Information Rich Wheat Markets in the Early Days of COVID-19

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Abstract

This paper uses the information implicit in commodity futures and option prices to infer market beliefs about the impact of early-stages COVID-19 on commodity market fundamentals. The particular commodity examined is soft red winter (SRW) wheat, and the timeframe is early February to late March 2020. The analysis highlights various adjustments in the cash and futures price of SRW wheat in light of surging short run demand from consumer hoarding of staple food products, and a weakening long run market from growing wheat stocks and an emerging global recession. This split is causing the forward curve to flatten and basis levels to invert. The change over time in the price of options on wheat futures reveals increased price volatility in response to growing uncertainty about the COVID-19 impacts. Similarly, changes in the skewness of the option's volatility smile illustrates a shift in traders' perception about risk in the right versus left tail of the price distribution.

Keywords: COVID-19, Commodity Futures, Options, Price Volatility

JEL Codes: G13, Q11, Q14

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1. Introduction

Profit-driven speculation implies that beliefs about market fundamentals which are inferred from agricultural commodity futures and option prices are generally more accurate than other sources of market information. For this reason a commodity market's response to the unexpected rapid spread of the SARS-CoV-2 (Corona) virus is of considerable interest. The nature of the price response to a global crisis such as COVID-19 is multidimensional. First, commodity prices tend to rapidly decline along with the broader market when a crisis-induced global recession such as the one caused by COVID-19 unexpectedly emerges. Second, due to inelastic short run supply, crisis-induced changes in the short run demand for an agricultural commodity will normally have a strong immediate impact on that commodity's price. These impacts may be negative such as a sharp drop in the price of corn in response to a sizeable reduction in ethanol demand, or positive such as a sharp rise in the price of wheat in response to large-scale consumer hoarding of food staples. Third, changes in the demand for storage that results from anticipated surpluses or shortages in the future will typically jolt the cash price and the full set of futures prices. The market's estimate of the extent that COVID-19 will reduce up-and-coming global grain production and weaken the up-and-coming demand for livestock feed is of particular importance. Fourth, changes in the strength of domestic demand relative to export demand will skew the distribution of prices within a region. In recent weeks consumer hoarding of staples due to perceived COVID-19 food shortages significantly strengthened local demand, and this resulted in a rapid strengthening of the wheat basis for most inland regions. Finally, the Canadian dollar typically weakens with the onset of a global recession, and this weakening serves as a partial buffer for declining commodity prices in the Canadian market. This is clearly illustrated within the current COVID-19 crisis.

The price of options on commodity futures provide important signals about the market's estimate of future price volatility. Not surprisingly, the exceptionally high degree of uncertainty concerning the impact of COVID-19 on current and future food supply and demand has significantly raised the level of commodity price volatility. For example, in January and early February of this year wheat prices were in gradual decline as estimates of Chinese demand were revised downward, and estimates of the size of the Australian wheat harvest were revised upward. By late February and early March the rapid decline in the price of oil and the early projections of a COVID-19 induced global recession caused wheat prices to drop sharply. However, this drop rapidly reversed itself and instead wheat prices surged due to an unexpected jump in the demand for wheat by local processors who were attempting to address consumer hoarding-induced shortages. The price of options and the level of implied volatility steadily grew over the February to March period in response to growing uncertainty about future supply and

demand conditions. At the same time, the price premium for out-of-the-money (OTM) call options relative to OTM put options initially increased but then decreased as traders changed their minds about whether the right tail or the left tail of the price distribution contained the most significant source of risk.

