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Drivers of Commodity Volatility in the Biofuel Era

Felipe G. Avileis*and Andrew Swanson †

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Abstract

How biofuel policy communications affect the soybean complex in the U.S.? Using an event study approach and causal inference methods, we analyze 36 policy events between 2021 and 2025, including Environmental Protection Agency (EPA) announcements, California Air Resources Board (CARB) reports, and news "leaks" from media sources with early information access. We find that soybean oil futures returns increase significantly on announcement days (0.59%) and continue rising the following day (0.62%), exhibiting what we term Post-Announcement-Leak Drift (PALD). The informational value of these biofuel policy signals rivals that of major USDA WASDE reports. Our causal analysis reveals that a 1% biofuel-induced price increase in soybean oil leads to a 0.19% rise in soybean prices and a 0.30% drop in soybean meal prices. These findings contribute to the food-versus-fuel debate by demonstrating that while biofuel mandates increase soybean oil prices, they simultaneously decrease soybean meal prices, partially offsetting inflationary concerns. Soybean farmers benefit most from expanded biofuel mandates, followed by livestock producers who face lower feed costs, while crushers see more modest benefits as approximately 50% of the gains from higher oil prices are offset by lower meal prices. Our results highlight the growing importance of biofuel policy signals in agricultural commodity markets and reveal the complex price dynamics within the soybean complex in response to biofuel demand shocks.

Keywords: biofuel policies, commodity volatility, renewable fuel standard, price risk, energy markets

JEL Codes: G13, Q11, Q42

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1 Introduction

U.S. biofuel policy has fundamentally transformed agricultural commodity markets, particularly in the soybean complex. Since the Renewable Fuel Standard (RFS) began mandating biomass-based diesel (BBD) blending in 2009, soybean oil use for fuel has sextupled (USDA (2025)), creating unprecedented shifts in demand patterns. Currently, 45% of U.S. soybean oil is allocated to biofuel production, placing fuel use on par with food industry consumption for the first time in history. This dramatic reallocation has driven domestic soybean crushing up by approximately 30% and significantly increased soybean meal production as a co-product USDA (2025).

As policymakers consider further expansions of biofuel mandates through increased BBDs levels, understanding the economic ripple effects becomes critical. This study addresses two essential questions regarding biofuel policies and the soybean complex. First, how do biofuel policy announcements and news "leaks" affect soybean oil markets on the day of their release? Second, what are the consequences of changes in biofuel mandates for soybeans, soybean meal, and the gross margins of soybean crushing? By examining these questions, we analyze how demand shocks originating from biofuel policy reverberate through the entire soybean complex.

There is a substantial literature examining the effects of government announcements on commodity prices. Much of this work focuses on the USDA's World Agricultural Supply and Demand Estimates (WASDE), which are shown to be major drivers of agricultural commodity returns and volatility (Isengildina-Massa et al. (2008), Karali, Dorfman, and Thurman (2010), Adjemian (2012), Bunek and Janzen (2024)). Parallel research has assessed how Energy Information Administration (EIA) reports influence energy markets (Bjursell, Gentle, and Wang (2015), Prokopczuk, Simen, and Wichmann (2021)), and whether USDA reports continue to provide valuable market-relevant information (Karali et al. (2019)).

While existing studies have focused on well-established and confidential information releases such as WASDE and EIA reports, we turn our attention to a different yet increasingly important set of policy signals: biofuel policy announcements and reports. Specifically, we examine the federal Renewable Fuel Standard (RFS), regulated by the Environmental Protection Agency (EPA), and California's Low Carbon Fuel Standard (LCFS), regulated by the California Air Resources Board (CARB). These agencies independently issue both scheduled and unscheduled policy announcements, which, unlike WASDE reports, are not always confidential. EPA announcements, in particular, are frequently leaked to the media prior to their official release. Two reporters from Reuters, Jarret Renshaw and Stephanie Kelly, are known to disseminate such early information and are considered policy "insiders." Our study uniquely combines the effects of official policy releases with these informal information leaks to examine how biofuel news, both formal and informal, shapes returns in agricultural commodity markets.

These reports and 'leaks' primarily provide information about structural changes in biofuel demand, which represents a significant market shift affecting the demand for feedstocks like soybean oil. Combining CME futures price data between 2021 and 2025 on soybeans, soybean oil, soybean meal, corn and WTI with our event days, we follow an event study framework, following Isengildina-Massa et al. (2008) and Adjemian (2012) to measure changes in absolute returns on a 10 day window surrounding EPA and CARB announcements and news "leaks". Given the recent increase in relevance of biofuels in the soybean complex, fully understanding the impact and informational content of such reports is useful to policymakers and traders.

We divide the events in three groups: EPA announcements, CARB reports and news "leaks". EPA announcements are when the EPA proposed or finalized new biofuel mandated volumes. These are unscheduled. CARB reports are quarterly reports published every last day of the quarter. CARB reports the amount of biofuel consumed in CA and the feedstock used for their production. Lastly, as "leaks", we select articles from Jarret Renshaw and Stephanie Kelly related to biodiesel mandates with the word "sources" on the headline. In total, we have a set of 36 events in our sample.

Our event study finds that soybean oil returns increase significantly on announcement days (0.59%) and continue rising the next day (0.62%), a pattern we term Post-Announcement-Leak Drift (PALD), akin to the well-known PEAD in equity markets (Fama (1998)). This is mostly driven by the uncertainty and risk associated with news "leaks". Our results are comparable to Adjemian (2012) WASDE announcement effects on soybeans. Soybeans absolute returns increase by 0.7% on the most important WASDE release days. In other words, the informational value of these reports is as big as the most relevant WASDE reports.

Since the start of the renewable diesel (RD) "boom", that saw US RD production increase by 500% since 2021, policymakers have been concerned about the impacts of higher soybean oil use for fuel on food prices and inflation. There is a long standing debate on whether biofuel policies are inflationary, with mixed evidence (Zilberman et al. (2013), Chen and Khanna (2013)). While most initial studies focused on the corn-ethanol complex, some recent work has looked at the soybean complex.

Lusk (2022) uses a Seemingly Unrelated Regressions (SUR) approach to point that a portion of the effects of an increase in soybean oil prices due to biofuel usage increase is offset by soybean meal price reduction. Yang and Karali (2022) use a Generalized Autoregressive Conditional Heteroskedasticity (GARCH) to find volatility spillovers between US soybeans and Chinese oil and meal. However, these measures are not causal.

Causality is complicated in this framework due to the simultaneity issue. Soybeans, soybean oil and meal are cointegrated. Crucially, because EPA and CARB reports, especially leaks, create sudden, exogenous shocks to soybean oil prices, we can leverage this quasi-experimental variation to estimate causal effects on soybeans, soybean meal and the soybean crush prices. For robustness, we also estimate the effects using Rigobon-Sack IV (Rigobon and Sack (2004), Scrimgeour (2015)) approach.

We leverage these exogenous shocks to causally estimate the pass-through of biofuel-induced changes in soybean oil prices to the rest of the agricultural complex. A 1% biofuel-induced price increase in soybean oil leads to a 0.19% rise in soybean returns, a 0.30% drop in soybean meal returns. This translates to a \$0.029/bu increase in soybeans prices and a decrease of \$0.026/bu in meal prices. Consequently, crush margins improve by \$0.01/bu.

