The Reference Price Effect on Crop Producer's Hedging Behavior

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Crop producers’ hedging behavior is at odds with the optimal hedging under expect utility theory. However, there is little consensus on how producers hedge otherwise. In this paper we present an intriguing empirical observation using the Commitment of Traders reports (COT) published by Commodity Futures Trading Commission (CFTC), which shows the hedging behavior of corn and soybean producers may be reference-dependent. We show that producers are likely to hedge when the futures price rises above a reference. Though this reference varies among producers, on the aggregate level, last year’s average price and 20-trading-day moving average of the current futures price are likely candidates. We also discuss the limitation of the data as well as the identification strategies.

Key words: hedging, reference dependence.

Introduction

Most farm level hedging theories with futures and forward contracts as risk management tools are developed under Expected Utility Theory (Johnson 1960, Holthausen 1979, Grant 1985, Lapan and Moschini 1994), but extension economists often suggest the limited relevance of risk management research to real-world marketing decisions of crop producers (Brorsen and Irwin, 1996, Anderson and Mapp, 1996 and Parcell et al. 1998). One reason for this different view is the lack of empirical evidence regarding what motivates producers’ hedging decisions; and a rising number of empirical anomalies (Brorsen and Anderson 2001) lead economists to explore applications of alternative theoretical frameworks to comprehend farmers’ risk preferences and management behaviors (e.g. Collins, Musser and Mason 1991, Musser, Patrick, and Eckman 1996, Lien 2001, Mattos, Garcia and Pennings 2008, Kim, Brorsen and Anderson 2010). Prospect theory as a prominent alternative to Expected Utility theory draws from a large body of evidence from lab experiments suggesting that decisions are reference-dependent (Tversky and Kahneman 1979), namely individuals generate utility from gains and losses measured relative to a reference point (Tversky and Kahneman 1992). Reference dependence is also an essential feature of other utility theories such as regret theory (Loomes and Sugden 1982) and expected target utility (Fishburn, 1977).

Yet research studying the role of reference dependence in hedging is limited as there is little empirical evidence supporting the existence of such an effect. Using data from a hedging game, McNew and Musser (2002) find hedge ratios respond to changes in the futures price relative to last year’s high price. Kim, Brorsen and Anderson (2010) show that under an expected target utility function, the producer will hedge more when price rises above a targeted profit margin; the reference point. The motivation of such a theoretical construct comes from the profit margin hedging strategy that is often suggested by market advisory services and anecdotal evidence that farmers sell a greater portion of their crop forward when prices are high. However, profit margin hedging is only optimal under restrictive assumptions about dynamics of futures prices. In addition, there is no empirical evidence regarding how widely this mechanical rule of hedging is adopted by farmers and even less consensus on the choice of a reference price.

Many empirical literature studying the relationship between prices and participants' positions in futures markets shows that predictive content of trader's positions for returns on futures prices is statistically insignificant (e.g. Hamilton and Wu 2015). This is consistent with the efficient market hypothesis that futures price represents the best expected future price of a commodity and farmers cannot consistently outperform the market using forward contracts (Zulauf and Irwin, 1998; Irwin, Good and Maritnes-Filho, 2006, Cunningham III, Brorsen and Anderson, 2007).

Farmers who believe futures markets are efficient shall only use forward pricing strategies as pure risk-reducing under Expected Utility than pricing-enhancing (McNew and Musser, 2002), and their optimal hedge ratio should be a constant equal to the ratio of covariance between cash and futures prices to the variance of futures price, and not respond to the change in the price level alone. Yet as can be seen from figure 1 this appears to be the case. Figure 1 plots the aggregate hedgers' hedge ratio for corn and the percentage deviation of the nearby futures price from last year's average price. Immediately apparent in the plot is the high degree of correlation between two series. Similarly graph is obtained for soybeans in figure 2 (see appendix).