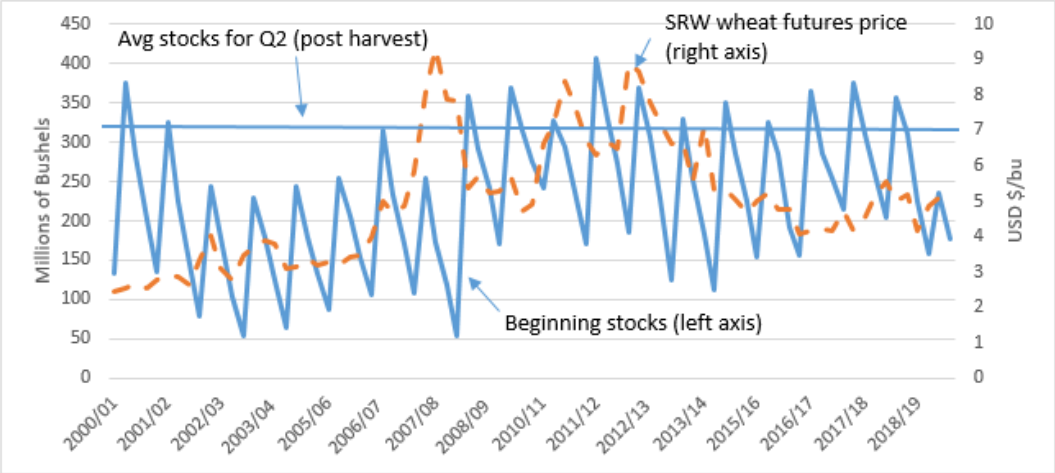
The next section of this paper examines the price dynamics and changes in the slope of the forward curve for SRW wheat futures during the early days of the COVID-19 crisis. Section 3 examines how COVID-19 impacted the basis (i.e., the difference between the cash price and the futures price) of SRW wheat for farmers and grain buyers who operate near London, Ontario. The connection between market price volatility and SRW wheat option pricing during the early days of the COVID-19 crisis is the topic of Section 4. Concluding comments are provided in Section 5. It should be noted that data for commodity futures and options come from the CME. Data for the basis, which together with the futures price allows the cash price to be calculated, comes from the Daily Commodity Report of the Grain Farmers of Ontario.[2]

2. Commodity Futures

The general results of this analysis are applicable to a broad range of agricultural commodities because the analysis focuses on fundamental principles of supply and demand. Soft red winter (SRW) wheat is used as a case study because wheat is a direct input into the human food chain and given recent consumer hoarding of staple foods, this feature is important. To set the stage for the analysis, Figure 1 shows for the preceding two decades quarterly U.S. stocks and the monthly average next-to-expire futures price of SRW wheat.[3] Notice how the below-average stocks in the early 2000s is associated with a rising futures price (with a lag), and the above-average stocks in the late 2000s is associated with a falling futures price (with a lag). The repeated sharp peaks in stocks occurs in the first quarter (Q1), which is when harvest is added to stocks which are carried into the new crop year. Figure 1 shows that a sharp reduction in the size of the 2019 harvest reduced stocks from an above-average level in 2018/2019 to a below-average level in late 2019.

[2] This report was downloaded from https://gfo.ca/marketing/daily-commodity-report/ on March 24, 2020.
[3] The quarterly stock data comes from the USDA wheat database (https://www.ers.usda.gov/data-products/wheat-data/). The stocks for the first two quarters of 2019/20 were estimated using the 2019 SRW wheat production estimate of 239.16 million bushels, and assuming that quarterly imports, exports, seed use and the residual variable each take on a value equal to the average of the five preceding years.

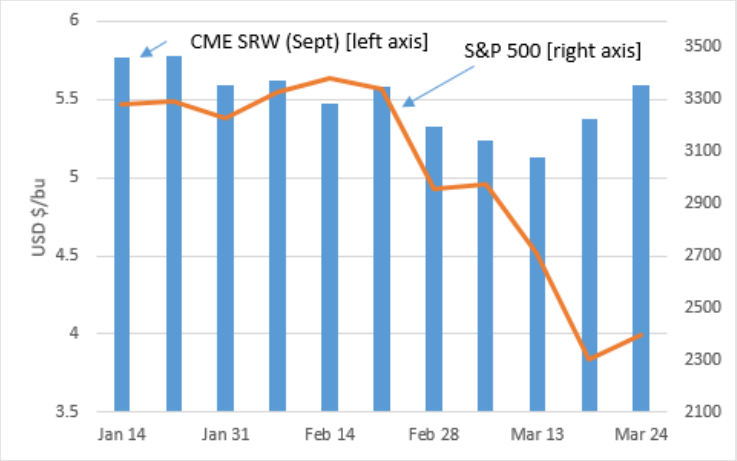
Figure 1: Quarterly Stocks and Average Quarterly Futures Price of SRW Wheat: 2000/01 – 2019/20



