Discussion-piece #9
Semi-independent Forecasts of Ridership and User Benefits for New Starts Projects
Federal Transit Administration
June 6, 2006

1. Motivations. A powerful way to generate insights into forecasts is to use two separate methods to make the forecasts. Much is learned from analysis of the differences between the two results. A clear lesson from detailed review of New Starts forecasts over the last several years is that many uncertainties in forecasts occur because of problems in transit pathbuilding and mode choice. So, a high priority for FTA is that project sponsors (1) generate parallel "quality control" forecasts using methods that are – in part – independent of locally developed models, (2) understand the differences between these QC forecasts and the "sponsor's" forecasts prepared with local forecasting procedures, and (3) use any insights gained from the comparisons to make any appropriate adjustments to the sponsor's forecasts.

2. Strategy. The QC forecasts will produce a parallel set of estimates of new transit riders, project ridership volumes, and user benefits for the proposed New Starts project. They will be based on the sponsor's forecast routinely prepared for the baseline alternative and will employ incremental models to predict changes in ridership and user benefits. This approach is only "semi-independent" of the sponsor's forecasts because it relies heavily on the travel patterns, transit service levels, and transit ridership markets established in the sponsor's forecasts for the baseline alternative. This grounding in the sponsor's baseline forecasts informs the QC forecasts on the key characteristics of local travel patterns and transit markets understood by the local models. The independent aspects of the QC forecast reflect are that it:

    - Relies only on the "best" walk-access paths and the "best" drive-access paths developed from the sponsor's coded transit networks and transit pathbuilding procedures for the baseline and build alternatives – but with FTA-specified weights for pathbuilding; and

    - Uses an FTA-specified incremental-logit mode choice model to predict ridership changes and user benefits for the build alternative as increments from the baseline alternative.

   The idea is to capture from the local travel models their understanding of local conditions and travel markets by grounding the semi-independent forecasts on the locally prepared forecasts for the baseline alternative, but produce deltas for the build alternative using methods with simple, known, and nationally consistent properties.

3. Best paths. A potentially large simplification for the QC forecasts is that they will forego the complexity in many local models that consider a wide range of discrete transit options in transit pathbuilding and mode choice analysis: urban rail, commuter rail, local bus, express bus, and so forth. These models employ a variety of devices in pathbuilding to find available travel options using each transit mode. Their mode-choice components have relatively elaborate structures that attempt to sort out the competition among these options, predict their

mode shares and ridership, and summarize their contributions to mobility. Recent experience suggests that, while this complexity is a useful response to the complexity of urban transit systems and travel markets, it is a frequent source of unexpected model "properties," unexplainable outcomes, and outright errors. The best-path approach that will be employed for the QC forecasts simplifies the pathbuilding by finding for each zone-to-zone interchange only the single best paths available for (1) walk-access and, separately, (2) drive-access travel on the transit system. The specific nature of these "best" paths will depend on the transit pathbuilding algorithm employed in the local travel models. Ideally, the best paths will:

- avoid multiple-path effects across different transit modes, but
- reflect combined-headway effects where multiple transit lines of the same mode serve common boarding and alighting locations on a transit path.

All-or-nothing transit pathbuilders in older software packages were designed to find paths with both of these characteristics. The extent to which more recent pathbuilders – particularly those employing "multi-path" algorithms – can produce similar paths depends on the specific package, pathbuilder, and version of the software. In any case, the common characteristic across all QC forecasts will be the elimination of any devices used to generate transit paths to represent particular transit travel options (rail, BRT, local bus, and so forth). Table 1 shows the impedance weights for path selection that, at this point, are draft and subject to revision.

Table 1. Impedance Weights for Path Selection

Impedance	Units	Weight
In-vehicle time for (most) transit modes	Minutes	1.0
In-vehicle time for commuter rail	Minutes	0.8
All out-of-vehicle time	Minutes	2.0
Drive-access time	Minutes	2.0
Transfers	Number	5.0
Fare (cents) (peak / off-peak)	Cents	0.15 / 0.075
--- --- --- Subject to revision --- --- ---		

Other than the difference in the weight on transit fare, these weights will apply to both peak and off-peak pathbuilding.

4. <u>Mode choice model.</u> The second potentially large simplification in the semi-independent forecasts will be the mode choice model. Many current model sets consider a large number of discrete transit choices. That strategy is useful in sorting out large numbers of different transit line-haul and access modes where they compete closely for various travel markets. However, mode choice models have been found over the last several years to be the source of unexpected – and often unexplainable – properties related to large choice structures, nesting coefficients that have been asserted (rather than estimated with sufficient data), embedded decision rules, and other complexities. The QC forecasts will employ an incremental mode choice model that will consider three choices: auto, transit/walk, and transit/drive. Because the model will be applied in its incremental form and no changes in auto impedances will be

assumed between the baseline and build alternatives, all changes in utility for the auto mode will be zero. Similarly, no changes in socio-economic characteristics will occur between the alternatives. Consequently, the model will rely only upon the changes in transit/walk and transit/drive service characteristics that occur between the baseline and build alternatives. Figure 1 illustrates the structure of the nested model.

