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GASOLINE PRICE FORECAST MODEL

Retail gasoline prices in the United States were running nearly $1/ gallon higher than year- earlier levels as of mid- April 2011. Higher energy prices have reignited the off-and-on debate over US energy policy, or lack thereof, and have raised concerns about potential damage to the economic recovery currently underway. In short, higher gasoline prices affect every American consumer and business to some degree.

In this paper, the KCRES team presents a statistical model designed to analyze and forecast changes in the retail price of regular gasoline for the United States and for the Tri-Cities and Knoxville areas. Our model ties changes in gasoline prices to changes in the refiner acquisition price of crude oil and to the seasonal variation in the demand for gasoline.

Methodology: Multiple regression analysis was employed to estimate the base forecast model. The general equation for the US model is:

$$P_g = a + bP_o + b_1Q1 + b_2Q2 + b_3Q3,$$

where P_g is the quarterly average retail price of regular gasoline (cents/gal.); P_o is the quarterly average refiner acquisition price of crude oil ($'s/barrel), and Q1, Q2 and Q3 are 0, 1 variables to capture seasonal variation in gasoline prices (The fourth quarter is the base quarter and is not required to be in the equation.)

The above model was used to derive quarterly forecast equations for US gasoline prices. Quarterly equations for the Tri-Cities and Knoxville markets were derived by adjusting the US equations for recent differences between the US price and the Tri-Cities and Knoxville prices.

Results and Analysis: We downloaded US quarterly average gasoline and oil price data for 2001 - 2010 from the US Department of Energy (DOE) website (www.eia.doe.gov/analysis). Using these 40 quarters of data, the following equation was estimated for the US:

$$P_g = 80 + 2.61P_o - 0.04Q1 + 9.6Q2 + 9.2Q3$$

Variable Q_1 was dropped from the equation since the estimated effect was insignificant and very nearly zero.

The estimated equation explains 97.2 percent (the R^2 value) of the quarter-to-quarter change in US gasoline prices over the 2001-2010 period. This result warrants additional comment as it indicates that the US retail market for gasoline in the short-run is overwhelmingly dominated by supply-side factors, namely the price of crude oil, which accounts for a high proportion of the variable costs of producing gasoline. In fact, we considered demand for gasoline fixed from quarter-to-quarter, except for the seasonal shifts. The remarkably high value for R^2 confirms that this is not an unrealistic assumption for short-run analysis of gasoline prices. However, this would not be a realistic assumption for a longer-run model of gasoline prices as demand shifters, such as population growth, average miles-per-gallon of the vehicle fleet and consumer income, would have to be taken into account.

As for seasonality, the equation reveals that the average retail price of regular gasoline tends to be 9.6 cents/gal. higher in the second quarter and 9.2 cents higher in the third quarter, compared to the first and fourth quarters. Thus, other things equal, prices at the pump tend to peak in Q2 and Q3, the spring and summer quarters.

Adjusted for seasonal variation, the KCRES equations for the US market are:

Q1: $P_g = 80 + 2.61\ P_o$

Q2: $P_g = 89.6 + 2.61 P_o$

Q3: $P_g = 89.2 + 2.61 P_o$

Q4: $P_G = 80 + 2.61 P_o$.

The "b" coefficient (or slope) of 2.61 indicates that the average retail gasoline price changes by 2.61 cents/gallon for each $1/barrel change in the average acquisition price of crude oil. If, for example, the average price of crude were to rise $10 from one quarter to the next, we would expect the average gasoline price to increase 26.1 cents per gallon.

The DOE estimates that 19 – 21 gallons of gasoline are produced from a 42-gallon barrel of oil. The midpoint of this range, 20 gallons, suggests that a $1/barrel change in the price of crude oil changes the marginal cost of producing gasoline by five cents per gallon. The "b" coefficient of 2.61 indicates that 52 percent of the change in marginal cost is passed through to retail consumers

(2.61cents/5 cents). This result conflicts with the popular perception that all, or nearly all, of added production costs are passed through to retail consumers.

