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by

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Weekly Options on Grain Futures

Shorter-dated options have become more popular in the grain and oilseeds markets. While they remain tied to (or derivatives on) the common underlying futures contracts, they have shorter tenor or maturity dates than the regular options that are typically listed for a year or more prior to expiration. The shortest common tenor are "weeklies", so named because they have expiration dates for weeks that do not have regular nor serial options expiring, generally on Fridays, and they generally trade for three or four weeks. The value of weeklies can be lower than regular options because of the shorter tenor, and higher because of a volatility risk premium. Weeklies are touted as useful for positioning around major USDA reports. Empirically, this would be reflected in differences among the implied volatility, realized volatility and spot volatility of weeklies and regular options. The implied and realized volatility levels are higher in weeks that contain major USDA reports. The implied and spot volatility explain realized volatility, but at degrees that vary depending on the timespan considered. The results suggest that the weeklies contain information about short-run price behavior that is not fully explained by regular options.

Keywords: weeklies, implied volatility, spot volatility

1. Introduction

Short-dated options have grown in popularity as ways to gain option exposure outside of the normal options on futures for grains and oilseeds that typically expire toward the end of the month prior to the delivery period of the futures month. The short-dated options include serial options, which expire monthly when a regular option is not expiring, short-dated new-crop options, which expire monthly leading up to the settlement of the new-crop futures, and weekly options or weeklies that expire during weeks that do not have regular nor serial options expiring. The addition of weeklies means that every Friday (that is a business day) would have some time of option maturing or expiration that could be offset or exercised into a nearby futures contract that is not about to enter the delivery period.

Weekly options on major grain and oilseed futures are currently listed on the CME Group for three or four weeks prior to expiration. Such tenor is much shorter than the typical twelve months for most options and multiple years for new-crop options. The short tenor compared to regular options results in a generally lower theoretical value and observed lower premiums. The short tenor also increases the chance of an underlying price move that would not have time to revert prior to maturity, which may result in a volatility (variance) risk premium[1] for weeklies. This may be due to the perceived need to have a risk premium by option sellers, lower overall trading volume in weeklies (a liquidity premium), or higher volatility for a given week that affects weekly option premiums more than regular option premiums. An example in the grain markets of specific events would be major crop reports, e.g., World Agricultural Supply and Demand Estimates (WASDE) reports, expected to change the underlying futures prices. As trading volumes and open interest levels have grown, especially for weeklies on corn, it may also be possible that the weeklies are providing additional information about the short-run movement of prices that would not be readily discerned using regular options.

[1] We will use volatility risk premium and variance risk premium interchangeably in this paper.

Weekly options on grain futures have gained their popularity in the last decade. Weekly options for corn, wheat and soybeans were introduced in May 2011, on top of existing standard and serial options. Weekly options add at least four option contracts expiring on successive Fridays during the nearby month or months of a futures contract. According to the CME Group, weekly options trading volumes increased 65% from 2018 to 2019, with an average daily volume of almost 7,000 (Britnell and Sutton-Vermeulen, 2020). The unique characteristic of weekly options, compared to longer-date options, is their ability to provide direct exposure to diffusive price risk via at-the-money (ATM) options and separately price jump risk via deep out-of-the-money (OTM) options. In practice, weekly options on grain and oilseed futures offer farmers and agribusinesses (or speculators) an inexpensive way to lay off (acquire) short-term risks, such as drastic weather conditions, fundamental news in USDA reports, geopolitical news, etc. Conversely, the longer-dated options are more expensive and insensitive to the short-term event risks that may concern interested participants. With ever-increasing popularity in weekly options, we are interested in examining whether the unique information content implied in these short-dated options can help predict futures returns and their realized volatility. Presumably, market participants tend to express their short-term views via the short-dated options.

Egelkraut et al. (2007) found that forward volatility implied in regular options can predict future realized volatility better than can historical volatility, especially with earlier-year options. To our knowledge, there is no existing literature on weekly options on agricultural futures. However, related literature includes the predictability of implied volatility and weekly options on stock index. Andersen et al. (2017) proposed a semi-nonparametric model to extract negative tail risk from S&P 500 index options between 2011 and 2015. They found that jump metrics implied in weekly options help predict stock returns. Related research by Jia et al. (2021) is the predictability of high moments on non-ag commodity returns, in which they found the fourth moment implied in options are predictive of future returns.

The goal of this paper is to determine (a) whether weekly options on grain futures are unique in the marketplace that has been dominated by regular options; (b) whether weekly and regular options are priced fairly in the sense that volatility implied in the options differs from realized volatility, especially around WASDE and other important dates. If information about the short-run price situation is reflected in weekly options on grain and oilseed futures, implied volatility of weeklies would track realized volatility closely. Testing their differences would inform market participants about the fairness of pricing, particularly around major events. (c) whether weekly options provide additional information beyond regular options and spot volatility (Todorov 2019) that utilizes more OTM strikes are informative beyond the classical Black-Scholes implied volatility; (d) whether option-implied risk factors, namely spot volatility and Black-Scholes implied volatility, are priced in grain futures markets?

We employ end-of-day options data for corn and soybeans from the CME Group. Both weekly and standard options are included from 2017 to 2021. We discuss trading activities and liquidity of weekly options as well as their comparison to regular options over the last five years. We document stylized facts on volatility risk premium and volatility term structure based on Black-Scholes ATM implied volatility and spot volatility using Todorov (2019), surrounding important events such as USDA reports. To highlight the potential information embedded in weekly options, we run regressions of realized volatility on spot volatility and Black-Scholes implied volatility from both weekly and regular options. We also regress futures return on both measures of implied volatility to examine the return-risk tradeoff in the two commodities.

We organize the rest of paper as follows: Section 2 reviews the relevant literature on weekly options and predictability of various implied volatility measures. Section 3 proposes hypotheses to be tested. Section 4 presents data and regression models. Section 5 discusses the regression results and the effects of WASDE and other important reports. Section 6 concludes.

