Policy Uncertainty under Market-Based Regulations:
Evidence from the Renewable Fuel Standard*

Gabriel E. Lade, C.-Y. Cynthia Lin, & Aaron Smith

Department of Agricultural and Resource Economics
University of California, Davis

August 2014

TRADEABLE CREDITS & MARKET-BASED POLICIES

Tradeable credits designed as a cost effective tool for quantity mechanisms.

- ▶ Uses include cap and trade (e.g. SO_2), resource management (e.g. fishery catch shares), and quotas (e.g. NYC taxicabs, liquor licenses, import/export restrictions).

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More recently, credits have been used in mandates which require large investments in environmental services and the emergence new industries.

- ▶ US Renewable Fuel Standard (RFS); Regional Low Carbon (or Clean) Fuel Standards; State & regional Renewable Portfolio Standards.

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We show policy uncertainty has played a key role in driving credit prices. Our results call into question the efficacy of the policy in sending a stable price signal to the advanced biofuel industry.

Established by the Energy Independence and Security Act (2007).

▶ Mandates increasing volumes of biofuel through 2022.

▶ Each gallon of renewable fuel is associated with a RIN distinguished by vintage year and biofuel type.

▶ Each year, EPA releases a Proposed and Final Rule, laying out subsequent year's mandate.
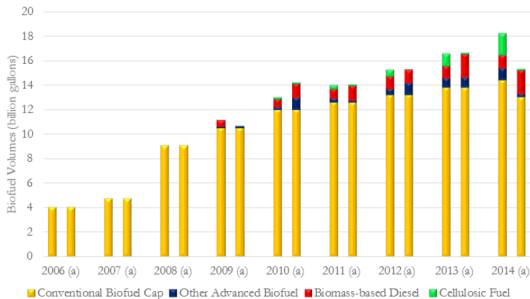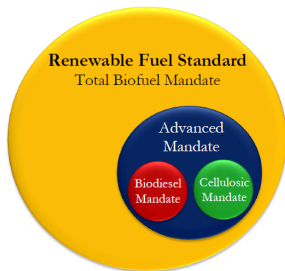
Dynamic Model of a Regulated Fuel Industry

Competitive industry composed of N firms:

▶ Firms produce fuel using conventional and renewable inputs.

Dynamic RIN Model: Overview

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Policy implemented over time. In simplest case:

▶ One compliance period (T) and production takes place in $t \in [1, T]$.

▶ Firms uncertain about future fuel costs and future policy levels.

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Extensions include:

▶ Consider sub-mandate structure.

▶ Consider two compliance periods with banking restrictions.

Market Clearing RIN Prices (simplest case):
Under perfectly competition and if firms have rational
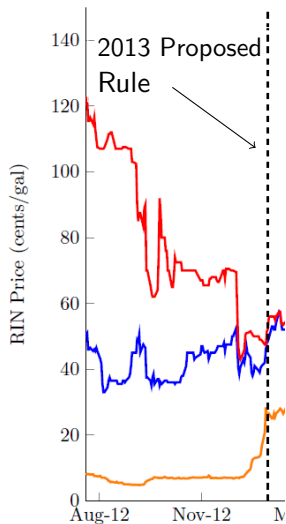expectations, equilibrium market clearing credit prices are:

$$r_t = \begin{cases} \beta^{(T-t)}\mathbb{E}_t[\lambda_T; \Theta] & \text{if } t \in [1, T-1] \\ \lambda_T & \text{if } t = T \end{cases}$$
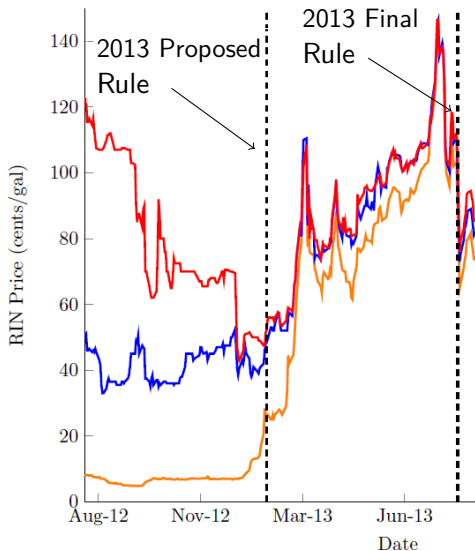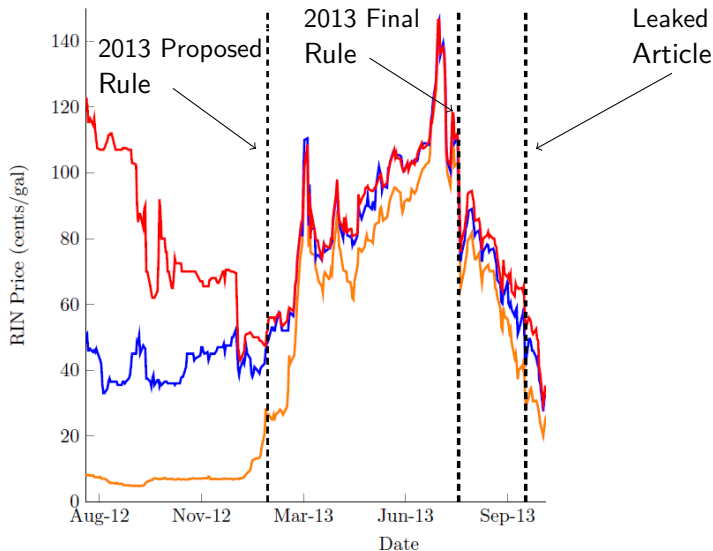
where

