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Implied Volatility Patterns Around Crop Reports

CME Group lists weekly and short-dated new crop options for corn, wheat, and soybeans to complement standard and serial options. Weekly and short-dated new crop options on futures provide market participants with a way to trade more precisely around events such as USDA crop reports. While the finance literature has identified that short-dated options can provide exposure to both volatility and jump risks, these phenomena have not been identified in agricultural commodities. The intra-day release of reports is suspected of masking volatility patterns. Regular and short-dated options are examined to determine whether nearby and new-crop futures respond similarly to fundamental information in major crop reports. Both nearby and new-crop futures have higher price variability on report dates. In general, the implied volatility of short-dated options is reduced following the release of fundamental reports. There is evidence of concavity in the implied volatility distribution during the release date prior to release of reports, suggesting that jumps are expected before some reports.

Key words: short-dated new crop options, weekly options, spot volatility

Introduction

Regular options on deliverable futures contracts have settlement or expiration dates that precede the delivery period of the underlying futures. As commodity futures markets have matured, exchanges have facilitated the delineation of risk by adding option contracts with earlier settlement periods. These are collectively referred to as short-dated options. The earliest variations are also known as serial options, which would expire roughly one or two months prior to regular options. Weekly options, settling to the nearby and short-dated new-crop options have

traded for over a decade. Recently, the CME Group introduced weekly new-crop options. These options settle against an existing futures contract prior to the normal or regular option settlement date. For major grains and oilseeds on the CME, these options expire on Fridays.

As short-dated options have gained in popularity, as evidenced by the larger trading volume, option interest and expanded offerings, they could have switched from using the price information from existing, regular options, to providing unique or distinct information about price expectations specific to the tenor they reflect. In other words, a short-dated option series may say something about short-run prices that augments what the regular option series would convey.

Major fundamental reports in storable commodities may provide information that affects both nearby (old-crop) and new-crop prices. The level of effect would not have to be uniform nor would both prices necessarily be influenced by any information. WASDE reports, for example, may provide signals about either old- or new-crop prices. *Grain Stocks* reports are simultaneously released with *Prospective Plantings* and *Acreage* reports. The former would predominantly influence nearby prices, while the latter the new-crop prices.

Short-dated options can provide exposure to both volatility and jump risks. The immense popularity of short-dated options around USDA reports offers a great opportunity to examine the market's perception before and after the report. It has been well documented that option implied volatilities run up before the event and attenuate after the event (Cao and Robe 2021). Implied volatilities are often measured as at-the-money (ATM) Black-Scholes option implied volatility, or a VIX-like volatility based on a portfolio of options (Todorov 2019). In this study, we aim to understand the shape of the whole implied volatility curve across all strikes around USDA reports, instead of implied volatility at the market price (ATM) or the overall level of implied volatility as mentioned above.

To our knowledge, there is no existing literature on the implied volatility surface of crop options around USDA reports. The most closely related literature is implied volatility smirk of commodity options (Jia et al. 2021) and implied volatility of stock options surrounding earnings announcement days (Alexiou et al. 2022; Dubinsky et al. 2019). Jia et al. (2021) found that implied volatilities of the four commodity ETF, namely oil, natural gas, gold, and silver, are negatively skewed with a positive curvature. The shape of implied volatility curves can predict future commodity returns. Their research focuses on standard options, instead of short-dated and weekly options. Alexiou et al. (2022) documented implied volatility curves often become concave prior to the earnings announcement day, reflecting a bimodal risk-neutral distribution of stock prices. Given the importance of USDA reports on crop prices, analogous to earnings announcements on stock prices, we hypothesize that concave implied volatility curves may exist for short-dated options prior to USDA crop reports. The concavity of implied volatility curve indicates market participants (over)pay a significant premium for price jump (or gamma) risk and/or volatility (or vega) risk.

In this study, we aim (a) to document whether implied volatility curves exhibit concavity before USDA reports and return to convexity after the reports; and have different predictability of future grain prices; (b) to assess whether the concavity is driven by jump risk or volatility risk; (c) to compare the volatility patterns between old crop and new crop options.

