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The feasibility of modernizing the Interstate highway system via toll finance

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ABSTRACT

This paper addresses two related problems: how to pay for reconstruction and modernization of the aging Interstate highway system and how to deal with political opposition to increased use of direct charging for highway use. It proposes introducing tolling only on individual corridors as they are reconstructed and (if needed) widened. First, the cost of reconstructing all existing Interstate lane-miles is estimated, using FHWA HERS unit cost data. The cost of adding lanes, where indicated by projected growth in light and heavy vehicle travel, is estimated using HERS unit costs. The revenue that could be generated by an inflation-adjusted per-mile tolling system (to be implemented via all-electronic tolling) on this rebuilt and modernized system is estimated. Finally, the net present value of toll revenues is compared with the net present value of modernization cost as an initial estimate of financial feasibility. The analysis is carried out for each of the 50 states and the District of Columbia.

1. Introduction

The Interstate Highway system is America's most valuable set of highways. With just 2.52% of total lane-miles (Federal Highway Administration, Table HM-60), the urban and rural Interstates account for 24.4% of all vehicle miles of travel (VMT) (Federal Highway Administration, Table VM-1). But this system is not adequate for the 21st century.

Its major corridors were mostly opened during the 1960s and 1970s. With a typical design life of 50 years, most will need reconstruction between 2010 and 2030. While some have been widened to accommodate traffic growth, others will likely need widening when they are rebuilt for another 50-year period. In the most truck-heavy corridors, widening might take the form of truck-only lanes, while in the most-congested urban areas, a growing number of long-range transportation plans include networks of variably priced express lanes. Over 100 major interchanges constitute serious bottlenecks, mostly on urban Interstates (Cambridge Systematics, Inc., 2008).

This paper seeks to estimate whether reconstruction and selective widening of the Interstates could be financed via per-mile toll revenues. It first develops a cost estimate for reconstructing the existing Interstate system, both rural and urban, based on unit-cost reconstruction figures from the Federal Highway Administration (FHWA). Next, it develops estimates of traffic and potential toll revenue on the reconstructed Interstate systems of each state, over a 35-year period. The net present value of toll revenues in 2010 is then compared with the 2010 reconstruction cost estimates as an initial indication of toll-finance feasibility.

Because some of the projected traffic volumes are beyond the capacity of the existing lanes, the analysis next identifies specific Interstate corridors which will need widening, based on level of service (LOS) standards. The cost and time-frame for these lane additions are estimated, using FHWA lane-addition unit costs. The widening analysis also uses data from FHWA's Freight Analysis Framework to identify corridors where truck volume warrants truck-only lanes as part of the widening, and cost estimates for these additions are included.

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The net present value of the reconstructed and widened system is then compared with the previously estimated net present value of toll revenue as an indication of the toll-feasibility of financing the overall project via per-mile tolls.

2. Summary of previous research

In the early 2000s, the National Cooperative Highway Research Program conducted a study of future options for the Interstate system. Task 10 of this project defined a case for modernizing the system (PB Consult, Cambridge Systematics, Pisarski, & Heanue, 2007). It was premised not only on the network layout itself being 70 years old and the pavement beginning to exceed its 50-year design life, but also on new factors like global economic integration, metropolitan congestion, and post-industrial geography.

The study foresaw a slowdown in the growth rate of VMT and the likely topping out of VMT per capita, and therefore used a 2% annual growth rate for the first 20 years of its 30-year projection and 1.5% thereafter. Based on those VMT assumptions, it projected a revamped Interstate system widened by 88,600 lane-miles on the existing 46,800 route miles (plus an additional 84,000 lane-miles on 15,000 route-miles to be added to the system). The widening was estimated to cost $1.4 trillion (in 2003 dollars) and the new routes another $1.74 trillion—a total of $3.14 trillion over 30 years.

Reconstruction of worn-out pavement and bridges was not explicitly dealt with in that project. As a result, a Task 14 was added to assess the extent to which reconstruction needs were or were not already being addressed via the investment needs identified every two years by FHWA in its biennial Conditions & Performance reports. The researchers concluded that such needs "appear to have been underrepresented in prior work" and "should be the subject of a follow-on effort to develop appropriate estimating methodologies." (American Association of State Highway and Transportation Officials, 2007)

In 2010 AASHTO produced three reports based on the Interstate vision from the 2007 NCHRP report (American Association of State Highway and Transportation Officials, 2010). Its numbers came largely from the NCHRP report, but its planning horizon was extended to 50 years from the previous report's 30 years. Both the NCHRP and the AASHTO reports used a benefit/cost ratio screen of 1.0 in estimating which lane additions and new corridors should be included. Neither report identified a funding plan for the $3 trillion upgrade, though both mentioned that tolls and congestion pricing could help generate funding.

