“Forecasting Gasoline Prices Using Consumer Surveys”

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The payoff to investments in new energy production, energy-using durable goods, and energy-related research all hinge critically on the quality of predictions about future energy prices. Low-quality predictions can lead to poor or insufficient investments and large welfare losses. Moreover, biased predictions may explain the so-called “energy paradox”—the apparent failure of market participants to make seemingly cost-effective investments in energy efficiency. To date, however, the research community has not had access to participants’ energy price forecasts, and studies have instead examined the forecast accuracy of no-change models, futures contract prices, expert predictions, and econometric models (see Ron Alquist, Lutz Kilian, and Robert J. Vigfusson 2010 for a survey). This paper introduces a new dataset on consumers’ retail gasoline price forecasts obtained from the nationally representative Michigan Survey of Consumers (MSC).

The MSC is best known for its Consumer Sentiment Index, a monthly indicator of consumers’ attitudes about the economy and their own financial outlook. MSC survey data on consumers’ beliefs about future inflation have been used widely and have been shown to out-perform time-series and macroeconomic models (such as ARMA or Phillips-curve models) in out-of-sample inflation forecasting (Andrew Ang, Geert Bekaert, and Min Wei 2007). Since

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1993, the MSC has also asked consumers to report their beliefs about future retail gasoline prices, but these data have not been used by the research community until now. In Soren T. Anderson, Ryan Kellogg and James M. Sallee (2011), we use these data to ask *what* consumers believe about real future gasoline prices, concluding that the average consumer's belief (over a 5-year horizon) is statistically indistinguishable from a real no-change forecast for nearly the entire sample period, deviating substantially only during the 2008-2009 economic crisis. Here, we ask the related question of *how well* consumers predict future prices.

We first examine the accuracy with which MSC respondents forecast real retail gasoline prices, making an explicit comparison to a benchmark no-change forecast and a more qualitative comparison to futures market forecasts of wholesale gasoline and crude oil prices. We then test whether the MSC data contain useful information about gasoline price volatility by correlating the dispersion of individual MSC forecasts to implied volatility data derived from oil futures options markets. This test relates to previous work that has interpreted the dispersion in inflation forecasts—both in the MSC and in surveys of economists and professional forecasters—as a rough proxy for "uncertainty" about future inflation rates, although others have interpreted dispersion more literally as measuring forecast "disagreement" that potentially arises because agents only update their expectations periodically or have private information (N. Gregory Mankiw, Ricardo Reis, and Justin Wolfers 2003, Richard Curtin 2010). We conclude by discussing our related and ongoing work with these unique survey data. Overall, we find that consumer forecasts of real gasoline prices perform about as well as no-change forecasts at most times and may even out-perform no-change forecasts following a large shock. This finding suggests that consumers hold "reasonable" beliefs about future prices and that these beliefs are therefore unlikely to be the source of the energy paradox.

I. The Michigan Survey of Consumers (MSC) Data

Every month, the MSC asks a nationally representative sample of about 500 respondents to report their beliefs about the current state of the economy and to forecast several economic variables. Since April 1993, the MSC has regularly asked respondents to report whether they think gasoline prices will be higher or lower (or the same) in five year's time and then to forecast the exact price change (for details, see Anderson, Kellogg, and Sallee 2011). Since late 2005, the MSC has also asked respondents to report their beliefs about gasoline prices in one year's time. We have obtained the individual responses to these (and most other MSC questions) for all surveys conducted through January 2010.

We use these data to construct the mean MSC respondent's forecast for the future price of gasoline in real terms.[1] Because the survey asks respondents to report expected price changes in cents and because the questions about gasoline follow a series of similar questions about price levels in general (i.e., expected inflation), we interpret survey responses as nominal expected changes in gasoline prices. We construct each respondent's nominal gasoline price forecast by adding his or her forecasted nominal price change to the current retail price of gasoline.[2] We then deflate this nominal forecast by the respondent's own forecast for the inflation rate over the next 5-10 years, and we convert this inflation-adjusted forecast to January 2010 dollars using the

[1] In constructing the mean forecast, we use weights provided by the MSC that correct for survey issues such as multiple phone line ownership and non-responses, so that the mean is representative of all U.S. households. We focus on the mean rather than the median because the individual nominal price change forecasts exhibit digit preferences ($0.25, $0.50, etc.) and because the mean performs slightly better in forecasting.

[2] We obtained data on current retail gasoline prices from the Energy Information Administration (EIA). We use the EIA's national sales-weighted average retail gasoline price (including taxes) over all gasoline grades (regular, midgrade, and premium) and formulations (conventional, oxygenated, and reformulated).

Consumer Price Index.[3] Finally, we take the mean forecast across all individuals to construct our mean MSC forecast for the future price of gasoline in real terms.

