Analysis of Whether the Prices of Renewable Fuel Standard RINs Have Affected Retail Gasoline Prices

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Key Findings

- Changes in the prices of renewable identification numbers (RINs) did not cause changes in retail gasoline prices from 2013 through the summer of 2017.
- Retail gasoline prices were driven primarily by movements in crude oil prices and secondarily by changes in the spread between domestic and international crude oil prices and the level of vehicle miles driven in the US, which varies seasonally.

Background and Introduction

The Renewable Fuel Standard, which requires gasoline sold in the US to contain at least certain minimum volumes of biofuel, was established in the Energy Policy Act of 2005. Two years later, the Energy Independence and Security Act of 2007 significantly expanded the previous volumetric requirements, and the revised Renewable Fuel Standard (known as RFS2) was allocated among specific categories of renewable fuels.

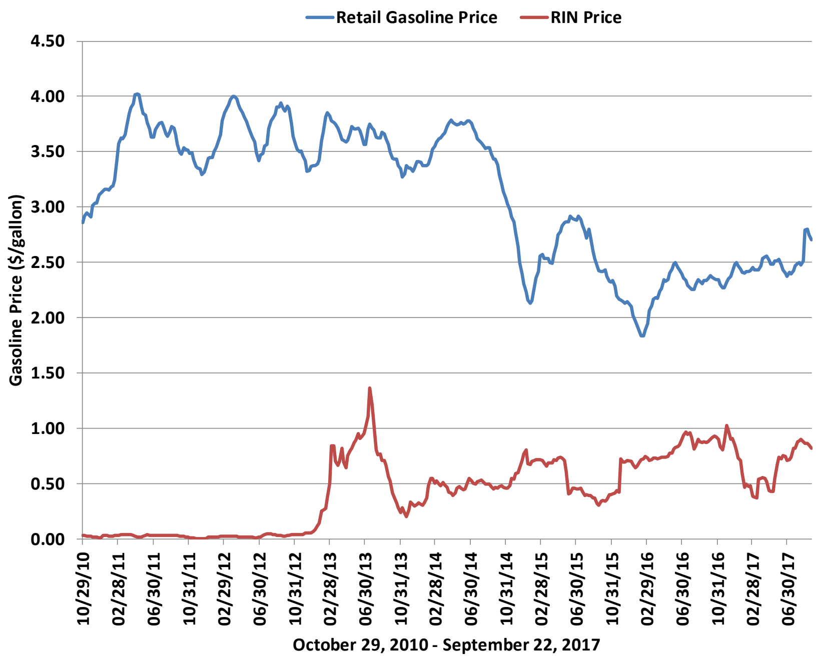
A system of renewable identification numbers was designed by the EPA for compliance with RFS2. A RIN is a 38-digit code representing a specific volume of renewable fuel. RINs are generated by a producer or importer of renewable fuel. Once the fuel is blended, the separated RINs can be used by obligated parties (mainly refiners) for compliance purposes, held in inventory for future compliance or traded to other companies.

In early 2013, market participants began to realize that ethanol usage could fall well short of levels needed to meet RFS2 in the future, and prices of conventional ethanol RINs (known as “D6” RINs) rose to levels that were multiples of prices that had been experienced previously, spiking to nearly $1.50 during July 2013. This was partly a result of the 2012 drought, which reduced the size of the corn crop and led to record-high corn prices. Some ethanol plants were idled in late 2012 and early 2013, as market prices for ethanol were not sufficient to allow producers to offset higher production costs.

During the late summer and early fall of 2013, RIN prices dropped precipitously. In November 2013, the EPA proposed substantial cuts to the volumes required in 2014 for all RFS2 standards except the one for biomass-based diesel. The general structure of the proposal had become known to industry and the press in advance of the official release. Conventional ethanol RIN prices also reached a bottom in November 2013.

