Title

Induced Travel Primer

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Induced Travel Primer

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What is Induced Travel?

When we widen and extend roads, people drive more. This is the "induced travel"[1] effect—a net increase in vehicle miles traveled (VMT) across the roadway network due to an increase in roadway capacity. The basic economic principles of supply and demand explain this phenomenon. Adding capacity can increase the average travel speed on the roadway (at least initially), increase travel time reliability, and make driving on the roadway appear safer or feel less stressful. It might also provide access to previously inaccessible areas. All of these effects reduce the perceived "cost" of driving. And when the cost of driving goes down, the quantity of driving goes up (Figure 1). Short-term changes in behavior include changes in trip timing, route changes, shifts in travel mode, destination changes, and entirely new trips. Longer-term changes in residential and commercial locations, as well as changes in land development patterns and auto ownership, can also occur.

Accounting for induced travel in transportation planning is important from the standpoint of accurately assessing both the benefits and costs of projects that expand roadway capacity. If induced travel is underestimated, benefits in the form of congestion reduction will be overestimated, while environmental impacts, including greenhouse gas emissions, will be underestimated. This brief summarizes the robust empirical evidence on the magnitude of the induced travel effect and discusses the limitations of travel demand forecasting models in fully capturing the effect.

Empirical Evidence of Induced Travel

A substantial body of high-quality evidence links roadway capacity expansion to increased VMT, as summarized in multiple recent literature reviews (Manville, 2024; Volker, in press (a), in press (b); Volker & Handy, 2022). The many studies synthesized in those reviews use time-series data and sophisticated

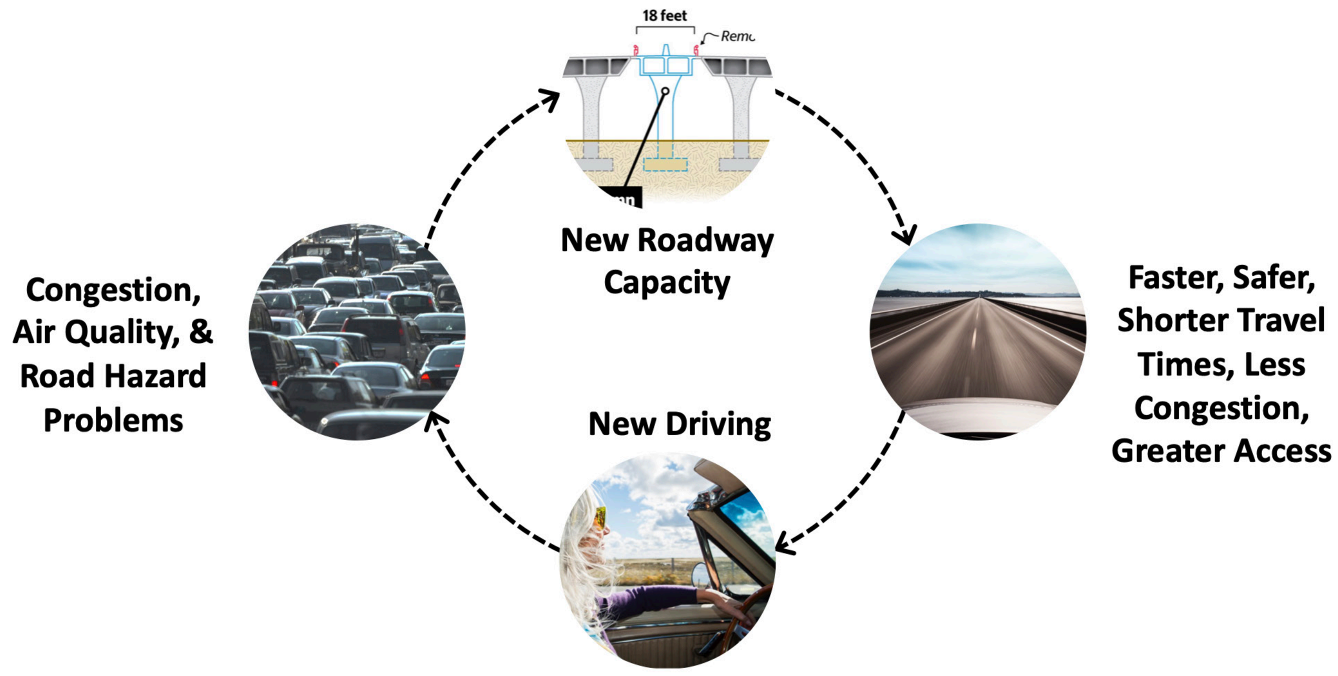

Figure 1. A conceptual illustration of the induced travel effect in response to roadway capacity expansion

statistical techniques to estimate the effect of increased capacity on VMT. All of those studies also control for other factors that might also affect VMT, such as population changes, income changes, geographic effects, and time period effects. In addition, most studies attempt to correct for the endogeneity of roadway capacity—the possibility that VMT growth can cause roadway capacity expansion and not just the other way around.