Forecasts For 2011: To initiate our model, we use the DOE forecasts for the refiner acquisition price of crude oil, as of their April 12, 2011 update (**www.eia.doe.gov/analysis**). Forecast oil prices are shown in Table 1 for each quarter of 2011. The forecasts of US regular gasoline prices by quarter are also shown in the table. Note that the DOE and KCRES forecasts for the US market are (more than) reasonably close. We think this is a validation of our forecast model, given that the DOE forecasts are official forecasts of the federal government.

Table 1. Forecasts by Quarter, 2011

Forecast by:	DOE	DOE	KCRES	KCRES	KCRES
Market:	US	US	US	Tri-Cities	Knoxville
Product:	Crude oil	Gasoline	Gasoline	Gasoline	Gasoline
Q1 2011	95.51	330	329	317	312
Q2 2011	112.50	388	383	371	366
Q3 2011	112	385	381	369	364
Q4 2011	113.5	373	376	364	359
Units:	$/barrel	cents/gal.	cents/gal.	cents/gal.	cents/gal.

To derive the quarterly forecast equations for the Tri-Cities market, we adjusted the KCRES quarterly forecast equations for the US market by the average difference between the US price and the Tri-Cities price for the 50-day period ending March 31, 2011. We followed the same procedure to derive the forecast equations for the Knoxville market. Daily price data were obtained from **www.fuelgaugereport.aaa.com.** The Tri-Cities price averaged 12 cents/gal. below the US price, and the Knoxville price averaged 17 cents below the US price over the 50-day period (Figure 1).The KCRES forecast equations for the local markets are:

Q1 and Q4, Tri-Cities: $P_g = 68 + 2.61P_o$

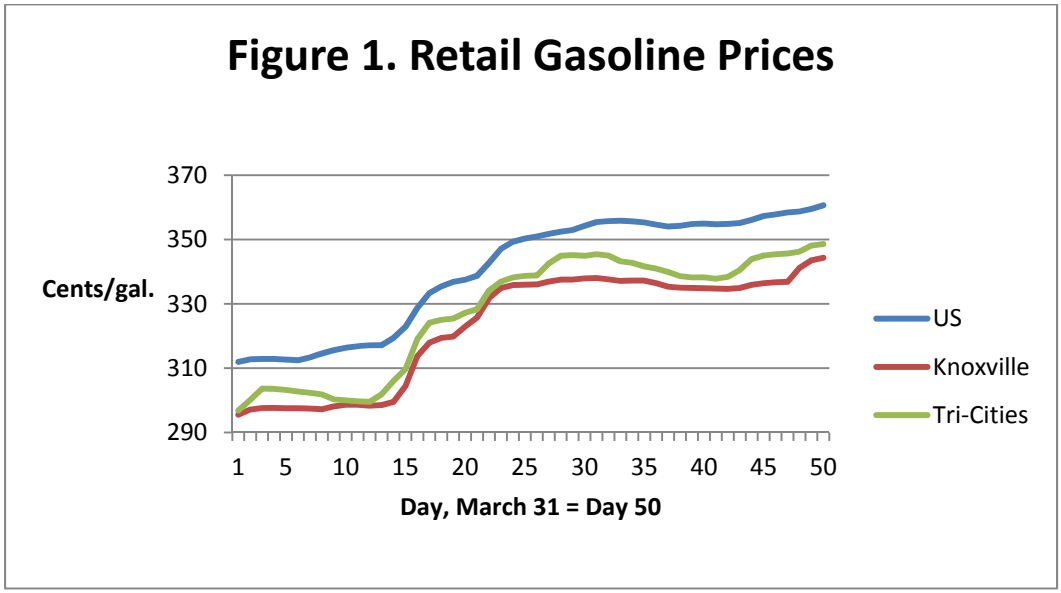
Q1 and Q4, Knoxville: $P_g = 63 + 2.61P_o$