Conventional ethanol RIN prices then rebounded and rose to an average of $0.70 during the first quarter of 2015. On the other hand, gasoline prices fell by one-third between the week of July 4, 2014, and the end of the first quarter of 2015 (Exhibit 1). This was driven by a substantial drop in oil prices. Since that time, both RIN and retail gasoline prices have been volatile, but they have stayed within broad ranges.

Exhibit 1: Weekly Retail Gasoline and Conventional Ethanol (D6) RIN Prices



Sources: DOE-EIA (Gasoline Prices), OPIS (RIN Prices)

In the past, some commentators speculated that RIN prices might have driven retail gasoline prices higher. While such speculation has ebbed since the RIN price spike of mid-2013, such allegations still are in the public discourse from time to time. During and shortly after the initial price spike, difficulties in conducting near-real-time analysis were compounded by limited historical data, as RINs for the different categories of biofuels under RFS2 had only traded since 2010.

Now that additional time has passed, the Renewable Fuels Association ("RFA") commissioned Informa's Agribusiness Consulting Group ("Informa") to conduct an analysis of whether the RIN prices changes have been driving gasoline prices for US consumers, or if not, to determine the main factors that actually have caused retail gasoline price changes.

Informa conducted its analysis in two phases. First, Informa used a statistical method to determine whether changes in RIN prices "caused" (i.e., were a significant driver of) changes in retail gasoline prices. Second, a streamlined statistical regression "explaining" gasoline price movements was developed. If it were concluded in the first phase that changes in RIN prices have "caused" changes in gasoline prices, they would be considered as an explanatory variable in the regression developed during the second phase.

Causality Analysis

In order to test whether or not changes in RIN prices "caused" changes in retail gasoline prices, a statistical method called a Granger causality analysis was utilized. Weekly average D6 RIN prices reported by OPIS for the period spanning from October 29, 2010, to September 22, 2017, were paired with weekly average retail gasoline prices reported by the Energy Information Administration ("EIA") for the same time period. Prior to use in the Granger models, the data were differenced, and thus the resulting models were built using the weekly change in RIN prices compared to the weekly change in gasoline prices.

Of primary interest was the question: Did changes in RIN prices cause gasoline prices to change? In the past, the discussion centered around whether higher RIN prices caused higher retail gasoline prices. However, as can be seen in Exhibit 1, retail gasoline prices fell dramatically after the summer of 2014, whereas RIN prices were relatively steady through the summer and fall of 2014 before trending moderately higher (with considerable volatility) through 2017.

To test the question of causation, a two-stage process was utilized. First, an initial model was developed that specified the current change in gasoline price as a function of the previous week's change in the price of gasoline. Next, a secondary model was constructed identical to the first, except that the previous week's change in the RIN value was added as an explanatory variable.

The idea behind the Granger causality analysis is simple: If the second model (containing the lagged RIN variable) is superior to the initial model, then this means that the previous week's RIN price has some explanatory power relative to the current week's gasoline price. If this is found to be the case, then it can be asserted that gasoline price changes are "caused" to some extent by changes in the RIN price. The term "caused" is used loosely here, since it does not imply that the RIN price was the only factor affecting gasoline prices. In the context of this analysis, the term "caused" would simply refer to the presence of some connection between the change in the RIN price and subsequent changes in gasoline prices.

To determine if one model is superior to another, it is appropriate to look at the size of the error terms associated with each model (i.e., the difference between the actual prices observed and the prices that would have been predicted by the model). If the errors from one model are significantly smaller than those of the other, this implies that the model has superior predictive power, and thus, is a better representation of reality.

Granger causality analysis compares the sum of squared errors associated with the model containing the RIN variable with same statistic for the model that does not contain the RIN variable. Exhibit 2 provides the results of the Granger causality analysis. The P-values reported in the table measure the probability that the errors from the unrestricted model (the one containing RIN values) are the same as the errors from the restricted model (no RIN value). There is an 98.5% probability these model errors are not significantly different, leading to the conclusion that changes in RIN prices do not appear to cause changes in gasoline prices.

