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Searching for induced travel: Elimination of a freeway bottleneck and subsequent effects on rail and freeway volumes

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ABSTRACT

The removal of a freeway bottleneck in California has allowed researchers to investigate short-term induced travel and a potential mode switch from rail transit. This particular bottleneck, a double lane drop from reduced tunnel capacity, is a unique case as alternate auto routes are quite undesirable; the only other option is to consider nearby rail transit. Freeway volumes and rail ridership were examined before and after the removal of the bottleneck to estimate the extent of induced travel. Freeway volumes during both commute periods increased 10–13%, faster than other nearby locations, and rail transit ridership between stations on either side of the pre-existing bottleneck showed modest declines despite system wide increases. Differences of means testing confirmed that many of these changes were statistically significant. Examining the magnitude of induced travel is relevant when making policy decisions for removing mature bottlenecks that involve the use of public finances.
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1. Introduction

In the San Francisco Bay Area, the Caldecott Tunnel bottleneck on State Route (SR) 24 had long been a flashpoint for frustrated drivers. At that specific location the eight lane freeway dropped to just six lanes passing through the three two-lane tunnel bores. The reversal of the center bore back and forth to give the peak direction four lanes, once thought to be innovative, was increasingly failing to accommodate off-peak demand with only one bore and two lanes. In November 2013, a fourth tunnel bore was completed by the California Department of Transportation (Caltrans) allowing each direction to have four lanes throughout the day for the first time. Due to the topography of the area, the Caldecott Tunnel is the only reasonable crossing through the Berkeley Hills for a significant distance on either side. Prior to the opening of the fourth bore, reverse commuters were either faced with congestion at the tunnel entrance from the lane drop or if their jobs were within a reasonable walking distance from transit, ride the Bay Area Rapid Transit system (BART). BART also passes through the Berkeley Hills at a similar location and offers congestion free travel from Oakland to expanding job centers in Eastern Contra Costa County. Although BART was originally designed to take commuters into San Francisco and Oakland, ridership had increased in the opposite direction, corresponding with the increased congestion at the reverse commute bottleneck on SR 24.

The completion of the fourth bore, removing a mature freeway bottleneck, offered researchers a unique opportunity to view the onset of short-term induced travel and study the changes in mode choice among reverse commuters who may have previously taken BART to avoid freeway congestion. Again, since the topography of the Berkeley Hills makes it quite hard for travelers on that particular commute to go any other way, it might be possible to observe a modal switch from rail transit (BART) to the automobile. Here, perhaps, we might see whether there is measurable short-term induced travel in a case where there exists a functional alternate mode; this case is not the situation of a typical freeway widening in a vacuum. In this case study, will commuters conduct a modal switch? Will more travelers use their personal vehicles?

2. Background

2.1. Definitions

Induced travel from freeway expansion has been a regular topic among researchers for nearly a century. A majority of the research

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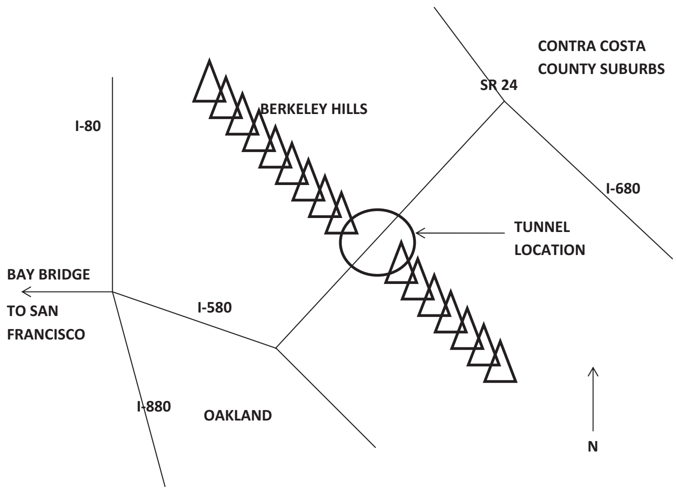

Fig. 1. Schematic of Regional Freeways.

has focused on what percentage of new traffic following freeway improvements is from exogenous (i.e. from population growth or new housing units) or endogenous factors (i.e. increased supply lowers travel cost and latent demand appears). Over fifty years ago Downs (1962) was already documenting limited congestion relief from the construction of urban freeways and stating that freeway expansion would not improve travel time due to induced demand. Researchers have proposed a simple definition that induced travel is "an increase in daily vehicles miles traveled (VMT), with reference to a specific geographic context, resulting from expansion of a highway facility." (Decorla-Souza and Cohen 1999, 251) Others have provided additional depth by breaking up induced travel into its constituent parts; Fröhlich (2003) lists the five sources of new vehicles that constitute induced travel:

1) A time of day shift by existing traffic
2) A route shift from other roadways
3) Mode shift from transit to auto
4) Change in destination choice due to reduced travel time (longer trips)
5) Entirely new trips (latent new trips)

There is commentary on whether all five of these contributions are truly *induced demand*. Cervero and Hansen (2002) stated that only the last three are induced demand while the others are merely induced travel. Noland (2001) stated that all five constituted induced travel, although he noted that mode shift has been a subject of debate as no new trips are being made. Still others follow the DeCorla-Souza model and refer to all types of 'additional demand generated by improvements in travel conditions' (Weis and Axhausen, 2009, 8) as induced demand.

Frohlich also notes that there is a question of short-term versus long term induced travel. As discussed by Lee et al. (1999), the only change in the short term is supply; new lane-miles while demand remains constant. Lee defines changes in the short-term as induced travel. However, in the longer term one should see changes in the demand curve as people change their employment or housing locations. These types of permanent decisions are what Lee refers to as true induced demand. As such, this report will be referring to any changes as short-term induced travel only.

2.2. Studies of induced travel

There have a number of studies utilizing different econometric methods to approximate the effect of induced travel. In the UK, Goodwin (1996) found an elasticity of 0.5 in the short term and close to 1.0 in the long term between reduced travel times and increased travel volume as part of a large change in the UK policy of motorway construction. In the US, demand elasticities comparing additional lane miles to VMT have been found to be between 0.5 and 0.9 by Hansen and Huang (1997) as well as Noland (2001) with long term elasticity nearly 0.9. Cervero and Hansen (2002), as a follow up to earlier works, attempted to use a more refined model and still found short term elasticity values greater than 0.5. Lower values of 0.2 found by Hymel et al. (2010) appear to be from aggregation at the state level and include more control variables. The accepted range of 0.5–0.9 was challenged by a Duranton and Turner study in 2011 which found an elasticity of 1.03 on interstate freeways in the United States, indicating no benefits from increased freeway capacity. This was followed up by a similar study in Japan by Hsu and Zhang (2014) that the elasticity could exceed 1.2, indicating the potential for a new equilibrium of travel speed that is lower after capacity expansion. In the reverse direction, Chung et al. (2012) analyzed the short and long term effects of a noteworthy freeway removal above the Cheonggye-choen River in Seoul. The study found that travel speeds returned to pre-removal values by virtue of a large drop in vehicle volume (deterred demand), changes in departure times, and mode shift to rail transit. The researchers concluded that the "anxiety about additional traffic problems due to the associated decrease in road capacity was unfounded." (Chung et al., 2012, 176).

There has been a similar research analog in regards to induced travel from changes in fuel efficiency or reductions in fuel prices, known as the rebound effect. This form of induced travel compares vehicle-kilometers per liter of fuel to increases in VMT. Sorrell et al. (2009) reviewed a number of empirical estimates and found that the average rebound effect ranged from 10% to 30%. Su (2011) found a value of 11% in the United States during the 2001–2008 period and found that the rebound effect became stronger at higher fuel prices. In Europe, when examining road freight transport, Matos and Silva (2011) determined that during the 1987–2006 period the rebound effect was 24%, higher than Su found in the United States.

It is noted that in much of the research described above, with the exception of the Korean example, examinations utilized very large data sets at the county, state, or national level. This case study differs in that we get to directly examine the induced travel following the removal of a freeway bottleneck that has no alternate routes and has a viable alternate transit mode (BART). Indeed, lower estimates for induced travel found by Cervero (2003) as well as DeCorla-Souza and Cohen (1999) were found during the examination of specific examples and by using a more detailed model of induced effects such as travel caused by time-of-day switches.

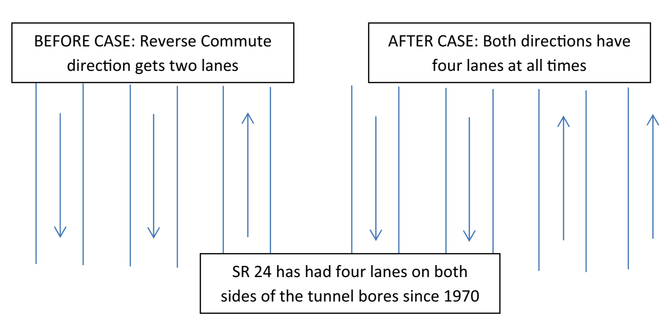

Fig. 2. Before and after November 2013 opening of fourth two-lane Caldecott Tunnel bore on SR 24.

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