The main beneficiary of increases in BBDs mandates are soybean farmers, with the largest increase in revenue. Cattle ranchers and hog and chicken producers also benefit from lower animal feed prices, as meal prices are lower. Soybean crushers' have the lowest benefit, as around 50% of gains associated with higher soybean oil prices are offset by decreases in meal prices.

These results addresses a critical concern related to the expansion of BBDs mandates: food price inflation. Our results indicate that while soybean oil prices do increase, soybean meal prices decrease, relieving part of the inflationary pressure. This is particularly interesting for the food and fuel debate. We show that the expansion of BBDs mandates can lead to more soybean meal production, which in turns reduces the price and increases availability of this important animal feed source.

Additionally, we argue that international trade policy is crucial for the soybean crush sector's profitability. Most of the new supply of meal goes for exports, especially to Asia. Had this market not existed, crush margin deterioration due to lower meal prices could be larger.

Overall, biofuel policy announcements and "leaks" are at least as important to the soybean complex as other major US agencies reports, such as the WASDE. This highlights that biofuels are key drivers of commodity returns. We also add to the fuel and food debate by causally identifying that increases in soybean oil prices induced by biofuel shocks have a negative effect on soybean meal prices. In other words, meal prices serve as a price anchor when it comes to biofuels.

These findings provide evidence of the growing influence of biofuel policy communications, both formal announcements and media leaks, in shaping commodity markets returns. Importantly, we contribute to the food-and-fuel debate by showing that rising soybean oil prices due to biofuel demand are partly offset by falling soybean meal prices, mitigating inflationary concerns.

2 Biofuel Policy Background

The US motor fuel industry is subject to federal and state-level biofuel policies. At the federal level, the Renewable Fuel Standard (RFS), governed by the Environmental Protection Agency (EPA), dictates the number of gallons of biofuels required in the fuel pool each year. The mandate was first enacted in 2005, as RFS1, and later significantly expanded in 2007, as RFS2. In 2023, the RFS required the consumption of around 22 billion gallons of renewable fuel in the US. The ultimate goal of the RFS is to reduce transportation sector emissions, while increasing US energy sector independence (U.S. Environmental Protection Agency (2024)).

Working within the federal mandates, states can implement their own mandates. The most important state fuel policy is California's Low Carbon Fuel Standard (LCFS), implemented in 2011 [1]. California is the second largest fuel market in the United States, and currently over 60% of diesel consumed in the state are biomass-based because of the LCFS. Unlike the RFS that sets consumption levels, the LCFS set emission reduction levels that agents have to achieve each year. In 2023, almost 4 billion gallons of renewable fuel were consumed in CA. The goal of California's LCFS is to reduce greenhouse gases (GHG) emission in the state by 20% by 2030 (CARB (2025)).

These policies use a similar credit mechanism to support the expansion and production of biofuels. Under the RFS, each time a gallon of biofuel gets blended with a non-renewable fuel (e.g., biodiesel and conventional diesel), a Renewable Identification Number (RIN) is generated relative to that fuel. To be compliant, each year obligated parties (i.e., refiners and importers of non renewables) must submit enough RINs to the EPA proving their consumption of biofuels. Similarly, the LCFS requires that obligated parties submit LCFS credits of the end of each year showing their compliance. However, unlike the RFS that awards RINs

[1] Oregon, Washington and New Mexico currently have also implemented LCFS mandates

equally across same fuel categories, the LCFS awards credits based on the actual emissions of that specific fuel.

For example, imagine two identical renewable diesel plants, with only one difference: one is located in Nebraska and one is located in Illinois. Under the RFS, both fuels generate the same amount of RINs. However, under the LCFS, the plant in NE would generate more credits than the one in IL. That happens because it would require a longer transportation, causing more emissions, to get a product from IL to CA, compared to the exact same product from NE. Thus, the emissions associated, referred as Carbon Intensity (CI), are bigger, leading to less credits generated. Both these credits can be traded in the market and have a "dollar" value attached to them. Ultimately, these credits work as an implied subsidy for biofuel production.

2.1 Biodiesel and Renewable diesel volumes

Two of the key biofuels used for compliance in these policies are Fatty Acid Methyl Esters (FAME) biodiesel and renewable diesel (RD). These fuels are the biofuel "counterpart" of conventional diesel, used in trucks and trains, for example. In this work, we refer to biodiesel and RD combined as biomass-based diesels (BBDs).

Since 2009, the first year that the RFS officially required biodiesel consumption, over 90 billion gallons of BBDs have been consumed. The projection for 2025 is that more than 10 billion gallons of the fuel will be consumed in the US, as shown in Figure 1 (U.S. Environmental Protection Agency (2024)).

While we aggregate these fuels as BBDs because of their relation to conventional diesel, it is important to highlight a key difference. FAME biodiesel is a complementary product to conventional diesel, whereas RD, a newer technology, is a perfect substitute. For example, legally fuel blenders can only blend up to 5% FAME biodiesel with conventional diesel, but they can sell 100% renewable diesel at gas stations. RD technology is a key aspect for the future outlook of BBDs mandates. As there is no blending cap, policymakers are able to

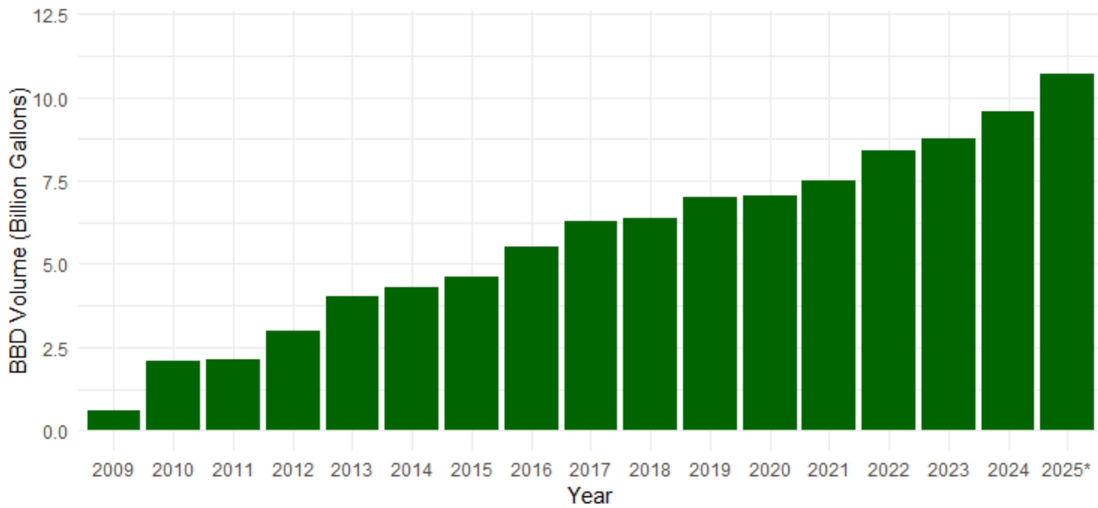

Figure 1: BBDs volume consumed under the RFS
Source: EPA (2024)

expand BBDs mandates. Ethanol consumption mandates, on the other hand, have stagnated over the last decade near 10% of gasoline consumption because of blending restrictions in conventional gasoline.

