Price Responses in Forward Contracting: Do We Limit The Upside And Expose The Downside?

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Abstract

It's a salient observation in the literature that hedgers' net short futures positions for agricultural commodities, as reported in the Commodity Futures Trading Commission (CFTC) Disaggregated Commitment of Traders reports (DCOT), correlate strongly with futures prices. However, the DCOT data limits researchers' ability to discern what influences producers' hedging decisions from other activities such as storage hedges and spread trades. This is because the DCOT data aggregates open positions of all active contracts. This paper addresses this issue by examining the potential economic stimuli of corn producers' forward contracting decisions before harvest using a unique data set of forward contracts between producers and large grain and farm supply cooperative over a five-year period. We find that producers forward price more of their crops when the futures price is trending up, and they are reluctant to hedge when the futures price is falling. We show that the producer level hedging data and the DCOT hedge series respond in a remarkably similar manner to economic stimuli despite this dissimilarity.

This paper presents and analyzes pre-harvest hedges placed by corn producers in Iowa. The data consist of 115,000 forward contracts written by a major grain cooperative for the period January 2009 through August 2013. The only prior data on the use of pre-harvest hedges by crop growers has been survey based, and this literature shows widely different participation rates.[1]

The Commodity Futures Trading Commission Disaggregated Commitment of Traders Report (DCOT) provides weekly estimates of the open trading position for short hedgers, and this data presumably contains information about producer hedging. However, the DCOT report is limited in accurately classifying traders' activities (CFTC 2006a). Even within a trader's classification it is not clear what the aggregate short trader's position represents. This is true because the DCOT aggregates across all futures contracts, and thus the DCOT report will include storage hedges as well as spread trades. To the extent that pre-harvest hedging behavior can be extracted from the DCOT report, the trades will be a mixture of futures hedges placed by producers with futures trading accounts and hedges placed by grain buyers to offset the risk incurred when they forward contracted with producers.

Forward contracts between producers and grain buyers are all written with the intent to deliver and there is no easy way to offset the forward contract prior to the harvest period. Growers who use *futures* markets to hedge can, if they wish, offset a hedge at any time. The restriction on forward contracts means that the pre-harvest hedge ratio can only grow as the crop year progresses. The pre-harvest position of producers using futures hedges can increase or decrease depending on when the futures hedge is lifted. Once the data is adjusted for the restrictive nature of forward contracts, the pre-harvest hedging behavior found using the individual transaction data is very similar to the behavior found in the DCOT data.

The individual transaction data and the DCOT data are used to examine the price triggers that induce hedging. The results suggest that the critical decision factor is the opportunity to sell grain at a price that is above a specific reference price. We also examine whether the hedging patterns of either group improves revenue relative to other strategies.

Literature on Hedging and Commodity Prices

Under expected utility theory, if commodity producers believe futures markets are efficient they should: (*a*) forward price a large portion of their crop each year; (*b*) not vary their hedge ratio year-to-year; and (*c*) not vary their hedge ratio over the growing season. However, much empirical evidence exists to suggest that expected utility theory cannot explain hedging and forward contracting behavior. Using marketing club data from a forward pricing game, McNew and Musser (2002) find no empirical support for these EU based hypotheses. Sartwelle et al. (2000) find no evidence that producers' self-identified risk attitudes impact their hedging practices, while Goodwin and Schroeder (1994) find a *negative* impact of risk aversion on the use of forward contracts. On the contrary, Schroeder et al. (1998) find that both producers and extension economists perceive forward contracts as more price-enhancing than risk- reducing and believe in the existence of market timing strategies, even though these strategies have little support in the literature (Irwin et al. 2006). Cheng and Xiong (2013), using the DCOT data, show that short hedgers in corn, soybean, wheat, and cotton markets deepen their short positions as the futures price increases, and vice versa. Cabrini et al. (2010) find that marketing advisory service recommendations in corn and soybean markets use trend analysis and believe in trend reversal.

The COT data is widely employed in academic research. This literature typically utilizes Granger causality to explore: (*a*) whether variations in participants' open positions can help predict the return on futures contracts; and (*b*) whether the change in futures prices lead to any changes in the behavior of market participants. The prior literature has also explored the hedging pressure hypothesis (e.g., De Roon et al. 2000; Sanders et al. 2004), and the Masters Hypothesis. The latter hypothesis claims the increasing speculation by commodity index funds is responsible for the excess volatility in futures markets (Irwin and Sanders 2012). This prior literature is consistent with the hypothesis that the futures price represents the best available prediction of a commodity price and that producers cannot consistently outperform the market using forward contracts (Zulauf and Irwin 1998; Irwin et al. 2006; Cunningham et al. 2007).

Another strand of literature is concerned with the actual behavior of futures traders. This literature finds evidence that short-term price changes cause changes in positions. Wang (2003) documents that increasing prices result in the decline of DCOT hedger's net long position in the corn market. This suggests that short hedgers sell more when price rises and/or that long hedgers buy less. McNew and Musser (2002) also find that producers respond to short-term futures price changes but that they do not outperform the market. Anderson and Brorsen (2005) find similar results with farm-level transaction data showing that wheat producers in Oklahoma sell more when price increases relative to the previous period. Using DCOT data, Cheng and Xiong (2013) find that short hedgers futures position in agricultural markets is reduced as the futures price falls relative to the same futures price in the prior period.

Reference Dependence

Price-based triggers for changes in hedging positions include both the price change from a prior period and the price level itself. Brorsen et al. (1995) find that when prices are low, there is a lack of interest in forward contracting. What defines a 'high' crop price that would motivate producers to hedge has yet to be identified. Another way to define the level of prices is by measuring it relative to a reference. Tversky and Kahneman (1991) demonstrate that utility is generated from gains and losses measured relative to a reference level, and that people are more averse to losses than fond of gains of the same amount. Thus, they posit that utility-maximizing choice is reference-dependent. Reference-dependence is also a key feature of several other utility theories, for example, regret theory (Loomes and Sugden 1982) and expected target utility theory (Fishburn 1977).

Extension economists incorporate the idea of reference dependence in marketing recommendation such as profit margin hedging—hedging only when the futures price is above a preset target (e.g., Parcell and Pierce 2009). Kim et al. (2010) developed the theory of profit margin hedging, but again, how producers choose their target is unknown. Babcock (2015) also shows that cumulative prospect theory with insurance premiums as a reference can generate crop insurance purchase decisions that are consistent with observed decisions (Du et al. 2014), a result that is anomalous to expected utility maximization.