Exhibit 2: Results of the Granger Causality Test

	---- P Values -----
RIN Price Causes Gas Price	**0.985**
Gas Price Causes RIN Price	**0.481**
	---- Significant at 5% Level? -----
RIN Price Causes Gas Price	**N**
Gas Price Causes RIN Price	**N**

P-values are the probability that the sum of squared errors in the unrestricted model is not different from the sum of squared errors in the restricted model.

It is worth noting that as an auxiliary part of this analysis, a second set of models was prepared that reversed the flow of causality, in order to examine whether or not changes in the gasoline price caused changes in RIN values. In the reverse case, there is a 48% probability that there is no difference between the models, and though this is much lower than for the RIN-to-gasoline case – implying that there is a higher probability from a statistical perspective that changes in gasoline prices "caused" changes in RIN prices – this is not considered strong enough to make this conclusion.

In summary, the evidence from the Granger causality work leads to the conclusion that changes in RIN prices have not caused changes in retail gasoline prices (or vice-versa). To any extent that the two are related, it is not a direct causal relationship.

Gasoline Price Drivers

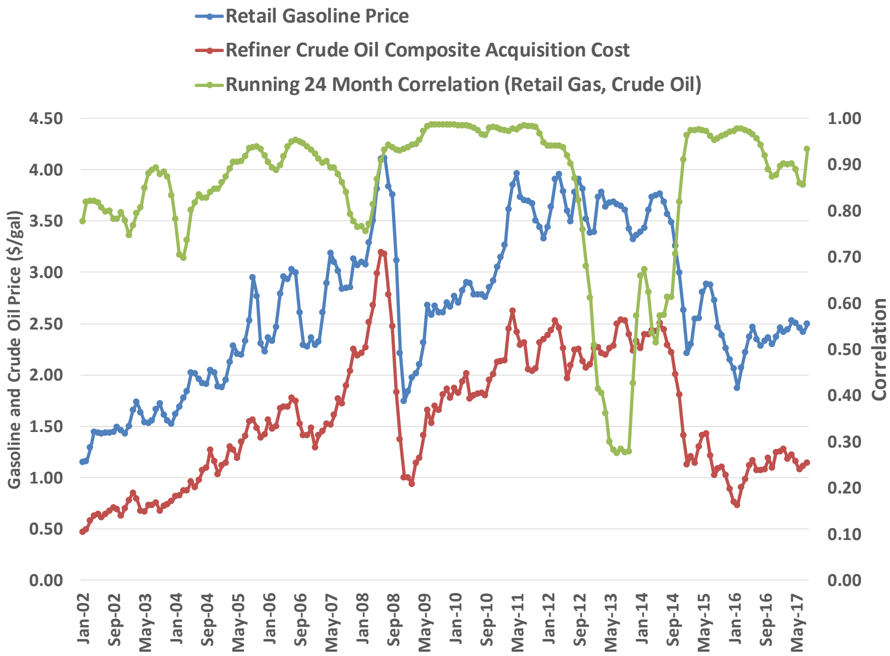
Given the results of the analysis above, a second question naturally arises: What does drive retail gasoline prices? Accordingly, the second phase of the analysis examines the key factors that do "explain" retail gasoline price movements. It should be remembered that RINs were created only in the aftermath of the establishment of the Renewable Fuel Standard in 2005, and the differentiation of RINs by biofuel category did not take effect until 2010, whereas gasoline prices have been volatile for decades.

The primary driver of retail gasoline prices is crude oil prices, as crude oil is the primary input to gasoline production. Historically, the running 24-month correlation between crude oil[1] and retail gasoline prices has generally been between 0.80 and 0.99, which indicates a very strong relationship, given that a coefficient of 1.00 would indicate perfect positive correlation (Exhibit 3).

[1] For each month illustrated, the correlation between crude oil and retail gasoline prices during the previous 24 months was examined. Refinery composite crude oil acquisition cost data was utilized to represent crude oil costs for US refineries, as this reflects a weighted US average of imported and domestic crude oil used to produce gasoline.