We will employ end-of-day options data for corn from the CME Group. Both weekly/short-dated and standard options will be included as a comparison from 2017 to 2021. Identifying patterns may suggest better hedging outcomes from the use of weekly or short-dated new crop options compared to regular nearby or new crop options. Because of the importance of volatility risk and jump risk surrounding USDA reports, we anticipate that both factors may contribute to the potential overpricing of report-day option premiums. We hypothesize that any

concavity in the volatility curve of short-dated options before USDA reports would reflect option buyers (hedgers) overpaying option premiums for fear of price jumps. The proposed study will help inform risk management practices by farmers and agribusinesses.

Conceptual Framework

A regular option can trade for two or three years prior to expiration. With a long time until maturity, option premiums can reflect an infinite number of potential paths that could arrive at or be consistent with the implied distribution at expiration. At some tenor, a week's or month's worth of volatility may not matter much relative to futures price changes that may still occur. Thus, at one extreme a short-dated option may merely reflect the capital advantage from holding an option with less time value than the regular option with the same underlying futures. This would be consistent with constant volatility expected over the full span of the regular option, and thus also over the full span of the short-dated option.

At another extreme, a short-dated option may reflect a distinct portion of a price change that will occur during its tenor that may be reflected in the level of implied volatility or in the shape of the implied volatility distribution. The underlying implied volatility term structure need not be constant over the remaining life of an option. Seasonally, crop volatility tends to be higher during the growing season. Thus, a short-dated option may not reflect the same implied volatility as its regular counterpart. This was largely the motivation used in Diersen and Wang (2022), where they compared weekly and serial options to regular nearby options.

Expanding from a difference in the implied volatility, differences in the shape of the distribution would be consistent with price jumps. Hull (2022) provides a rationale for distinct patterns that could be reflected in the implied volatility. First, either non-constant volatility or price jumps can result in the implied distribution being different from a lognormal distribution.

This results in a smile or similar pattern in the implied distribution. Second, a large price jump, for example, following a fundamental report, could result in the true underlying price distribution to be bimodal. It will still be observed as a single, skewed distribution with a concave volatility smile. Jumps in the underlying futures price can readily occur when major reports bring new or revised information to the market.

Concavity and other implied volatility patterns have been documented in equity markets. Preliminary efforts to identify such patterns in agricultural commodity markets were not evident when using settlement or end-of-day data. For about a decade the major reports have been released during the trading day. Most settlement series are smoothed to have internally consistent valuations for clearinghouse members. Looking at Bloomberg, for example, would rarely suggest any unusual patterns exist in the volatility surface.

Data

Some of the preliminary analysis was done directly through the CME Group website, Interactive Brokers, and Bloomberg. The tables and any modeling were prepared using corn futures and options data from 2017 through 2021. This is a combination of end-of-day data and intra-day data. The options include regular, serial, weekly (on the nearby), and short-dated new-crop. Note that not all options traded back to the beginning of the sample period. The release dates for various reports were from the National Agricultural Statistics Service.

Results

To discern whether short-dated new crop options would behave similarly to weekly and serial options, the dates of releases were tracked for WASDE, *Crop Production, Grain Stocks, Prospective Plantings*, and *Acreage* reports. There were 74 report observations from 2017-2021.

Following Diersen and Wang (2022), the daily range of nearby and new-crop (December) futures were compared on the full sample, report dates, and non-report dates (Table 1). The average range was slightly higher for the nearby contract relative to the new-crop contract. On report dates, the average range was higher for both nearby and new-crop prices compared to non-report dates.

Table 1. Average High-Low Daily Range of Corn Futures Prices

Contract	Full Sample	Report Dates	Non-Report Dates
Nearby	8.43	14.19	8.08
December	7.57	13.51	7.20

Note: cents per bushel from 2017-2021.