The existence of a reference effect is well documented in other markets. In a study of the stock market, Grinblatt and Keloharju (2001) find reference price effects in stock trading by individual investors, who have a higher propensity to sell if a stock rises above its high of the past month. In fact, individual investors in general are found to have greater tendency to sell stocks with positive returns than at losses (Shefrin and Statman 1985; Odean 1998). This is called the disposition effect and it cannot be reconciled with portfolio management or justified by the subsequent portfolio returns. The reference effect is also found in the real estate market. Those who move from expensive cities tend to rent more expensive apartments (Simonsohn and Loewenstein 2006), and home sellers use the original purchase price as a reference when setting asking prices (Genesove and Mayer 2001).

Data and Methods

This study utilizes daily forward contracts for corn from a major grain marketing cooperative in Iowa for the period from January 2009 to August 2013. This firm has over 30 grain-receiving locations with an average annual total handle of more than 100 million bushels of corn. The data include over 115,000 priced forward contracts for corn and contain the contract date, commodity type, bushels contracted, and delivery date. The contract data for corn and soybean are available from the authors on request.

We focus on forward contracting for post-harvest delivery in the period January 1 to August 31. Harvest grain bids are commonly given between January and the end of August (Mallory et al. 2015). Restricting our analysis in this way separates the decision to hedge anticipated production from storage hedges and shorter-term contracts meant to lock in favorable prices or basis for planned deliveries. We compare the observed hedging behaviors of producers with those of commercial hedgers reported in the DCOT, published by the Commodity Futures Trading Commissions (CFTC). For each, we construct weekly pre-harvest hedge ratios that are the current proportion of the total expected harvest that is hedged. We refer to hedges placed with the Iowa cooperative as producer hedges and to those placed via the DCOT data as commercial hedges.

Commercial hedge ratio

The CFTC COT report provides, weekly, the long and short open interest over all active contracts for participants of different categories as of Tuesday's closing positions (CFTC, 2009). In the legacy format, traders are categorized as either "Commercials" or "Non-Commercials." Some reporting financial institutions that classify themselves as Commercials do not have underlying physical exposure and instead take over-the-counter derivative positions (CFTC 2006a, b). In response to this classification problem, the CFTC has, since 2009, separated Commercials into "Producers/Merchant/Processor/User" (Hedger) and "Swap Dealer" in the Disaggregated Commitment of Traders reports (DCOT).

Corn producers can hedge their expected crop either by taking a short position in the futures markets or by forward contracting with a local grain dealer or warehouse that in turn hedges this exposure on futures markets. Grain managers and buyers at these firms typically follow narrow open-interest policies and are not believed to take significant speculative positions. Thus, the short open positions in the *Disaggregated* COT reports should reflect information about producers covering price risk using both futures and forward contracts. We rely on the short hedgers open positions to approximate the total hedged positions at the aggregate level. This is the numerator of the commercial hedge ratio. In a pure sense, the denominator should reflect the total harvest, for which we use the USDA's estimate of total U.S. corn harvest.

Producer hedge ratio

The ideal construct of the producer hedge ratio will reflect the proportion of the total expected harvest of the group of producers that is forward contracted at any point in time. For our purposes, the producer hedge ratio at date *t* is the total number of bushels contracted from January to date *t* for delivery in in the period September 1 to August 31 expressed as a proportion of total grain purchased by the cooperative during the marketing year, September 1 to August 31.[2]

Visual analysis of the data

Figure 1 plots the level of hedge ratios using both DCOT data and farm level data. The data show no discernable seasonal pattern and the proportion of corn hedged varies considerably from year to year. With the producer hedge ratio, more than 20% of corn was forward priced in the high price years of 2010–2012, while only 3.75% was hedged at the same time in 2013, a year when prices fell significantly from 2012 levels.[3] The commercial hedge ratio in the DCOT data reflects use of both futures and forward contracts. The commercial hedge is greater than the producer hedge in the beginning of the year. This is probably due to storage hedges and spreads, on contracts other than the December futures. The commercial hedge ratio in August is 5%–10% above the producer hedge ratio on August 31. This suggests that, in this period, 5%–10% of corn is hedged directly on the futures market instead of via forward contracts.

Figure 2 plots the weekly changes of the commercial and producer hedge ratios. While it is immediately apparent that these two series are highly correlated, the change in the commercial hedge ratio can be negative, while the producer ratio never is. Further, we observe that in periods where the commercial hedge ratio change is negative, the farm level hedge ratio stays approximately level. Producers who use futures rather than forward contracts can offset a hedged position prior to harvest to take advantage of changing market conditions. This is not the case with forward contracting: producers can choose not to forward contract more of their crop but cannot undo (unwind) the position in place. Thus, one goal of our empirical strategy is to understand to what extent the two data sets might still differ after accounting for the inflexibility of the forward contracts.

The weekly producer hedge ratio changes versus the percent change in the December futures price is plotted in Figure 3. Visually, positive futures returns result in an increase in the hedge ratio, but the producer hedge ratio is relatively unchanged when the futures price declines. Note that the correlation between changes in hedge ratios and prices is stronger in some periods than in others. This observation motivates the consideration of explanatory variables other than the recent price change. One candidate variable is the level of futures price relative to a longer-term average. The intuition is that producers may be reluctant to price their crops when the futures price is “too low.” This important observation in the data motivates a search for a reference price for producers’ forward contracting behaviors.

A reference price impacts producers’ hedging in at least two ways. First, it may serve as a threshold, whereby a futures price below the reference price causes the hedge ratio to be less sensitive to price changes. A close look at figure 3 reveals a number of examples where price changes of similar size do not consistently lead to the same response in the hedge ratio, whether within or across years. Second, the magnitude of the price change relative to the reference price may be driving the change in the hedge ratio. We investigate empirically the existence of reference price behavior in our data in the following section.

Empirical strategies to identify reference price effects

We begin with a simple model motivated by Cheng and Xiong (2013) to examine the effect of recent futures price changes on the hedge ratio. We then expand their work by considering alternative reference prices and by exploring whether the change in the producer and commercial hedge ratios responds differently to price changes when the futures price is lower than an ascribed reference price. The empirical strategy uses weekly price changes to permit comparison of the DCOT, and the producer hedge ratio series.

Suppose the representative producer's decision on how much crop to hedge in a week depends the December futures contract price one week ago and the time is remaining until harvest. A simple model can be written:

$$(1)\quad (h_t - h_{t-7}) = \beta_0 + \beta_1 time + \beta_2 (p_t - p_{t-7}) + \beta_3 (p_t - p_{t-7}) 1_{\{p_t - p_{t-7} < 0\}} + \varepsilon_t ,$$

where $h_t - h_{t-7}$ is the weekly change in producer hedge ratio at time *t*, *time* is the days-to-harvest from *t*, p_t represents the logarithm of the December futures price at time *t*, $p_t - p_{t-7}$ is the weekly difference in the logged price of the December futures contract, and $1_{\{P_t - p_{t-7} < 0\}}$ is a dummy variable equal to 1 if the price change in the week is negative. The error term, ε_t, is an identically, independently and normally distributed shock, with mean zero and variance σ^2. In this model, the intercept β_0 estimates the average proportion of the crop hedged per week. The variable *time* is a control variable to capture the non-price effects that induce changes in hedge ratios. As one example, Lapan and Moschini (1994) note producers may hedge a greater proportion of new crop as harvest approaches due to resolving uncertainty over yields. Finally, the coefficients β_2 and β_3 capture price effects.