2. Literature Review

Different strands of research are related to the current study: weekly options, predictability of various implied volatility measures, and the prevalence of volatility around major reports. Existing research on weekly options is focused on equity markets. Andersen et al. (2017) propose a semi-parametric model to extract tail risk from SPX weekly options. They find that left-tail risk embedded in weekly options is not spanned by market volatility and helps predict future returns. Todorov (2019) proposes a non-parametric measure of spot volatility from short-dated options that is separated from jumps by virtue of diminishing effect of higher values of characteristic exponent for the log return. Todorov and Zhang (2021) show that combining return-based and option-based volatility estimators offers nontrivial gains in volatility prediction. The forecasting gain is due to more precise measure of spot volatility. The literature is abundant in using option-implied volatility to predict future volatility. Carr and Wu (2009) employ variance swap rate (option-implied variance) to predict realized variance and documented the significant variance risk premium, namely implied variance (volatility) being higher than realized variance (volatility). In the agricultural commodity literature, Egelkraut et al. (2007) show that regular options-implied volatility is better in predicting future volatility than historical volatility does for the corn market. Wang et al. (2012) find that VIX-like measure of implied volatility improves volatility prediction over both historical volatility and Black-Scholes implied volatility for corn.

Several recent studies have connected events to different futures price changes and changes in volatility, but none have incorporated the presence of weekly options. Using daily data from 2009 through 2019, Cao and Robe (2022) find that the implied volatility on the nearby regular options prices fall from the closing before major reports to the close on the day of major reports. For corn and soybeans, the typical change in the implied volatility from day-to-day was close to zero, then statistically different on major report dates. Similar findings about the scope of the decrease in the implied volatility following reports were found by Goyal and Adjemian (2021). They modeled the daily change in the implied volatility of the nearby prices using daily data from 1995 through 2019 to assess the impact of the WASDE report that was not released in January of 2019. Such studies consistently find report-related declines in the implied volatility. However, knowing changes occur does not say anything about the relative effectiveness of the implied volatility as a forecast of the volatility around the reports.

Isengildina-Massa et al. (2021) clearly describe the range of major USDA reports likely to affect the prominently-traded futures contracts. Using data from 1985 through 2018, they compare the nearby futures price changes on report dates to non-report dates across commodities. They find that prices generally, and often in statistically significant ways, fluctuate more on report dates. Similarly, Adjemian (2012) found higher price volatility around WASDE releases for cotton, soybeans and wheat. Thus, by providing information to the market the prices can respond and afterwards volatility can be reduced. What is missing to date from the studies of major reports is any connection between implied and realized volatility.

3. Hypothesis Development

The main objectives of this research are to investigate (i) whether weekly options on grain futures are unique in the marketplace that has been dominated by regular options; (ii) whether weekly and regular options are priced fairly in the sense that implied volatility differs from realized volatility, especially around major USDA reports; and (iii) whether weekly options provide additional information beyond regular options and spot volatility (Todorov 2019) are informative beyond what is embedded in the classical Black-Scholes implied volatility.

We address objective (i) by comparing the trading activities of weekly options to regular options over time. Regarding objective (ii), we hypothesize that there is a negative volatility risk premium (VRP) for both weekly and regular options, i.e., the underpricing of realized volatility relative to implied volatility. The existing literature has pointed to the existence of VRP for regular options in equity markets (Carr and Wu, 2009) and in grain markets (Wang et al., 2012). We further hypothesize that the overpricing (or underpricing) of implied (realized) volatility is more pronounced around major report dates, such as WASDE reports. Regarding objective (iii), we conjecture that (a) weekly options provide additional information for predicting future volatility due to their short-tenor nature, as opposed to their longer-term counterpart in regular options; (b) spot volatility is more informative than at-the-money Black-Scholes implied volatility due to the inclusion of the full range of out-of-the-money strikes in the former calculation. The traditional asset pricing model supports volatility is a priced risk factor for asset returns. We anticipate the positive return-risk tradeoff holds for corn and soybeans.

4. Data and Methodology

4.1 Data

We employ end-of-day corn and soybean futures and options data from the CME group. The data span from 1/1/2017 to 12/31/2021. The options data include weekly, regular, and serial options. Weekly options have up to 5 contract offerings for a given calendar month. Regular options have the contract months of March ("H" as the month code), May (K), July (N), September (U) and December (Z) for corn and January (F), March (H), May (K), July (N), August (Q), September (U) and November (X) for soybeans. Serial options cover all other calendar months that are not available for regular options. The options dataset includes 70 variables, of which settlement price, open interest, volume, Globex open-high-low prices, delta, Black-implied volatility are used in this research.

We pair each option with their underlying futures. The underlying futures contract for a weekly option is typically the nearby futures contract, or the next deferred futures contract if the options expiration week is after the regular options expiration date. Table 1 provides the timeframe of each respective underlying futures contract for corn and soybeans.

Table 1. Time Periods for Options by Settlement Months

Corn		Soybeans	
Time frame	Contract (code)	Time frame	Contract (code)
Late Nov-Early Feb	Mar (H)	Late Oct-Early Dec	Jan (F)
Late Feb-Early Apr	May (K)	Late Dec-Early Feb	Mar (H)
Late Apr-Early Jun	Jul (N)	Late Feb-Early Apr	May (K)
Late Jun-Early Aug	Sep (U)	Late Apr-Early Jun	Jul (N)
Late Aug-Early Nov	Dec (Z)	Late Jun-Early Jul	Aug (Q)
		Late Jul-Early Aug	Sep (U)
		Late Aug-Early Oct	Nov (X)

4.2 Volatility Measures

Implied volatility Measures

We consider two options-implied volatility measures: Black-Scholes implied volatility and spot volatility proposed by Todorov (2019). The former measure is provided in the CME dataset, while the latter is computed according to Todorov (2019). The calculation of spot volatility for a given contract month includes all available strikes, therefore embedding the information about volatility smile. Todorov and Zhang (2021) show that spot volatility is more informative than high-frequency measure. Following their approach, we extrapolate out-of-the-money (OTM) options to the value of 2 ticks or 2.5 cents to overcome the limited range of option strikes when computing spot volatility. The key difference between spot volatility and at-the-money (ATM) Black-Scholes implied volatility is that spot volatility spans the whole spectrum of strikes, therefore potentially embedding the information on price jumps.