After observing similar variability of the nearby and new-crop prices on report dates, the implied volatility was compared before and after report dates. Following Diersen and Wang (2022), the implied volatility from the CME Group was averaged on the day prior to major reports, and on the settlement the day of major reports. The weekly and short-dated new crop options closest to expiration were used in the comparison. The pronounced change in the weekly implied volatility was not as evident in the short-dated new crop options (Table 2).

Table 2. Implied Volatility of Corn Options

Contract	Pre-Report Dates	Report Dates
Weekly	35.1	22.5
Nearby	23.8	21.0
SDNC	20.9	19.4
December	22.3	21.8

Note: Black-Scholes annualized implied volatility from 2017-2021.

To further refine the exploratory analysis of the short-dated new-crop (SDNC) options, those with the shortest tenor were isolated around the *Prospective Plantings* and *Acreage* report dates. Those reports are released on the last business day of March and June, respectively. The

May SDNC settles in late April, while the August SDNC settles in late July. Thus, these were analyzed to discern any impact from the reports. The preliminary findings suggest that the *Prospective Plantings* can reduce the short-run volatility in the new-crop contract as it is being incorporated. The implied volatility at the close prior to the report tends to be substantially higher than at the close on the day of the report (Table 3). The implied volatility for the regular December contract tends to increase following the report, suggesting that it takes longer than a day to incorporate the information from the report (Table 3). Note that the April WASDE would be released before the May SDNC option expires, but it only contains "old-crop" information.

Table 3. Implied Volatility Around Prospective Plantings Reports.

	May SDNC		December	
Year	Pre-Report	Post-Report	Pre-Report	Post-Report
2017	19.3	16.5	22.5	22.6
2018	18.4	14.1	20.5	21.6
2019	12.3	11.8	18.0	16.6
2020	24.2	21.5	21.5	20.3
2021	33.4	35.5	30.3	32.6
2022	37.4	31.2	23.5	22.6

Note: Black-Scholes annualized implied volatility from 2017-2022. The 2022 data are from Bloomberg.

Changes in the implied volatility are less pronounced following the Acreage report. The implied volatility at the close prior to the report was only higher for the August SDNC in 2019, and was otherwise lower than at the close on the day of the report (Table 4). The implied volatility for the regular December contract tends to increase following the report, suggesting that acreage information takes longer than a day to incorporate (Table 4). Note that the August WASDE and Crop Production reports would be released with specific "new-crop" information before the August SDNC option expires.

Table 4. Implied Volatility Around Acreage Reports.

	August SDNC		December	
Year	Pre-Report	Post-Report	Pre-Report	Post-Report
2017	26.9	27.9	22.3	23.4
2018	24.4	24.7	20.8	21.1
2019	33.6	28.6	28.8	26.2
2020	28.1	30.4	22.0	23.2
2021	55.2	55.9	38.4	40.0
2022	38.7	40.4	18.7	18.1

Note: Black-Scholes annualized implied volatility from 2017-2022. The 2022 data are from Bloomberg.

