A Peer Review: The Volpe/FHWA National Vehicle Miles Traveled Forecasting Models

Developed by Jack Faucett Associates, Inc., for FHWA Office of Highway Policy Information

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Overview of VMT Forecasting Models and Approach

The Volpe National Transportation Systems Center (Volpe) developed vehicle miles traveled (VMT) forecasting models, based on forecastable socio-demographic variables, for light duty vehicles (LDV), single unit trucks (SUT), and combination trucks (CT). The JFA team conducted a review of the Volpe approach and supporting literature and vetted model inputs and parameters via expert panels and validity checks.
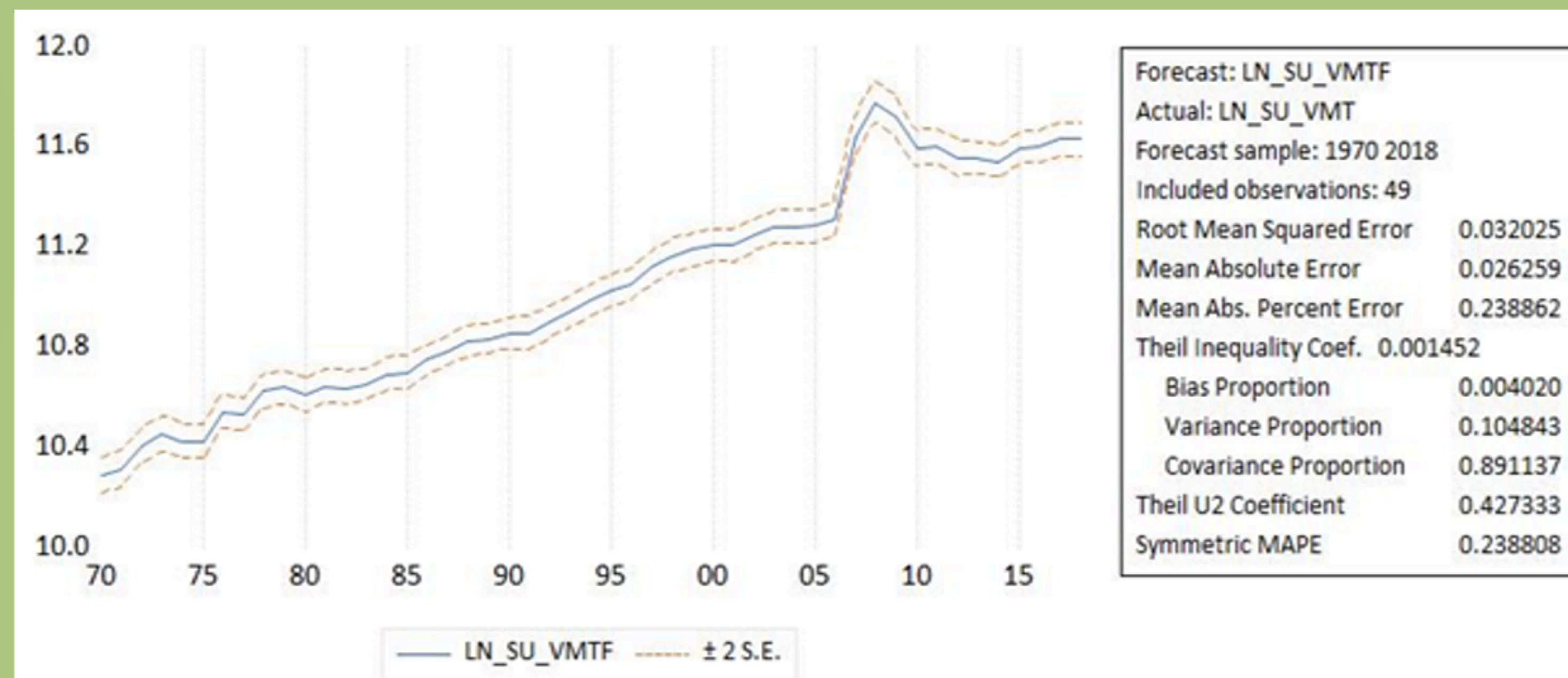
LDV, SUT, and CT Models