The combination of ambitious renewable fuels target and the new RD technology are incentivizing the expansion of BBD mandates in the US. This led to the "RD boom" of 2021, where domestic production of RD soared, increasing by over 500% in 3 years, as shown in Figure 2. The key feedstock that supported this growth in the short run was soybean oil.

With this new biofuel available, policymakers have focused the expansion of biofuel mandates based on increasing BBDs demand. In this work, we focus on the policy changes period post-RD boom (i.e., post 2021) and on the main input used for BBDs production in the US, soybean oil (Gerveni, Hubbs, and Irwin (2023)).

2.2 Current state of soybean oil use for fuel production

Soybean oil has been the main input in BBDs production since the implementation of the RFS. Currently, around 13 million pounds per year of soybean oil are used for BBDs production in the US (GATS (2024)).

The majority of soybean oil is used for FAME biodiesel production, however, since the

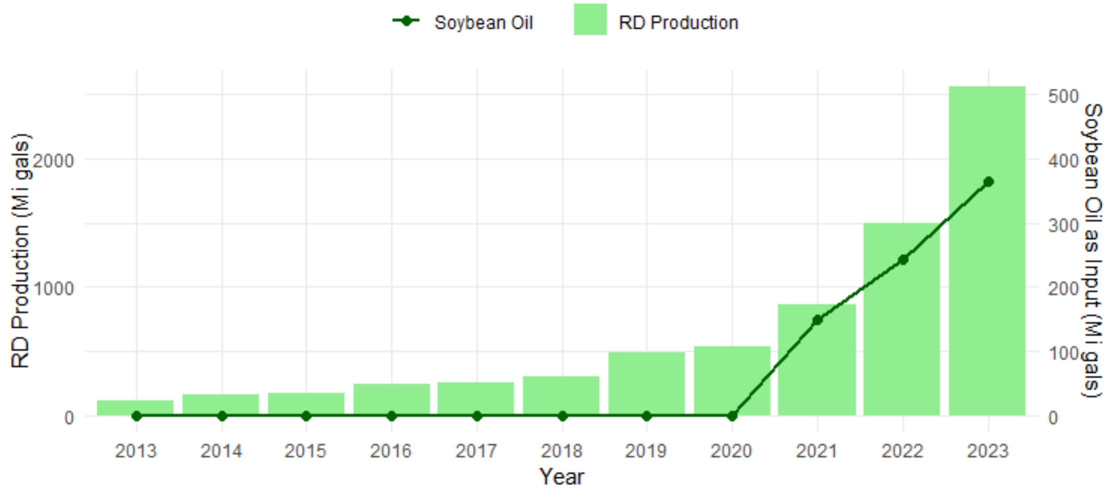

Figure 2: RD production and soybean oil use as feedstock
Source: EIA and CARB (2025)

RD boom, the share of soybean oil used for RD production is increasing. Figure 3 shows the increase in total amount and also the share of the soybean oil used for fuel production.

Notably, the RD boom is an inflection point in both total use and share. Total use increased by almost 40%, while the shared of soybean oil used increased by 10%. Currently, almost 50% of the soybean oil produced in the US is allocated for fuel production.

2.3 Soybean Complex

Increasing demand for soybean oil not only impacts this market, but the entire soybean supply chain called the soybean complex. Soybean oil is a by-product from processing soybeans called crushing. A typical crushing process yields about 20% of soybean oil and 80% of soybean meal. Meeting increasing demand for soybean oil either requires diverting soybean oil from other uses like food, or an increase in the domestic crushing of soybean oil Domestic soybean crushing has increased by 7% since 2021. This also translates into an increase of 7% in meal production (GATS (2024)), as soybean oil and soybean meal are produced jointly.

However, domestic meal demand for feed use remained the same throughout this period, as it is fairly inelastic. Feed demand has increased by only 4%, generating a surplus of meal

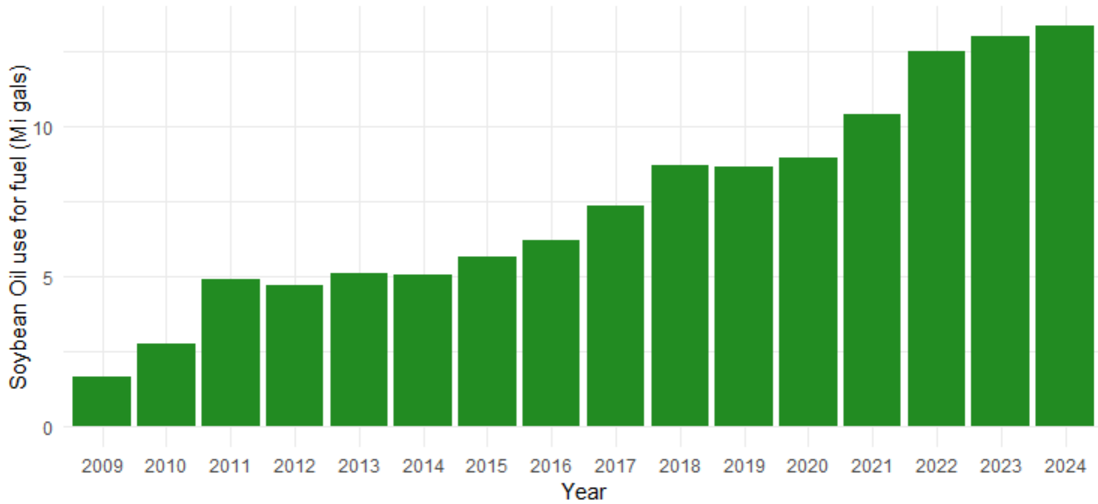

Figure 3: Soybean oil use as feedstock for BBD production
Source: USDA (2025)

domestically. On the other hand, soybean meal exports have soared since the RD boom. USDA's Foreign Agriculture Data (2024) shows that US meal exports increased by 16% since 2020, at the current record level of 33 billion pounds, as shown in Figure 4. Therefore, biofuel mandates have not only affect soybean oil dynamics, but also the entire soybean complex.

2.4 Policy Announcements and Leaks

There are two agencies overseeing biofuel policies in the US. The EPA oversees the RFS, while the California Air and Resources Board (CARB) oversees the LCFS.

These agencies provide updates, generally, in two main fronts. They provide policy guidelines, referred to as mandate updates, and also provide reports regarding credit generation and biofuel consumption.

The EPA announces proposed and final Renewable Volume Obligations (RVO) for the RFS. These announcements are non-scheduled, but the market expects them to occur before the new year begins [2]. Overall, the EPA proposes an RVO in June and finalizes the mandates in December. For example, the RFS2 program established policy guidelines between 2008-

[2] While the EPA has a responsibility of providing final mandates before the year starts, there have been instances when the actual yearly mandate is confirmed after the year begins.

