DRISI
Caltrans Division of Research, Innovation and System Information

Research Results

From Trend Spotting to Trend Setting:

Modeling the Impact of Major Technological and Infrastructural Changes on Travel Demand

Planning, Policy, and Programming

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Project Title:
From Trend Spotting to Trend Setting: Modeling the Impact of Major Technological and Infrastructural Changes on Travel Demand

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WHAT IS THE NEED?

Major technological and infrastructural changes over the next several decades, such as the introduction of autonomous vehicles and the implementation of mileage-based fees, are expected to have a profound impact on lifestyles, modality styles and travel behavior. Travel demand models currently in practice are not equipped to predict long-range trends in travel behavior, such as the recently observed saturation in car use (peak auto). Studies in the past that have examined trends in travel behavior have done so retrospectively, and a framework for predicting future trends remains lacking. We propose integrating models of technology adoption with models of travel demand in an attempt to develop a dynamic framework of disaggregate decision-making that can be used to understand and predict long-range trends in travel behavior, and offer insights to planners and policy-makers on what can be done to influence possible outcomes. The framework will be estimated and evaluated using longitudinal travel diary datasets from Santiago, Chile and the Puget Sound Region, United States.

WHAT WAS OUR GOAL?

Integrate models of technology diffusion (Prof Zilberman's expertise) and travel demand models (Prof Walker's expertise) to predict trends in travel and activity behavior in response to major changes in the transportation system (highway capacity expansion, carsharing, bikesharing and bike infrastructure, high speed rail, mileage-based fees, autonomous vehicles).

WHAT DID WE DO?

The project will consist of the following four tasks: (1) the procurement and preparation of datasets in a format that can subsequently be used for model estimation; (2) the development of models of technology and service adoption; (3) the development of models of travel and activity behavior; and (4) the joint application of these model systems to understand and predict the implications of major technological and infrastructural changes in the transportation and land use system on the demand for travel.

WHAT WAS THE OUTCOME?

In order to tackle and address the general research questions we are interested in, we have addressed three specific components regarding developing the methodological framework:

1. Projecting membership and market shares of upcoming modes of transport. Developing such a framework will be based on integrating models of technology adoption and discrete choice analysis (Paper #1).
2. Understanding and predicting structural long-range trends of travel behavior. Developing such a dynamic framework of disaggregate decision-making will require integrating hidden markov models (HMM) with current travel demand models (Paper #2).

While the first two components focus on developing quantitative behavioral analysis tools to guide transformative mobility to ensure a sustainable and efficient system, we also investigate the adoption and diffusion processes in light of economic theory and its pertinent literature.

PAPER #1: An Econometric Framework for Modeling and Forecasting the Adoption and Diffusion of New Transportation Services

- This paper is motivated by existing work in technology adoption modeling which employs a microeconomic utility-maximizing representation of individuals. This framework is of interest to us as it could be easily integrated with our disaggregate activity-based models. Moreover, we are interested in capturing the impact of social influences and network effect (spatial component) on the adoption process.

PAPER #2: Integrated Hidden Markov and Discrete Choice Models:

- This paper is motivated by existing work that integrates the construct of modality styles in travel demand models. Our model identifies the following market segments: multimodal segment with a concentration on drivers, bus users, bus-metro users and auto-metro users. The transition probability model identifies how decision-makers can transition from one segment to the other as a function of sociodemographics and the derived consumer surplus from subscribing to a certain market segment (modality style).

PAPER#3: What can the Literature on Technology Adoption Teach Us about Autonomous Vehicles?

- In this initial report we begin to investigate how the economic literature on technology adoption can help us understand and predict the expected market penetration rates of autonomous cars in order to guide the diffusion of this new technology. We also highlight some key research questions that should be addressed with autonomous vehicles being on the horizon. In addition to that, the report addresses the potential role required by the government to support this transformative mobility trend. Finally, it is essential to understand the importance of effective policies and investment strategies, whether on the public or private level, and how they can guide the evolution of the vehicles market.

WHAT IS THE BENEFIT?

The developed methodological framework in this research project will provide the means to assess how policies and investment strategies can transform cities to be more efficient and sustainable, provide a higher level of connectivity and improve the economic and environmental health for people. Those models provide key quantitative analysis tools that try to understand how the transportation system performance is going to look like in the future. Planners, policy makers and transportation specialists are eager about the investments in infrastructure and technology that are bound to occur and are interested in assessing how current decisions will play out in the future. This research project shall provide the building blocks to advances in dynamic travel demand modeling to guide transformative mobility and infrastructure investments towards a more sustainable and efficient system.

LEARN MORE

The two journal publications and the brief report:

- El Zarwi, F., Vij, A., and Walker, J. An Econometric Framework for Modeling and Forecasting the Adoption and Diffusion of New Transportation Services. In preparation for Submission for Transportation Research: Part C.
- El Zarwi, F., Vij, A., and Walker, J. Integrated Discrete Choice and Hidden Markov Models: Developing a Forecasting Framework for the Transition Matrix Model. In preparation for Submission for Transportation Research: Part B.
- Brief report on autonomous vehicles that focuses on what we can learn from the economic technology adoption literature.

These papers are all works in progress that we will submit to archival journals. We ask that Caltrans keep them internal until we provide versions that we have submitted.