The first price coefficient will provide an estimate for the expected change in hedge ratio from a change in the log of price over the week. The second price coefficient – the interaction term – allows for distinct marginal effects on the weekly hedge ratio in response to decreases in the log price over the week. We use the interaction term as a test for symmetric price responses of the hedge ratio in both the producer and DCOT series, particularly, whether there are differences of price responses in the producer and commercial hedge ratios when prices decrease relative to the reference.

Alternative reference prices

Equation 1 is a starting point for analyzing hedge ratio responses to changes in futures prices, and this model is easily adapted to any price change that the researcher believes is relevant (e.g., weekly, daily, annual prices). Experience suggests a number of legitimate reference prices, including the 30-day moving average (McNew and Musser, 2002), last year's average marketing price (Kauffman and Hayes, 2011), the projected harvest price published by the Risk Management Agency (RMA), and an Iowa-specific break-even price (Plastina, 2015).

We separate candidate reference prices into two groups based on the frequency of change. The first group consists of last year's average marketing price, the RMA project harvest price and the estimated production cost per-bushel. These are reference prices that do not change during the pre-harvest period. The second group includes references prices that update each trading day: the price of the December contract 365 days ago, the current 30-day average of the December futures contract, and the price of the December futures contract 30 days ago.

When the reference price is one that does not change in the forward-contracting period, the change of the current December futures price from the first group of reference prices will mimic the behavior of the December futures price, thus containing a unit root. However, these candidate reference may still provide information regarding the motivation for producer hedging. In particular, the producer may be reluctant to hedge when the futures price is below his production cost, regardless of recent price increases. We modify equation 1 such that the fourth term on the right-hand side is a binary variable that takes the value of 1 if the December futures price is below the candidate reference price.

$$(2)\ (h_t - h_{t-7}) = \beta_0 + \beta_1 time + \beta_2 (p_t - p_{t-7}) + \beta_3 (p_t - p_{t-7}) 1_{\{p_t - p_t^r < 0\}} + \varepsilon_t\ .$$

Whereas in equation 1 the interaction term jointly captured the potential asymmetric hedge ratio response to price changes and a threshold effect, here the interaction term captures only a threshold response in the hedge ratio when the current December futures contract price is below the producer's candidate reference prices.

The second group of candidate reference prices are dynamic, changing every trading day. To account for this, we again modify equation 1, making explicit that we are interested in hedge ratio responses to a change in the reference price. For example, assigning as a reference the price of December futures contract 30 days ago, we are interested in the difference between the logged December futures price at time t (p_t) and the logged December futures contract price 30 days prior. The modified equation is:

$$(3)\ h_t - h_{t-7} = \beta_0 + \beta_1 time + \beta_2 (p_t - p_t^{\,r}) + \beta_3 (p_t - p_t^{\,r}) 1_{\{p_t - p_t^{\,r} < 0\}} + \varepsilon_t$$

As in equation 1, the binary variable is equal to 1 if, continuing with the example, the logged December's future price today is below the reference price, i.e., the logged December futures contract price 30 days ago.

Empirical Results

Table 1 presents estimates and model fit statistics for equation 1 for the producer and DCOT series. The regression estimates using the producer hedge ratio series suggests that they price more of their expected harvest as yield uncertainty diminishes as expected. The same effect is not observed using the DCOT hedge series. The DCOT series may not exhibit this time-to-harvest effect, in part, because of the potential to undo short positions at any time. The estimated marginal effect on the hedge ratio from a 7-day price change is positive and statistically significant in both series, but the interaction term is only significant in the producer series. The commercial hedgers and producers respond to positive price changes by increasing the proportion of their hedged position, and the response is greater in the individual producer series: a 1% increase in the December futures price relative to last week increases the producer hedge ratio by 0.13 percentage points and the DCOT hedge series by 0.08 percentage points. The smaller price impact found in the DCOT hedge series is consistent with the finding of Cheng et al. (2015), that treating traders aggregate positions as exogenous leads to downward bias of the estimated price impact.

The two series are dissimilar in the observed hedge responses to negative price. The producer data shows little response when the price is lower than the 7-day reference price, the DCOT hedge data shows a significant response. A test of restrictions on the estimated coefficients for the price change and interaction term was conducted to identify whether there is a hedge ratio response to negative price changes. The Wald statistic for the restriction test $(\beta_2 + \beta_3 = 0)$ was not statistically significant, indicating that the impact of negative price change on the producer hedge series is statistically insignificant.

Tables 2 and 3 present the estimation results for equation 2 for the individual producer and DCOT hedge series, respectively. Recall that this empirical specification differs from that in equation 1 in that the interaction term captures a threshold response in the hedge ratio when the current December futures contract price is below the producers' candidate reference prices (i.e., previous year average marketing price, the estimated costs of production, and the RMA projected marketing price).

Examining first the producer hedge series, for each of the examined reference prices – these do not change throughout the pre-harvest season – a time-to-harvest effect is statistically significant. The producer hedge ratio increases as the time to harvest decreases, and the size of this effect is consistent regardless of the reference price chosen. Also, across all reference prices, the statistically significant and positive hedge ratio response to the week-over change in the December futures price is observed; however, the size of the hedge response attributable to this price change differs. When both last year's average marketing price and the RMA projected price are used as reference prices, a 1% increase in the December futures contract implies producers will hedge an additional 0.12% of their total crop, and if the current December futures contract price is below the threshold, that effect is diminished by approximately 0.09%. When the reference price is the estimated cost of production, the response to a 1% weekly price increase is to increase the hedge an additional 0.05% of the crop, and the current price relative to the reference price does not appear to play a role. The restriction tests rejects the null hypotheses that price change has no significant impact on producers' hedging when the price is below the candidate thresholds. Specifically, when the thresholds are last year's average price, estimation cost and RMA projected price, the corresponding Wald statistics are 38.34, 3.98 and 4.83 respectively, which are greater than the critical value, 3.84 at 5% significance level. Nonetheless, the impact of price changes on hedge ratio is smaller in magnitude when the price level is lower with respect to these thresholds.

The estimates using the DCOT series (table 3) are relatively unchanged from those in table 1. These alternative specifications of the threshold price explain about as much as equation 1. Even though the reference price is static and unchanged for an entire year, it would appear that some producers use this static reference price and that this helps explain the very low level of hedging in 2013.