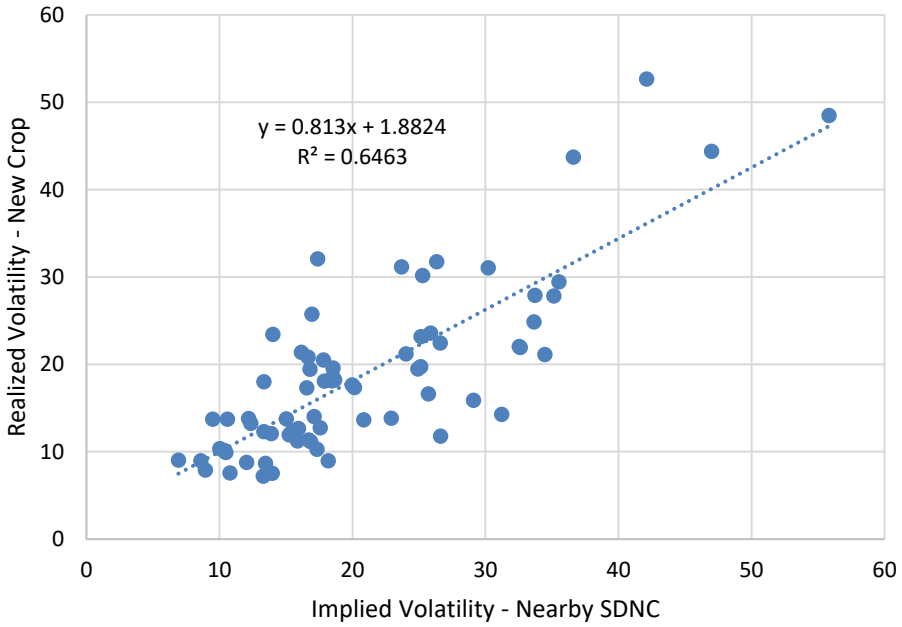
When comparing the SDNC options in these situations to the regular options, the term structure of the implied volatility is evident (Tables 3 and 4). In the May SDNC option, the implied volatility was consistently lower than the regular option. In the August SDNC option, the implied volatility was consistently higher than the regular option. The [corn] growing season uncertainty is seasonally higher than at other times, or it is relatively low prior to the May SDNC expiration and relatively high until after the August SDNC expiration.

Based on discussions with hedgers and commodity brokers about the various short-dated options, the impression is that the weekly options are used to position around reports. The rationale for SDNC options was more subtle and focuses more on stepping in pre-harvest sales. The differences in the implied volatility could thus be explained or justified by hedgers being willing to pay a risk premium to use the short-dated versus regular options. There was some evidence of a risk premium by Diersen and Wang (2022). The tenor for the SDNC options can be quite long. However, if used to step in sales they would likely be used for the shortest tenor available to meet such an objective. That is, the February, March, and April SDNC options may all be used to implement some hedges in January, February, and March of a given year. Similarly, some portion of unhedged bushels may be positioned for months or weeks prior to the *Acreage* report, but consistently using August SDNC options.

Another way to think about how SDNC options may be distinct is to consider if they are fairly or reasonably priced. If there was a substantial risk premium for using them, hedgers would be better off using regular options for the duration wanted. If the implied volatility were to reflect noise or be randomly distributed relative to the realized volatility, hedgers would [likely] be better off using regular options instead. To empirically assess SDNC options along these lines, the options were sorted, and the implied volatility obtained for when a given SDNC became the next to expire, generally within a month. For example, the May SDNC would be the next option to expire following the April SDNC expiring on the relevant Friday in March. The implied volatility was measured and compared to the realized volatility of the underlying December futures prices for the remaining life of the May SDNC option. This was done for the nearby year's worth of SDNC options and rolled to the next crop year when the September SDNC options expired.

The sample spanned from the February SDNC option that settled to the 2017 December futures price to the January SDNC option that settled to the 2023 December futures price giving 72 observations. The preliminary regression reveals that the intercept is significantly different from zero while the slope is significantly different from one (Figure 1). Thus, the implied volatility overstates the realized volatility, which would indicate a risk premium for hedgers. The adjusted R^2 and F-test support that the implied volatility is not random for the SDNC options. Thus, the SDNC options provide information about the tenor that may be distinct from that provided by the regular new-crop option.

Figure 1. Volatility of SDNC Options Four Weeks Until Expiration



Implied volatility curves were derived for all trading options on days before major reports. These were then plotted and examined for any type of concavity patterns. Recall, concavity is common in equities, but not necessarily common or prevalent in agricultural commodities. A lack of concavity, or the presence of a volatility smile was to be expected. For example, the volatility of the July option prior to the June 2020 WASDE report reflects the typical smile (Figure 2). Some evidence or expectation of a jump in prices was reflected in the July SDNC option and the weekly option prior to the 2021 *Acreage* report (Figures 3 and 4), reflecting similar expected moves for the new-crop and nearby contracts.

