Development of an Elasticity-Based Model to Forecast Rail Ridership Demand on the Northeast Corridor

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ABSTRACT

This paper describes the approach and methods to forecast ridership for the CONNECT 2035 (C35) operating plan for the Northeast Corridor (NEC). The ridership tool developed for this project uses elasticity/sensitivity analyses estimated from existing models in the NEC to create a "meta model." A meta model takes a model or a suite of models and simplifies them by estimating simpler models/elasticities based on results of the complex underlying models. This method was used to create a ridership tool to predict changes in rail ridership for intercity and commuter rail under the C35 operating plan. The model also calculates shifts to rail from auto, bus, and air modes using cross elasticities. The ridership tool was able to achieve the goal of creating quick, sensible, and comprehensive forecasts for the complex NEC at the Metropolitan Statistical Area (MSA) level of geography with enough ridership detail to be useful in the planning process. The ridership tool allowed the Northeast Corridor Commission (NECC) to estimate demand much more efficiently and effectively than if they had used each of the individual forecasting models on their own and the ridership tool ensures consistent ridership results across the entire NEC.

WHY AN ELASTICITY APPROACH?

1. Existing NEC models run scenarios to examine **changes in ridership based on changes to core service** (fare, travel time, and frequency), the fundamental elasticity structure.
2. This approach also enables estimation of **mode shift** to rail through use of cross elasticities of demand for other modes (auto, air, and bus).
3. The C35 operating plan consists of incremental improvements in service; elasticity models excel at examining **incremental changes**.
4. Elasticities are **additive**. When they can be estimated individually on each variable, it is possible to apply them separately and then sum the resulting change in ridership.

MODEL ESTIMATION

The elasticity estimation process is complex but had three primary phases:

1) Importing and cleaning model summaries, scenario inputs, and demand data
2) Calculating elasticities
3) Modeling elasticities and validating the models

Estimated elasticities based on existing model runs for:

1) Time
2) Fare
3) Frequency

Time and fare elasticities were calculated from the NEC FUTURE model, while frequency elasticities were calculated from a combinations of the MNR and NJT regional models.

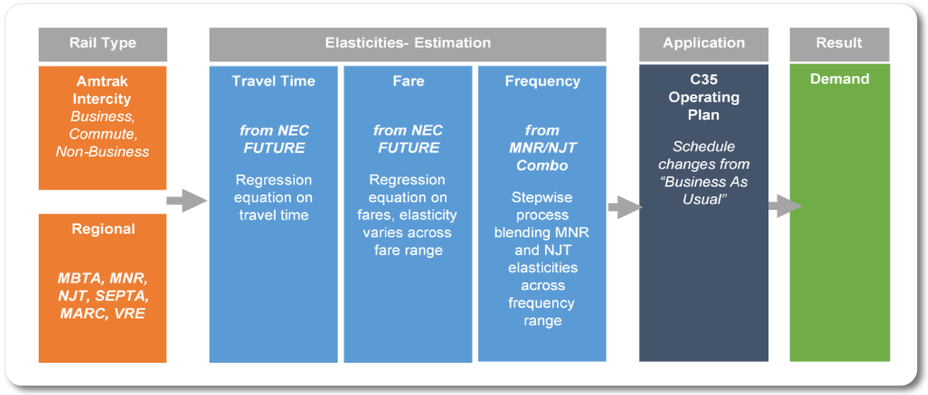

Figure 1. Overview of the approach.

MODEL APPLICATION

1. **Establish base and build levels of service:** For the business as usual (BAU) and C35 build scenarios, the study team created operating plans in the form of new train schedules for the entire NEC. From the schedules, the team derived level of service (LOS) variable changes between the BAU and C35 operating plans.
2. **Calculate changes between scenarios and apply elasticities:** A ridership tool was developed to calculate the changes between the base and build scenarios and apply the appropriate elasticity and cross-elasticity using regression models.
3. **Calibrating the time, fare, and frequency models:** The time, fare, and frequency models were calibrated so that they would return the best possible fit to the existing model runs.
4. **Assumptions:**
   - The 2035 BAU scenario uses a 2019 operating plan as the best available proxy to a no-build scenario in 2035.
   - Base demand was interpolated from the base and scenario horizons (which differed by input model) to approximate 2035 demand. Ridership results were further interpolated to 2030 to account for presumed slowdown in growth associated with the COVID-19 pandemic.

RESULTS

Demand for Annual Rail Trips (in millions), by Scenario

	2019	2035 BAU	C35	% Change
Amtrak Intercity	16	20	24	20%
Commuter	133	145	183	27%
Total	149	165	208	26%

Change in Annual Rail Trip Demand (in millions), by Mode

	Rail	From Auto	From Air	From Bus
Amtrak Intercity	4	-3	-0.5	-0.4
Commuter	39	-26	-	-13
Total	43	-29	-0.5	-13

PMT for Annual Rail Trips (in millions), by Scenario

	2035 BAU	C35	% Change
Amtrak Intercity	2,757	3,523	28%
Commuter	4,719	6,262	33%
Total	7,475	9,785	31%

Change in Annual PMT (in millions), by Mode

	Rail	From Auto	From Air	From Bus
Amtrak Intercity	766	-571	-113	-82
Commuter	1,544	-960	-	-584
Total	2,309	-1,531	-113	-665

CONCLUSIONS

The elasticity approach used in the ridership tool has significant value:

1. Produced **reasonable ridership estimates** at a level of detail and precision that enabled an effective evaluation of the overall C35 operating plan.
2. Method was **faster to develop and easier to maintain and use** compared to the alternative of trying to run and reconcile multiple complex models for the region.
3. Relevant and potentially **useful for many systems and geographies** around the United States.