For convenience, we reproduce Todorov (2019) option-based spot variance at time *t* with time-to-maturity *T* as follows:

$$V_{t,T} = -\frac{2}{T\hat{u}_{t,T}^2}\mathcal{R}\left\{\log\left(\mathcal{L}_{t,T}(\hat{u}_{t,T})\right)\right\}$$

$$\mathcal{L}_{t,T}(u) = 1 - (u^2 + iu)\sum_{j=1}^{N_{t,T}} e^{iu[log(K_{j-1})-log(F_{t,T})]}\frac{O_{t,T}(K_{j-1})}{K_{j-1}^2}\Delta_j\,, u \in \mathrm{R}$$

where $N_{t,T}$, $F_{t,T}$, K_j $O_{t,T}(K_j)$, Δ_j, T are the number of OTM option strikes, futures price with maturity T, strike price, option premium for strike K_j, strike increment ($K_j - K_{j-1}$) and time-to-maturity, respectively. Furthermore, $\hat{u}_{t,T} = \hat{u}_{t,T}^{(1)} \wedge \hat{u}_{t,T}^{(2)}$ is defined below:

$$\hat{u}_{t,T}^{(1)} = \inf\{\mathrm{u} \geq 0: \left|\hat{\mathcal{L}}_{t,T}(u)\right| \leq 0.2\}$$

$$\hat{\mathrm{u}}_{\mathrm{t,T}}^{(2)} = \mathrm{argmin}_{u\in[0,\bar{u}]}\left|\hat{\mathcal{L}}_{t,T}(u)\right|$$

where $\bar{\mathrm{u}}_{\mathrm{t,T}} = \sqrt{\frac{2}{\mathrm{T}}\frac{\log(1/0.05)}{\widehat{\mathrm{BSIV}}_{\mathrm{t,T}}^2}}$ and BSIV is Black-Scholes implied volatility of the option with the closest strike to the underlying futures price.

Realized Volatility Measure

We calculate realized volatility (RV) as the standard deviation of the underlying futures' daily returns. Daily return at time *t*, r_t, is defined as log difference of daily futures price with maturity T as follows:

$$r_t = \log\frac{F_{t,T}}{F_{t-1,T}}$$

$$\mathrm{RV}W_t = \sqrt{\frac{\sum_{i=0}^{N-1}(r_{t+i} - \bar{r})^2}{N}}$$

where $F_{t,T}, \bar{r}, N$ are futures prices with maturity T, mean return, and the number of days, respectively. "W" is the default timeframe of 1 week. For volatility prediction, we consider realized volatility ranging from 1 week, 2 weeks, 4 weeks, and 8 weeks, denoted as RVW, RV2W, RV4W, RV8W respectively. Note that all volatility measures are annualized in this study.

We aim to document (a) whether options-implied spot volatility and jumps (both positive and negative) help predict future short-term volatility; (b) what are the asset implications of option-implied risk factors, namely spot volatility and jump risks are priced in grain futures markets and can predict futures returns in the future, especially in the short term.

4.3 Volatility Prediction

The unique features of weekly options lend themselves to potential advantage in predicting future volatility. We run a regression of realized volatility on a combination of implied volatility measures, an extension of Egelkraut et al. (2007), Carr and Wu (2009), and Wang et al. (2012). We conjecture that (a) both weekly and regular options can inform future volatility and (2) spot volatility proposed by Todorov (2019) embeds additional information beyond Black-Scholes implied volatility.

The regression is given as follows:

$$RV_t = b_0 + b_1 SV_{wt} + b_2 BSIV_{wt} + b_3 SV_{rt} + b_4 BSIV_{rt} + e_t \quad (1)$$

where "w" and "r" denote "weekly" and "regular" respectively, and the dependent variable, RV, can take the form of RVW, RV2W, RV4W, RV8W for 1-week, 2-week, 4-week, and 8-week realized volatility, respectively.

4.4 Return Risk Trade-off

We investigate whether spot volatility, Black-Scholes volatility and various realized volatilities are priced as factors in daily futures returns. The following regression provides empirical evidence on the return-risk trade-off in corn and soybean markets.

$$r_t = b_0 + b_1 SV_t + b_2 BSIV_t + b_3 RVW_{t-1} + b_4 RV2W_{t-1} + b_5 RV4W_{t-1} + b_6 RV8W_{t-1} + e_t \quad (2)$$

5. Results and Discussions

5.1 Summary Statistics

We report end-of-day summary statistics on select variables for corn and soybeans futures and options (2017-2021) in Table 2. The variables include daily futures price (FutP), futures return (FutR), spot volatility (SV), Black-Scholes implied volatility (BSIV), 1-week (RVW), 2-week (RV2W), 4-week (RV4W) and 8-week (RV8W) realized volatilities, option trading volume (Volm) and open interest (OI). Such statistics as mean, standard deviation (std), minimum (min), median (med), and maximum (max) are reported for the overall sample and for weeklies.

We find that the mean of futures prices is greater than the median for both commodities, indicating positive skewness. RV exhibits a contango term structure, higher volatility for longer maturity, for both commodities. For corn, SV is higher than BSIV and RV. This implies the market impounds more premium in options due to the likelihood of price jumps. For soybeans, the relationship only holds largely for weekly options. We conjecture that it might be due to less liquidity in the soybean options and the extrapolation procedure potentially biases the estimate of SV downward.