Exhibit 3: Monthly Retail Gasoline and Crude Oil Price Relationship

(January 2002 – August 2017)



Sources: EIA (Prices); Informa (Analysis)

This relationship began to show signs of weakening starting in the spring of 2012. One of the key factors behind the weakening has been the divergence between international and domestic crude oil prices and the heightened volatility of the spread between these prices[2]. This divergence was mainly attributable to growing crude oil stocks at inland locations – especially the delivery point for NYMEX crude oil futures at Cushing, Oklahoma – as a result of a combination of increased domestic oil production from shale plays such as North Dakota's Bakken formation and lagging infrastructure construction to move the oil to consumption centers. The oil-price spread has narrowed significantly, particularly since 2014, as infrastructure came online to facilitate movements of crude oil to the Gulf Coast.

Another relatively recent development is that the US has emerged as a significant exporter of gasoline. Brent crude oil serves as an international benchmark and influences the pricing of gasoline in international markets. Consequently, the previously wide and still volatile spread between Brent crude oil prices and US oil prices has also added a layer of complexity to US gasoline-pricing dynamics.

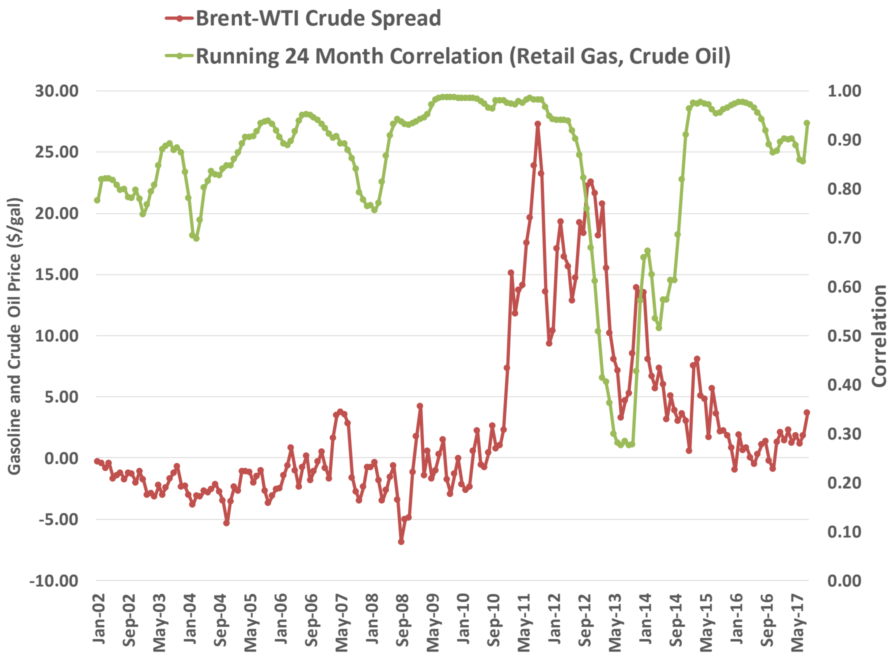
As illustrated in Exhibit 4, the weakening relationship between crude oil and retail gasoline prices followed the growing spread between US West Texas Intermediate (WTI) and

[2] Brent crude oil prices were utilized to represent prices in the international market, and WTI prices were utilized to represent prices in the domestic market.

Brent crude oil prices between 2011 and 2014[3]. It is notable that this weakening price relationship preceded the increase in RIN prices that occurred starting in early 2013. Additionally, since 2015 the correlation between crude oil and retail gasoline prices has returned to previous high levels.

Exhibit 4: Monthly Brent-to-WTI Crude Oil Price Spread vs. Retail Gasoline and Crude Oil Price Correlation

(January 2002 – August 2017)



Sources: EIA (Prices); Informa (Analysis)

Another factor affecting retail gasoline prices is seasonal demand. There is a distinct seasonal pattern to gasoline prices and crack spreads (i.e., the margins refiners earn by processing crude oil into transportation fuels, in this case gasoline). Gasoline prices and crack spreads tend to slump during the last quarter of the calendar year, particularly November and December, and then strengthen considerably through the first quarter of the year and remain strong through the summertime driving season (see Exhibit 5). A key factor behind this trend is the increase in vehicle miles driven during the summer months, which is anticipated by the markets and prepared for by refiners.

