FORCASTING MOTOR GASOLINE CONSUMPTION IN THE UNITED STATES

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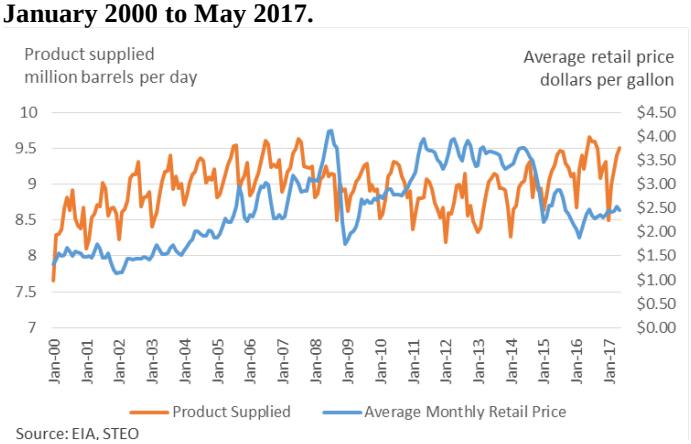
Overview

Motor gasoline consumption forecasts are important to numerous stakeholders. State and federal governments rely on motor gasoline forecasts for planning purposes to estimate income from motor gasoline tax revenues. Government officials and researchers also use motor gasoline consumption forecasts to analyse potential policy scenarios. However, accurately forecasting motor gasoline consumption can be a challenge and recent changes in oil prices, macroeconomic indicators, and consumer preferences have not made it easier.

Over the last two decades motor gasoline consumption has oscillated between growth, contraction, and is currently in a period of growth again (Figure 1). In the early to mid-2000s there was a general fear of reaching peak supply as motor gasoline demand and prices continued to creep upward. The storyline changed to reaching peak demand in the late 2000s and early 2010s during the great recession and the corresponding high gasoline prices during the recovery. Now, neither of those market observations may hold. What was thought to be a regime switch to lower VMT and more fuel efficient vehicles might have been a consequence of high oil prices and the great recession and not a fundamental change in consumer preferences. Now, with fuel prices remaining low and consumption creeping up, the question becomes are we back on the pre-Great Recession trajectory; have we entered a third gasoline consumption regime; or have all the changes experienced in the last two decades been explainable through changes in macroeconomic indicators and prices and not changes in consumer preferences resulting in no regime changes. Knowing that we have entered a new regime or returned to the pre-Great Recession regime could be beneficial when developing a forecast model. However, this is typically determined after the fact and could slow down the inclusion of new market dynamics that could improve a models ability to predict future demand.

Figure 1. Monthly motor gasoline product supply and average motor gasoline retail price in the U.S. from January 2000 to May 2017.



The purpose of this study is to determine the forecast model or pooled forecast models that best predict monthly motor gasoline consumption in the United States. Multiple forecasting models and levels of aggregation are considered to determine which model best forecasts motor gasoline consumption for up to 24 months. This study contributes to the literature since it is one of the first studies since the downturn in oil prices to analyse motor gasoline consumption and may help researchers understand the changes in motor gasoline consumption that have happened since 2014.

Methods

In order to determine the best motor gasoline consumption forecast model or pooled forecast models several models and aggregation levels of data are tested. These consumption forecast models fall into three model categories – auto-

regressive integrated moving average (ARIMA) model, vector autoregressive (VAR) model, and structural econometric modle. All of these models have benefits and downsides for forecasting.

The first model considered is the ARIMA model. The ARIMA model has a couple advantages. First, the model only relies on the lagged dependent variable for an input. This can eliminate the need for other forecasted variables that may be biased (i.e. macroeconomic variables during the recovery). Second, because it only relies on the lag of the dependent variable, it can potentially pick up changes in the trend more quickly than other forecasting models that use multiple input variables. Two levels of aggregation are tested using the ARIMA model. The first relies on nationwide data, while the second relies on Petroleum Administration Defense Districts (PADD) level data.

A second set of models were tested using a VAR model specification. Unlike ARIMA models, VAR models rely on multiple lagged independent variables. There are several advantages to using the VAR model. First, changes in other variables may precede changes in motor gasoline consumption which could lead to an early response in motor gasoline consumption. Second, VAR models allow for analysis of what affects changes in motor gasoline consumption which can be beneficial when analysing policies. Third, if the variables are cointegrated an error correction term can be added to the VAR model to take into account the long-run relationship between the variables. A couple VAR models are tested. The first VAR model assumes that there are no asymmetric price or macroeconomic responses. The second model assumes an asymmetric price response.

A structural model is also tested. The structural model can give researchers insight into what is causing changes in motor gasoline consumption but it is very data intense. Two structural models were tested. Like the ARIMA model, the first structural model relies on nationwide data while the second relies on PADD level data.

All three models have their benefits and downfalls when it comes to forecasting. For this reason a pooled forecasting model is also tested. Though the effect of changes in price and macroeconomic variables may be hidden in the pooling of the forecast, the overall forecast may be more robust.

The data used in the analysis come from the Energy Information Administration (EIA) Short-term Energy Outlook. The dependent variable is monthly product supply at the national and PADD level. Product supply is used as a proxy for product consumed since there is no comprehensive motor gasoline consumption dataset. Due to the short storage time of finished products, this is likely a good proxy. The independent variables considered include average retail price of gasoline across all products, gross domestic product (GDP) gross state product (GSP), non-farm employment, civilian unemployment rate, VMT, Chicago Fed National Activity Index, and heating degree days. Heating degree days is included since motor gasoline consumption typically decreases during the winter and this is a monthly forecast.

Results

As a standalone model the ARIMA model outperforms the other two models. However, for the period of analysis the ARIMA model was biased toward underestimating motor gasoline consumption. There was no consistency between the ARIMA model and the structural model to say if the models should be estimated at the national or regional level. The regional model slightly out preformed the national model in the ARIMA analysis. However in the structural model anlysis the national model out forecasted the regional model. In the VAR analysis the model with the symmetric price response out forecasted the model with the asymmetric price response. The pooled model forecasted as well as the regional ARIMA model but reduced the underestimation bias that was present in the ARIMA model.

Conclusions

Government agencies and researchers all have different motivations for using motor gasoline consumption forecasts. For the purpose of this analysis we tried to determine the best way to forecast motor gasoline consumption. Based on the strength and weaknesses of the ARIMA, VAR, and structural models a pooled forecasting model may be the best way to forecast motor gasoline consumption. However, if understanding the effect a change in price or a macroeconomic indicator has on motor gasoline consumption is important a strucutral may need to be used instead.

At this point it is hard to determine if we have entered a new regime in motor gasoline consumption. VMT and the purchase of larger vehicles has been up over the last couple years leading to year-over-year growth in motor gasoline consumption. However, these increases could have been brought on by higher economic growth and employment and lower gasoline prices and not fundamental changes in consumer preferences.