Table 2. Summary Statistics for Corn and Soybeans (2017-2021)

Corn		FutP	FutR	SV	BSIV	RVW	RV2W	RV4W	RV8W	Volm	OI
	mean	4.129	0.000	0.290	0.202	0.197	0.206	0.235	0.266	5178.4	66062.7
	std	0.876	0.016	0.136	0.069	0.110	0.095	0.121	0.118	10510.3	107793.3
All	min	3.078	-0.191	0.030	0.075	0.027	0.045	0.068	0.087	0.0	2.0
	med	3.770	0.001	0.269	0.185	0.171	0.185	0.209	0.238	784.5	14135.5
	max	7.323	0.062	3.619	0.835	0.796	0.637	0.940	0.750	193404.0	584350.0
	mean	4.158	0.000	0.300	0.234	0.203	0.211	0.238	0.268	1086.7	2878.1
	std	0.888	0.016	0.196	0.095	0.114	0.097	0.121	0.119	1905.8	3325.6
Weeklies	min	3.078	-0.191	0.030	0.075	0.027	0.045	0.068	0.087	0.0	2.0
	med	3.790	0.001	0.259	0.213	0.177	0.191	0.211	0.238	338.0	1603.0
	max	7.323	0.062	3.619	0.835	0.796	0.637	0.940	0.750	18304.0	20981.0
Soybeans		FutP	FutR	SV	BSIV	RVW	RV2W	RV4W	RV8W	Volm	OI
	mean	10.289	0.000	0.149	0.168	0.158	0.166	0.187	0.204	3217.0	31831.9
	std	1.931	0.012	0.075	0.042	0.091	0.075	0.092	0.095	6249.6	50857.5
All	min	8.025	-0.086	0.005	0.070	0.013	0.043	0.075	0.098	0.0	1.0
	med	9.563	0.001	0.132	0.160	0.140	0.155	0.166	0.178	400.0	6985.0
	max	16.425	0.064	0.924	0.599	0.783	0.663	0.735	0.533	95350.0	301963.0
	mean	10.413	0.000	0.201	0.179	0.162	0.170	0.189	0.209	280.9	804.2
	std	2.016	0.012	0.097	0.057	0.095	0.078	0.095	0.098	405.6	834.9
Weeklies	min	8.025	-0.086	0.021	0.070	0.013	0.043	0.075	0.098	0.0	1.0
	med	9.650	0.000	0.183	0.169	0.142	0.157	0.168	0.181	130.0	541.0
	max	16.425	0.064	0.924	0.599	0.783	0.663	0.735	0.533	4353.0	6542.0

A further look into options trading volume and open interest in Figure 1, there is a slight upward trend in weekly options, but no clear trend in regular options over the sample period of 2017 to

2021. Figure 2 shows that trading volume and open interest in weekly options have grown relative to regular options, for both commodities. Corn weeklies have seen a significant increase in trading volume, from 2.5% to 9.5% of regular options.