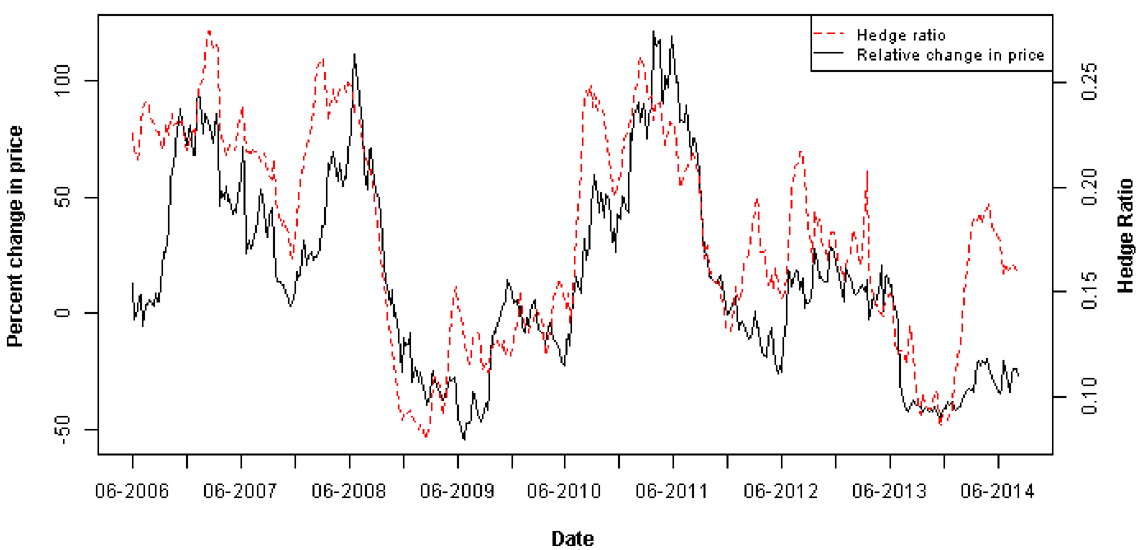

Figure 1. Corn: Producer's hedge ratio and the relative change in futures prices, 06.2006 – 08.2014

There is ample empirical evidence that hedgers' use of futures/forward contracts varies considerably, responding to the change in futures price level. Sanders, Boris and Manfredo (2004) find that increasing prices result in the decline of commercial hedgers' net long position in the energy markets. Consistent with this finding, Anderson and Brorsen (2005) using farm level transaction data show that wheat producers in Oklahoma tend to sell more when price increases. However, Wang (2003) presents results for 15 different U.S. futures markets suggesting that hedgers engage in positive feedback trading, i.e. hedging increases when prices fall. This is of no surprise that responses of traders' *net* positions to changes in futures prices are not robust to changes of commodity types because the composition of participants in different markets varies substantially.

Theoretical Underpinnings

This section reviews determinants of optimal hedging under expect utility theory that is reference-independent, and under other theories of hedging with reference-dependence. To facilitate the comparison, we consider a simple two-period hedging problem for a representative farmer who manages his exposure to price uncertainty, the only risk, using forward contracts. Forward contracts are the most common marketing tools used by farmers in reality (Musser, Patrick, and Eckman 1996, Garcia, P., Leuthold, R.M., 2004).

Expected utility

We assume that the representative farmer has a mean-variance utility function and maximizes his expected utility of revenue in the last period:

$$\max_h E(\Pi) = E\{[p^S(1-h) + p^f h]Q\} - \frac{1}{2}A(1-h)^2 Q^2 \sigma_p^2 .$$

p^s is the spot price in the second period with mean p^f, the forward price as it's unbiased and variance σ_p^2. p^s is unknown to the farmer in the beginning when he determines his optimal hedge ratio, h., Q is the production and A is the absolute risk aversion coefficient of the farmer. Maximizing with respect to h obtains the first order condition:

$$A(1-h^*)Q^2\sigma_p^2 = 0 .$$

Clearly the optimal hedge ratio is equal to one, a full hedge. This result is robust to any concave utility functions and incorporation of production decisions because of the separation theorem (Feder, Just and Schmitz 1980). Adding basis risk, the optimal hedge ratio is less than a full hedge, depending on the correlation coefficient between spot and forward prices (e.g. Castelino 1992). Further incorporating yield risk, Lapan and Moschini (1994) show that under mean-variance approach the optimal hedge ratio is the regression coefficient of random revenue on the futures price.

Alternative hedging theories with reference dependence

The farmer can either set his reference point with regard to the level of unit price, or the variation of prices. The latter is referred to as the mean-semivariance optimization (Markowitz 1959) where the investor is averse to the downside risk, the risk below his targeted return, but risk-neutral over gains. However, as shown above if the forward price is unbiased, the expected return on the hedged portfolio is zero. Thus it's still optimal to fully hedge.