Much of this analysis focuses on the price of SRW wheat between January and March of 2020 (i.e., the early days of COVID-19). Throughout January the price of wheat together with the prices of the other major grains bumped up and down in response to forecasted changes in a variety of supply and demand variables. Of particular importance for wheat was the level of rainfall in Australia since a timely rainfall would reduce the severity of the Australian drought and increase future wheat production. The left side of Figure 2 shows that this business-as-usual trajectory changed in late January when it became apparent that the Chinese demand for commodities could shrink significantly in the coming months due to the Chinese lock-down response to COVID-19. After this late January price decline, throughout much of February commodity markets largely shrugged off the potential for a COVID-19 pandemic and instead focused on USDA WASDE reports and Australian wheat production projections. By early March the implications of COVID-19 for current and future global economic activity became increasingly apparent. Indeed, Figure 2 shows that the price of wheat fall fell sharply along with equities as reflected by the S&P 500.[4] The simultaneous decrease in the price of oil sharply reduced the demand for corn used in ethanol. This reduction in corn demand put further downward pressure on the price of wheat because the lower grades of wheat and corn are substitute livestock feeds.

Figure 2 Wheat Futures (CME SRW September) and S&P 500: Jan – March, 2020

[4] Price data for the S&P 500 price index comes from Yahoo Finance (https://ca.finance.yahoo.com/quote/%5EGSPC/history?p=%5EGSPC).



In the third week of March Australia received significant rains, and more rain was in the forecast.[5]Shortly after this news broke, the 2020 production of SRW wheat in the U.S. was forecasted to exceed the 2019 level by 19 percent.[6] Under normal circumstances this combination of news would immediately put downward pressure SRW wheat futures, especially in light of the S&P 500 and the price of oil, which continued to fall. Instead, as Figure 1 shows, the price of wheat turned upwards in the middle of March. This rally was primarily due to the hoarding of wheat-based food staples by consumers who were worried about future food shortages. This mass buying drastically shrank flour inventories and raised the demand for wheat by local millers. Another contributing factor to the late March rise in the price of wheat was an on-going shift by large institutional investors out of equities and into safer asset classes such as agriculture.

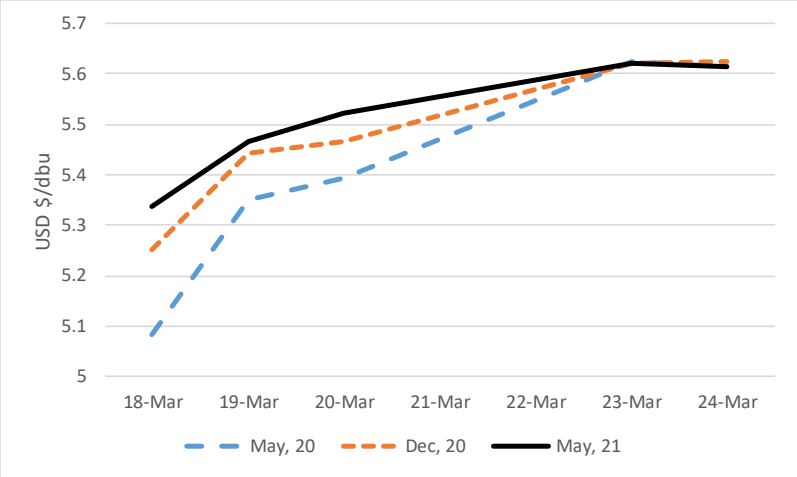
Figure 3 shows how the wheat futures market simultaneously deals with a short term spike in demand for wheat by processors and an anticipated long term slump in market fundamentals due to rising stocks and an emerging global recession. The three schedules show how the price of the May 2020, December 2020 and May 2021 futures contracts changed over the March 18th to 24th period. For a particular trading day (e.g., March 18th) the difference in the height of the three schedules is the set of futures price spreads. If these spreads are plotted with the three trading months on the horizontal axis and the price of the contract on the vertical axis then the resulting schedule for a particular day is the futures forward curve. In a normal agricultural market with abundant stocks the price spreads are positive and the forward curve slopes up. This is because each price spread is expected to equal the unit cost of

[5] See Pratt (2020) for more details.