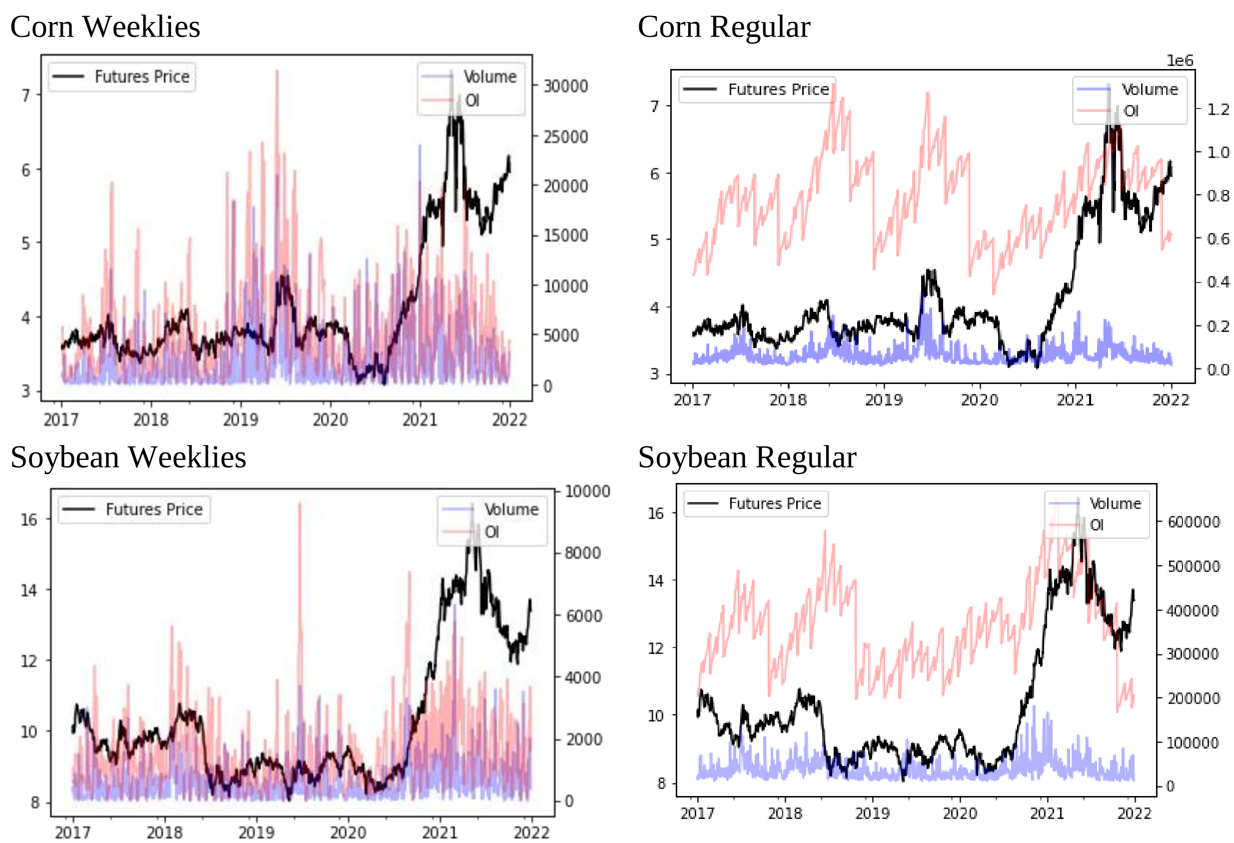

Figure 1. Options Trading Volume and Open Interest

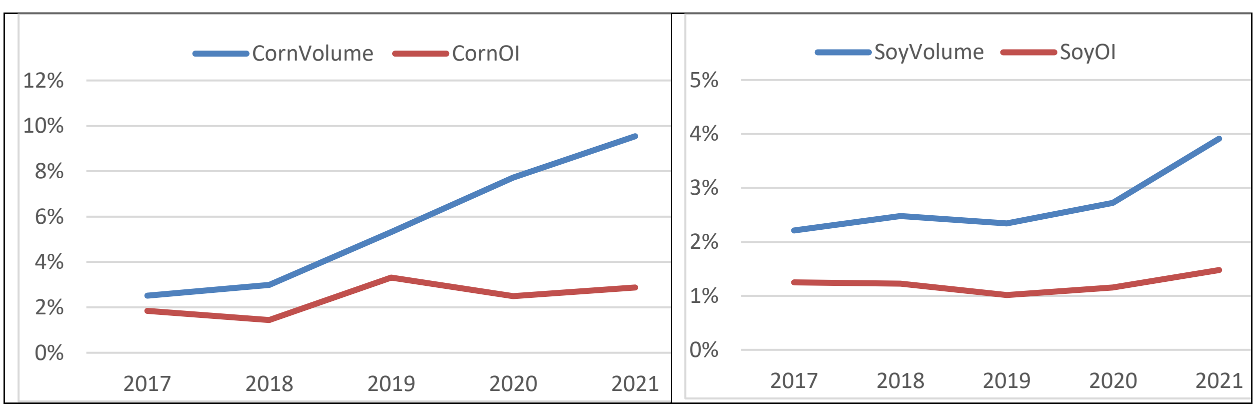

Figure 2. Weeklies as % of Regular (Volume and Open Interest)

5.2 Effects of Major Reports

For major row crops in the U.S., there are several major reports produced by the U.S. Department of Agriculture that provide fundamental information to the markets at consistent times throughout the year. The major reports include: WASDE, Crop Production, Grain Stocks, Prospective Plantings and Acreage. The WASDE and Crop Production reports are release at the same time during the second full business week of each month. The Grain Stocks are released quarterly with the January (reflecting December 1) on the same date and time as the WASDE. In March the Grain Stocks and Prospective Planting are released at the end of the month. In June, the Grain Stocks and Acreage reports are released at the end of the month. In September, the Grain Stocks are released at the end of the month. By bringing fundamental information to marketing participants, futures prices change reflecting the incorporation of the information by market participants. Several studies have connected events to different futures price changes and changes in volatility.

Industry participants often refer to positioning ahead of or stepping in orders surrounding major report events. Using short-dated options, weeklies, provide ways to enter positions. The U.S. federal government shutdown of 2019 influenced the availability and timing of reports. There was not a WASDE released during January of that year. The other major reports that were scheduled to be released in January (Crop Production and Grain Stocks), were released on February 8, 2019. During the sample period, 2017 through 2021, there were thus 59 WASDE dates and 74 distinct dates with reports. The WASDE and other reports were released during trading days at noon ET during the sample period. There are several ways the variability could be assessed around such reports. The futures price changes can be measured from close-to-close, which would measure the realized effects of major reports. Doing so, however, would mask the intra-day variability in prices that may result from positioning ahead of and then reacting to the information.

To assess the futures variability on WASDE and other major report dates, a preliminary analysis was conducted using the daily high and low prices on major report and non-report dates. Holidays are present in the futures data, so those observations were removed. On average for the full sample, 1,261 trading days, the observed range was $0.084 per bushel. On dates with a major report, 74 trading days, the daily high-low spread averaged $0.142 per bushel on the nearby corn futures. On non-report dates, 1,187 trading days, the spread averaged $0.081 per bushel. Thus, there is more variability and risk present on major report dates. Such risk could be measured and potentially mitigated using weekly options.

Because of the timing of the release of the major reports, they occur during weeks that a weekly option would expire or be trading, in addition to a regular option and sometimes a serial option. The regular and serial options were treated as interchangeable, and whichever had the shorter maturity was the active, nearby normal option. The data contained the annualized Black-Scholes derived implied volatility for all options, for all strikes, being calculated using the settlement prices for a given day. Thus, the implied volatility was obtained for the at-the-money options for the weekly option that was nearest to expiration and the normal option that was the nearest to expiration. The implied volatility was then sorted and compared based on the close the day before a major report to the close on the day of a report. Prior to a major report, the implied volatility averaged 35.1% for weekly options and 23.8% for nearby options. Following a report, the implied volatility averaged 22.5% for weekly options and 21.0% for nearby options. Thus, both sets of options have the same scope of reduction in the implied volatility following major reports.

The literature often breaks out the effects for specific months but uses longer data sets. There are seasonal patterns in the implied and realized volatility related to the growing season. The WASDE includes multiple marketing years, and switches to the current new-crop marketing year in May for corn and soybeans, e.g., the May 2021 WASDE was the first to break out the 2021-2022 marketing year, reflecting the crop harvested in late 2021. The literature focused on WASDE and related reports also often considers a longer lead time prior to and following the event date, e.g., the event window in Cao and Robe (2022). Considering short-dated options allows for different insights into implied and realized volatility. By design, there is a weekly option that will expire on the Friday following a given major report. The underlying futures price may continue to adjust and/or incorporate information, but the weekly option's expiration provides a different way to look at positioning around events.