Now consider that the farmer sets a target for the revenue. Tversky and Kahneman (1979) define the value function as:

$$v(\pi) = \begin{cases} (-b)^{\alpha} & \forall\, \pi \geq b \\ -k(b-\pi)^{\beta} & \forall\, \pi < b \end{cases},$$

where b is the target with reference to which the farmer measure his performance. α and β measure the farmer's risk attitudes in gains and losses respectively. k is the level of loss aversion. In lab experiments, Tversky and Kahneman (1992) estimate α and β being equal to 0.88, and k equal to 2.25. These results imply that individuals are risk-averse in gains, risk-seeking in losses and averse to losses. With no basis risk and yield risk, the value function can be rewrite as:

$$v(\pi) = \begin{cases} (p^{s}(1-h) + p^{f}h - b)^{\alpha} & \forall\, \pi \geq b \\ -k(b - p^{s}(1-h) - p^{f}h)^{\beta} & \forall\, \pi < b \end{cases}.$$

This is the same functional form as expected target utility studied in Kim, Brorsen and Anderson (2010). The difference is the choice of probability distribution for the spot price where in prospect theory, the probability weighting of each prospect is subjective.

Without loss aversion and probability weighting, Kim, Brorsen and Anderson (2010) show that if $\alpha = \beta < 1$ namely the farmer is averse to risk over gains, and risk-seeking in losses, then the farmer's optimal hedging follows a "switching" strategy, selling everything if prices are above his target but nothing if below. Adding loss aversion complicates the optimization because of preference reversal around the reference point, as the objective function is not globally concave. But such preference reversal might be hard to discern statistically in hedging as a loss in the futures position because an unfavorable price movement is exactly offset by the gain in the cash position, and vice versa. Mattos, Garcia and Pennings (2008) show that loss aversion only matters to hedge ratios in the presence of probability weighting.

Reference Price Effect

In this paper, we define the reference price effect in the farmer's hedging as the tendency to hedge more when the current price moves above his reference price.

In theory, gains and losses are measured relative to the reference and people may exhibit different behaviors when experience gains than losses. In Prospect Theory, Tversky and Kahneman (1979) argue that people are risk-averse in gains but risk-seeking in losses (preference reversal) and losses are more painful (loss aversion). Barberis and Xiong (2009) extend the Prospect Theory framework to argue that because loss is painful, people are reluctant to realize the loss, which explain the famous disposition effect in the financial markets that investors are less likely to sell stocks with losses than with gains. This observation coincides with our observation in figure 1 that farmers tend forward price greater proportion of their crops when prices are high, relative to last year's average.

Data

Aggregate Data

A typical dataset used in literature for studying the relationship between traders' positions and futures prices is comprised of weekly COT reports and nearby futures prices. The hedge ratio from the perspective of producers is defined as the value of futures contracts sold in relation to the producer's cash commodities (Moschini and Myers, 2002).

$$HR \equiv \frac{5000 * \ \# \text{ of short futures contracts}}{\text{inventory + expected production}} .$$

On the aggregate level, the cash position consists of both storage that is to be marketed as well as the growing crop. Since for corn and soybean each standard futures contract represents 5,000 bushels of the underlying commodity, the number of short futures contracts is multiplied by 5,000 to reflect the amount of crops being sold forward. The total number of short futures contracts held by producers/grain merchants are readily available from weekly disaggregated Commitment of Traders reports produced by CFTC. The disaggregated Commitment of Traders report provides the weekly position of producer/merchant/processor/user in futures markets by separating swap dealer from the commercial classification in the legacy format. This series is available back to June 13, 2006, Thus we choose our sample period from June 2006 to Aug 2014.

The USDA publishes a Grain Stocks report quarterly on the 1st of March, June, September and December. Assuming constant depletion rate of grain stocks, we linearly interpolate the weekly inventory level between ending stocks of each quarter. Approximate weekly inventory schedules are plotted in figures 3-4 for corn and soybean respectively. The assumption of linear reduction of grain stocks during the post-harvest session seems reasonable according to plots because red dots, the actual numbers reported for total stocks, are aligned fairly straight within each year especially for corn. In the literature concerning dynamic hedging of inventories, a deterministic inventory schedule is often assumed (e.g. Lence, Kimle, and Hayenga 1993). This simplifying assumption can be reasonably justified by the fact the aggregate consumption of major agricultural commodities is stable. As shown in figures 3-4, a linear depletion of post-harvest inventory is consistent with the quarterly stocks report. We update the expected production of the coming year using the average production of the past five years, the USDA's Prospective Plantings report released in April, the intended planting acreage is multiplied by the trend yield from last five years to obtain an updated expectation of harvest.

On average, 17% of corn is hedged on a weekly basis but varies considerably from 7.9% to 27.3%. The hedge ratio of soybean is average around 34% with range from 13.9% to 70%. Clearly the variability in hedge ratios of both corn and soybean are at odds with the hedge ratio under Expected Utility, which is only determined by the past price relationshipdon't vary significantly (McNew and Fackler. 1994).