Figure 2. Typical Volatility Curve Reflecting a Smile, July 2020 Corn

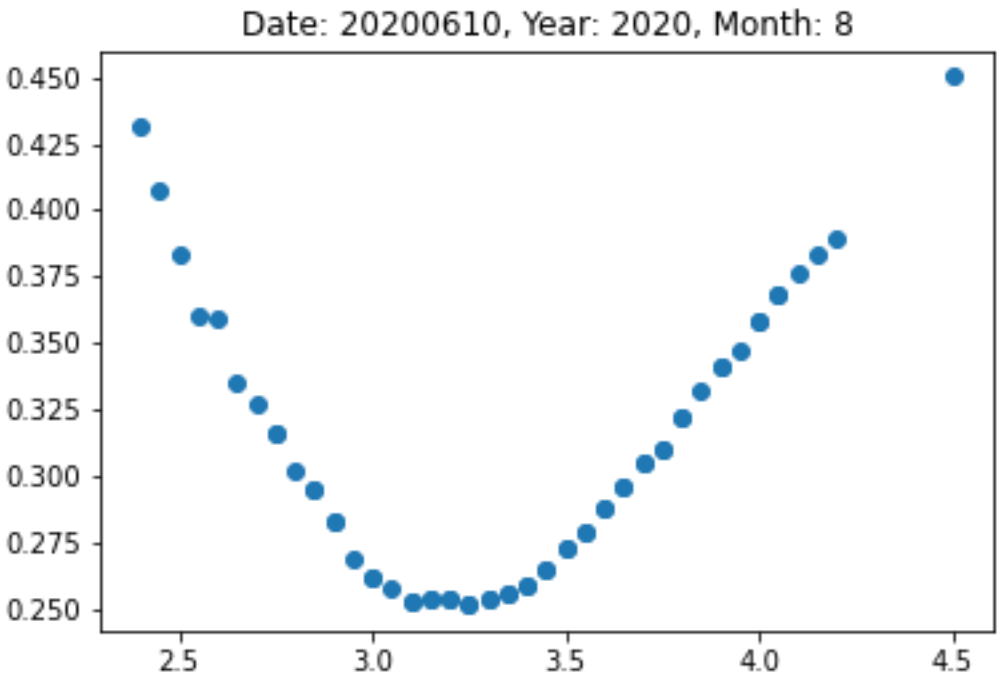


Figure 3. Concavity in July 2021 Short-Dated New-Crop Corn Options

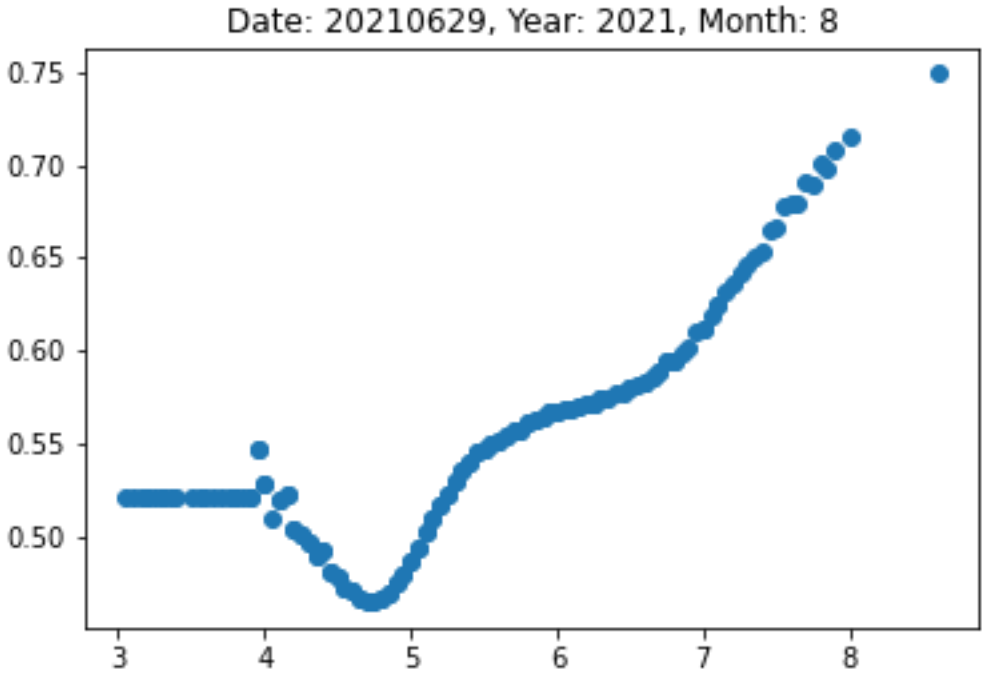
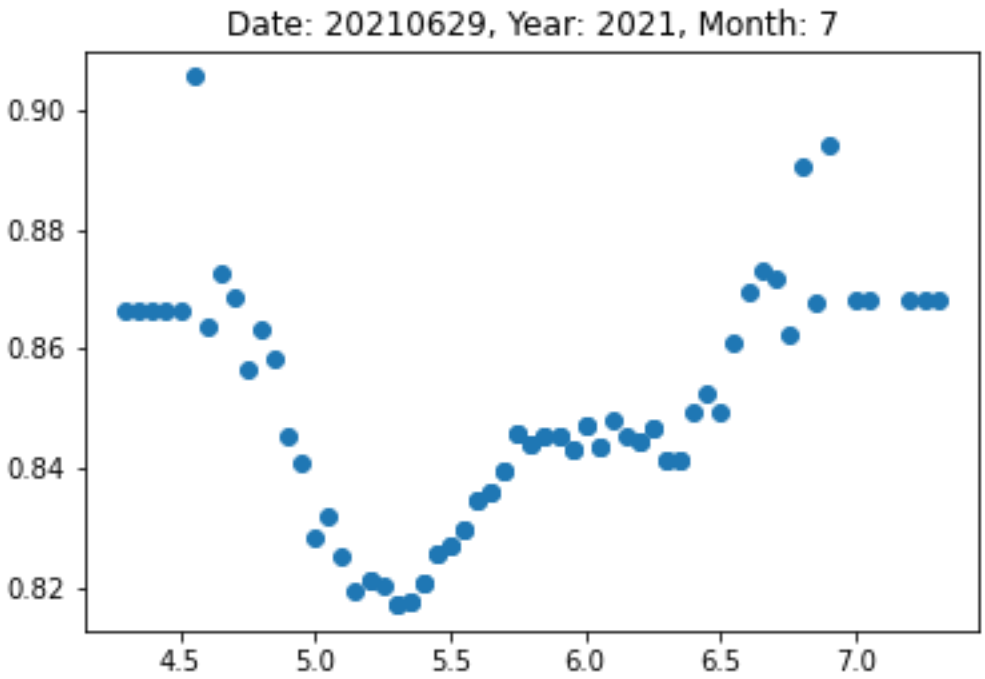


Figure 4. Concavity in July 2021 Weekly Corn Options



Using intraday data, the implied volatility curves were prepared for all trading options on the days major reports were released. The last trade by strike price prior to the 12 EST report release was used to build the curves. This was done across regular, short-dated new-crop and weekly options that traded on report dates from 2017-2021. The curves were than plotted for all report dates and options and visually inspected for any indications of concavity (Table 5). None of these would be mutually exclusive or the same underlying expectation of price jumps, for example, could be reflected in several options on a given date.