$$\lambda_T = f\left[MC^r(q^r) - MC^c(q^c)\right].$$

Empirics

Estimating Historical RIN Price Drivers

Main specification:

$$\Delta r_t = \underbrace{\alpha + \Delta x_t \beta}_{\substack{\text{Normal} \\ \text{Returns}}} + \underbrace{\sum_{m=1}^{M} \sum_{s=s_{m,0}}^{S} \gamma_{m,s} \tau_{m,s}}_{\substack{\text{Abnormal} \\ \text{Returns}}} + \epsilon_t,$$

where

$$\tau_{m,s} = \begin{cases} 1 & \text{if event} = m \text{ and } t = s \\ 0 & \text{otherwise} \end{cases}$$

# Regression Results: Main Specification

Table: Cumulative Abnormal Returns

		Conventional RINs	Advanced RINs	Biodiesel RINs
2013 Final Rule	Event Day	-0.136**	-0.132**	-0.062**
		(0.006)	(0.006)	(0.005)
	5 Day	-0.360**	-0.284**	-0.247**
		(0.028)	(0.024)	(0.025)
Leaked Reuters Article	Event Day	-0.145**	-0.020*	-0.048**
		(0.007)	(0.008)	(0.007)
	5 Day	-0.148**	0.046*	-0.110**
		(0.027)	(0.021)	(0.021)
2014 Proposed Rule	Event Day	-0.042**	-0.035**	-0.048**
		(0.005)	(0.005)	(0.005)
	5 Day	-0.086**	-0.063**	-0.179**
		(0.024)	(0.020)	(0.019)

Figure: Log Abnormal Return Kernel Densities
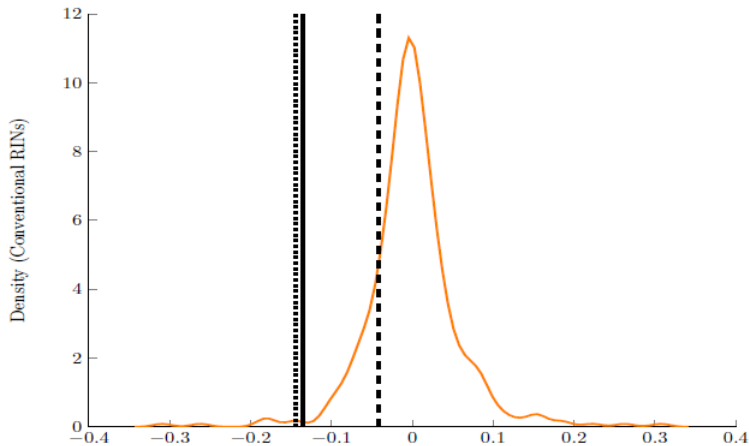
Change in Value of Tax/Subsidy

TABLE: Change in Value of Tax/Subsidy in 2013 (bill. $)

2013 Final Rule	Event Day	-$2.19
	5 Day	-$5.92
Leaked Reuters Article	Event Day	-$0.73
	5 Day	-$0.78
2014 Proposed Rule	Event Day	-$0.17
	5 Day	-$0.39

Conduct similar event studies for commodity futures markets:

- ▶ Find no large movements in commodity markets following announcements (ethanol, soybean oil, corn, sugar).

EXTENSIONS

Conduct similar event studies for biofuel firm stock prices:

► Find little movement in large biofuel firms' stock prices (i.e., ADM, ANDE).

► For large advanced biofuel producers (i.e, Pacific Ethanol) and biodiesel producers, see significant losses (10%) following 2013 Final Rule;

► Largest loser was Kior, only publicly traded cellulosic producer (lost ≈ 50% within 5 days of 2013 Final Rule release).

- ▶ EPA announcements have been primary driver of historic RIN prices.
    - ▶ No large corresponding movement in commodity futures prices following announcements.
    - ▶ Changes in biofuel firm stock prices suggest advanced biofuel firms hurt the most by announced cuts.

Conclusions

▶ EPA announcements have been primary driver of historic RIN prices.
  ▶ No large corresponding movement in commodity futures prices following announcements.
  ▶ Changes in biofuel firm stock prices suggest advanced biofuel firms hurt the most by announced cuts.

▶ Results imply high marginal cost of moving beyond 10% ethanol-gasoline blend, but below 10% the mandate is not very costly.

- ▶ EPA has demonstrated it has time inconsistent preferences.
    - ▶ When compliance costs become high, EPA shown it will retreat on program goals.
    - ▶ Creates option value to delaying investments in advanced fuel technologies, further undermining the program.

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- ▶ Efficiency may increase by putting price collars on credit prices or altering program to be equivalent (revenue-neutral) tax-subsidy scheme.

Thank you!