U.S. Department of Transportation

TRUCE 3.0 User's Guide

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This guide is designed to assist users of the FHWA's Tool for Rush Hour User Charge Evaluation, Version 3.0, known as TRUCE 3.0. Readers interested in a technical description of the model and results of its application to three urban areas can consult our report to the U.S. Department of Transportation, *Congestion Pricing: Analyzing Financial and Greenhouse Gas and Fuel Impacts with TRUCE 3.0*

What is TRUCE 3.0?

TRUCE 3.0 builds on the foundation of the TRUCE model developed at the U.S. Department of Transportation. As indicated by the model's full name (Tool for Rush-Hour User Charge Evaluation), users can apply TRUCE to quantify the impacts of congestion pricing on urban highways. In its current form, the model considers scenarios for congestion pricing on the network of limited-access highways, or "freeways'. The source for the key inputs of traffic data is the Urban Mobility Report series produced by the Texas Transportation Institute. In this series, the peak traffic periods are defined as 6-10 am and 3-7 pm, a total of eight hours.

TRUCE 3.0 enhances the original TRUCE model in several key respects:

(1) The average per mile charge for rush-hour travel has been made sensitive to differences among urbanized areas in: (a) the average value travelers attach to their time, and (b) the average speed on the arterial highways (which remain a "free" alternative to the freeways).
(2) The model allows for the possibility that congestion charging on the freeways will influence traffic volume and average speed on the arterials.
(3) The impact of congestion charging on freeway traffic volume, rather than being set uniformly at a 10 percent reduction, depends on the base case distribution of freeway traffic by level of congestion.
(4) Estimation of the capital and operational costs of congestion pricing, and of the impacts of congestion pricing on fuel consumption, rests on a fuller synthesis of the available evidence. In addition, the model has been expanded to predict the impacts of congestion pricing on emissions of greenhouse gases.
(5) For comparison with the capital and operating costs of congestion pricing, the model now provides estimates of the collection costs for the existing sources of highway funding, such as the fuel tax and vehicle registration fees.
(6) In addition to a congestion pricing scheme to establish free-flow conditions defined as an average speed of 60 MPH, the model also predicts the impacts of a congestion pricing scheme with the more moderate target of an average peak-period speed of 50 MPH. In the spreadsheets, these are labelled "Free-flow CP" and "Moderate CP". Together with the base case that represents the status quo, the model thus considers three scenarios.

The original TRUCE model includes structure for benefit-cost evaluation in terms of consumer surplus. Since a welfare evaluation of this sort is not the focus of TRUCE 3.0, and including the equations for consumer surplus calculation would add considerable clutter, these equations have been suppressed in our spreadsheet by being marked as hidden. Users of the spreadsheet model can unhide any of these equations. It should be noted, however, that some equations will contain assumptions or parameter values that have been superseded by TRUCE 3.0. The main purpose in retaining these equations in hidden form rather than deleting them is to provide users of the model with a structure they can build on.

The Model Interface

The graphical user interface allows the user to enter input data, change a number of default assumptions and view the model's results. The "Inputs" worksheet contains separate sections for traffic and socioeconomic data and for assumptions about electronic tolling costs and current funding sources (e.g. fuel taxes, tolls etc.). Data inputs should be values specific to the urbanized area being studied. For illustration, the inputs in the user interface are based on data for the three urbanized areas, referred to for short by the names of their principal cities: Los Angeles, Chicago, and Washington, DC.

For the annualization factor, used to generalize from daily to annual estimates, the default value is 250, which approximates the number of days in the year excluding weekends and public holidays. This value is appropriate for a scenario where congestion charges apply only on the regular workdays. Users have the option to increase the annualization factor for scenarios where congestion charges apply at other times as well. The original TRUCE used an annualization factor of 330, which is an option in the dropdown menu in the entry for Los Angeles; selecting this option for Los Angeles will automatically for the same for the other areas represented in the other columns.