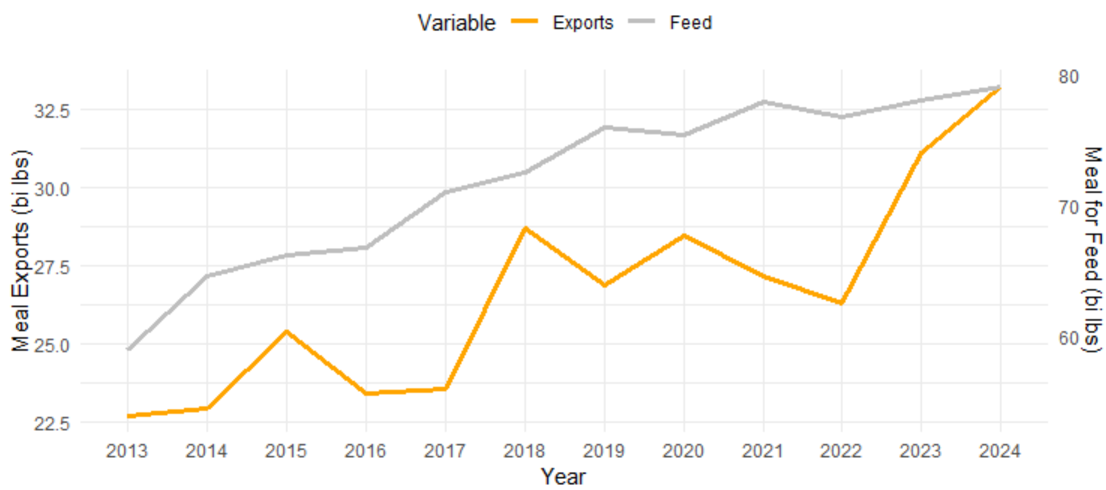

Figure 4: Domestic meal disappearance
Source: USDA(2025)

2022. After this period, the EPA has proposed and ruled on new volumes every year.

CARB, on the other hand, provides mainly updates regarding feedstock use and credit generation under the mandate. These are quarterly reports published at the end of every quarter, with pre-specified dates.

However, due to the relevance and uncertainty surrounding these announcements, several news leaks might occur on the days preceding the announcements. These leaks are surprise to the markets and report the discussions the EPA is having regarding the next RVO and CARB about new rules. There are two main reporters who have, recently, been prominent "leakers": Jarret Renshaw and Stephanie Kelly, both from Reuters.

Therefore, markets agents observe 3 types of surprised biofuel demand shocks. Proposed and final RVO rule makings from the EPA, CARB quarterly feedstocks and credits report, and news leaks related to EPA and CARB rule makings.

3 Data

Daily commodity futures data for the nearby and first deferred contracts were downloaded from Bloomberg from 2019 until February 2025. We collect futures prices data for Soybeans, Soybean Oil, Soybean Meal, Corn, WTI Crude Oil and Heating Oil. In total, we collect 1,034 trading days per contract.

Contract rolling occurs based on volume traded (i.e., our dataset automatically rolls when the volume traded on the first deferred is higher than in the nearby). This typically happens on the last week of trading, though the exact day can vary. We manually control for cases in which news or reports overlap with contract rolling.

Using this data, we calculate gross crush margins on a per bushel basis for a representative soybean crushing plant. We use the standard method of calculation used by traders following CME's "Soybean Crushing Reference Guide".

We calculate absolute returns for all commodities and the crush as the difference between market open (i.e., market close of the previous trading day) and market close for a single day. We follow Adjemian (2012) and do not adjust these returns for potential limit price moves. This can lead to an underestimation of effects.

Events are chosen based on their relevance and "surprise" effect. The choice is based on two aspects: (i) it needs to release information that fundamentally alters the demand for biofuels;(ii) must not be fully anticipated.

EPA announcements data are collected directly from the EPA website, that publishes all announcements [3]. In general, the EPA publishes announcements related to three matters: proposed/ final mandates, small refinery exemptions (SREs) and technical compliance requirements (i.e., changes in the date RINs must be submitted). There is no publication schedule for these announcements.

We narrow our EPA events as the days with either a "Proposed Renewable Fuel Standards" or "Final Renewable Fuel Standards". Our selected events clear these two barriers. It fundamentally changes the demand for biofuels and the final information is a secret until its release [4].

[3] All announcements are available at: https://www.epa.gov/renewable-fuel-standard-program/news-notices-and-announcements-renewable-fuel-standard .

[4] As will become clear, some of these changes "leak" to the market. However, the final legal number is only released on that day and is considered a surprise to traders.

SREs release, on the other hand, can fundamentally alter the demand for biofuels, but is seldom a surprise. Since 2021, the EPA has denied all SRE petitions, as a standing policy of the agency during the period. These denials are, most times, challenged in court. Because of this uncertainty related to the actual change and if it will hold, we discard these events. We also discard technical compliance requirements as they fail to fundamentally alter the demand for biofuels.

In total, between 2019 and 2025, the EPA has published 6 relevant events. Two are the proposals for the 2020,2021 and 2022 and 2023,2024 and 2025 RFS volumes, and the other two are the final rulings for these years.

CARB quarterly reports are collected from the CARB website [5]. Unlike EPA announcements, CARB reports are scheduled to be released at "the last day of the month following the reporting deadline for the quarter by 3pm of that day" (CARB (2025)).

There are two key information available in this report. First, the total LCFS credit bank. This information is relevant to biofuel producers in the sense that it drives credit values (i.e., biofuel production subsidies). CARB also publishes feedstock use for biofuel production, which informs traders of soybean oil use for biofuel purposes in CA.

These two information clears conditions (i) and (ii) to be considered an event in our study. In total, there are 25 quarterly reports during out sample period.

The last set of events we study are news reports and leaks before EPA announcements. We can breakdown these news in two main groups. The first groups is on news related to "when" the EPA will either propose or issue a final mandate ruling. The second group of news articles anticipated what these mandates will look like.

We collect news articles from the two main "insiders", Jarret Renshaw and Stephanie Kelly, both journalists at Reuters[6]. We collect these articles, with timestamp, from X (former Twitter) and cross-validate with Reuters' website. There are a total of 48 articles published

[5] All announcements are available at: https://ww2.arb.ca.gov/resources/documents/low-carbon-fuel-standard-reporting-tool-quarterly-summaries .

[6] The word "insiders" here is used in the sense of reporters who often break news related to the topic. The word use has nothing to do with "insider trading".