Q2, Tri-Cities: $P_g = 77.6 + 2.61P_o$

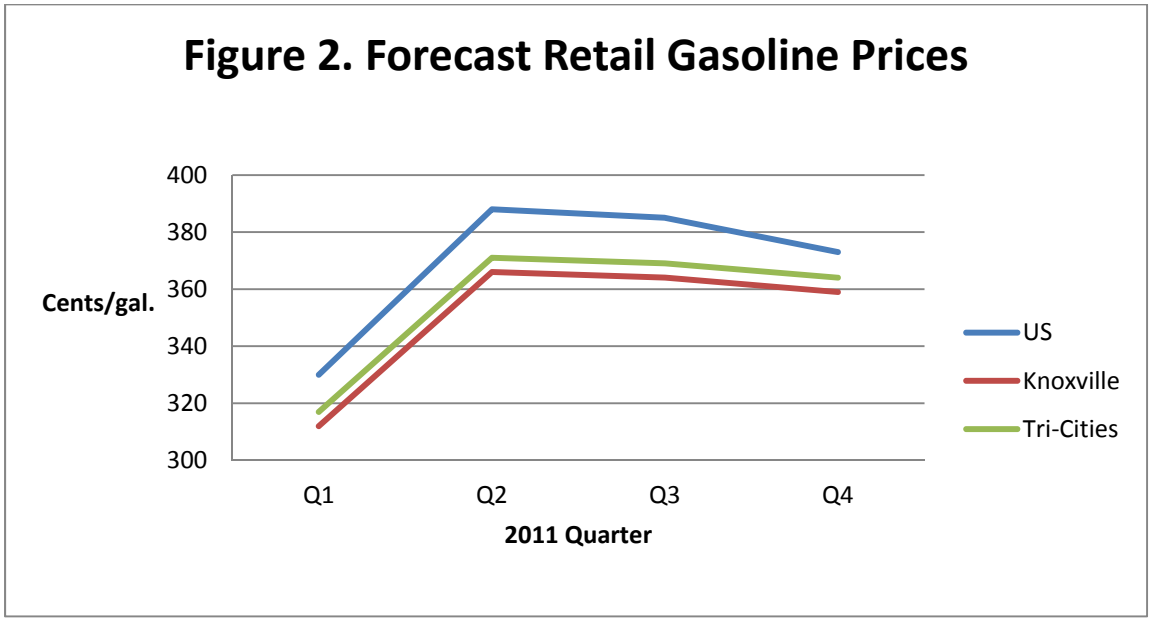
Q2, Knoxville: $P_g = 72.6 + 2.61P_o$

Q3, Tri-Cities: $P_g = 77.2 + 2.61P_o$

Q3, Knoxville: $P_g = 72.2 + 2.61P_o$



We expect the retail price of regular gasoline to peak in the second and third quarters, averaging $3.70 per gallon in the Tri-Cities and $3.65 in the Knoxville market. Prices in the fourth quarter are expected to fall to an average of $3.64 in the Tri-Cities and $3.59 in Knoxville. (Table 1 and Figure 2).



Forecast Uncertainties: The major uncertainty to our forecasts is the price of crude oil. Crude oil prices will be affected by social and political unrest in oil producing countries, the pace of worldwide economic growth and production/pricing policies enacted by

OPEC and other important oil producers. As our analysis indicates, a $1 change in the quarterly average crude oil price will change the average price of gasoline by 2.61 cents per gallon. If the DOE forecasts for oil prices for the balance of 2011 are on the mark, our forecasts for gasoline prices likely will be reasonably accurate.

The accuracy of our forecasts for the Tri-Cities and Knoxville areas will be affected by any changes in the basis, i.e., the difference between the national average price and the local market price. We calculated the basis over a 50 – day period ending March 31, 2011. Our assumption is that the basis we calculated for the Tri-Cities market (12 cents/gal.) and the Knoxville market (17 cents/gal.) will hold up reasonably well throughout 2011.

KCRES Paper No. 2 was prepared by Dr. Sam Evans with assistance from students enrolled in his MBA course*, Quantitative and Research Methods*, which met at the King College site in Knoxville during February – March 2011. The following students contributed to KCRES Paper No. 2:

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