In general, despite using different data, different geographies, and/or different control variables, the studies arrive at the same conclusion: the long-term elasticity of VMT with respect to lane miles centers around 1.0. This means that a 10% increase in lane miles is likely to increase VMT by 10% in the long run (within three to 10 years). In the short run (within three years), the empirical research indicates an elasticity of approximately 0.3-0.8. The evidence also shows that additional traffic on the new or widened highway is not simply traffic that shifted from slower and more congested roads, but is actually an overall increase in VMT across the network.

The empirical studies mostly focus on major general-purpose roadways including interstates, other freeways and expressways, principal arterials, and minor arterials, and show a potentially greater effect for interstates. However, the available evidence suggests that new high-occupancy vehicle (HOV) lanes and high-occupancy toll (HOT) lanes might have similar induced travel effects as general-purpose lane expansions. Indeed, on very congested roadways, adding an HOT or pure toll lane could induce greater VMT than adding a general-purpose lane, assuming the lanes are priced so as to prevent hypercongestion – the point where traffic becomes so dense that both speed and flows decrease. Expansions of collectors and local roads are also likely to induce VMT, though the empirical evidence as to the relative magnitude of the effect is limited.

In terms of broader regional context, the research shows that induced travel occurs in both urban and rural areas and on roadways with different levels of existing congestion. Indeed, induced travel can be expected to occur anytime a project increases average travel speed, increases travel time reliability, makes driving on the roadway appear safer or feel less stressful, or provides access to previously inaccessible areas. However, the induced travel effect might be slightly smaller in rural areas, at least in the short run. Conversely, the limited available evidence indicates that metropolitan areas with higher baseline levels of congestion could potentially have lower elasticities than metro areas with less congestion, but the body of research is far too limited to be conclusive one way or the other.

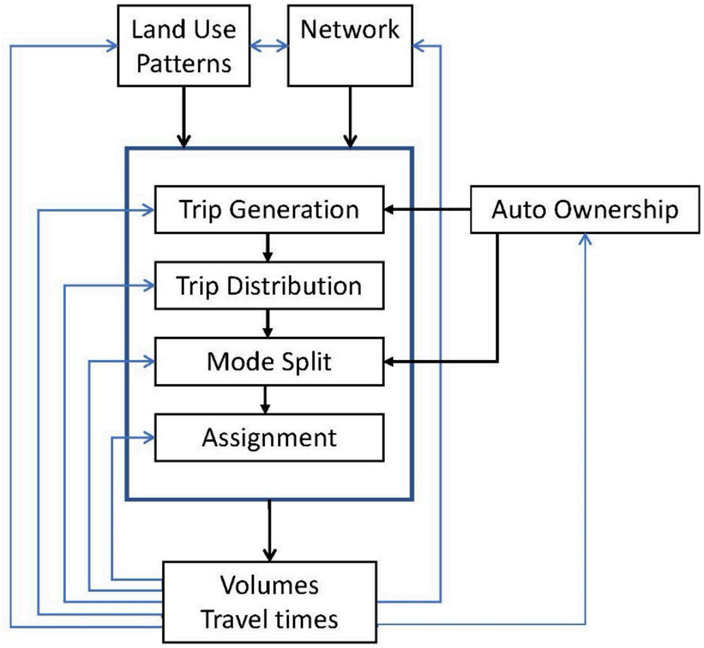

Figure 2. Possible Travel Time Feedback Loops for Four-Step Travel Demand Models

Travel Demand Models and Induced Travel

Metropolitan Planning Organizations (MPOs) and other agencies rely on travel demand models (TDMs) to forecast the outcomes of transportation investments, whether for a specific project or the entire set of projects proposed in a long-range plan. The original models were used to determine how much additional highway capacity was needed in the future to maintain acceptable levels of congestion. The models are now used for a wide array of purposes, including assessment of environmental impacts. The ability of the models to accurately forecast VMT, including induced VMT, is crucial to both uses.

The TDMs in use today, though varied, fall into two general categories. The four-step TDMs are built around a system of traffic analysis zones and consist of submodels for trip generation, trip distribution, mode split, and route assignment. Activity-based models (ABMs), in contrast, simulate the behavior of individual households at a fine level of spatial detail. These models represent the timing and sequencing of travel and incorporate interrelationships among long-term and short-term decisions. Many of the larger MPOs are now using ABMs, but some smaller MPOs have developed hybrid models that combine elements of ABMs and four-step TDMs.