Tables 4 and 5 provide the estimation and model fit results for equation 3 for the producer and DCOT hedge series, respectively. Here, the price difference of interest is today's December futures contract price relative to one of three candidate reference prices—last year's price on the same date, the average price in the past 30 calendar days, and the price one month prior. Taking the last as an example, $(p_t - p_t^r)$ is difference in the logged December futures price today and the logged December futures price observed 30 days ago. The interaction term serves to capture a hedge ratio response to this price change when the current price is below the referenced price.

There are consistencies with the prior estimates for both the DCOT and producer hedge series. The goodness-of-fit statistic, R^2, indicates that for both series, the 30-day average price provides more explanatory power. Focusing then on that reference price, the DCOT series suggests that for every 1% higher the current December futures contract price is above the 30-day average price of that contract, producers hedge an additional 0.12% of their crop. The DCOT series suggests the hedge ratio response is 0.10%. However, while the commercial hedgers seem to have a symmetric price response to downward changes in prices, the producers do not. The sign and significance of the interaction term suggests that when the current price is below the reference price, producers will temper their response by hedging much less, perhaps nothing at all. Similar to the finding with equation 1, the negative price change has no statistically significant impact on the individual producers' hedge ratio. Producers increase the proportion of their crop hedged in response to increases in the price when the price is above the 30-day contract average. However, if the price is below that threshold, there appears to be no attributable change in the hedge ratio from price movements.

Figure 4 illustrates the producer hedge ratio change against the price change from the 30-day average price of the December contract. Figure 5 plots the 30-day moving averages of the December futures and the level of producer hedge ratio. It again shows that producers tend to forward hedge more of their harvest during the pre-harvest season when the futures price is trending up rather than down.

Other alternatives that were explored

There are a number of other potential candidate reference prices to be considered. One plausible scenario is that hedge ratios respond to older moving averages. However, we found that the 30-day average contract price parameter is robust to adding longer-dated price changes such as a 60 day, 90-day, or 6-month old moving average.

Yearly seasonality may also play a role in explaining variation in producers' hedging behavior, since the uncertainty of harvest may be resolved at different paces in different crop years. We tested for such seasonality by adding yearly dummies as well as interacting the yearly dummies with the *days to harvest*. The joint test did not reject the null hypothesis of no yearly seasonality in producers' hedging.

We also consider adding the lagged hedge ratio changes, as it's been found in the previous literature that DCOT hedge series is serially correlated. Adding a lagged hedge ratio change to equation 3 with the past 30-day average price as the reference provides limited additional explanatory power for both data sets. Thus an alternative explanation for the autocorrelation exhibited in the hedge ratio changes is that the producers respond to the price change from a reference, and when the reference price is serially correlated, the hedge ratio change will appear to be autocorrelated.

Daily farm level hedging data

The prior analysis was restricted to observing weekly changes in the hedge in order to compare directly the commercial traders' hedging behaviors with the individual data. We now explore the producer data using daily hedging behavior and price changes.

The producer data contain 836 daily observations of forward contracting. However, there are 62 days when no contracts are made. To account for the nature of these data, we employ a Tobit specification to analyze the hedge ratio response to a change in price from the 30-day average. The use of the Tobit specification eliminates the need to use dummy to allow for asymmetric response. The empirical results are presented in table 6. On a daily basis, a one percent increase in the futures price from the past 30-day average price results in a 0.02% daily increase in the amount hedged by producers in these data. This is one-fifth of the estimate for the weekly data shown in table 4. The daily time-to-harvest effect on corn producer's hedging is also about one-fifth of the magnitude estimated for the weekly data.

Do Observed Hedging Patterns Result in A Higher Price?

The previous results suggest that hedging behavior is related to price changes, which in turn suggests that hedging is driven in part by an attempt to time the market. This raises the question as to whether this trading pattern is better than selling a fixed portion of the expected crop each month or all of their crop at harvest or at planting. The October and January average price of the December futures contract is used to approximate the harvest price and planting price respectively. To facilitate the analysis, we use the weekly hedge ratio change for both data sets. We ignore the transaction cost and margin calls, and assume that the producers adjust their hedge ratio weekly.

For the farm level data, we calculate the weighted average price per bushel received on the hedged crop using actual pre-harvest hedging, where the weights correspond to the volume sold at each data point normalized by the total bushel sold forward. For the commercial hedgers, the average price they would have received on their hedged crop corresponds to the weighted average price in periods when the hedge ratio rises. Those who use futures contracts appear to reduce their hedge positions when the price falls, however, whether they end up with a gain or loss in their margin account depends crucially on the timing and size of each trade. The accumulated return normalized by the harvest in each pre-harvest season is calculated as the average of weekly price changes weighted by the hedge ratio level at the beginning of each week.

Table 7 shows the average prices per bushel sold using the farm level data, the futures price at harvest, the futures price at planting, and the average price of December futures contracts during the pre-harvest period. With only five years of data it is not advisable to use these results to draw strong conclusions. However, we can say that during this five-year period both farm level and commercial hedgers obtained a better price than the strategy of selling equal amounts every month before harvest and the strategy of selling all of their expected production in January or March. The dominant strategy during this somewhat unusual period was to wait until harvest to sell grain. This is due to large increases in corn prices during 2010 and 2012. It is striking that the 5-year average price received by producers who forward contract and commercial hedgers differs only by one cent. This is consistent with our previous result that the commercial (DCOT) data do, in fact, reflect producer behavior. However, aggregate hedges do not profit from the flexibility to cash out the futures positions when the price declines. As shown in table 7, the five-year average return from the aggregate trading strategy is zero.

Summary and Conclusions

We analyze a dataset of every forward contract for corn written at more than thirty locations over a five-year period. We compute a producer hedge ratio by comparing the proportion of corn that was forward contracted to the total amount delivered in that year to these elevators. The data show that in the period 2010-2012, when prices trended up, as much as 24% of the crop was forward contracted. In 2013, when prices trended down only 4% was forward contracted. We compare the farm level hedging behavior with the short hedgers positions in the Disaggregated Commitment of Traders report and show that changes in open interest in the DCOT report mirrors actual farm level hedging behavior in periods when prices increase. Hedgers respond to price changes, and in particular they sell more when the current futures price is above the monthly average. Producers using forward contracts do not have the opportunity to reduce their hedged position when prices fall. However, those who hedge on the futures market have this flexibility and they use it. The tendency of hedgers to sell into a price rally, will in the short run, help to stabilize futures prices. However, the tendency to sell more corn in drought years may exacerbate harvest time price volatility because a smaller proportion of the crop will be uncommitted at the end of the season. The reduction in hedging behavior in years when prices trend down is problematic from a risk management perspective. These are the years when hedging is needed to stabilize revenues. We also examine whether this price induced hedging activity results in higher prices than less active hedging strategies. The evidence is mixed, in part because the data base is too short to make a statistically valid conclusion. This is something that can be addressed for a range of commodities now that it has been shown that the DCOT data reflects actual producer behavior.