Reference Price

There are many prices that can serve as or influence farmer's reference price, and one way to specify the reference price is:

(1) $R_t = \sum_i \alpha_i p^i{}_t$

where α_i is the weighting parameter and p_t^i is the potential price that the farmer may use as his reference.

In practice, the reference price may be a point against which the farmer measure his performances and one alternative choice of p_t^i is the average price that would have been received by the farmer over his marketing window (Irwin, Good, Martines-Filho and Batt, 2006). Performance evaluations are in retrospect by construct, while a more interesting question, as motivated by figures 1, is why the benchmark of last year seems to play a role in the farmer's marketing decisions. In this study we consider a benchmark the simple average crop price of the past marketing year. We also consider monthly average price of the same month last year for robustness check.

Using last year's marketing price as reference assumes that producers' reference price is not influenced by the current price movement, which cannot be ruled out as a possibility because producers are monitoring the futures markets closely to determine at what price they'd like to lock in for their crops. Following McNew and Musser (2002), we also hypothesize that hedge ratios respond to change in current futures price relative to its past 20-day moving average. The use of moving average prices implicitly assumes that the current price movement does affect producer's hedging decisions, but it's a slow process, i.e. producer's reference point doesn't change overnight.

Estimation

We make no assumption about the farmer's objective function except that he believes the futures market is efficient and test the hypothesis that his hedging decision is partially driven by the reference price effect: $\Delta hr_t = \beta(p_t - R_t)$.

The efficient market view assumes that futures prices follow a random walk:

$$(2) \quad p_t = p_{t-1} + \varepsilon_t$$

The autoregressive analysis of the first difference of nearby futures prices is presented in the summary table 3, showing the weekly past returns on futures contracts cannot predict future returns. Thus the deviation of the current futures price from the reference point is the difference between equation (1) and (2):

$$(3) \quad p_t - R_t = \sum_i \alpha_i (p_{t-1} - p_t^i) + \varepsilon_t$$

Based on the above discussion on reference price, we simplify the analysis by using the producer's reference price as last year's marketing prices, p_t^y, and the 30-day moving average of the current futures price p_t^{30}, and assuming the effect of all other p_t^i in an error term v_t that is uncorrelated with ε_t.

Substitute (1) into (3) we obtain that:

$$(4) \quad p_t - R_t = \alpha_1 (p_{t-1} - p_t^y) + \alpha_2 (p_{t-1} - p_t^{30}) + (p_t - p_{t-1}) + v_t$$

Regression model for the aggregate data

Dicky-Fuller tests of aggregated hedge ratios presented in table 1 show that unit root hypotheses cannot be rejected. Thus we specify the independent variable as the change in hedge ratios and the regression equation becomes:

$$(5) \quad \Delta hr_t = \sum_{t=1}^{11} \gamma_t Month_t + \beta_1 \Delta hr_{t-1} + \beta_2 (\alpha_1 PR_t^y + \alpha_2 PR_t^{20} + \Delta p_t) + v_t,$$

where Δhr_t is the change in producer's hedge ratio between time *t* and *t-1*, and Δhr_{t-1} is its lag to control for the serial correlation of changes in hedge ratios.

$PR_t^y = P_{t-1} - R_t^y$ and $PR_t^{30} = P_{t-1} - R_t^{30}$, are binary variables equal to one if the futures price in the last period is above the reference prices and equal to zero otherwise.

Δp_t is the change in futures price. *Month$_i$* is the monthly dummy variables from January to November. $v_t's$ is serially uncorrelated random shocks. Parameters of interests are α_1 and α_2 which capture whether a deviation of futures price from references affect producer's hedge ratio, although the signs are unclear *a priori*. For example, if drought causes this year's futures price higher relative to last year, farmers would expect the price to remain high and withholding his forward sale for a possibly better price later. Or farmer could believe that the current price may revert back to last year's average thus forwarding more crops when the current price is higher. Finally β_2 measures the extent to which the hedge ratio responds to a price change from reference points.

