, they are a well-used framework for understanding “intersections of opportunity” in business and related literature. Savitz and Weber explain that sustainability sweet spots are found at the intersection of stakeholder interests and business interests (2014). In the business context, sweet spots are instances where sustainability policies provide benefits to both producers and consumers, subject to maximizing total welfare. Examples are General Electric’s clean technologies that are profitable for the firm, save consumers money, and benefit the environment, as well as PepsiCo’s healthy product acquisitions and improved environmental processes (Savitz and Weber, 2007). Taken broadly, the sustainability sweet spot concept can be applied in situations where multiple trends or causal factors that are unlinked or loosely linked come together to maximize benefits to multiple parties. In this research, we define sustainability sweet spots as places where the means to commute sustainability, relatively low average commute lengths and vehicle emissions per capita, combine to lower time and monetary costs for individuals while benefiting the local and global environment.

The analysis is conducted across voter precincts, functioning as a proxy for neighborhoods as well as a relevant scale for understanding the political ramifications of policy designed to encourage green behavior. Transportation sustainability is shaped by practices and policies that unfold across a wide range of geographic and institutional scales. A new fuel technology may be released internationally, investments in infrastructure are decided at Federal, state, and regional scales, land use policy is primarily local, while travel choices are ultimately up to the individual and household. Precincts are voting districts centered around a neighborhood polling place, smaller than cities or counties, each averaging about 3000 residents across Virginia. Precincts allow us to examine spatial patterns and trends in transportation sustainability at a scale that is relevant to policy and decision making at multiple levels of government, as well as being a basic unit of the American democratic process. Our analysis finds that the sustainability of commuting patterns is highly differentiated across precincts and precinct clusters across the state, and in fact these differences are increasing over time. We contend that while transportation and land use policies have resulted in some clear successes in parts of Virginia, the increasing unsustainability of commute patterns and vehicle choices in other parts of the state could undermine progress to date and must also be addressed by policies that account for significant socio-economic and even cultural variability across metros and the state as a whole.

2. Literature review

Literature relevant to this paper encompasses prior research on sustainable land use, travel behavior, and the intersection of these two fields. We review key literature in these areas and then discuss the gaps that this analysis fills.

Over the past few decades, there has been growing interest in sustainable land use. Some studies emphasize neighborhood form without taking regional context into account. Girling and Kellett provide case studies how green neighborhoods can mix housing types and retail options along with natural environmental elements of streams, wetlands, wooded areas and open space (2005). Lehmann describes how existing cities can be transformed into low carbon cities by considering the connections between low carbon cities and sustainable design, social and individual values, public space, housing affordability, public transport and urban microclimates (2015). Policies, plans, and technologies have all been identified as approaches to reducing the climate footprint of cities and their impact on emissions and carbon mitigation (Kahn, 2012; Millard-Ball, 2012).

Another body of literature emphasizes sustainable travel behavior. Some approaches to increased sustainability seek to shift individual decision making, such as incentive-based travel behavior change, the power of green marketing or social influences in “green” behavior, and revealing the value of green in mode choice (Taylor, 2007; Gaker et al., 2010; Gaker and Walker, 2013). Many researchers explore the psychological and social dimensions of green behavior, such as whether grams of carbon reduction metrics had more of an impact on travel behavior choices than more emotional contexts like a number of trees (Waygood and Avineri, 2013). Other papers look at “eco-friendly attitudes” in walking and biking to work and empirical evidence of low carbon awareness and behavior in specific cities such as Tianjin, China (Bopp et al., 2011; Bai and Liu, 2013). A recent paper uses a web-based experiment provided to participants after an introductory session to investigate the tradeoffs between emissions and travel time in daily travel decisions of route and departure time choices (Aziz and Ukkusuri, 2014). Further work uses a similar experiment to study travel behavior under a personal mobility credit allowance (Aziz et al., 2015). Findings across these studies are truly diverse, with cost, social factors, and culture all playing a role in understanding why individuals and households make or don’t make green travel choices (Girod et al., 2013, 2014). Importantly, both the sustainable land use and travel literatures show that there is no one way to improve urban sustainability outcomes, and the greatest benefits will likely derive from multifaceted approaches that change urban form and appeal to individual sustainability attitudes.

Understanding sustainability as a combined product land use and travel behavior has become a critical part of transportation research over the past two decades. Ewing and Cervero’s meta-analyses of travel and the built environment are predicated on the contention that accessibility is key to changing travel behavior (2010). Cervero and Duncan further highlight that commute lengths and the balance of jobs and housing across regions remains a critical factor in overall travel sustainability (2006). Cao, Mokhtarian, et al. ask whether changes in neighborhood characteristics lead to changes in travel

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