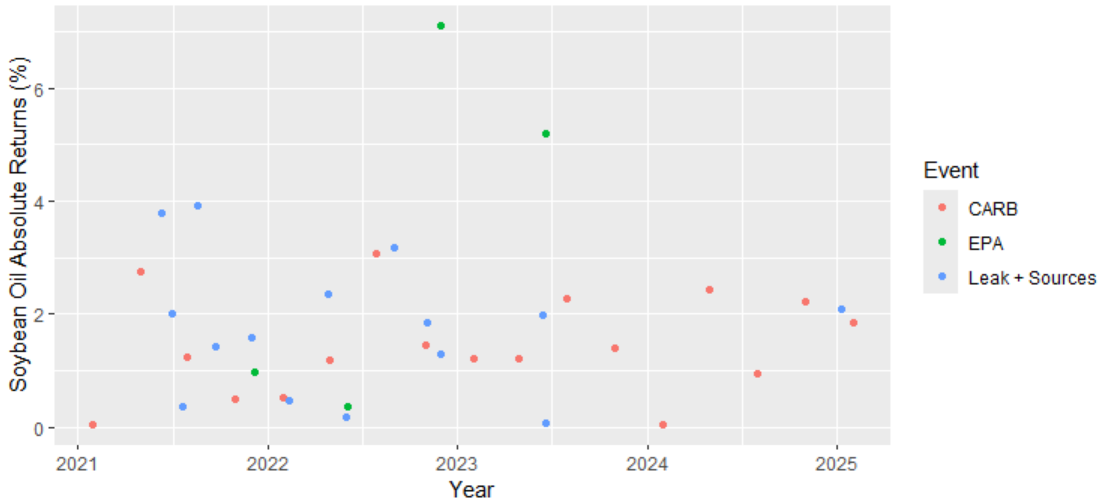

Figure 5: Soybean Oil absolute returns on biofuel event days
Source: CME, Reuters, EPA and CARB (2025)

in the period.

We follow our selection criteria to narrow these news to a total of XX events. In addition to criteria (i) and (ii), we also need to adjust the data for two things. First, some articles are published post market closure. When that is the case, we consider the event the following trading day.

Secondly, some news articles are follow ups from the "breaking news" one. For example, on 12/02/2021 Jarret Renshaw published an article titled "U.S. biofuel blending proposals to come in days, sources say". On the following day, he published "U.S. EPA to propose expanding credit eligibility under biofuel program -sources", which is just a follow up article on the previous one. This fails condition (ii) of our criteria. Therefore, we discard this news event. The full list of news articles can be found in the Appendix.

A final set data cleaning we work is making sure events do not overlap with WASDE reports. We explicitly control for this on our models. In total, our dataset contains 37 individual event days. Figure 5 shows the selected event dates and respective soybean oil absolute returns.

4 Model and Methodology

In this work we seek to answer two main questions. Are biofuel related reports and news adding valuable information to soybean oil markets? What are the effects of biofuel induced shocks on the soybean complex and sector profitability?

We employ an event study to measure the effect of EPA, CARB and news leaks on soybean oil absolute returns on days around the event. Following that, we leverage exogenous shocks generated by surprise biofuel mandate announcements on soybean oil prices on event days to measure the effects on the other components of the crush (i.e., soybeans and soybean meal) and the crush itself. Alternatively, we also approach this question by estimating the responses of soybeans, soybean meal and the crush to biofuel shocks using identification by heteroskedasticity (Rigobon and Sack (2004)).

4.1 Announcements and Leaks Effects

The first question we seek to answer is whether or not EPA and CARB announcements and news leaks bring useful information to market agents. We also further explore whether news leaks are more relevant than actual government agencies reports. We measure the effects of these events following Isengildina-Massa et al. (2008), Adjemian (2012), and Bunek and Janzen (2024). Those studies focus on WASDE report effects on agricultural commodity markets. As this study connects the agricultural and energy sectors, we also follow the energy market releases literature, as Prokopczuk, Simen, and Wichmann (2021) and Basistha and Kurov (2015). We consider our events to be of similar conceptual content: updates to the fundamentals of these markets.

We estimate the model described in equation 1. We define $y_{k,t} = ln(F_{k,t}) - ln(F_{k,t-1})$, that is, the absolute returns of commodity k at time t. In this setting, $y_{k,t}$ is a measure of market volatility.

$$|y_{oil,t}| = \sum_{i=-5}^{5} \beta_d D_{t,i} + \sum_{p=1}^{15} |y_{oil,t-p}| + \delta_d + \omega_w + \sum_{i=-5}^{5} \phi_{WASDE} + \epsilon_t \quad (1)$$

Similarly to these studies, we define a dummy variable, $D_{t,i}$ for the event day (i.e., day of the report release or of the news leak) and define a 10 day window around the event. As autocorrelation is a natural problem of time-series, we add lags of the commodity returns selected by AIC. Recognizing that different weekdays and closeness to maturity, thoroughly discussed in Karali, Dorfman, and Thurman (2010), we add weekdays and week fixed effects. Lastly, we add a series of dummy variables to take into account days in our sample with WASDE report releases.

4.2 Returns effects on the soybean complex

4.2.1 Identification

We proceed to evaluate the secondary effects of these reports, and in consequence biofuel mandates, in the soybean complex and industry. A natural challenge in estimating these effects is that these markets are endogenous to each other. One can think of it as a simultaneous equations problem (Rigobon (2003)).

We attain identification by exploring the different co-movement of soybean oil, soybeans and soybean meal on event and non-event days. Figures 6 and 7 depict the co-movement on event and non-event days between soybean oil and soybeans, and soybean oil and soybean meal, respectively.

Soybean oil and soybeans returns are positively correlated on both event and non-event days. However, a central difference is which product leads the relationship on each day. We assume that, on non-event day, soybean news are the key driver of soybean complex prices. On event days, soybean oil drives returns.

On the other hand, there is a clear different pattern when it comes to soybean oil and

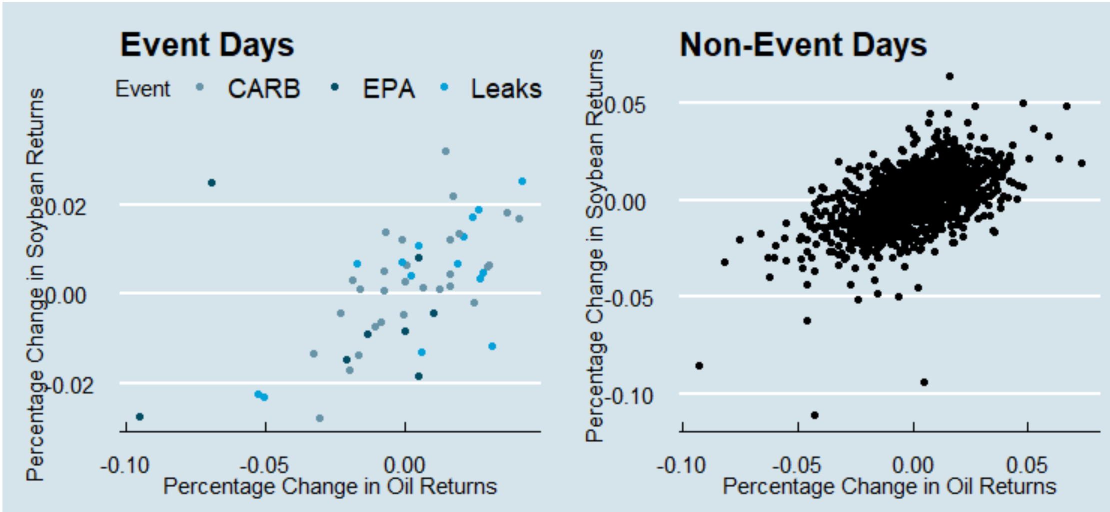

Figure 6: Co-movement between soybean oil and soybeans returns
Source: CME

soybean meal. Returns are random on non-event days, while there is a clear negative correlation on event days. We use these difference in co-movement between even and non-event days to obtain full identification.