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Footnotes

1. Sartwelle et al. (2000) find that 70% of grain producers surveyed, 351 respondents in total, use forward contracts. Musser, Patrick, and Eckman (1996) and Schroeder et al. (1998) find similar adoption rates for forward contracts at 74% and 64%, respectively. Davis et al. (2005) and Velandia et al. (2009) find significantly smaller adoption rates at 30.8% and 38%, respectively. In a 1999 study, the USDA Agricultural Resource Management (USDA-ARMS 1999) found that out of 2,662 corn producers, only 12% used forward contracts. Other surveys find that farmers who utilize forward contracts use them to hedge 15%–40% of their harvest (Schroeder et al. 1998; Davis et al. 2005).
2. Grain marketed in September is likely crop from a prior year; the data do not permit us to separate cleanly grain marketed from storage and new crop. Our estimation strategy relies on changes in the hedge ratio and price changes.
3. The average December futures prices during the pre-harvest season are $4.02, $3.95, $6.42, $6.09, and $5.38 per bushel for the years 2009, 2010, 2011, 2012, and 2013, respectively.
4. The change in hedge ratio is used because the Dicky-Fuller test fails to reject the null hypothesis of a unit root in hedge ratio levels for both the producer and commercial series.

Tables and Figures

Table 1. Parameter Estimates Using 7-Day Reference Price (eq. 1)

$$h_t - h_{t-7} = \beta_0 + \beta_1 time + \beta_2 (p_t - p_{t-7}) + \beta_3 (p_t - p_{t-7}) 1_{\{p_t - p_{t-7} < 0\}} + \varepsilon_t .$$

	Hedge Series	
Variables	Producer	DCOT
Intercept	0.0062***	0.0003
	(0.0012)	(0.0019)
Time to Harvest	-2.48E-05***	-3.42E-06
	(7.63E-06)	(1.19E-05)
Weekly December Price Change	0.1325***	0.0800***
	(0.0222)	(0.0345)
Price Change with Interaction	-0.1217***	-0.0058
	(0.0302)	(0.0471)
R^2	0.29	0.12
N	166	166

Note: Significance levels indicated as: * p<0.1; ** p<0.05; *** p<0.01. Standard errors in the parentheses.

Table 2. Parameter Estimates Using Static Reference Prices, Producer Series (eq. 2)

$$h_t - h_{t-7} = \beta_0 + \beta_1 time + \beta_2 (p_t - p_{t-7}) + \beta_3 (p_t - p_{t-7}) 1_{\{p_t - p_t^r < 0\}} + \varepsilon_t .$$

	Static Reference Prices		
	Last year average	Production cost	RMA projected price
Intercept	0.0078***	0.0087***	0.0080***
	(0.0010)	(0.0011)	(0.0010)
Time to Harvest	-2.44E-05***	-2.98E-05***	-2.77E-05***
	(7.55E-06)	(7.92E-06)	(7.54E-06)
Weekly December Price Change	0.1238***	0.0569***	0.1222***
	(0.0200)	(0.0127)	(0.0200)
Price below reference price	-0.0964***	-0.0125	-0.0949***
	(0.0230)	(0.0257)	(0.0237)
R^2	0.30	0.22	0.29
N	166	166	166

Note: Significance levels indicated as: * p<0.1; ** p<0.05; *** p<0.01. Standard errors in the parentheses.

Table 3. Parameter Estimates Using Static Reference Prices, DCOT Series (eq. 2)

$$h_t - h_{t-7} = \beta_0 + \beta_1 time + \beta_2 (p_t - p_{t-7}) + \beta_3 (p_t - p_{t-7}) 1_{\{p_t - p_t^r < 0\}} + \varepsilon_t .$$

	Static Reference Prices		
	Last year's average	Production cost	RMA projected price
Intercept	-0.0002	0.0005	0.0005
	(0.0016)	(0.0016)	(0.0016)
Time to Harvest	-3.46E-08	-4.05E-06	-3.93E-06
	(1.18E-05)	(1.18E-05)	(1.17E-05)
Weekly December Price Change	0.0598***	0.0738***	0.0696***
	(0.0190)	(0.0189)	(0.0312)
Price below reference price	0.0601	0.0103	0.0094
	(0.0363)	(0.0382)	(0.0369)
R^2	0.13	0.13	0.13
N	166	166	166

Note: Significance levels indicated as: * p<0.1; ** p<0.05; *** p<0.01. Standard errors in the parentheses.

Table 4. Parameter Estimates Using Dynamic Reference Prices, Producer Series (eq. 3)

$$h_t - h_{t-7} = \beta_0 + \beta_1 time + \beta_2 (p_t - p_t^r) + \beta_3 (p_t - p_t^r) 1_{\{p_t - p_t^r < 0\}} + \varepsilon_t .$$

	Dynamic Reference Prices		
	1 year ago	30 day average	30 days ago
Intercept	0.0126***	0.0055***	0.0071***
	(0.0016)	(0.0011)	(0.0013)
Time to Harvest	-4.67E-05***	-1.98E-05***	-2.45E-05***
	(8.69E-06)	(7.14E-06)	(7.85E-06)
Change from Reference Price	-0.0007	0.1169***	0.0417***
	(0.0032)	(0.0146)	(0.0080)
Price below reference	0.0133***	-0.1049***	-0.0241***
	(0.0057)	(0.0214)	(0.0140)
R^2	0.20	0.39	0.29
N	166	166	166

Note: Significance levels indicated as: * p<0.1; ** p<0.05; *** p<0.01. Standard errors in the parentheses.

Table 5. Parameter Estimates Using Dynamic Reference Prices, DCOT Series (eq. 3)

$$h_t - h_{t-7} = \beta_0 + \beta_1 time + \beta_2 (p_t - p_t^r) + \beta_3 (p_t - p_t^r) 1_{\{p_t - p_t^r < 0\}} + \varepsilon_t \, .$$

	Dynamic Reference Prices		
	1 year ago	30 day average	30 days ago
Intercept	0.0073***	-0.0010	0.0006
	(0.0024)	(0.0018)	(0.0019)
Time to Harvest	-3.13E-05	3.59E-06	-2.66E-06
	(1.31E-05)	(1.13E-05)	(1.17E-05)
Change from Reference Price	-0.0108***	0.1016***	0.0379***
	(0.0048)	(0.0230)	(0.0120)
Price below reference	0.0279***	-0.0318	0.0145
	(0.0086)	(0.0337)	(0.0209)
R^2	0.07	0.23	0.19
N	166	166	166

Note: Significance levels indicated as: * p<0.1; ** p<0.05; *** p<0.01. Standard errors in the parentheses.