[6] See Sjerven (2020) for more details.

storing the commodity between the corresponding pair of futures months minus the market's convenience yield.[7] Figure 3 reveals an increasing convenience yield and thus a shrinking of the price spreads and a flattening of the forward curve over the March 18 – 24th period. This increasing convenience yield is likely due to the on-going consumer hoarding of food staples and a corresponding low flour inventory. Notice in Figure 3 that on March 24th the May, 2021 futures traded slightly below the May, 2020 futures. This situation where the convenience yield is greater than the transaction cost of storage and thus the forward curve slopes up is referred to as backwardation.

Figure 3: Futures Prices for Alternative SRW Wheat Futures: March 18 – 24, 2020



3. Cash Prices and the Basis

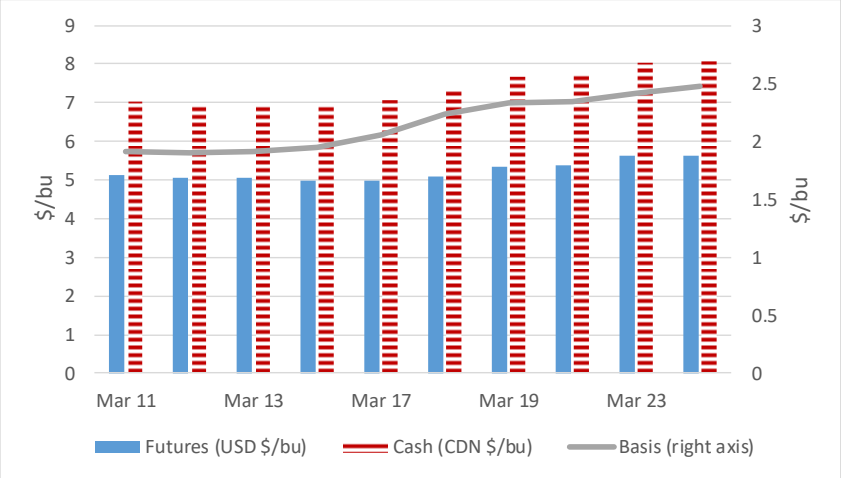
The COVID-19 crisis also impacted the difference between the farm-gate cash price and the corresponding futures price (i.e., the regional basis) for the major commodities. The daily cash price, which grain buyers pay to grain producers, is typically calculated by adding a regional basis to the prevailing futures price. The basis reflects the cost of storing the commodity during the forward contracting period, a transportation cost differential, the Canada-U.S. exchange rate for the case of a Canadian regional market and a final variable that measures the strength of local market demand relative to export market demand.

Figure 4 shows the May, 2020 CME futures price for SRW wheat, the cash price for SRW wheat at London, Ontario and the corresponding basis (i.e., the cash price in CDN dollars minus the futures price

[7] Convenience yield is defined implicitly as the transaction cost of storage minus the price difference across two periods (i.e., it is a residual to ensure that the law-of-one-price holds). Convenience yield can be interpreted is the implicit benefit that a processor receives from having stocks on hand rather than having to source the stocks in the market. Convenience yield typically increases when the stock to use ratio decreases.

in USD dollars). Notice that the futures price and the basis both trended up beginning in mid March, apparently in response to the surge in local demand for consumer food staples. A strengthening basis sends a signal to farmers to immediately sell their wheat to a local processor rather storing it for sale in the future. The overall result is that the cash price of wheat at London, Ontario increased from about CDN $7.00/bushel on March 11th to CDN $8.00/bushel on March 24th. If instead the export demand for wheat had surged relative to local demand in response to the COVID-19 crisis then the basis would have weakened rather than strengthened, in which case the increase in the cash price of wheat at London would have been smaller.

Figure 4 SRW Wheat Futures, Spot Prices and the Basis at London Ontario: March 11 – 24, 2020

