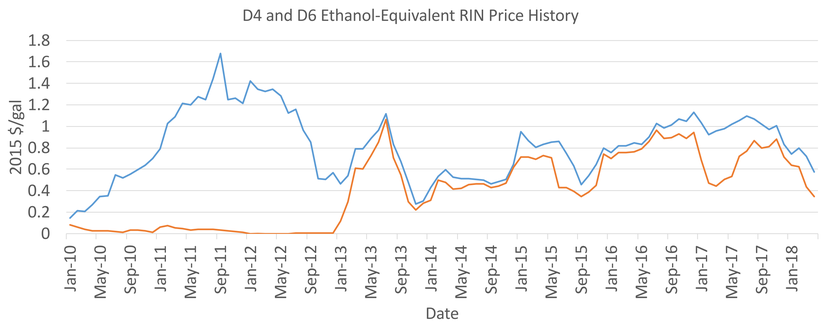
Project 001
A method for more-realistic simulation of RIN prices in biofuels TEAs

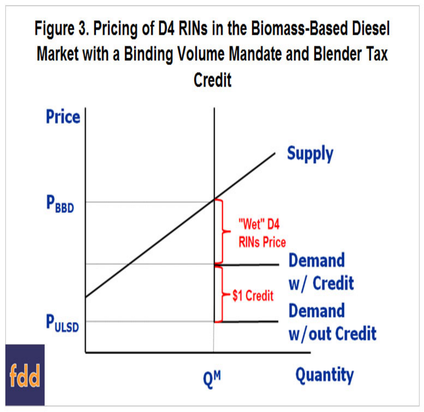
Motivation and Objective

- The level of support from policies such as the Renewable Fuels Standard (RFS), which created the market for Renewable Identification Numbers (RINs), is often a key parameter in techno-economic analyses of biofuels production pathways (Chu, Vanderghem, MacLean, & Saville, 2017) (McGarvey & Tyner, 2018).
- However, the value of these credits is often simulated quite simplistically in the literature, either by taking the most recent value as a deterministic estimate of future values (McGarvey & Tyner, 2018) or by assigning values from a random probability distribution (Bann et al., 2017).
- This is not a satisfactory way to model such an influential and variable parameter. (See graph of RINs prices below.)
- ***Objective:*** to demonstrate a method for stochastically modelling RINs prices that reflects the fundamental drivers of the RINs market, which are frequently already parameters of interest in biofuel TEAs.



Methods and Materials

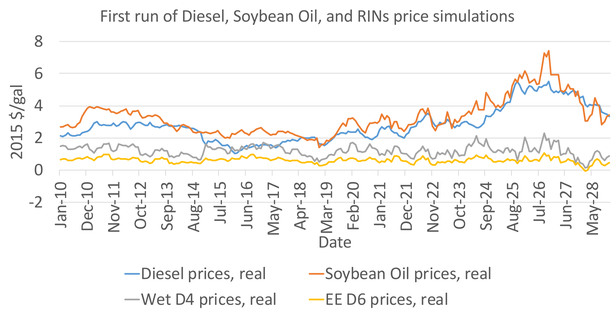
- This approach to simulating RINs price behavior will build on a theoretical model of RINs pricing that is well-attested in the literature, namely, that D4 RINs and the Blender's Tax Credit (BTC) must sum to the amount above the wholesale price of fossil diesel that RFS obligated parties must pay to biodiesel producers in order for those producers to cover their costs, which in the US are mostly driven by the price of soybean oil (Irwin, 2013, 2014; Irwin & Good, 2017). This model is represented graphically below.
- Using Iowa State University's biodiesel profitability model and soybean oil price data from the USDA, the breakeven price of soybean-derived biodiesel in a period was estimated by OLS, and the difference with wholesale diesel prices from the EIA was taken, defining the "blend gap" that the BTC and "wet" D4 RINs (D4 RINs value per physical gallon of biodiesel, not per ethanol-equivalent gallon) must fill.
- Two OLS regressions of "wet" D4 RINs on this "blend gap" and quarterly or semester dummies were conducted, one for years in which the BTC is in place ex-ante and one for years in which it is not.
- These estimated "wet" D4 RINs were then divided by 1.5 to convert them to ethanol-equivalent values. EE D6 RINs were regressed on these estimates of EE D4 RINs for the period beginning in 2013, when the "blend wall" made biodiesel the marginal gallon for compliance with RFS ethanol mandates. Two regressions were performed, one for years with the BTC in place ex-ante, and one for other years.
- Soybean oil and diesel fuel prices were simulated into the future in Excel using the time series functionality of the @Risk decision support software from Palisade™ Corporation. The BTC was simulated into the future with a binomial annual variable that takes value 1 with probability 0.4, based on the proportion of years since the enactment of the RFS in which the BTC has been in place ex-ante.

