Methods for Assessing NEMS Solution Data for Interpretive and Diagnostic Purposes
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Background: The National Energy Modeling system produces twenty-year forecasts of energy prices, quantities and related variables. Each forecast generates thousands of numbers arranged in 229 distinct tabular displays. The size of the output only hints at the complexity of the underlying models that together produce an integrated (internally consistent) forecast.

Model users and clients have long been interested in having relatively simple ways of sorting through individual forecasts, comparing individual forecasts and identifying assumptions that have particularly large effects on the results. The basic idea of this project is to treat NEMS forecasts as if they were "real" data and present the "data" graphically. That allows fairly efficient visual analysis of a host of individual "data" series. In addition, it is easy to make graphical comparisons of forecasts across various assumptions and model versions. Finally, we modeled the data with simple regression equations. The regressions link model outputs (forecasts) to the assumed data (such as GDP and world oil prices) that the model uses to make its forecasts.

Representative applications of this software technology include:

Comparisons of NEMS Solutions. The NEMS solution series used for the regression analyses were compared directly for the years 2010-2020. The issue at stake was the apparent stability of the forecasts. The following measurements were made:

- for each forecast year the ratio of the standard deviation across the alternative forecasts to the mean forecast value;
- for each forecast series, the number of times there were changes in rank across NEMS versions, i.e., the number of times time series plots of the solutions would cross; and,
- for the forecast year 2010, whether the difference between the 1998 and 1999 projections was larger (as would be expected) or smaller than the difference between the 2003 and 2004 projections.

NEMS Approximation and Interpretation. NEMS solution series for the production and consumption of major fuels, as well as important influences upon energy supply and demand, have been extracted and analyzed for the 1998-2004 *AEO* versions of NEMS. A linear model of energy supply and demand was fit to these data which provided generally very accurate approximations of the NEMS projections. The model is based upon over fifty regression equations that can be executed as a group automatically. The sensitivities among NEMS variables are measured by elasticities. The elasticities are compared across NEMS versions to asses the stability and robustness of NEMS' representation of the U.S. energy system as reflected by the changes in size, and sometimes sign, of the elasticities. Accurate approximations of NEMS solutions have also been constructed using kernel regression.

Backcasts. A comparison of the NEMS projections to actual data for the year 2003 is scheduled. The regression results will be used to partition differences between those due to forecasting uncertainty in general versus those due to errors in the projection of exogenous variables.

Issues. The NEMS solution processing results referred to above are available for inspection. The measures chosen are intended to be illustrative, rather than definitive At issue is the usefulness of such measures and the specification of other measures for the purpose of revealing and auditing the features of NEMS' representation of energy markets and enabling diagnostic assessments of NEMS forecasting methods.

Questions for the Committee:

- What measures, based upon the approximations of stable NEMS solutions, would assist in the assessment of NEMS solutions under development to help uncover programming errors or inappropriate assumptions?

- What procedures would be appropriate for using NEMS approximations to facilitate convergence of the NEMS solution algorithm?

- What diagnostics based upon regression-based approximations would be useful for interpreting NEMS and supporting priorities for further model development?

- What would be good ways to utilize prior NEMS solutions to audit and test current solutions?

- What would be good ways to utilize regression-based NEMS approximations to establish the partition of forecasting errors among (such as) errors in forecasting exogenous variables versus general forecasting uncertainty?

- In constructing the regression equations how should "goodness of fit" be traded off with the plausibility of specification in terms of representing energy supply and demand relationships?

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