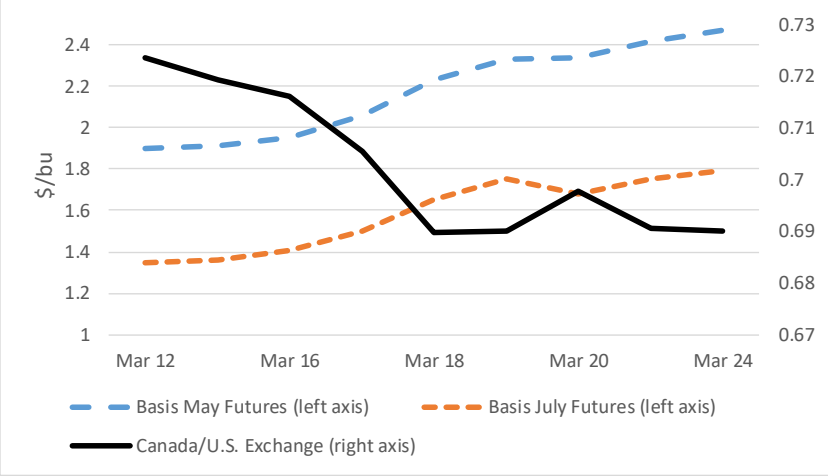


For the March 11 – 24th period Figure 5 shows for London, Ontario the old crop basis, which is calculated using the May, 2020 futures contract, and the new crop basis, which is calculated using the July, 2020 futures contract. Under normal market conditions the basis for the more distant futures month (in this case July) is expected to be larger than the basis for nearer futures month (in this case May) because of the higher storage cost associated with the former. Figure 5 shows the opposite result, which means that there must be a sizeable difference in the local market demand component of the two basis variables. Given the previous discussion this result is expected because a strong immediate demand for wheat will drive up the May basis more than the July basis. As noted, this inversion of the basis signals to those holding wheat inventory that they should sell immediately rather than continuing to store the grain.

An important reason why both the May and July basis strengthened over the sample period is that the Canadian dollar weakened relative to the U.S. dollar. As Figure 4 shows the May and July basis

strengthened by about $0.40/bu while at the same time the Canadian dollar dropped from about 0.725 at the beginning of the sample period to 0.690 at the end. The basis strengthens with a weaker dollar because Canadian SRW wheat is priced in U.S. dollars when sold in international markets and so a weaker dollar will result in a higher Canadian price after the foreign exchange transaction.

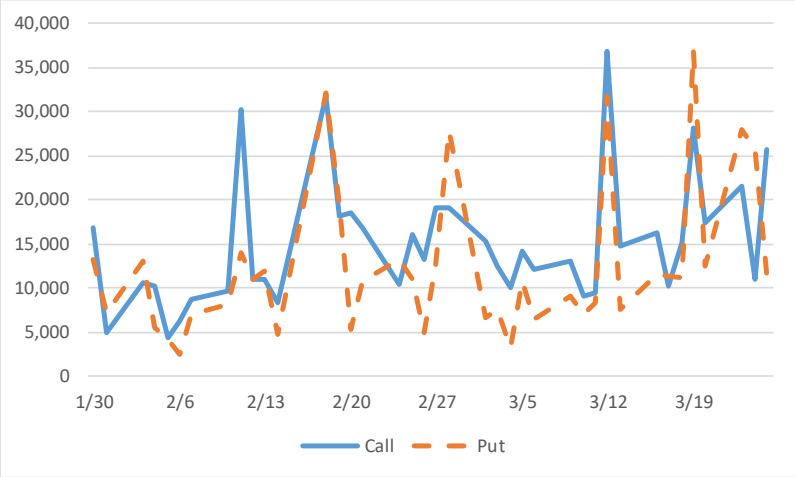
Figure 5 SRW Wheat Basis (May and July, 2020) and CDN/U.S. Exchange Rate: March 11 – 24, 2020



4. Options on Commodity Futures

Figure 6 shows the volume of call and put options which are traded on SRW wheat futures contracts between January 30, 2020 (very early days of COVID-19) and March 25, 2020 (full-blown COVID-19 crisis). The volume of trade, which is similar for puts and calls, is quite variable from day to day due to the relative thinness of this particular market. Figure 6 shows that the volume of trading of both puts and calls steadily increased over the sample period, apparently in response to growing uncertainty about the market price impacts of COVID-19. Options are commonly used by traders to speculate on future levels of price uncertainty because a call or put option limits the losses facing the holder of the option but not the gains. Consequently, higher uncertainty leverages the implicit value of the option.