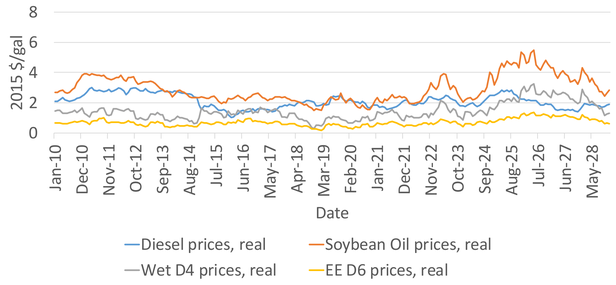


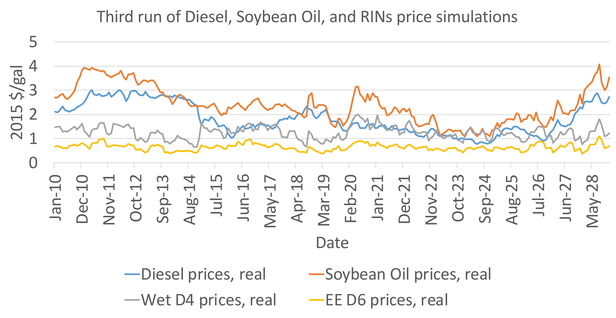
(Irwin & Good, 2017)

Summary

- This project represents an attempt to more-realistically simulate the behavior of US Renewable Fuels Standard (RFS) Renewable Identification Numbers (RINs) prices, a key parameter in biofuels technoeconomic analyses (TEAs).
- This was achieved using simple OLS regression, building up from a conceptual model for RINs prices that points toward the prices of soybean oil and diesel fuel as key determinants of the D4 – D6 set of RINs.
- The result is a well-behaved simulation of the behavior of RINs prices which can be easily integrated into new future biofuels TEAs.







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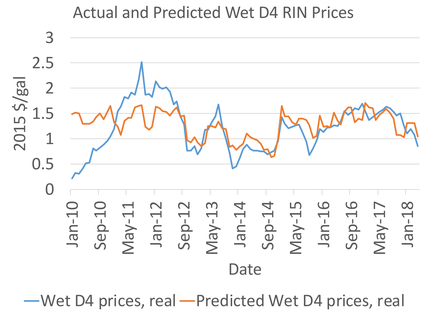
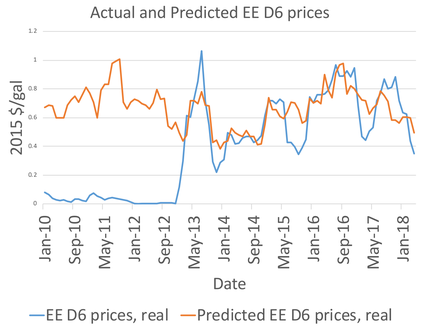
Results and Discussion

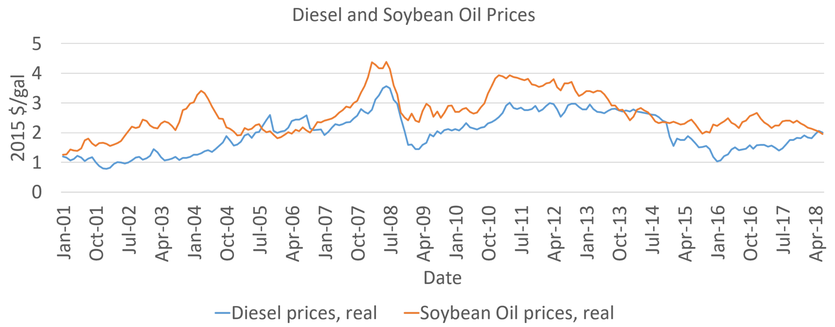
- Monthly biodiesel breakeven prices from January 2009 to December 2017 could be very easily predicted from the price of soybean oil. The adjusted R^2 was found to be 0.9958.
- Regressing monthly "wet" D4 RIN prices from January 2012 to May 2018 on the blend gap resulting from the above regression was similarly successful, both for years in which the BTC was in place ex-ante and for years in which it was not. The adjusted R^2 values were found to be 0.6376 and 0.6521, respectively.
- Regressing D6 RINs on EE D4 RIN estimates from January 2013 to May 2018 was quite a different prospect in years with an ex-ante BTC than in years without it. The resulting adjusted R^2 values were 0.7122 and 0.2806, respectively. This may be due to the effects the tax credit has on blender behavior through encouraging them to blend as much as possible while the credit exists.
- All coefficients were significant at the 90% confidence level, and the performance of these simple predictive models certainly seems of practical importance, as the graphs below demonstrate.





Conclusions and Next Steps

- The first and primary application of this research is that it provides researchers conducting TEAs of biofuels projects with a more-satisfactory means of modelling RINs prices in relation to the prices of diesel fuel and soybean oil, two price series that have rich data availability and are often already variables of interest for other reasons. Prices of diesel fuel and closely-related products, such as jet fuel, tend to move together. The price of soybean oil is strongly correlated with the prices of other vegetable oils.
- Second, to the degree that the prices of soybean oil and diesel fuel could be accurately forecasted, this research would provide a starting point for efforts to realistically forecast future RIN prices. The nature of the relationship between the prices of energy and agricultural commodities is the object of considerable attention in the literature (Harri, Nalley, & Hudson, 2009)(Ciaian & Kancs, 2011)(Natanelov, Alam, McKenzie, & Van Huylenbroeck, 2011), and would be important to any such forecasting efforts. Though the visual evidence for a strong relationship appears compelling (see below) econometric studies have been inconclusive. It could be that macroeconomic effects or other variables influence both prices. This will be investigated further.
- Third, that this approach performs reasonably well for the prediction of past RINs values provides some degree of validation for the theoretical model of RINs pricing on which it was built.



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