In the "Inputs" worksheet, users do not need to replace the values that appear in blue or red font. The values in blue font represent core assumptions of the model; those in red font are default values for variables that are either unlikely to differ much among areas or for which area-specific values would be difficult to obtain. Users have the option to replace these defaults with values they consider more appropriate. Entering area-specific values for the average fuel cost per gallon is also optional; these values enter the hidden equations for welfare calculation equations (specifically, in hidden rows 28-33 in the "Free Flow CP" and "Moderate CP" worksheets).

The graphical user interface presents tables of results for (1) traffic and revenues, arterial speeds, and toll collections costs under congestion pricing, (2) the average value of travel time savings per hour, (3) fuel consumption and greenhouse gas emissions in the base case and under congestion pricing and (4) the collection cost under the current funding system. Key results are summarized in the "Results" worksheet.

Key Model Features

The Value of Time

The charges in a congestion pricing scheme depend partly on how much drivers value travel time savings. The overall value of travel time is derived in TRUCE 3.0 as a trafficweighted average of values calculated for cars and trucks. For trucks, the calculation allows for the differences in wages between drivers of light and heavy trucks, as well as the value of time for freight cargo.

Values of time can differ between urbanized areas because of differences in income and wage levels. To estimate values for a particular urban area, users of TRUCE 3.0 must enter the median household income reported for that area in the American Community Survey. Wage and employment data for truck drivers and general wage data for all occupations are also required. The wage and employment data – mean hourly wage and number of employees for both heavy and light truck drivers – can be obtained from the Bureau of Labor Statistics (http://www.bls.gov/bls/blswage.htm).

ETC Capital and Operational Costs

Capital and operational cost factors from TRUCE 3.0 were thoroughly reviewed against toll feasibility studies, academic sources, and several expert opinions. Some cost factors were retained from the original TRUCE, but many have changed. A number of significant capital expenditures, such as software and the command center facilities, have been introduced. Users may want to alter the cost assumptions to reflect the most up to date cost estimates, or estimates specific to their project size and type. ETC costs may be changed by the user through the user interface. Modifications to assumptions about the toll system design (e.g. adding or removing capital items) must be made directly to the ETC Cost worksheet.

Fuel Consumption and Vehicle Emissions

The inputs to the fuel consumption and vehicle emissions calculations are generated internally within the model. The key inputs are the peak-period average speed and traffic volume (VMT) in each scenario, measured separately for freeways and arterials. Fuel economy is estimated using a modified version of the equation in the TTI 2007 Urban Mobility Report; this equation takes account of the differences in fuel consumption rates between automobiles and commercial trucks and expresses average miles per gallon as a function of average congested speed. The estimates of fuel economy thus obtained are then multiplied by vehicle miles of travel to generate estimates of total fuel consumption. EPA guidance on carbon dioxide emissions from gasoline and diesel fuel combustion is used to derive the CO2 emissions associated with each combination of speed and traffic volume. Vehicle emissions of nitrous oxides are derived from factors developed from the EPA MOBILE 6.2 emissions estimation model.

Collection Costs of Current Funding Sources

For each urbanized area, the amounts of current highway funding by source are estimated from data in the Federal Highway Administration's *Highway Statistics* series. The series provides data highway funding by source for each state. For TRUCE 3.0, these figures are localized by prorating each revenue estimate by the urbanized area's share of state vehicle miles traveled. For urbanized areas extending into more than one state, revenues and VMT are summed across the several states. State-wide vehicle miles traveled can be obtained from *Highway Statistics* and VMT for most large urbanized areas can be found in TTI's Urban Mobility Report. State VMT is input into the "Traffic Inputs" section of the "Inputs" worksheet.

For state motor fuel and motor-vehicle taxes, users of TRUCE 3.0 can obtain from *Highway Statistics* figures for various states on collection costs as a percent of revenues. For the other current sources of highway funding, TRUCE 3.0 includes default collection cost rates (the percentage of revenue expended in collection activities). These were developed after a review of revenue and budget data for the IRS (in the case of the federal fuel tax) and selected agencies in a few states. Users may wish to consider replacing the defaults for state and local taxes with values tailored to the state and area they are studying.

