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Cost-effectiveness of reductions in greenhouse gas emissions from High-Speed Rail and urban transportation projects in California

Juan M. Matute [a,*], Mikhail V. Chester [b,1]

[a] Institute of Transportation Studies, University of California, Los Angeles, 3320 Public Affairs Building, Mailcode #951656, Los Angeles, CA 90095-1656, USA
[b] Civil, Environmental, and Sustainable Engineering, Arizona State University, 660 S College Avenue, Tempe, AZ 85287-3005, USA

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ABSTRACT

A rising trend in state and federal transportation finance is to invest capital dollars into projects which reduce greenhouse gas (GHG) emissions. However, a key metric for comparing projects, the cost-effectiveness of GHG emissions reductions, is highly dependent on the cost-benefit methodology employed in the analysis. Our analysis comparing California High-Speed Rail and three urban transportation projects shows how four different accounting framings bring wide variations in cost per metric tonne of GHG emissions reduced. In our analysis, life-cycle GHG emissions are joined with full cost accounting to better understand the benefits of cap-and-trade investments. Considering only public subsidy for capital, none of the projects appear to be a cost-effective means to reduce GHG emissions (i.e., relative to the current price of GHG emissions in California's cap-and-trade program at $12.21 per tonne). However, after adjusting for the change in private costs users incur when switching from the counterfactual mode (automobile or aircraft) to the mode enabled by the project, all investments appear to reduce GHG emissions at a net savings to the public. Policy and decision-makers who consider only the capital cost of new transportation projects can be expected to incorrectly assess alternatives and indirect benefits (i.e., how travelers adapt to the new mass transit alternative) should be included in decision-making processes.

Introduction

As California establishes its greenhouse gas (GHG) emissions cap-and-trade program and considers options for using the new revenues produced under the program, the public and decision-makers have access to tenuous information on the relative cost-effectiveness of passenger transportation investment options. Toward closing this knowledge gap, the cost-effectiveness of GHG reductions forecast from High-Speed Rail are compared with those estimated from recent urban transportation projects (specifically light rail, bus rapid transit, and a bicycling/pedestrian pathway) in California.

Under California's cap-and-trade system, major emitters of GHGs must purchase or otherwise acquire a quantity of allowances equivalent to their emissions. The California Air Resources Board, which administers California's cap-and-trade

* Corresponding author. Tel.: +1 562 546 2831.
E-mail addresses: jmatute@ucla.edu (J.M. Matute), mchester@asu.edu (M.V. Chester).
URLs: http://www.lewis.ucla.edu/people/staff/juan-matute/ (J.M. Matute), http://chester.faculty.asu.edu/ (M.V. Chester).
[1] Tel.: +1 480 965 9779.

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program, issues allowances via both regular auctions and free allocations. Each allowance unit grants the bearer the right to emit one metric tonne of carbon dioxide equivalent (CO_2-e) in California, and the allowance must be surrendered to the Air Resources Board according to regulations. California's cap-and-trade system generates revenues for the state's Greenhouse Gas Reduction Fund. Existing law requires expenditures from this fund to reduce GHG emissions in California, but grants the Legislature leeway in choosing between opportunities that reduce GHG emissions.

The cost-effectiveness of a GHG reduction opportunity is one criterion which can be used to compare among expenditure alternatives. Cost-effectiveness is expressed as dollars expended (or saved) per metric tonne of CO_2-e reduced. The current price of an allowance serves as a marker for evaluating a reduction opportunity's cost-effectiveness. Allocating auction revenues to opportunities that achieve reductions in GHG emissions at a per-tonne cost that is lower than the allowance price allows California to move toward its GHG goals at a lower public and private cost. Allocating cap-and-trade revenues to reduction opportunities that reduce GHG emissions at a per-tonne cost greater than the allowance price likely means that some of the regulated emitters could reduce emissions more cost-effectively. Thus, allocating Greenhouse Gas Reduction Funds to opportunities that are less cost-effective than the allowance price could lead to lesser reductions in GHG emissions at a greater cost to California. As of March, 2015 prices for California allowances were $12.21 per metric tonne of CO_2-e (California Air Resources Board, 2014).