Table 6. Tobit Estimation of Producers' Daily Hedge Responses

The model for the latent hedge ratio changes is written as: $\Delta hr_t{*} = \beta_0 + \beta_1 time + \beta_2 (p_t - p_{t-1}^{30}) + \varepsilon_t$.

Dependent variables	Estimates
Intercept	0.0015***
	(0.0001)
Time to Harvest	-4.46E-06***
	(8.10E-07)
Change from Reference Price	0.0179***
	(0.0010)
Log-likelihood	3839
Number of Obs.	861

Note: Significance levels indicated as: * p<0.1; ** p<0.05; *** p<0.01. Standard errors in the parentheses.

Table 7. Average Price Received By Producers before Harvest, in Cents

	2009	2010	2011	2012	2013	5-year average
Sell equal amount monthly	402	395	642	609	538	517
Price at harvest	371	546	632	750	439	548
Price in January	435	413	569	567	585	514
Price in March	411	397	598	559	558	505
Price received by farm level hedger	415	400	657	680	549	540
Price received using by commercial hedgers	431	401	647	663	552	539
Cents per bushel gain by commercial hedgers	-26.51	-1.16	72.66	47.39	-90.72	0

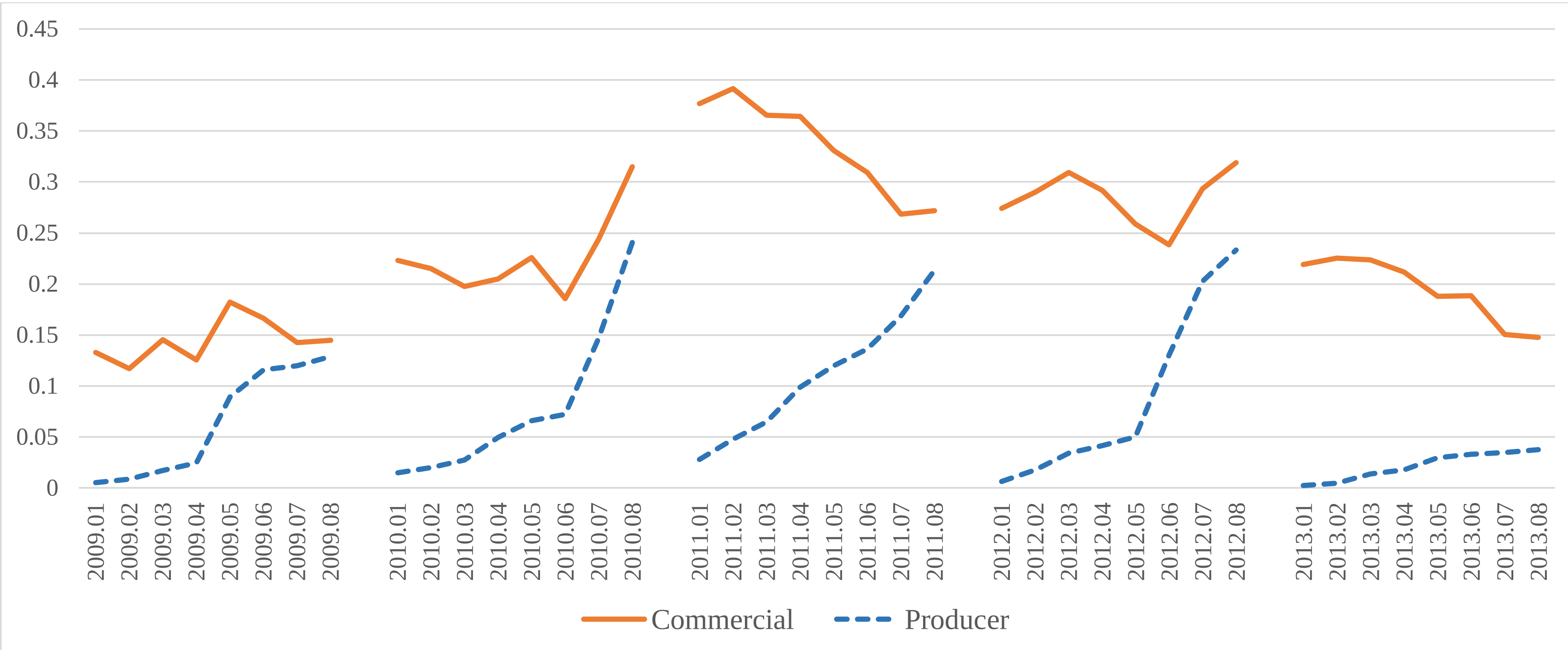

Figure 1. The level of hedge ratios, commercial vs. producer, 01/2009 – 08/2013

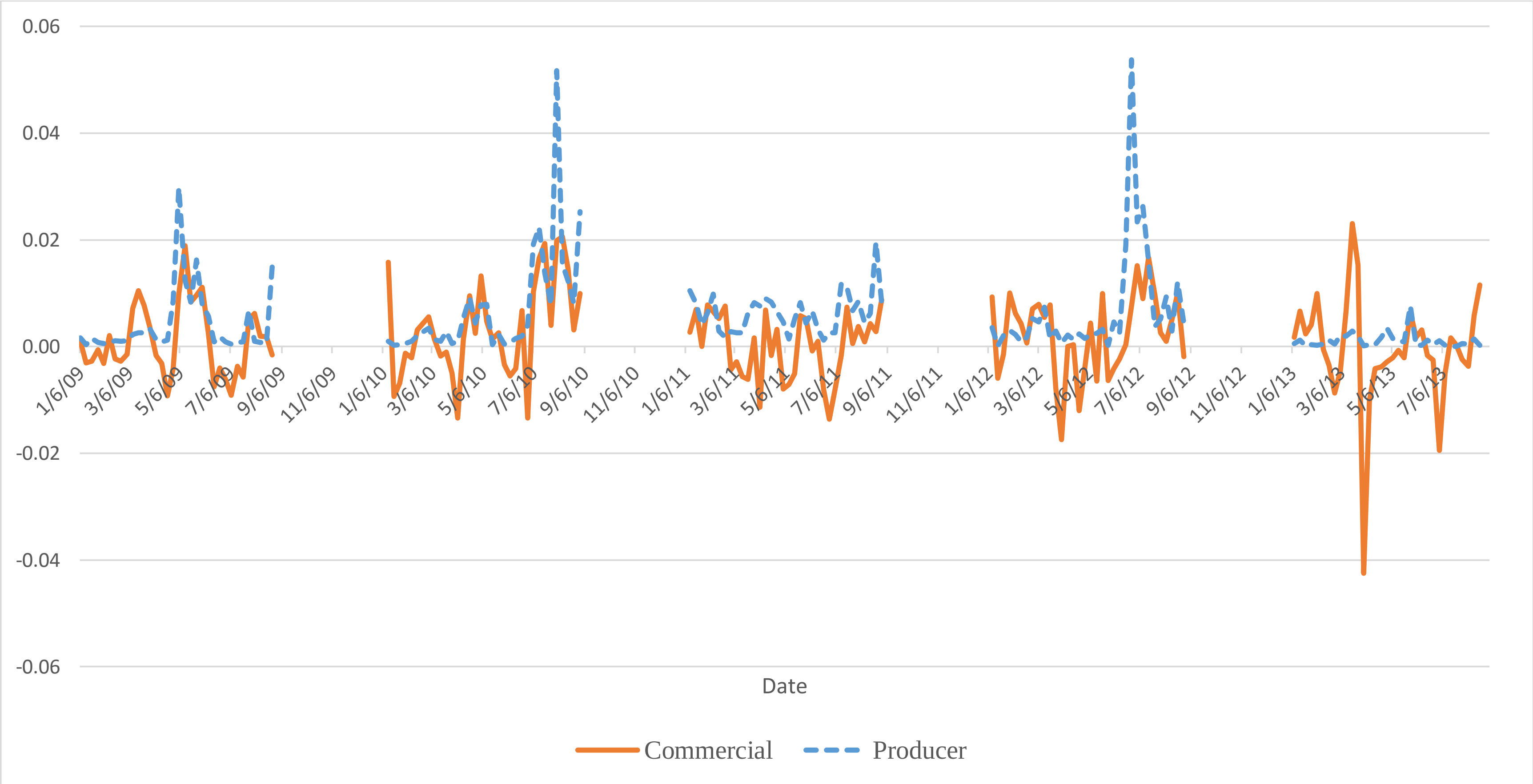

Figure 2. Weekly change in pre-harvest hedge ratios, commercial vs. producer series, 01/2009–08/2013.

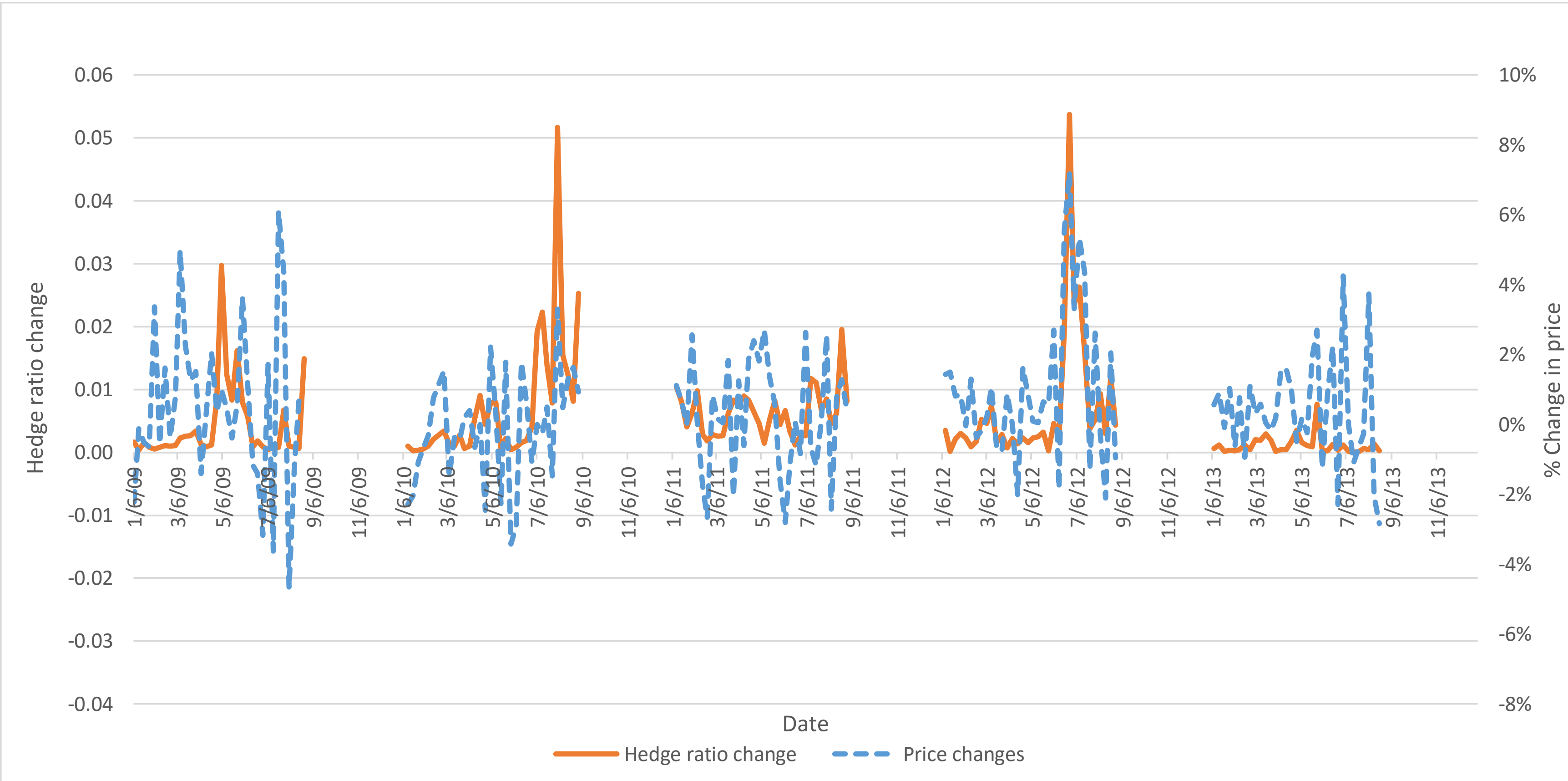

Figure 3. Weekly change in producer hedge ratios vs. weekly percent price changes of December futures, 01/2009–08/2013.