4.3 OLS Model for event day effects

Leveraging surprise biofuel demand and reports on events day, we estimate:

$$[z_{k,t}|D_t = 1] = \alpha + \psi_0[y_{oil,t}|D_t = 1] + \delta'[X_t|D_t = 1] + \varepsilon_t \quad . \tag{2}$$

This model in equation 2 is conditional on event days. The variable $z_{k,t}$ is the log absolute per bushel returns of products $k \in$ crush margins, soybeans, soybean meal, while $y_{oil,t}$ is the log absolute per bushel returns of soybean oil. X_t is a vector of commodity controls, like the absolute returns of WTI, corn and concurrent WASDE releases.

Our coefficient of interest is $\psi_{oil,t}$. It estimates the percentage increase in $z_{k,t}$ for a 1% increase in soybean oil returns on biofuel specific event days. Combining the exogeneity of these announcements and leaks, with the assumption of these shocks satisfying exclusion

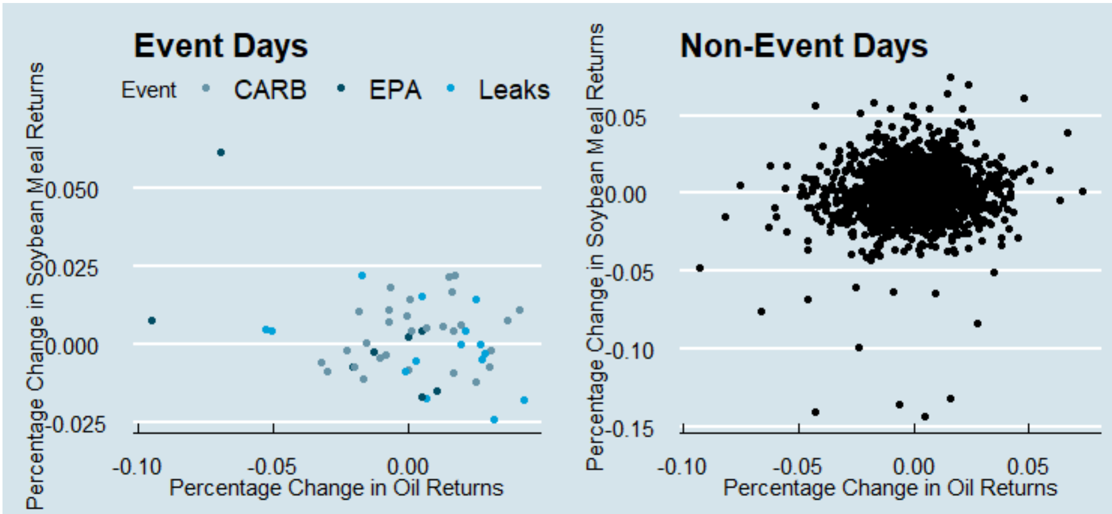

Figure 7: Co-movement between soybean oil and soybean meal returns
Source: CME

restriction (i.e., announcements only affect prices of soybeans and meal through effects on soybean oil prices), our estimates are causal.

4.4 Rigobon-Sack IV for event day effects

In addition to the model in equation 2, we also approach this question following the methods of Rigobon and Sack (2004) and Scrimgeour (2015). Conceptually, this approach recognizes two factors driving returns on event days: biofuel-induced soybean oil effects on the complex and background correlation among the complex components. We leverage the fact that on non-event days, only the background correlation exists.

$$z_{k,t} = \alpha + \psi_0 \hat{y}_{oil,t} + \delta' X_t + \epsilon_t \quad , \tag{3}$$

where the instrumental variable $w_{oil,t}$ in equation 3 is defined as

$$w_{oil,t} = \begin{cases} y_{oil,t} & \text{if } D_t = 1 \\ -y_{oil,t} & \text{if } D_t = 0 \end{cases} . \quad (4)$$

Unlike the previous model, we estimate equation 3 on all days (i.e., event days and also on $t - l$ days before the event, where $l \in 1, ...10$). Our IV estimator uses the fact that on non-event days returns co-movements are only due to the background correlations within the complex. By defining $w_{oil,t} = -y_{oil,t}$ **if** $D_t = 0$, we subtract the background correlations, getting left only with the desired effects. The only necessary assumption is that the background correlation of the complex is the same on event and non-event days. This ensures that the exclusion restriction requirement for identification is satisfied.

The key difference between the two approaches is that the event day OLS requires more assumptions. Namely, it require the exclusion restriction assumption on event days. That is, on these days, shocks from biofuel announcements only affect soybean oil returns, and then soybean oil returns affect soybeans and meal. The Rigobon-Sack IV approach requires less assumption in exchange for less efficiency.

5 Results

Results are presented in two steps. First, we discuss the event study results surrounding EPA, CARB and biofuels news "leaks". After, we discuss what are the effects of biofuel mandates announcements on soybeans, soybean meal and he crush. We finalize by discussing the policy implications of our results to the expansion of BBDs mandates.

5.1 EPA, CARB and "Leaks" on soybean oil returns

Figure 8 depicts the results for soybean oil absolute returns (volatility) on an event day window. Our results show that absolute returns cumulative increase by 1.21% on a two-day