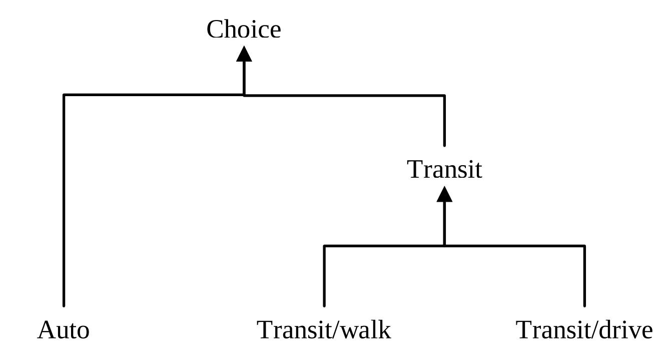

Figure 1. Structure of the Incremental Mode Choice Model

5. Table 2 documents the draft coefficients for the utility expressions of the two transit choices, subject to any revisions made before implementation of the QC-forecast check. Coefficients on the impedance variables are intended to represent the mid-range of national experience with mode choice models. The relative values of these coefficients are identical to the relative values of the pathbuilding weights in Table 1 to avoid the generation of spurious mobility benefits and disbenefits in the QC forecasts. The coefficient on the logsum variable is similar to the largely asserted coefficients on transit-access logsums found currently in nested mode choice models.

Table 2. Coefficients in the Mode Choice Model

Variables		Coefficients		
Attribute	Units	HBW	HBO	NHB
In-vehicle time for (most) transit modes	Minutes	-0.020	-0.010	-0.020
In-vehicle time for commuter rail	Minutes	-0.016	-0.008	-0.016
All out-of-vehicle time	Minutes	-0.040	-0.020	-0.040
Drive-access time	Minutes	-0.040	-0.020	-0.040
Transfers	Number	-0.100	-0.050	-0.100
Fare (cents)	Cents	-0.003	-0.0015	-0.0015
Guideway flag(s)	0/1	TBD	TBD	TBD
Transit-access logsum	Utiles	0.6	0.6	0.6
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6. Development of QC forecasts. Project sponsors will develop the QC forecasts for locally preferred alternative (LPA) emerging from alternatives analysis and submit the results as part

of requests to FTA for advancement of the LPA into preliminary engineering. Preparation of the forecasts will involve three steps:

- development of "best" paths for walk-access and drive-access for both the baseline and build alternatives;
- aggregation of the transit trip tables from the sponsor's forecasts for the baseline alternative – for walk-access and drive-access trips – for trip purpose and socio-economic market segment tracked by the sponsor's mode choice models; and
- application of the incremental mode choice model for each trip purpose and socio-economic market segment.

7. Analysis and documentation. Differences between the sponsor's forecast and the QC forecast will provide insights into the properties of the transit components of the sponsor's travel forecasting procedures. These differences may emerge in the service changes between the alternatives found in the impedance variables, the ridership changes estimated by the sponsor's and FTA's models, the number of new transit riders, and/or the estimated user benefits. Major differences – both in totals and in important district-to-district travel markets – will require analysis to identify the causes, potentially including differences between the sponsor's forecasts and the QC forecasts in:

   - model parameters on transit impedances used for pathbuilding and mode choice;
   - differences in the nesting effects associated with deeply nested mode choice models and asserted logsum coefficients that approach 1.0 (that is, in the range 0.7 to 1.0, implying a mathematically multinomial structure despite the nested portrayal of the model's structure;
   - rules that modify the availability of choices; and
   - other properties of the sponsor's models.

   Documentation of the QC forecasts will need to present the differences between the two sets of forecasts, explanations of the differences, evidence of the accuracy of the explanations, and conclusions on the reliability of the sponsor's forecasts.

8. Implementation. Through the end of 2006, FTA will sponsor testing of the usefulness of QC forecasts as a way of supporting the reliability of New Starts travel forecasts. The tests will verify the analytical usefulness of the approach, provide examples of the display of differences between sponsor and QC forecasts, and illustrate analyses useful in identifying the sources of those differences. Summit version 1.5 will include the means to prepare QC forecasts in parallel with (or independent of) the computation of user benefits from the sponsors forecasts. FTA anticipates that testing of the approach to QC forecasts will be completed by late 2006 and that QC forecasts will be a required element of requests for entry into preliminary engineering beginning in January 2007. The requirement may also apply to requests for advancement into final design for projects currently in preliminary engineering.