The presence of weekly, serial and regular options means that every Friday (or day prior for holidays) would have an option expiring. Some weeks would have reports, e.g., WASDE reports. In general, the major reports are not released in weeks with a serial nor regular option expiration. To further refine the comparison, the data were sorted and each Friday the implied volatility was identified for the closest weekly or nearby option. Thus, the option would have seven days until its last trade date or maturity. In weeks without a weekly, the option would either be the regular or serial option that was close to expiration. This can be read as, the volatility in the nearby futures with a trading option would be this percent for the coming week that is the remaining life of said option. The realized volatility of the futures was also computed for the upcoming week, adjusting for the number of trading days, and matched to the implied volatility. This gives a set of one-week ahead forecasts of the volatility (261 weeks or observations).

The volatility pattern is similar for corn and soybeans around major reports. For the full corn sample, the implied volatility for the week ahead averaged 21.5% while the realized volatility averaged 17.3%. However, much of the difference was concentrated in weeks that would contain a major report. During weeks with major reports pending, the implied volatility averaged 25.6% and the realized volatility averaged 16.8%. In weeks without a major report pending, the implied volatility averaged 19.8% and the realized volatility averaged 17.5%. For the full soybean sample, the implied volatility for the week ahead averaged 16.7% while the realized volatility averaged 13.9%. During weeks with major reports, the implied volatility was 19.0% and the realized averaged 14.5%. In non-report weeks the implied volatility was 15.8% and the realized was 13.7%. In other words, in the short run during weeks with major reports there was a substantial volatility risk premium paid for weekly options that was not present in the regular options with the same days until expiration.

The differences can be quantified by considering regression results where the dependent variable is the realized volatility, and the independent variables include an intercept, the Black-Scholes implied volatility, a dummy variable if the week contains a major report or reports, and a dummy variable interaction term with the IV if the week contains a major report or reports (Table 3). For corn, the default slope coefficient is 0.835 and statistically significant. The presence of major reports results in a pronounced shift up in the intercept and a pronounced shift down in the slope (Figure 3). In other words, during report weeks the implied volatility outpaces the realized volatility. For soybeans the results are not as pronounced. The implied volatility coefficient is similar to the corn model, but the report coefficients are not statistically significant.

For comparison, a one-month ahead model was developed with the dependent variable as the realized volatility with 28 days (or adjusted for holidays) until expiration. This gives 59 observations, each of which would have contained one or two major report dates except for January of 2019. The independent variables are an intercept and the implied volatility of each consecutive regular or serial option with 28 days until its expiration (Table 4). For corn, this model has an intercept coefficient that is not statistically different from zero at the 0.05 level. The implied volatility coefficient at 0.836 is greater than in the one-week ahead model, but less than 1.0 (Figure 3). This suggests that regular options also exhibit a volatility risk premium over the full span or period prior to expiration. For soybeans, the intercept is not statistically significant. The implied volatility coefficient is 0.966, again greater than in the one-week ahead model, and closer to 1.0 compared to the corn model. Thus, the volatility risk premium is less in the soybean options compared to in the corn options.

Table 3. One-Week Ahead Realized Volatility Model without Rolling

	Co-efficient	Standard Error	P-value
Corn RV			
Intercept	0.009	0.015	0.551
Implied Volatility	0.835	0.072	0.000
Major Report (Int)	0.073	0.031	0.000
Major Report (Slope)	-0.496	0.120	0.000
R^2	0.36	Prob (F-statistic):	0.000
Soybean RV			
Intercept	0.003	0.016	0.807
Implied Volatility	0.842	0.097	0.000
Major Report (Int)	0.014	0.032	0.672
Major Report (Slope)	-0.172	0.172	0.317
R^2	0.27	Prob (F-statistic):	0.000

Table 4. One-Month Ahead Realized Volatility Model without Rolling

	Co-efficient	Standard Error	P-value
Corn RV			
Intercept	0.038	0.019	0.052
Implied Volatility	0.836	0.085	0.000
R^2	0.62	Prob (F-statistic):	0.000
Soybean RV			
Intercept	0.004	0.023	0.846
Implied Volatility	0.966	0.133	0.000
R^2	0.47	Prob (F-statistic):	0.000