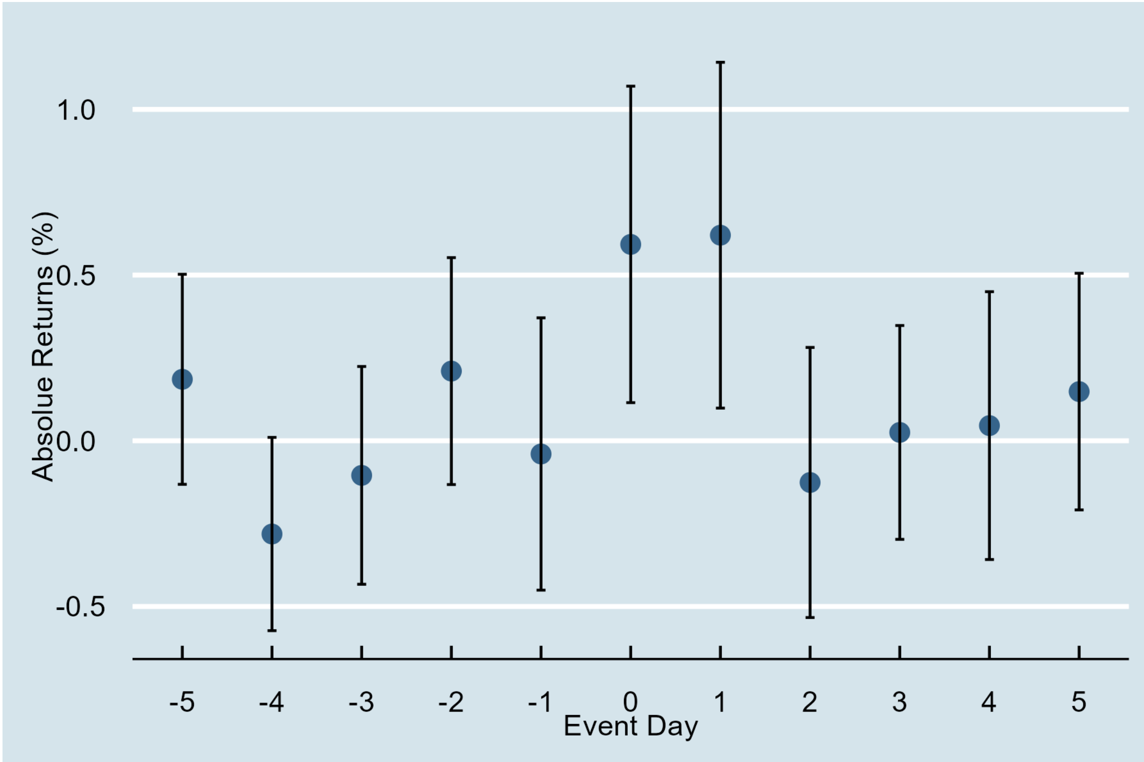

Figure 8: Effects of official announcements and news “leaks” on soybean oil absolute returns
Notes: The figure presents soybean oil absolute returns changes around event days. Standard errors are heteroskedasticity-consistent, accounting for potential small sample bias. Confidence interval reported are at the 95% level.

window (event day and one day after the event). For comparison, Adjemian (2012) finds that soybeans absolute returns on WASDE days increase by 0.70% on the most important month. In other words, effects of biofuels announcements and leaks are of the same magnitude as the most important WASDE reports.

Interestingly, our results shows a post-announcement-leaks drift (PALD) in agricultural commodities. This is similar to a well-known phenomena/ anomaly in stock markets, Post-Earning-Announcement Drift (PEAD) (Fama (1998)). As summarized in Fink (2021), PEAD contradicts the efficient market hypothesis by showing that “an earnings surprise does not lead to a full, instantaneous adjustment of stock prices”.

PEAD can be explained by several reasons. We highlight two: risk and uncertainty surrounding the announcement; and traders’ behavioral biases. Bird, Choi, and Yeung (2014) shows that firm and market-wide uncertainty affects PEAD. Delayed information

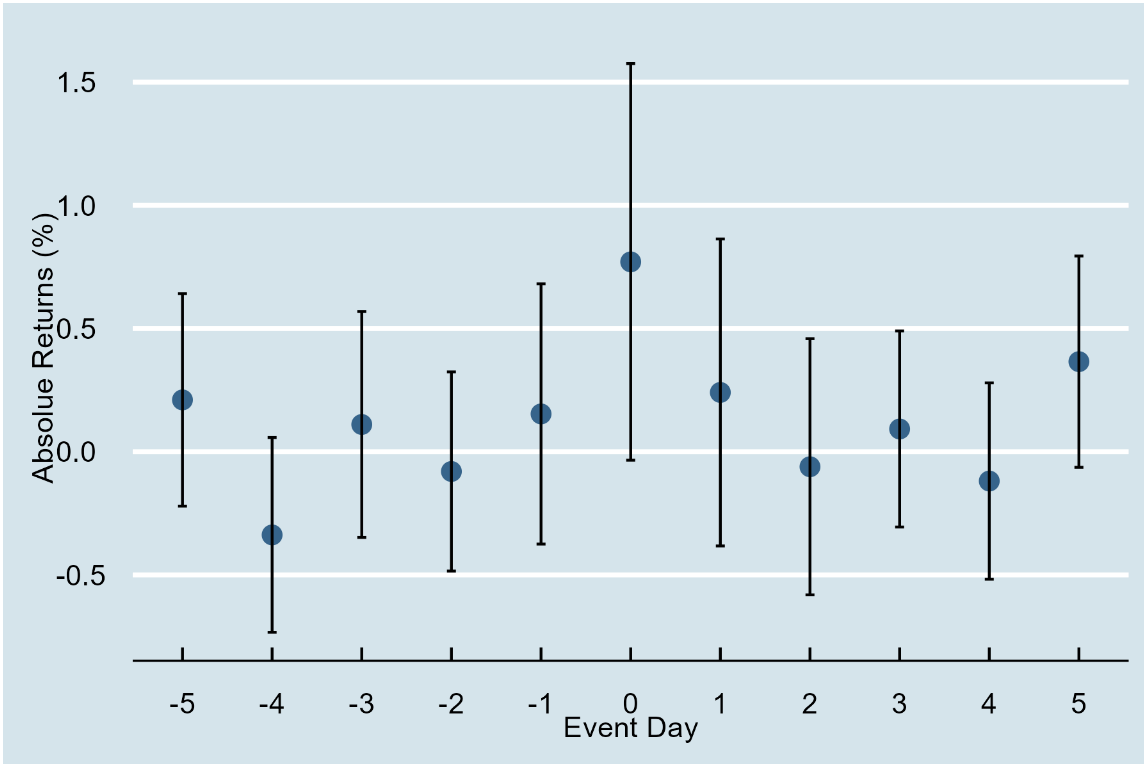

Figure 9: Effects of official announcements on soybean oil absolute returns
Notes: The figure presents soybean oil absolute returns changes around official event days. Standard errors are heteroskedasticity-consistent, accounting for potential small sample bias. Confidence interval reported are at the 95% level.

also lead to under-reaction of returns (Li, Nekrasov, and Teoh (2020)), supporting PEAD. Distraction, due to excessive news, also leads to bias (Hirshleifer, Lim, and Teoh (2009), Hung, Li, and Wang (2015)).

We believe this to be exactly the case of PALD in biofuel markets. Biofuel policies are uncertain (Markel, Sims, and English (2018)), subject to judicial challenges and political motivations. News "leaks" are also uncertain, as there are no guarantees that they will materialize in actual policy. This, following the PEAD literature, should lead to PALD.

Lastly, there is a lot of information and news surrounding these mandates. This leads to distraction and reduce the ability of trader's to assimilate these news.

We find a one-day drift in soybean oil abnormal returns following policy announcements and news leaks. However, as Figure 9 shows, this drift stems primarily from news leaks, not from finalized policy announcements, consistent with the role of uncertainty in PALD.

Overall, we find that EPA, CARB and news "leaks" surrounding biofuel mandates increase soybean oil absolute returns by 1.21% over a two-day period. This drift (PALD) is driven by uncertain and risky news "leaks" reports, that are unverified and subject to revision. Our results are comparable to the most important WASDE announcement effects on soybean futures.

5.2 Biofuel shock effects on the soybean complex

Table 1 shows that results for the effects of increases in soybean oil, due to biofuel policies, on the rest of the soybean complex. The leftmost column of the table discusses the results referent to the model in equation 2, while the rightmost side shows the results for equation 3.