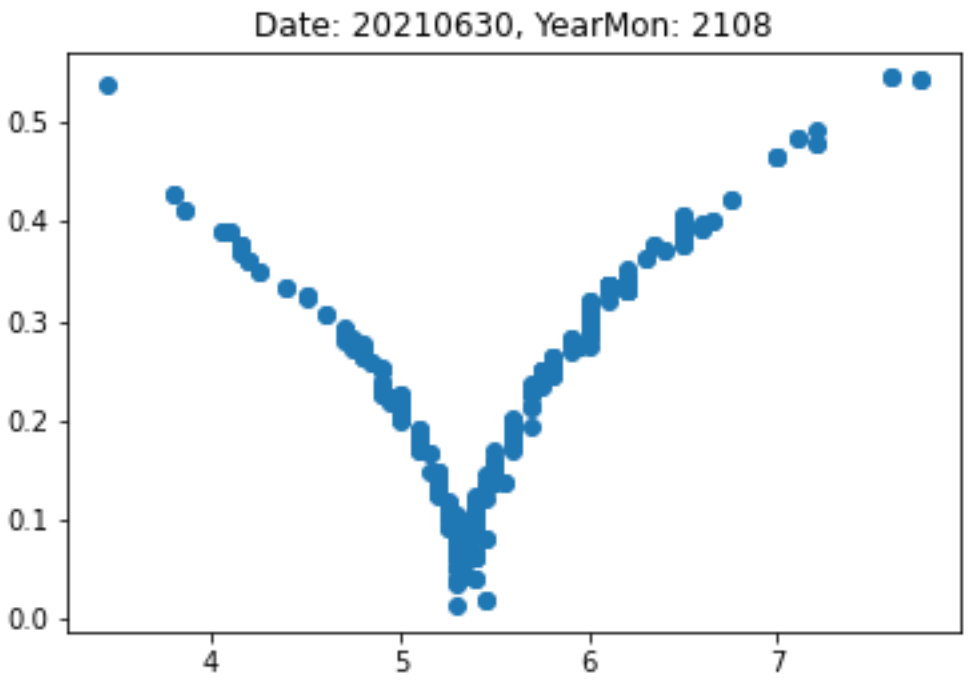
No attempt was made to distinguish among serial, nearby, deferred, or new-crop options for the initial pass, labeled as "Regular" option types in Table 5. The SDNC options were also examined together. While the share of SDNC with concavity was less than for regular options, when present the patterns were more pronounced. The weeklies were reported separately, thus

the slightly higher share for the PY4 would align with stocks and acreage reports more so than for WASDE releases. The concavity using intra-day premiums tended to be harsher curves (Figure 5).

Table 5. Presence of Concavity in Corn Options Prior to Major Reports

Option Type	Total Cohorts	Concavity	Concavity Share
Regular	477	103	21.6%
SDNC	674	83	12.3%
PY1	27	2	7.4%
PY2	65	5	7.7%
PY3	51	1	2.2%
PY4	11	3	27.3%
PY5	24	1	4.2%
Subtotal	1,319	198	14.9%

Figure 5. Intraday Concavity in July 2021 Corn Options



Conclusion

The implied volatility levels for nearby, short-dated, new-crop, and short-dated new-crop options vary, especially around the release of major fundamental reports. The SDNC options reflect the term structure of the underlying new-crop futures volatility, and the options do not reflect a sharp decline in implied volatility level following the release of major reports. Implied volatility curves can reflect concave patterns prior to reports. These can occur using end-of-day data but were also pronounced using intra-day data on the mornings of the release of major reports.

References

Alexiou, L., Goyal, A., Kostakis, A. and Rompolis L. (2022). Pricing Event Risk: Evidence from Concave Implied Volatility Curves. Working paper.

Cao, A and Robe, M. (2021). Market uncertainty and sentiment around USDA announcements. Journal of Futures Markets. https://doi.org/10.1002/fut.22283

Diersen, M. and Z. Wang (2022). Weekly Options on Grain Futures. Proceedings of the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. [http://www.farmdoc.illinois.edu/nccc134].

Dubinsky, A., Johannes, M., Kaeck, A., and Seeger, N. (2019). Option Pricing of Earnings Announcement Risks, Review of Financial Studies 32, 646–687.

Jia, X, Ruan, X, and Zhang, JE (2021). The implied volatility smirk of commodity options. Journal of Futures Markets. 41: 72– 104. https://doi.org/10.1002/fut.22161

Hull, J. (2021). Options, Futures, and Other Derivatives. 11th Edition, Pearson.

Todorov, V. (2019). Nonparametric Spot Volatility from Options. Annals of Applied Probability, 29(6), 3590-3636. DOI: 10.1214/19-AAP1488.