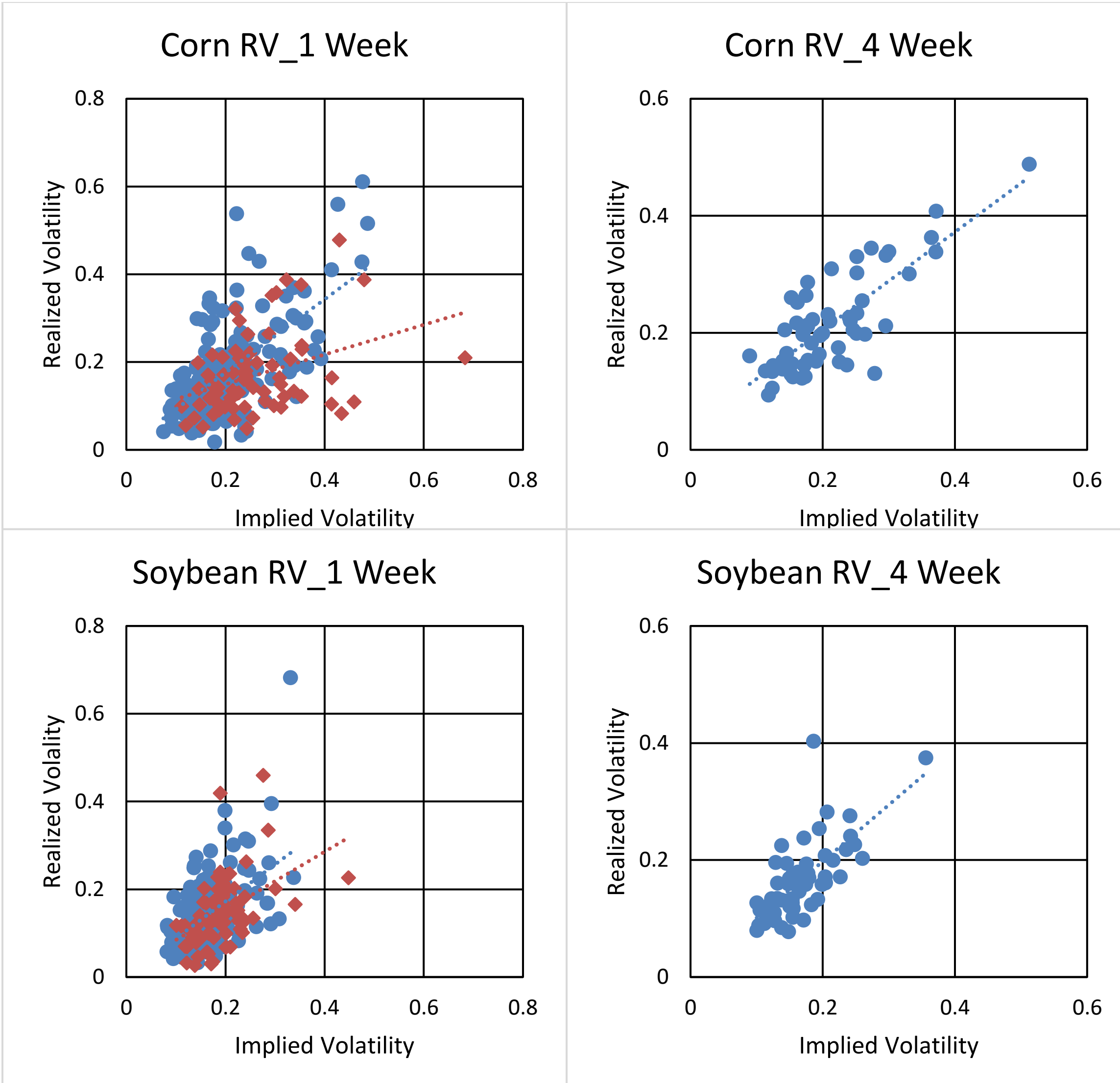

Figure 3. Volatility Comparisons without Rolling

5.3 Regression Results

Corn

We report realized volatility prediction results for corn in Table 5. The overall R^2 in Table 5 for corn shows a declining trend from 0.427 to 0.123 as prediction horizon increases from 1 week to 8 weeks. All coefficients that are statistically significant are positive, show that implied volatility is a leading indicator of subsequent realized volatility and different measures of implied volatility complement each other. Regular BSIV is statistically significant at the 1% level across all time horizons. This finding is consistent with the existing literature (Egelkraut et al. 2007, Wang et al. 2012). Regular BSIV also carries the highest weight among all four implied volatility measures in predicting future volatility. Weekly SV is also statistically significant across all time horizons, indicating additional information afforded by OTM options. Weekly BSIV is significant for only 1-week ahead. In contrast, regular SV is significant for longer time horizons, namely 4 weeks and 8 weeks into future. In sum, weekly options are particularly informative in near term, and spot volatility provides extra information beyond the traditional Black-Scholes volatility.

Table 5. Corn Realized Volatility Prediction

This table reports the regression of Equation (1) for corn using weekly and regular options from 2017 to 2021. Subscripts "w" and "r" in the regression variables denote "weekly" and "regular", respectively. "coef", "std err", "P>|z|", "R^2", "Prob" represent coefficient estimate, standard error, p-value, R-squared, probability of F-statistic. Standard errors are HAC robust with 5 lags. "***", "**", "*" denote 1%, 5% and 10% statistical significance respectively.

	Variable	**const**	**SVw**	**BSIVw**	**SVr**	**BSIVr**
1-W	**coef**	0.012	0.089***	0.159*	0.013	0.557***
	std err	0.013	0.020	0.087	0.034	0.121
	P>|z|	0.337	0.000	0.068	0.702	0.000
	R^2	0.427		**Prob (F-statistic):**		0.000
2-W	**coef**	0.019	0.062**	0.051	0.035	0.699***
	std err	0.011	0.028	0.077	0.034	0.121
	P>|z|	0.085	0.028	0.503	0.303	0.000
	R^2	0.540		**Prob (F-statistic):**		0.000
4-W	**coef**	0.063	0.087*	0.002	0.158**	0.477***
	std err	0.019	0.049	0.092	0.078	0.174
	P>|z|	0.001	0.076	0.983	0.044	0.006
	R^2	0.295		**Prob (F-statistic):**		0.000
8-W	**coef**	0.123	0.056**	-0.008	0.126**	0.443***
	std err	0.021	0.026	0.093	0.052	0.163
	P>|z|	0.000	0.032	0.931	0.015	0.007
	R^2	0.209		**Prob (F-statistic):**		0.000

Soybeans

We report realized volatility prediction results for soybeans in Table 6. The overall R^2 in Table 6 for soybeans are higher for 1-week and 2-week predictions than for 4-week and 8-week predictions. The model fit for soybeans is generally worse than that for corn.

As with corn, all coefficients that are statistically significant are positive for soybeans. Regular BSIV is statistically significant at the 1% level across all time horizons and contributes most among all four implied volatility measures to predicting future volatility.