Table 1: Impact of Soybean Oil Shocks on Commodity Markets

	OLS on Event Days			Rigobon-Sack IV		
	Soybeans	Soybean Meal	Crush Margins	Soybeans	Soybean Meal Strongest IV	Crush Margins
Soybean Oil	0.19**	-0.26**	1.59**	0.19**	-0.30**	1.40*
	(0.06)	(0.07)	(0.45)	(0.09)	(0.11)	(0.76)
WTI	0.08	0.20	0.00	0.04	0.14	-0.05
	(0.08)	(0.11)	(0.75)	(0.07)	(0.05)	(0.51)
Corn	0.40**	0.44**	0.06	0.38**	0.56**	-0.62
	(0.11)	(0.11)	(0.85)	(0.11)	(0.10)	(0.94)
WASDE FE	Yes	Yes	Yes	Yes	Yes	Yes
Days before event	–	–	–	4	4	4
F-Stat	–	–	–	34	34	34
Wu-Hausman	–	–	–	0.01	0.28	0.22
R-square	0.57	0.47	0.29	0.38	0.37	0.13

Notes: The table presents regression results for target coefficients under different specifications. Results represent a percent change in returns given a 1% increase in soybean oil prices on event days, induced by biofuel shocks. Standard errors are heteroskedasticity-consistent, accounting for potential small sample bias. Significance levels are reported as: *0.10, **0.01.

Results show that a 1% increase in soybean oil returns, induced by biofuel policies, increase soybeans returns, by 0.19% but reduces soybean meal returns by as most as -0.30%. This leads to an overall increase in gross crush margins of 1.40%.

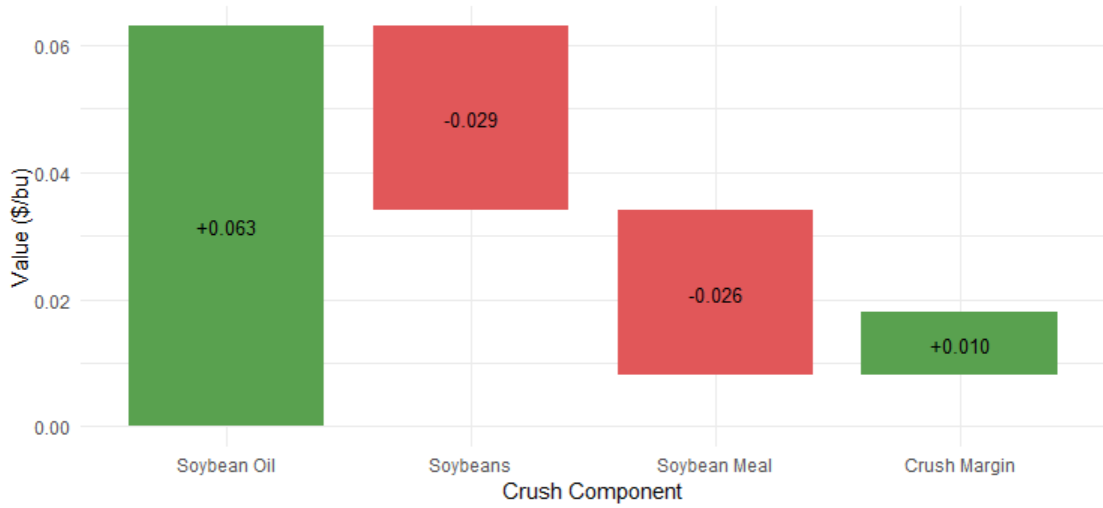

Figure 10: Crush margin breakdown ($/bu)

Notes: The figure presents the average crush breakdown for the period studied (2021-2025). Per bushel values are calculated based on the average price of the components between 2021- February 2025. The crush is determined as Soybean Oil per bushel value + Soybean Meal per bushel value - Soybeans per bushel value.

As a positive soybean oil biofuel shocks is a positive demand shock, it also is a positive demand shock for soybeans. However, in this process, more meal is produced. Therefore, this is a positive supply shock on meal. In other words, soybean oil prices increase, leading to increases on soybeans prices, but reduces the price of meal. Results are robust to the different specifications and estimation procedures. We provide, in the appendix, the RS-IV results for all instruments.

The extent of these changes depends on the elasticities of supply and demand of these products. Our results are consistent with Lusk (2022) findings, but ours are causally estimated.

Figure 10 illustrates the impact of a 1% increase in soybean oil prices, which corresponds to a $0.063 per bushel gain in revenue. At the same time, a 0.19% rise in soybean prices adds $0.029 per bushel to input costs in the crush margin calculation. Additionally, a 0.30% decline in soybean meal prices results in a $0.026 per bushel reduction in revenue.

In other words, the main benefactor of increases in biofuel mandates are soybean farmers, with a gross increase in revenue of $0.029/bu (per 1% increase in oil prices). Soybean crushers collect around $0.01/bu, due to increased costs from higher soybean prices, but also from lower meal prices, due to the increased supply. Lower meal prices also benefit cattle ranchers, and chicken and hog producers, that use the product as animal feed.

Meal returns could have been even lower were it not for the significant increase in meal exports, particularly to Asia, during this period. Between 2021 and 2024, meal exports rose by nearly 20%. Without this growth, the decline in meal prices might have been steeper, potentially offsetting more of the gains associated with higher soybean oil prices. This highlights the importance of international markets to soybean crushers.

6 Conclusion

This paper addresses two central questions. First, we demonstrate that biofuel-related reports and news significantly influence agricultural commodity returns. Second, we highlight the comprehensive impact of biofuel policies on the soybean complex: raising soybean prices and improving crush margins.

Event study regressions show that, on days surrounding EPA policy announcements, CARB reports, and news "leaks," absolute returns on soybean oil increase by 1.21%. These unofficial news leaks are particularly influential, as they introduce uncertainty and are subject to revision, making them key drivers of post-announcement-leaks drift (PALD). The magnitude of this effect is comparable to the impact of major WASDE reports on soybean returns, as documented by Adjemian (2012).

Soybean farmers are the primary beneficiaries of expanded biofuel mandates. A 1% increase in soybean oil returns translates to an estimated $0.029/bushel increase in soybean prices. Soybean crushers also gain, though to a lesser extent: crush margins increase by only $0.01/bushel under the same shock. While higher soybean oil prices boost revenue, approximately 50% of that gain is offset by declining soybean meal prices, which fall by around $0.026/bushel.

This study offers three key contributions and policy insights. First, we show that biofuel-related reports and news, especially leaks from unofficial sources, convey valuable information for soybean markets. Market participants, including traders and producers, should pay attention to these less formal channels of information.

Second, our findings indicate that the inflationary effects of biofuel mandates are partially mitigated by the internal dynamics of the soybean complex. Although biofuel mandates increase demand for vegetable oils like soybean oil, leading to higher prices, the accompanying increase in soybean crushing generates more meal, which puts downward pressure on meal prices. This supply response effectively anchors food price inflation. In our estimates, roughly 50% of the price increase in soybean oil is offset by the decline in meal prices.

Third, international trade plays a critical role in maintaining the profitability of the U.S. soybean crushing sector. The benefits crushers gain from biofuel mandates are closely tied to the availability of export markets for soybean meal. Without the expansion of meal exports, particularly to Asia between 2021 and 2024, lower meal prices could have further eroded crushers' margins.

In summary, our results establish biofuel policy as a pivotal force shaping agricultural commodity returns. The expansion of biofuel mandates, especially through increased BBD blending requirements, supports farmers via higher soybean prices while exerting less upward pressure on food prices due to the counterbalancing effect of lower meal prices. Sustained access to export markets is essential to ensuring the long-term profitability of soybean crushers.

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