Traffic Impacts

The freeway speeds under congestion pricing are largely fixed inputs into the model, as they represent policy targets that are assumed to be realized. In the aggressive pricing scenario, average freeways speeds on the freeways are 60 mph. In the moderate congestion pricing scenario, the elimination of severe and extreme congestion brings the average speeds on sections currently experiencing those congestion levels up to the average speed that prevails under "heavy" congestion (the level below "severe"). For the highway sections currently at the heavy level of congestion or below, moderate congestion pricing has no impacts on speeds. The average speed under all freeway sections under moderate congestion pricing is calculated in the model ("Traffic Impacts" worksheet).

The impacts on freeway traffic volumes are outputs of the model that depend on the base case distribution of traffic by congestion level. The Texas Transportation Institute prepares unpublished data on this distribution for each urbanized area covered by the Urban Mobility Report. Analysts obtained these data for the Los Angeles, Chicago, and Washington, DC areas, and users of TRUCE 3.0 can request from TTI the estimated distributions for other areas. In addition to "uncongested", which means average speed of 60 MPH, the congestion levels that TTI distinguishes are medium, heavy, severe, and extreme. To convey an idea of what these levels mean, the "Traffic Impacts" worksheet (Table 1) presents the corresponding average peak-period speeds for freeways in the Los Angeles area.

Once the spreadsheet determines the overall impact of congestion pricing on peak-period VMT (columns C, F, and H in rows 22 and 32), it determines the portion of this change that represents diversion of traffic toward the arterials (row 64). This portion is a function of the transit share of commuting trips in the area concerned. A high transit share indicates that many car-drivers priced off the freeways would turn to transit as an alternative rather than switching to the heavily clogged arterials. Representing this end of the spectrum is London, UK, where 38 percent of commuters take transit, and only 25 percent of the traffic reduction due to congestion pricing diverted to arterials. At the other end of the spectrum is the Los Angeles area, where fewer than 7 percent of commuters take transit, and study findings suggest that abut 60 percent of the reduction in freeway traffic after congestion pricing would shift to the arterials. Linear interpolation between these extremes yields predictions of the extent of diversion to arterials in other cases. The actual extent of diversion onto arterials that would accompany a congestion pricing scheme would depend, of course, on policy actions such as the extent to which investments in transit accompany congestion pricing. Users are therefore encouraged to adjust the predicted values as appropriate.

Revenue Impacts

The equation for predicting the congestion charge is similar to that in the original TRUCE model. The charge equals the value of the average time saved per mile from traveling on an uncongested freeway rather than on an alternative route limited to congested arterials (see row 35 in the worksheets “Moderate CP” and “Free flow CP”). The amount of time saved is based simply on the difference in average speeds between these alternatives; based on limited evidence pertaining to Los Angeles, the distance traveled is assumed to be the same. The preliminary estimates of congestion charges for the Los Angeles area looked distinctly high compared to other studies’ estimates of optimal congestion charges for U.S. urban areas, so they were scaled downward by a toll adjustment factor. Since the over-estimation for Los Angeles can be assumed to represent a general bias, the same adjustment factor has been retained for applications of TRUCE 3.0 to other urbanized areas.

To annualize the estimates of congestion revenue per day, TRUCE 3.0 assumes conservatively that the revenues are collected on 250 days per year, fewer than the 330 assumed in TRUCE. Another difference between versions is that TRUCE 3.0 incorporates no specific travel subsidy or discounts for low-income travelers. The decision to subsidize low income travelers or other target user groups remains an option for any community. And the ability to implement that travel assistance, for example, by electronic transfer of travel funds into users’ “smart card” or similar travel use accounts has become less complicated due to improvements in data and communications technology. (Users of the TRUCE 3.0 and other models could readily calibrate budgetary effects for subsidizing user groups, depending upon target traveler group size and assumed per-traveler amounts of assistance.)

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