Unlike corn, weekly SV is not statistically significant for any predictive time horizon. As with corn, weekly BSIV is significant for 1-week and 2-week predictions. We attribute this discrepancy to inferior liquidity in OTM soybean weekly options, because BSIV utilizes ATM options while SV requires (extrapolation of deeper) OTM options. As with corn, regular SV in soybeans is significant for longer time horizons, namely 4 weeks and 8 weeks into future. In sum, near-the-money weekly options are particularly informative in near term, and spot volatility in regular options provides extra information beyond the traditional Black-Scholes volatility.

Table 6. Soybean Realized Volatility Prediction

This table reports the regression of Equation (1) for soybeans using weekly and regular options from 2017 to 2021. Subscripts "w" and "r" in the regression variables denote "weekly" and "regular", respectively. "coef", "std err", "P>|z|", "R^2", "Prob" represent coefficient estimate, standard error, p-value, R-squared, probability of F-statistic. Standard errors are HAC robust with 5 lags. "***", "**", "*" denote 1%, 5% and 10% statistical significance respectively.

	Variable	const	SVw	BSIVw	SVr	BSIVr
1-W	**coef**	0.021	0.007	0.236*	-0.049	0.654***
	std err	0.021	0.036	0.135	0.036	0.149
	P>|z|	0.316	0.842	0.080	0.171	0.000
	R^2	0.238		**Prob (F-statistic):**		0.000
2-W	**coef**	0.021	0.032	0.198*	-0.002	0.563***
	std err	0.018	0.027	0.105	0.031	0.143
	P>|z|	0.250	0.228	0.060	0.954	0.000
	R^2	0.320		**Prob (F-statistic):**		0.000
4-W	**coef**	0.022	0.024	-0.018	0.108**	0.642***
	std err	0.025	0.037	0.097	0.046	0.171
	P>|z|	0.382	0.517	0.853	0.019	0.000
	R^2	0.180		**Prob (F-statistic):**		0.000
8-W	**coef**	0.044	0.031	0.009	0.099**	0.535***
	std err	0.024	0.036	0.093	0.039	0.144
	P>|z|	0.066	0.390	0.926	0.011	0.000
	R^2	0.174		**Prob (F-statistic):**		0.000

Return-Risk Tradeoff

We report return-risk regression (Equation 2) results for corn and soybeans in Table 7. The overall R^2 shows a better fit for corn than for soybeans. Consistent with early findings, the regression explanatory power for soybeans is weak, especially for weeklies. For corn, SV is positive and statistically significant for weekly options as is BSIV for regular options, controlling historical realized volatilities. Implied volatility, either via spot volatility or Black-Scholes volatility is a factor that is priced in one-day futures return. For soybeans, we will focus on the regression with regular options, as the model fit for weekly options is poor. BSIV is positive and statistically significant for regular options, controlling historical realized volatilities.

Table 7. Return-Risk Regression Results

This table reports the regression of Equation (2) for corn and soybeans using weekly and regular options from 2017 to 2021. RVW, RV2W, RV4W, RV8W represent 1-week, 2-week, 4-week, and 8-week realized volatility, respectively. "coef", "std err", "P>|z|", "R^2", "Prob" represent coefficient estimate, standard error, p-value, R-squared, probability of F-statistic. Standard errors are HAC robust with 5 lags. "***", "**", "*" denote 1%, 5% and 10% statistical significance respectively.

	Weeklies			Regular		
Corn	**coef**	**std err**	**P>|z|**	**coef**	**std err**	**P>|z|**
const	0.002	0.002	0.231	0.001	0.001	0.592
SV	0.011**	0.005	0.042	-0.001	0.002	0.808
BSIV	0.001	0.011	0.910	0.021**	0.008	0.008
RVW_{t-1}	0.012	0.010	0.210	0.012*	0.007	0.070
$RV2W_{t-1}$	0.005	0.012	0.673	0.005	0.009	0.544
$RV4W_{t-1}$	-0.034*	0.021	0.098	-0.028*	0.015	0.067
$RV8W_{t-1}$	-0.009	0.012	0.471	-0.010	0.008	0.245
	R^2=0.024	**Prob**=0.05		**R^2**=0.014	**Prob**=0.03	
Soybeans	**Coef**	**std err**	**P>|z|**	**coef**	**std err**	**P>|z|**
const	0.000	0.002	0.812	-0.002*	0.001	0.077
SV	0.007	0.005	0.179	-0.003	0.003	0.302
BSIV	-0.004	0.011	0.738	0.027***	0.009	0.003
RVW_{t-1}	0.000	0.008	0.973	0.000	0.006	0.994
$RV2W_{t-1}$	-0.004	0.015	0.779	0.003	0.009	0.691
$RV4W_{t-1}$	0.023	0.015	0.142	0.005	0.012	0.673
$RV8W_{t-1}$	-0.025*	0.013	0.064	-0.017	0.011	0.106
	R^2=0.006	**Prob**=0.51		**R^2**=0.005	**Prob**=0.09	

6. Conclusions

In this research, we examine (a) whether weekly options on grain futures are unique in the marketplace that has been dominated by regular options; (b) whether weekly and regular options are priced fairly in the sense that implied volatility differs from realized volatility, especially around WASDE and other important dates; (c) whether weekly options provide additional information beyond regular options and spot volatility (Todorov 2019) that utilizes more OTM strikes are informative beyond the classical Black-Scholes implied volatility.

Using the end-of-day weekly and regular options on corn and soybeans, we find that:
(a) weekly options have gained popularity over the last five years due to its ability to position around important events, such as WASDE reports.
(b) there is a negative volatility risk premium, i.e., implied volatility greater than realized volatility surrounding the important events, but such a premium ceases to exist for non-event dates.

(c) weekly options are particularly informative in near term and spot volatility provides extra information beyond the traditional Black-Scholes volatility, although the empirical evidence is stronger for corn than for soybeans. Spot volatility from weekly options and Black-Scholes implied volatility from regular options are a positively priced factor for futures returns.

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