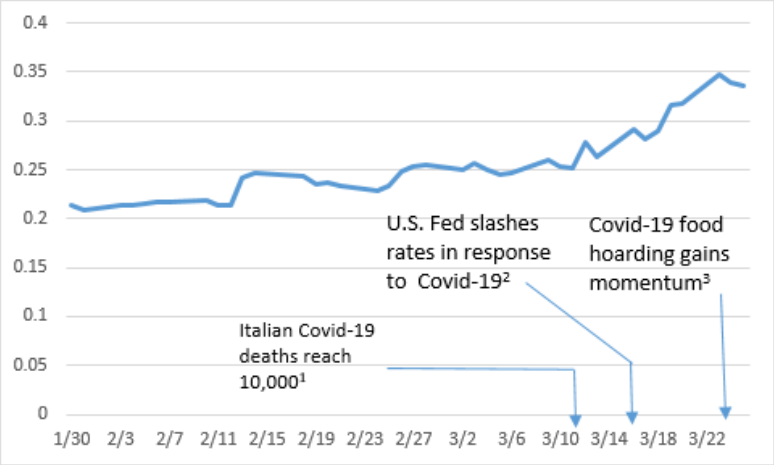
Figure 6 Daily Volume of Put and Call Options on SRW Wheat Futures: January 30 – March 25, 2020.



* If a particular contract (e.g., September 2020 expiry) did not include an ATM strike price then it was excluded.

The price of an at-the-money (ATM) call or put option on a commodity futures contract in conjunction with the Black-Scholes pricing formula provides a standardized measure of the implied volatility of the futures price. The implied volatility values which appear in Figure 7 were calculated for the case of SRW wheat using the prices of ATM call options that have a one to two month expiry window (i.e., March expiry for January dates, April expiry for February dates and May expiry for March dates). Figure 7 shows that implied volatility steadily increased over the January 30 – March 25 period, apparently due to growing uncertainty about the future price impacts of COVID-19. News concerning the relatively high COVID-19 death rate in Italy, the intervention by the U.S. Federal Reserve and increased hoarding of consumer staples by consumers all led to a steady growth in the level of implied volatility. This high level of price volatility is problematic for North American farmers who are currently making crop planting decisions because a high fraction of the input costs are sunk and there is a considerable time lag between when the inputs are committed and when the wheat is harvested and sold.

Figure 7 Implied Volatility from ATM Call Options on CME SRW Wheat Futures

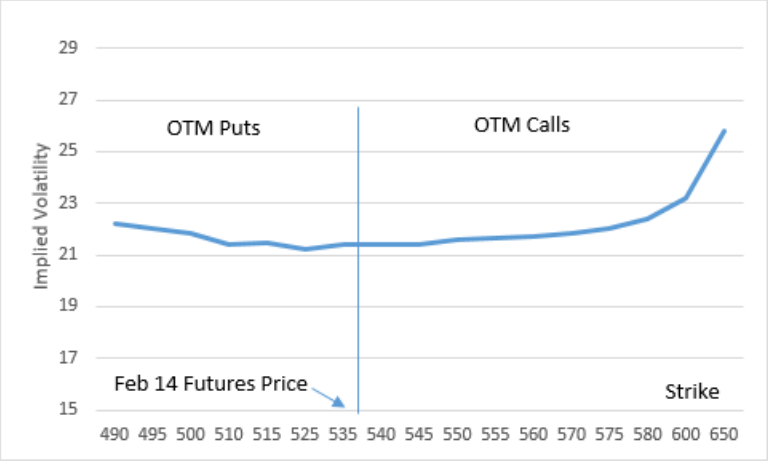


1. Wikipedia (March 11, 2020) 2. Elliot (March 15, 2020) 3. Bekiempis (March 23, 2020).
* March expiry for January dates, April expiry for February dates and May expiry for March dates.

Examining the volatility "smile" of a set of out-of-the-money (OTM) option contracts sheds light on how the market views the tails of the pricing distribution. Some traders will worry that a deep global recession will cause wheat prices to tumble to very low levels along with equities and non-agricultural commodities. Other traders worry that wheat production and distribution will be severely curtailed as a result of COVID-19 and this will cause the price of wheat to soar. In the first case those selling the option contract must estimate the probability in the left tail and in the second case they are concerned with the right tail. Option sellers typically believe that the Black-Scholes pricing formula, which assumes a normal distribution, underestimates the fatness of the tails. Consequently, these sellers will set the price of the OTM option above what is implied by the Black-Scholes formula. When these inflated prices are plugged into the Black-Scholes formula the calculated implied volatility will typically increase as the strike price of the option moves out toward either the left or right tail of the price distribution. It is for this reason that a graph of the strike price and inflated volatility values typically has the form of a smile.