The cost at which a project can reduce a metric tonne of GHG emissions should not be the sole criterion upon which a transportation project is evaluated. All projects produce ancillary effects and projects produce many co-benefits other than GHG emissions reductions. Transportation projects create new mobility and land use opportunities that can be beneficial independent of any reductions in GHG emissions. They also produce changes in other environmental impacts such as conventional air pollutants (Chester et al., 2013). However, because Greenhouse Gas Reduction Fund revenues are generated from a market-based mechanism (cap-and-trade), the cost-effectiveness of GHG reductions should be a key consideration in allocating California State expenditures.

But how should analysts evaluate the cost-effectiveness of GHG reductions from transportation projects? Choices to determine which monetary costs and which sources of emissions are included within the analysis can affect the results of the analysis. Whereas a public agency may only consider capital dollars invested, adding costs such as those associated with the building, owning, and operating of a transportation facility during its life-cycle and changes in private costs to use the transportation facility can greatly affect results. Our analysis highlights how the choice of accounting framing impacts the cost-effectiveness of GHG reductions.

Expansion of long-distance and local public transit systems are being promoted in California, a state where increasing air and automobile congestion has resulted in large fuel and time costs (Resource Systems Group, 2010; Texas A&M Transportation Institute, 2013). In addition to High-Speed Rail (which is on track for construction to break ground but is facing many legal and financial barriers), new urban transit systems, particularly in the Los Angeles area, are being extensively deployed. Since the passage of an additional ½-cent sales tax in 2008, Los Angeles Metro has completed or started construction on 2 new bus rapid transit and 4 rail lines or extensions with plans to break ground on at least 4 additional rail lines or extensions by 2020. The healthy interest in public long-distance and local transit underscores the challenges the state faces with a growing population and aging infrastructure.

The California High-Speed Rail (CAHSR) project continues to evolve, as is evident in the substantial differences between the 2012 Final and 2014 Draft Business Plans. The CAHSR Authority expects substantial change in passengers diverted from air, down from 17.23% in 2012 (California High-Speed Rail Authority, 2012a, 2012b) to 5.85% in 2014 (California High Speed Rail Authority, 2014a, 2014b). This is a shift from 5.1 M diverted air trips in 2040 under the Authority's 2012 benefit-cost analysis (California High-Speed Rail Authority, 2012a, 2012b) to 2.0 M diverted air trips in 2040 under the Authority's Draft 2014 plan (California High Speed Rail Authority, 2014a, 2014b). Furthermore, the average length of an avoided automobile trip avoided due to CAHSR changed from 150 miles (240 km) under the Authority's 2012 benefit-cost analysis (California High-Speed Rail Authority, 2012a, 2012b) to 118 miles (188 km) in 2014 (California High Speed Rail Authority, 2014a, 2014b). According to the Authority, "[t]he new [ridership forecast] results reflect recent data that projects an increase in the total number of trips people will take, but also a reduction in the average length of their trips compared to the data used for the 2012 Business Plan forecasts" (California High Speed Rail Authority, 2014a, 2014b).

Because of the continued uncertainty surrounding the future CAHSR project versus the established urban transit projects, we perform sensitivity analyses on major factors that affect per-tonne GHG reduction costs. We compare our results for CAHSR with three recent urban transportation projects in Los Angeles County:

- Phase I of the Metro Orange Line Busway, a $339M bus rapid transit (BRT) project in the San Fernando Valley that opened in 2005;
- The Metro Bicycle and Pedestrian Pathway, a $10.6M bicycle and pedestrian facility that opened alongside the Orange Line Busway in 2005; and,
- Phase I of the Metro Gold Line Light Rail Transit (LRT), a $859M project that connects Los Angeles Union Station with Pasadena, and which opened in 2003.