II. Mean MSC Forecasts of Future Gasoline Prices

Figure 1 presents the monthly time series of real U.S. gasoline prices and our mean inflation-adjusted MSC forecast. These two series overlap closely, suggesting that the average consumer forecasts the future real price of gasoline to equal the current price. The only substantial deviation occurs during the economic crisis in late 2008. In Anderson, Kellogg, and Sallee (2011), we show that, prior to 2008, the mean MSC forecast is statistically indistinguishable from a no-change forecast.

FIGURE 1 ABOUT HERE

The fact that the MSC and no-change forecasts overlap so closely suggests that their forecast accuracy will be similar, and indeed this is true. Using realized gasoline price data through October 2010, we compute the forecast error that results from using the current gasoline price and the mean MSC forecast to predict the real price of gasoline 5 years ahead. Over the 139 monthly predictions for which realized prices are available (April 1993 through October 2005, with a few small gaps), the root mean squared prediction error (RMSE) for the no-change forecast is \$0.807 while that of the MSC forecast is \$0.802. Forecasting performance is also similar under a mean absolute error (MAE) metric (\$0.601 for no-change, \$0.608 for MSC).[4]

We do not explicitly compare the performance of the mean MSC forecast to forecasts from futures prices because futures markets for retail gasoline do not exist and because futures

[3] Specifically, we use the non-seasonally adjusted index for all urban consumers, all items less energy (CUUR0000SA0LE).

[4] We fail to reject that the MSC and no-change forecast errors are identical for each of these metrics (p-values are 0.650 and 0.721 for RMSE and MAE, respectively), using the method of Francis X. Diebold and Roberto S. Mariano (1995).

markets for related, though different, products—crude oil and wholesale gasoline—at a 5-year horizon are thin and non-existent, respectively. Nevertheless, it appears that the accuracy of the mean 5-year MSC forecast, relative to a no-change forecast, in predicting future retail gasoline prices is superior to the relative accuracy of long-term crude futures in predicting future oil prices. Alquist, Kilian, and Vigfusson (2010) show that, although the accuracy of crude oil futures is similar to that of a nominal no-change crude oil price forecast over short horizons of less than one year, crude futures perform substantially worse over horizons of two to six years.[5]

The one substantial and sustained departure of the mean MSC forecast from the no-change forecast coincides with the onset of the economic crisis in late 2008. During this time, consumers consistently forecasted, at both the five-year and one-year horizons, that gasoline prices would increase in real terms. Given the rapid rebound in gasoline prices in 2009, these consumer forecasts were substantially more accurate than a no-change forecast. Between November 2008 and March 2009, during which time the mean one-year MSC forecast predicted increases in gasoline prices exceeding 10%, the one-year RMSE of the no-change forecast is \$0.769 while that of the mean one-year MSC forecast is only \$0.469. In addition, during this time the mean one-year MSC forecasted change in gasoline prices is similar to forecasts based on the New York Mercantile Exchange (NYMEX) wholesale gasoline futures market. Figure 2 shows the year-ahead predicted gasoline price changes of both the mean MSC forecast and the NYMEX market over the 2005-2009 period during which one-year MSC forecasts are available.[6] The increase in the MSC's forecasted price change in late 2008 coincides with an increase in the

[5] Were crude oil futures compared to a real no-change forecast rather than a nominal no-change forecast, their relative performance would be even worse given the increase in crude oil prices over the sample.

[6] We make this comparison in changes rather than levels because NYMEX wholesale gasoline prices do not include retail margins or taxes. The NYMEX migrated its gasoline contract specification from "HU" unleaded gasoline to "RBOB" reformulated blendstock during 2006. The data in figure 2 use RBOB beginning in January 2006.

price change predicted by the NYMEX futures market. Prior to this period, however, the MSC and NYMEX forecasts are only weakly related, with the MSC forecast generally predicting small price increases and the NYMEX market generally predicting small price decreases.

FIGURE 2 ABOUT HERE

While it is inappropriate to draw strong conclusions from this single short episode, the data do make a provocative suggestion: following a large shock, both consumer surveys and futures markets may contain useful information about future gasoline prices that improves over a no-change forecast. That is, while it is difficult for survey and futures market forecasts to improve upon a no-change forecast during “normal” times, the information possessed by consumers and market participants following a large price shock—such as knowledge of why the shock occurred—becomes important and may enable them to predict future prices more accurately.

III. Dispersion in MSC Forecasts and Price Volatility

Finally, we consider the merits of using the dispersion of gasoline price forecasts across MSC respondents each month as a proxy for price volatility. Our measure of dispersion is the standard deviation of the respondents’ real, deflated 5-year gasoline price forecasts, expressed as a percentage of the current real gasoline price. Figure 3 shows that dispersion typically hovers around 30% but rose to 60% during the recent crisis.