Figure 8 shows the February 14, 2020 volatility smile for the case of SRW wheat options with an April expiry. The left side of the diagram corresponds to OTM put options and the right side corresponds to OTM call options. The put (call) options are out of the money because the futures price must decrease (increase) in order to reach the strike price and then move into the money. Notice that the right (call) side of the smile is significantly more pronounced that the left (put) side. This outcome typically emerges for agricultural commodities because a severe drought can cause very large price increases whereas the price decrease that would result from large global production is limited to positive values.

Figure 8 SRW Wheat Futures Volatility Smile (April Expiry): February 14, 2020



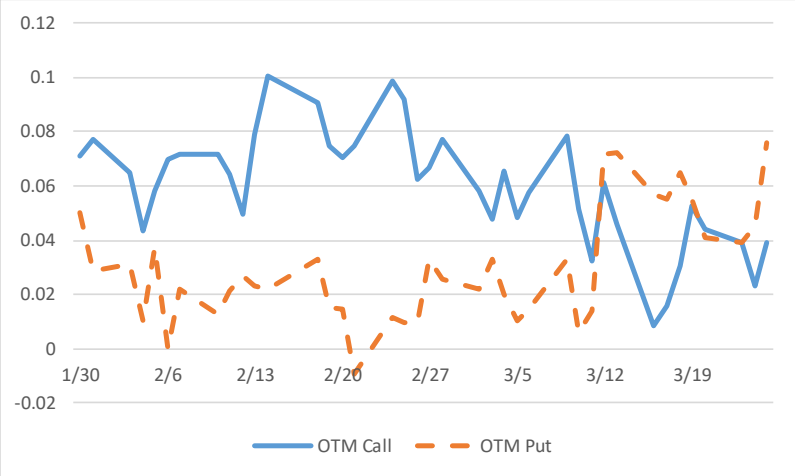
Of interest is how the shape of the volatility smile changes over time in response to an evolving reassessment of the risks in the left and right tails of the price distribution. Let *h* denote the height of the smile measured as the percent different between the implied volatility for a particular OTM option and the corresponding at-the-money (ATM) option. Let $\bar{h}_P$ denote the average value of h over all OTM put contracts and let $\bar{h}_C$ denote the average value of h over all OTM call contracts for a particular trading day.[8] In Figure 9 these two data series are plotted for the full set of trading days.

Figure 9 reveals that up until the middle of March the inflated implied probability values which give rise to the smile are much more pronounced for the calls than for the puts. This outcome is expected given the previous discussion about the bounds for the left and right tails of the price distribution. Figure 9 further reveals that throughout the month of February the implied volatility inflation increased for calls and decreased for puts. This change may reflect traders' growing concern about a price spike that results from a COVID-19 disruption in agri-food supply chains. What is unexpected is that in the middle of March there was a pronounced decrease in implied probability inflation for the calls and a

[8] For a particular set of options (e.g., those with a September, 2020 expiry), if there is no strike price that is near the money then this set of options is excluded from the average price calculation.

pronounced increase in the implied probability inflation for the puts. One possibility is that by late March traders began believing that a price spike is unlikely and instead due to a deep and prolonged global recession the prices for all commodities, including agricultural commodities, will follow the path of oil and plummet to very low levels. Quite likely the story is more complex than this. Extending the analysis to include April price data and more closely reading of the commodity trading blogs is likely to result in a more nuanced explanation for the interesting dynamics which are present in Figure 9.

Figure 9 Average Percentage Implied Volatility Inflation for OTM Puts and Calls on SRW Wheat Futures: January 30 – March 25, 2020



5. Conclusions

By the time this paper is published the world will know a lot more about the impacts of COVID-19 on agricultural commodity prices, and updated versions of the graphs in this paper may look very different. However, this does not diminish the value of this paper by a significant amount. Indeed, the most important feature of this paper is that it highlights that information-rich commodity prices reflect a great deal about market beliefs, and it shows how simple methods can be used to extract these beliefs along several different dimensions. Analyzing the changing steepness of the forward curve, plotting a time series of implied volatility values and determining how the skewness of an option's volatility smile changes in response to a crisis that affects both supply and demand is not routine in the agricultural economics discipline. Hopefully this paper will inspire agricultural economists to expand their way of thinking and their tool kit when analyzing commodity prices in the midst of various types of global crisis.

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