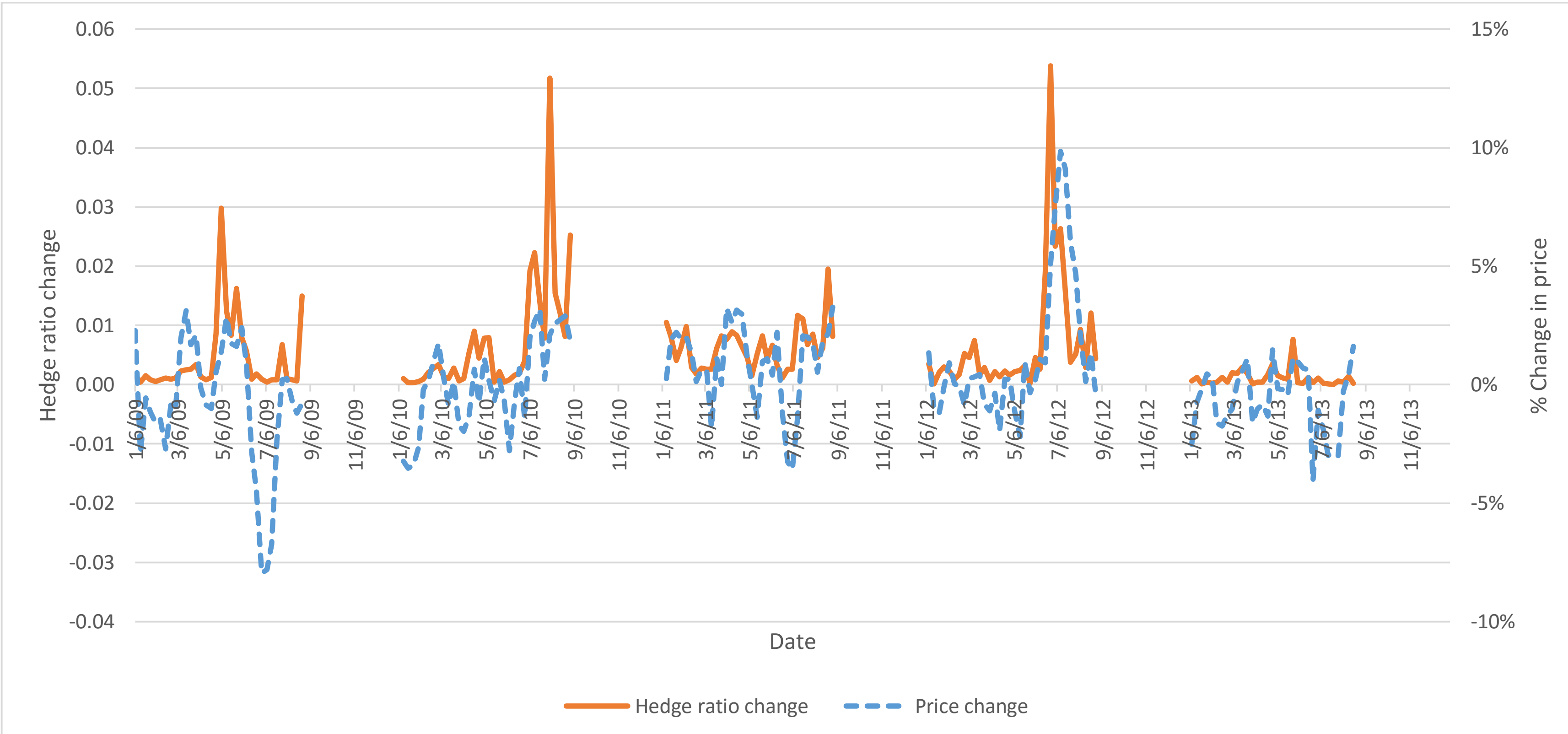

Figure 4. Weekly change in producer hedge ratios vs. percent price changes for December futures from its past 30-day moving average, 01/2009–08/2013.

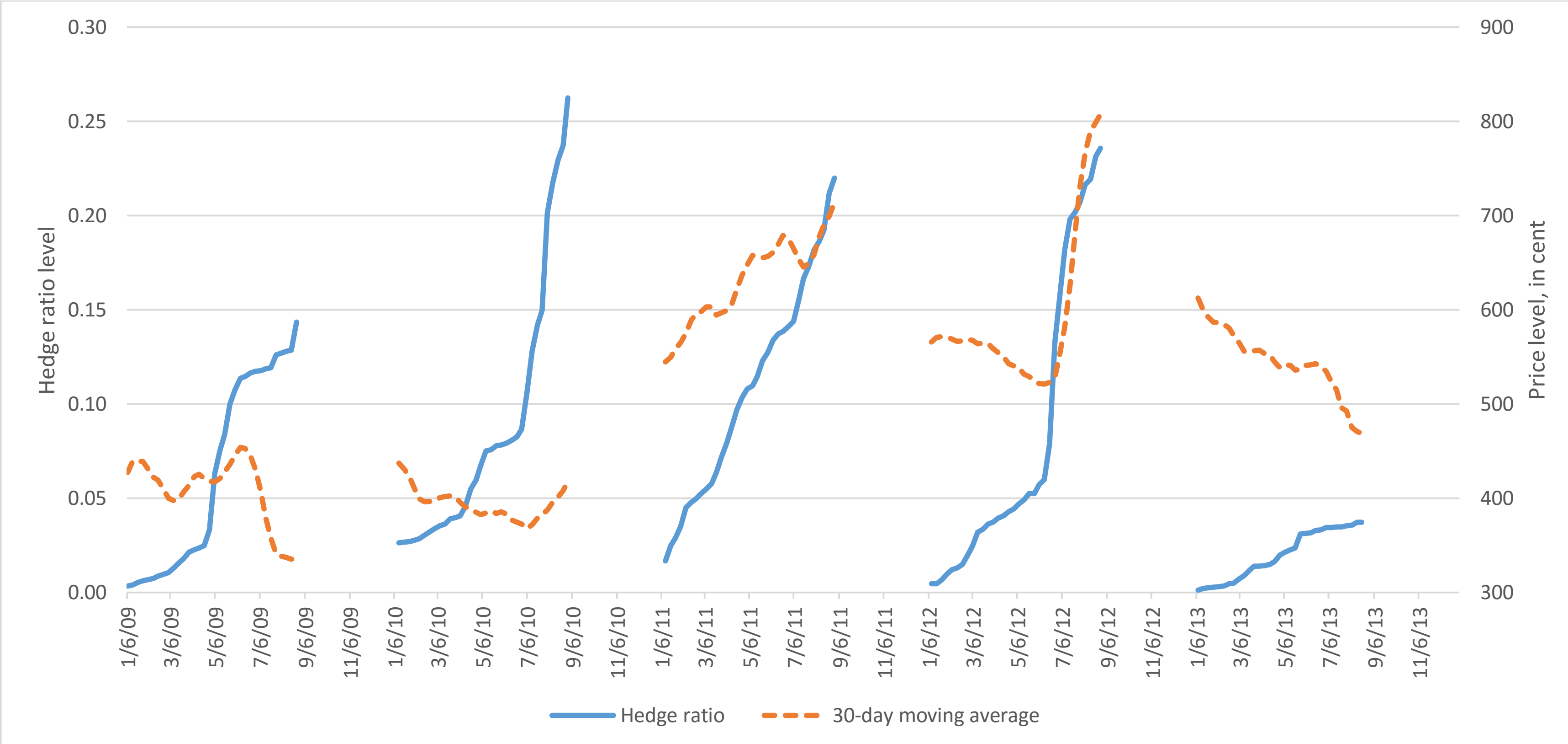

Figure 5. Producer hedge ratios vs. the 30-day moving average of December futures, 01/2009–08/2013