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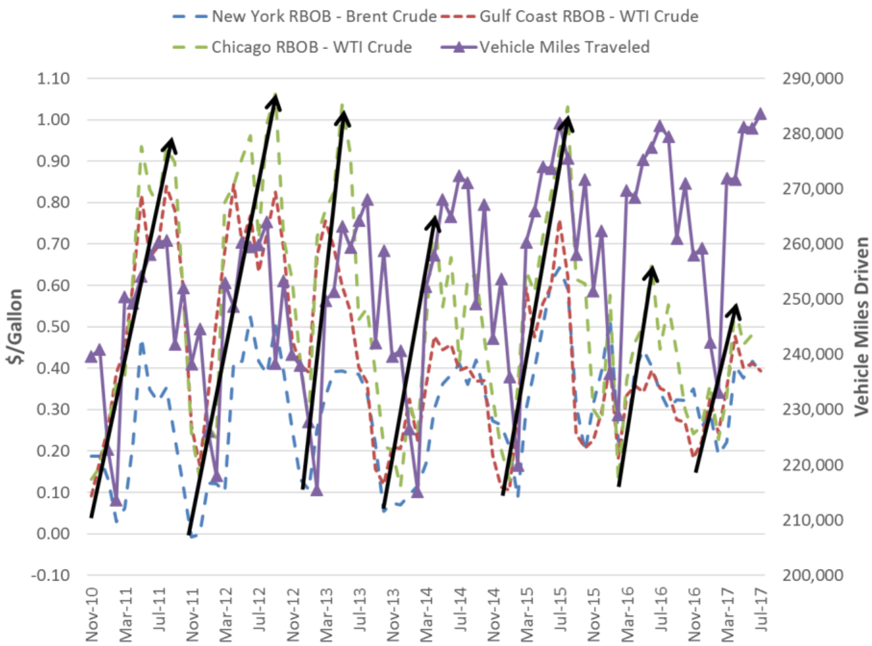
[3] It is notable that the chart uses a 24-month correlation, and thus there is a lag between when the Brent-WTI price spread begins to expand and when the correlation between crude oil and retail gasoline prices appears to weaken in the chart.

Exhibit 5: Seasonal Crack Spreads and Vehicle Miles Driven

(November 2010 – July 2017)



Sources: EIA (crude oil prices), OPIS (RBOB prices), US Department of Transportation (vehicle miles traveled), and Informa (analysis)

The relative role of each of the above factors in explaining movements in retail gasoline prices was estimated econometrically[4], and results are presented in Exhibit 6. A majority of the movement in gasoline prices can be explained by changes in crude oil prices. A $0.10/gallon increase in crude oil prices ($4.20/barrel) has resulted in a roughly $0.09/gallon increase in retail gasoline prices, all else being held equal. In the model, variables for the Brent-WTI crude oil price spread and vehicle miles driven were also statistically significant, and they improved model performance somewhat. Together these variables explain 96% of the historical retail gasoline price movements (as indicated by the adjusted R-squared statistic).

Exhibit 6: Retail Gas Price Model

Dependent Variable = U.S. Retail Gasoline Price

Explanatory Variable	Coefficient	Statistically Significant at 5% Level
Intercept	-0.157	
Refiner Crude Oil Composite Acquisition Cost	0.922	Yes
Brent - WTI Crude Oil Price Spread	0.018	Yes
Vehicle Miles Driven	5.628 * 10^-6	Yes

Adjusted R-Squared = .956

Source: Informa

[4] Monthly data from April 2008 – July 2017 was utilized within this regression.

Conclusions

Based on statistical analysis, it can be concluded that changes in RIN prices did not "cause" the changes that occurred in retail gasoline prices in 2013, and this has continued to be the case through the summer of 2017.