FIGURE 3 ABOUT HERE

For comparison, figure 3 also plots two measures of oil price volatility from Alquist, Kilian, and Vigfusson (2010): (1) implied price volatility from NYMEX oil futures options, which corresponds to the market’s forecast of volatility over the upcoming month; and (2) realized volatility, which the authors calculate as the within-month standard deviation of the daily percentage return on the spot price of oil.[7] We use these measures of oil price volatility because the data needed to construct similar measures for retail gasoline do not exist.

Figure 3 shows that the large increase in MSC forecast dispersion during the economic crisis is associated with a large increase in both measures of oil price volatility. Throughout the pre-crisis period, however, the association between fluctuations in the MSC forecast dispersion and the price volatility measures is weaker. Accordingly, the correlation coefficient between the MSC dispersion measure and the implied volatility of oil prices is large (0.708) and strongly statistically significant over the entire 2001-2009 period but only 0.256 prior to November 2008 (though still statistically significant at the 5% level).[8] These results suggest that, while greater dispersion in survey forecasts may proxy for greater uncertainty during extreme events, dispersion is otherwise a noisy measure of volatility or simply reflects disagreement in forecasts.

IV. Conclusions

This paper introduces a new dataset from the Michigan Survey of Consumers (MSC) that measures consumer beliefs about future gasoline prices. We find that, on average, the forecast accuracy of the MSC predictions is similar to that of a no-change forecast. However, there is evidence that the MSC forecasts out-perform the no-change forecast during the late-2008 economic crisis, when the MSC forecast more closely follows the futures market. This result suggests that survey or market-based forecasts may improve upon the no-change forecast

[7] While implied and realized crude oil price volatility are calculated using nominal, rather than real, futures options prices and spot prices, the short time-horizons used imply that the nominal vs. real distinction is not of material importance.

[8] Inference was conducted by regressing the MSC forecast dispersion on implied volatility using Newey-West standard errors with a number of lags equal to one-quarter of the regression sample. Standard errors are slightly under-estimated due to a small gap in the MSC data in 2004. Similar results are obtained when MSC dispersion is compared to realized oil price volatility. When we measure MSC forecast dispersion using the inter-quartile range rather than the standard deviation, we still find a strong relationship between dispersion and oil price volatility over the entire sample but find no significant relationship for data prior to November 2008.

following extreme events. We also find that the increase in price volatility during the economic crisis correlates with an increase in the dispersion of the individual MSC forecasts.

The MSC data on consumer forecasts are useful in answering many additional questions, some of which we are pursuing in related research. In Anderson, Kellogg, and Sallee (2011), we carefully evaluate the extent to which the mean and median MSC forecasts are consistent with a no-change forecast and conclude that these forecasts are statistically indistinguishable during the pre-crisis period. This finding suggests, for example, that researchers studying the demand for energy-using durables may be justified in assuming that consumers use a no-change forecast, as is common in practice. The large dispersion in individual forecasts, however, suggests that explicitly modeling the heterogeneity in beliefs may also be important. Thus, in other ongoing work, we are linking individual-level MSC price forecasts to information on automobile ownership and stated preferences regarding future ownership, which we expect may improve discrete-choice modeling of automobile demand.