Several others have examined the need for Interstate modernization and the possible use of toll revenues to finance it. In 2011 the former vice chairman of the National Surface Transportation Policy & Revenue Study Commission co-authored a paper calling for a national inflation-adjusted toll on all Interstate system users to pay for restoration, expansion, and modernization of the system (Schenendorf & Bell, 2011). The electronically collected toll revenues would be deposited in a new account in the Highway Trust Fund and would provide grants solely for the Interstate program. The modernization would be carried out on a cash basis, rather than using toll revenue bonds as is the normal practice for toll facilities.

Regan and Brown published a paper that year on tolling as a way to pay for Interstate modernization. Their top-down estimate of the cost to reconstruct and modernize was between $1.3 and $2.5 trillion (Regan & Brown, 2011). In a 2012 paper, Graells suggested that about 10,000 route-miles of rural, inter-city Interstates with heavy truck traffic could be rebuilt and modernized via toll financing, based on an average toll (car + truck) rate of 15 cents per mile, yielding an estimated $22 billion per year in revenues (Graells, 2011).

The above papers all made national-level estimates based on highly aggregated data. There appears to be no previous research aimed at quantifying the cost of Interstate reconstruction and selective lane additions on a *state-by-state* basis, or on estimating toll feasibility state-by-state. This paper may thus be the first attempt to do so.

3. Reconstruction cost

The starting point for this analysis is unit cost data from FHWA's Highway Economic Requirements System (HERS). Appendix A-4 in the U.S. DOT's *2010 Conditions & Performance Report* provides typical costs per lane-mile for various types of improvements. The data used for this portion of the analysis came from the column headed "Reconstruct Existing Lane." These unit costs are national averages in 2008 dollars. They were adjusted for inflation, using the Bureau of Labor Statistics CPI calculator, to provide costs as of 2010, the base year for all calculations.

Second, they were adjusted for state-specific variations, using data from R. S. Means Company's *Heavy Construction Cost Data* volume. This volume lists tables of cost factors for several cities in each state. An average of the "site construction" (which includes labor) and "concrete" (as a proxy for material) was used to give a highway construction cost index for each locale. For a state's rural index, the cost factor for a randomly selected small city in that state was used. For the urban index, the figure for the state's largest city was used. As an example, the state adjustment factor for rural Interstates in Alabama was .812 (meaning its cost is 81.2% of the national average). Hence, the 2010 national HERS rural unit reconstruction costs were multiplied by this factor for Alabama.

3.1. Rural Interstates

State-specific data on lane-miles of rural Interstates were obtained from FHWA Highway Statistics Table HM-60, available online. This table does not break down lane-miles by individual Interstate routes, so the reconstruction calculations dealt with each state's rural Interstate system as a whole. The spreadsheet for rural Interstates included 49 states, excluding Delaware and the District of Columbia (which have no rural Interstate miles in HM-60).

The HERS rural cost estimates are given separately for flat, rolling, and mountainous terrain. FHWA provided a listing of the fraction of rural Interstate route-miles in each category for each state. Those fractions were entered in the spreadsheet for each state and used to create a weighted average reconstruction cost per lane-mile. This composite unit cost was multiplied by the state's adjustment factor (from R.S. Means), and that unit cost was multiplied by the number of lane-miles to provide the estimated total rural Interstate reconstruction cost, in 2010 dollars. Those numbers ranged from a low of $101 million for Rhode Island to a high of $7.84 billion in California. Sensitivity analysis found that without the state-specific adjustments, the total cost would be 8% higher.

Since the premise of this study is the use of all-electronic tolling to provide the revenue stream, the reconstruction cost must also include outfitting each reconstructed corridor with the gantries and tolling equipment needed for AET. Electronic tolling expert Daryl S. Fleming estimates the cost of equipping rural highways for AET at $250,000 per mile (Fleming, 2013). After including this cost for each state, the total reconstruction cost is $148 billion, which is 5.4% more than reconstruction cost alone.

3.2. Urban Interstates

For urban Interstates, the HERS reconstruction unit costs are provided for four different-sized urban areas: small urban, small urbanized, large urbanized, and major urbanized. Table HM-60 provides lane-mile data only for the total of urban Interstate

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