- VMT estimation is driven by forecastable explanatory variables, including fuel consumption, vehicle class specific variables, and lag variables
- LDV Model: Assumes household demographics and economic characteristics are the central drivers influencing passenger demand
- SUT and CT Models: Recognize truck freight is driven by economic activity, particularly manufacturing
- Final Model Specification: The model specification for all three is the autoregressive distributed lag model (ARDL) structure, preferred when variables are cointegrated of of order I(0) or I(1), or both.
- Model Validation: The JFA team reproduced the results of the three models:
  - Error correction model (ECM) run for LDV VMT as an ARDL (1,3,1,0) with 47 observations spanning 1970-2016
  - ECM run for SUT VMT as an ARDL (3,1,0) with 43 observations spanning 1974-2016
  - ECM run for CT VMT as an ARDL (2,0,0) with 43 observations spanning 1974-2016
  - Bayesian Information Criterion (BIC) used to select the lag structure

In-sample and Out-of-Sample Validation

VOLPE Model	Period Reported in the Report	Code Indicates Period Used	MAPE Errors in Report	MAPE Errors as Estimated by JFA Team
LDV Model				
LDV in-sample	1974-2016		0.67%	0.69%
LDV out-sample (1)	2006-2016 [6]	1970-2006	3.64%	3.14%
LDV out-sample (2)	2011-2016		0.79%	3.11%
SUT Model				
SUT in-sample	1970-2016		2.62%	2.63%
SUT out-sample	2011-2016		4.2%	4.52%
CT Model				
CT in-sample	1970-2016		1.62%	1.62%
CT out sample	2011-2016		4.36%	4.149%

Rev:0.25%

Backcasting and Forecasting Performance

Forecast: LN_SU_VMTF
Actual: LN_SU_VMT
Forecast sample: 1970 2018
Included observations: 49
Root Mean Squared Error 0.032025
Mean Absolute Error 0.026259
Mean Abs. Percent Error 0.238862
Theil Inequality Coef. 0.001452
Bias Proportion 0.004020
Variance Proportion 0.104843
Covariance Proportion 0.891137
Theil U2 Coefficient 0.427333
Symmetric MAPE 0.238808

— LN_SU_VMTF ---- ± 2 S.E.

VMT report can be found at:
https://www.fhwa.dot.gov/policyinformation/tables/vmt/vmt_model_dev.pdf

Post-Estimation Tests and Parameter Stability

- Pesaran-Shin-Smith (PSS) bounds test- evidence of long run cointegration of VMT and included variables in all cases
- Cumby Huizinga tests for autocorrelation- no residual AR

	CUSUM Test	CUSUM Sq Test
LDV Model (N=47) 1970-2016	Test statistic = 0.6877 (not rejected at 1% significance level) Critical value = 1.143	See Appendix. Violations for periods 1995-2009 (squared residuals fall outside the 5% significance, 95% confidence bands)
SUT Model (N=43) 1974-2016	Test statistic = 0.1482 (not rejected at 1% significance level); Critical value = 1.143	See Appendix.
CT Model (N=43) 1974-2016	Test statistic = 0.208(not rejected at 1% significance level); Critical value = 1.143	See Appendix. Violations for periods 1995-2009 (squared residuals fall outside the 5% significance, 95% confidence bands)

Conclusions

- Volpe models tend to perform well overall
- LDV: 85-90% of all travel
  - Strong candidate for alternative specifications
- SUT and CT sample sizes could benefit from additional years of data
- Monitor trends in ecommerce that could affect SUT and CT shares of VMT
- These are long-term (20-30 year) forecasts
  - Use caution in short-term applications