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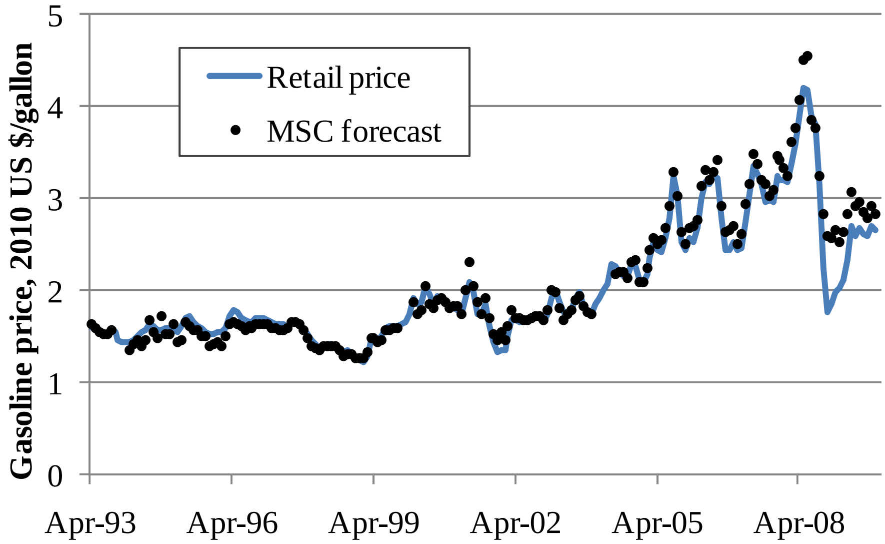
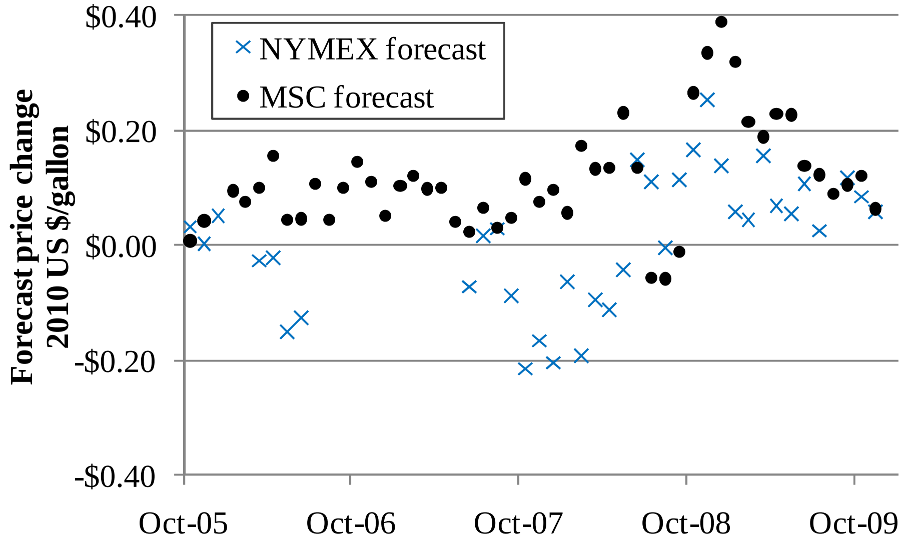
Figure 1: MSC 5-year forecast of the real price of gasoline



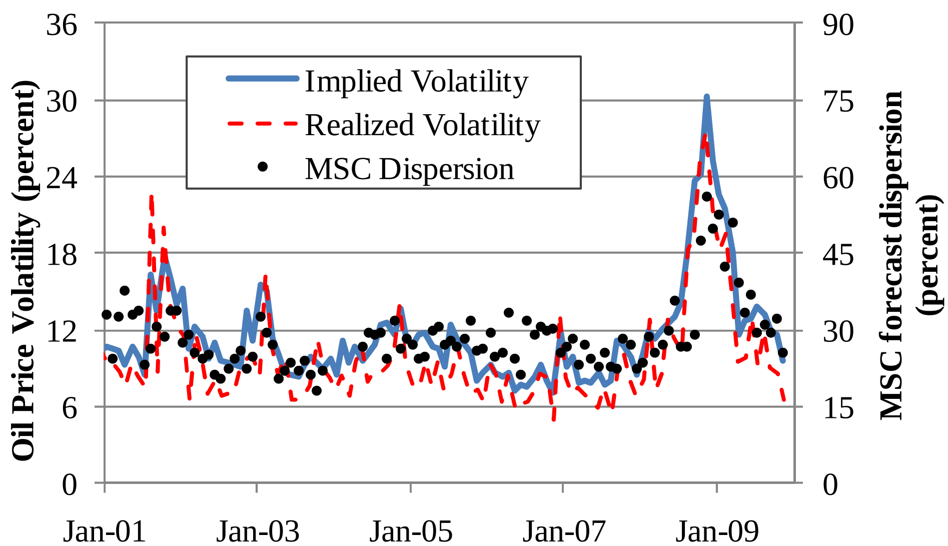
Notes: The plotted MSC observations are the mean, each period, of the respondents' inflation-adjusted expected gasoline price 5 years in the future. The retail price data are from the Energy Information Administration's weekly national retail price data. These data are sales-weighted over all locations, grades, and formulations.

Figure 2: MSC and NYMEX forecasted real price changes over 1 year



Notes: The MSC forecasted price change is the difference between the mean inflation-adjusted one-year retail price prediction and the contemporaneous retail price (EIA data). The NYMEX (New York Mercantile Exchange) forecasted price change is the difference, each month, between the one year ahead wholesale gasoline future price (adjusted using the inflation forecast from the Philadelphia Federal Reserve's Survey of Professional Forecasters) and the front-month price.

Figure 3: Comparison of MSC forecast dispersion to oil price volatility



Notes: The MSC forecast dispersion is the standard deviation of the real, deflated gasoline price forecast across respondents in each survey month, divided by that month's real EIA retail gasoline price. The implied and realized oil price volatility measures are from Alquist, Kilian, and Vigfusson (2010). Implied volatility is calculated from one-month at-the-money put and call oil futures options, and realized volatility is calculated from daily West Texas Intermediate (WTI) crude prices.