To forecast the VMT accurately, TDMs must fully account for the effect of changes in travel time on travel behavior (Milam 2017; Deakin 2020). To do so they must incorporate “feedback” loops in the model in which the congested travel times as estimated by the model are fed back into each of the elements of the model (Figure 2). Known as the “iteration” of travel times, this practice ensures that estimates of different aspects of travel behavior are sensitive to changes in travel time resulting from changes in highway capacity. These feedback loops vary from model to model but differ significantly by model type.

ABMs generally include more of the important feedback loops than four-step TDMs. An assessment of TDMs used by California’s MPOs found that while feedbacks to route assignment, mode choice, and trip distribution was standard or common in the four-step models, feedbacks to trip generation, departure time, auto ownership, and land use was rare (Handy, et al. 2024; Table 1). In contrast, feedbacks to all elements except land use was standard or common in ABMs. These models are thus likely to provide more accurate estimates of the induced VMT effects of highway capacity expansion, though their stochastic nature means the estimates may be more variable. The absence of feedback to the land use forecasts used as inputs to the travel demand model, however, means that ABMs do not capture the impact of changes in travel time on residential and business location decisions or on development patterns.

Given incomplete feedback loops, the TDMs in use today regularly underestimate induced VMT, meaning that they underestimate the increase in greenhouse gas emissions and overestimate reductions in congestion resulting from highway expansion projects. A comparison of induced VMT estimates based on TDMs to estimates based on empirical evidence for a sample of projects in California suggests that VMT can be underestimated by as much as a factor of 10 (Volker, et al. 2020). A sensitivity study of models from three MPOs found underestimation of induced VMT up to 102% and overestimation of reductions in travel time up to 236% when feedback to land use was not included (Rodier, 2004).

Table 1. Summary of Feedback Loops by Model Type for California MPOs

	Four-Step Travel Demand Models	**Activity-Based Travel Demand Models**
Route Assignment	Standard	Standard
Mode split or mode choice	Common	Standard
Trip Distribution or destination choice	Common	Standard
Trip generation or trip/tour frequency	Rare	Standard
Trip/tour departure time	Rare	Standard
Auto ownership	Rare	Common
Land use	Rare	Rare

Based on Handy, et al. 2024.

The movement toward the use of ABMs should improve the accuracy of induced VMT estimates, though more empirical testing of their accuracy is needed. Developing such models can be expensive (Castiglione, et al. 2015), but smaller MPOs may be able to recalibrate elements of ABMs developed for other regions, as has occurred in California. More challenging is the question of feedback to land use forecasts. Integrated transportation-land use models are expensive, complicated, and rare. Some MPOs have developed qualitative methods for accounting for the effect of transportation investments in preparing land use scenarios as an alternative (Handy, et al. 2024).

More Information

Castiglione, J., Bradley, M., & Gliebe, J. (2015). Activity-based travel demand models: A primer. SHRP 2 Report S2-C46-RR-1. https://nap.nationalacademies.org/login.php

Deakin, E. (2020). Calculating and Forecasting Induced Vehicle-Miles of Travel Resulting from Highway Projects: Finding and Recommendations from and Expert Panel. Institute of Transportation Studies, UC Berkeley. https://escholarship.org/uc/item/15d2t2gf

Handy, S., Kim, K., Byrd, D. (2024). Assessment of California MPO Travel Demand Forecasting Models. Institute of Transportation Studies, University of California, Davis, Research Report UCD-ITS-RR-24-80. https://doi.org/10.7922/G2C53J6W

Manville, M. (2024). Induced Travel Estimation Revisited. UCLA Institute of Transportation Studies. https://escholarship.org/uc/item/8m98c8j1

Milam, R., Birnbaum, M., Ganson, C., Handy, S., Walters, J. (2017). Closing the induced vehicle travel gap between research and practice. Transportation Research Record, 2653, 10-16.

Rodier, C. (2004). A Review of the Representation of Induced Highway Travel in Current Travel and Land Use Models. Institute of Transportation Studies, University of California, Davis. https://escholarship.org/content/qt2170k38v/qt2170k38v.pdf?t=l8wc60

Volker, J. M. B. (in press, a). Roadway Capacity and Induced Travel. California Air Resources Board.

Volker, J. M. B. (in press, b). Managed Lanes. California Air Resources Board.

Volker, J. M. B., & Handy, S. (2022). Updating the Induced Travel Calculator. National Center for Sustainable Transportation, Research Report No. NCST-UCD-RR-22-34. https://doi.org/10.7922/G2P55KTX

Volker, J. M. B., Lee, A. E., & Handy, S. (2020). Induced vehicle travel in the environmental review process. Transportation Research Record, 2674(7), 468-479. https://doi.org/10.1177/0361198120923365

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[1] This is often referred to as "induced demand." Technically, however, induced demand is just one component of the overall induced travel effect. It is the increase in VMT attributable to an increase in population or businesses following a roadway capacity expansion. In economic terms, it is the portion of induced VMT caused by a shift in the driving demand curve following a shift in the roadway supply curve.

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