Prior studies on reference-dependence focus on behavioral implications of whether the current price level is above or below the reference point. We show that under the efficient market view, reference price effect can be decomposed into two components, 1) the effect on the direction of change in hedge ratios and 2) the composition of reference price. In the finance literature, views on efficient market hypothesis are mixed, implying a potential endogenous issue of equation (5) that includes the contemporaneous return on futures price. To check the robustness of estimation of equation (5), we estimate the following regression model:

$$(6)\ \ \Delta hr_t = \sum_{t=1}^{11} \gamma_t Month_t + \beta_1 \Delta hr_{t-1} + \alpha_1 PR_t^y + \alpha_2 PR_t^{20} + \beta_2 \Delta p_{t-1} + v_t$$

with $PR_t^y = P_t - R_t^y$ and $PR_t^{20} = P_t - R_t^{20}$, that is, the reference price effects are measured as binary variables equal to one if the current futures price is above references. Equation (6) also uses Δp_{t-1}, return on futures price in the last period as opposed to Δp_t in equation (5). Note that equation (6) is a reduced form regression model with fewer structural assumptions than equation (5), but they all serve to test if the hedge ratio is affected by the reference price effect.

Results

We first estimate the reduced form of equation (5) with OLS. Structural parameters α_1 and α_2 are calculated as the reduced-form estimates on PR_t^y and PR_t^{30} respectively divided by estimated β_2, and bootstrap standard errors are used for hypothesis testing. Table 4 presents the estimation result of equation (5) and P-value is given in the parentheses.

Our result provides strong evidence that producers have greater tendency to forward price more of their crops when the futures price is above their reference point than below. These estimates are robust to whether the last year's price is measured as yearly or monthly average. This result should be intuitive as producers have a target price in their mind when making marketing decisions. Just like a consumer shopping in a market who may be incentivized to buy more of an item with a newly mark-down price, the crop producer may also want to lock in a greater proportion of his crop at the price level that is above his reference price.

There could be many potential factors that shape producers' reference prices. The result in table 4 shows that the last year's average as well as the current price trend appear to play important roles in determining the producer's reference price. Specifically, higher last year's price lowers producers' reference point. The rationale is that the farmer doesn't believe the market condition that made the last year's price would repeat yet again in the current crop year. He rather expects the price to revert to its long term average, and this mean-reversion is a stylized fact of agricultural commodity prices (e.g. Tomek and Peterson 2001). For instance, a drought as a negative supply shock in 2012 that caused the corn price to sky-rocket in 2012 was not expected to happen again in 2013. Thus the farmer would not use 2012 price as his reference price, but probably lower, when making his marketing decision in 2013. Further, this result implies that ceteris paribus, higher the last year's price (conditional on being below the current price), more crop would the farmer forward hedge.

On the other hand, we find that the farmer's reference price is positively correlated with the current price trend, but the estimation result is only significant for corn, not soybean. One explanation is that the farmer has adaptive expectation that believes current price trend will continue into the future, which implies that a positive price trend leads to higher reference prices and vice versa. As we show in the previous section, if farmer use a short-duration moving average to construct the price trend, the role of current price trend in determining the reference price may not be statistically discernable. This likely happens in a scenario where the farmer monitors the futures price daily but only use his memory to form the price trend. But the memory tends to be short term and an extreme example would be the yesterday's price as the reference, which is washed out in the regression equation.

Table 5 presents the estimation result of equation 6 that demonstrates the robustness of the reference price effect presented in table 4. But one should exercise caution when interpreting equation 6. For example, one tends to conclude that when the current futures price is above the last year's average, the farmer would hedge less; if the current price is above the current price trend, the farmer would hedge more. Both estimates appear to be highly significant but the joint reference price effect needs an additional step of testing. The issue is further complicated if more potential reference prices are added into the regression equation. However, the more important question is whether this reduced-form modeling reflects farmer's true decision making process. In this regard, equation 5 may have advantage over equation 6 as it allows for multiple factors to influence the producer's reference price but it restricts only one reference price for one activity, which is intuitively more appealing.

Another issue that confuses researchers in the past is that why past price changes seem to lead the change in hedgers' positions (table 5) when clearly the past return does not predict the future. Here we offer an alternative explanation that it's not the expected future price returns that causes farmer's to hedge but rather the deviation of current price relative to farmer's reference price that motivates his marketing decision.

Discussion

Our key finding that differentiate this paper from the previous literature is the reference price effects in crop producers hedging behaviors. When the price rises above the last year's market benchmark farmers who underperformed the market previously may be incentivized to lock in the gain, measured by the difference between the current price and the benchmark of last year, by selling forward to a grain elevator that in turn manage their exposure in the futures market by taking a similar short position. We show that the reference price effect is robust to various model specifications.

Our empirical observations have parallel counterparts in stock markets. Grinblatt and Keloharju (2001) find reference price effects in individual investors trading stocks, who have higher propensity to sell if a stock rises above its high of 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 the so called disposition effect that cannot be reconciled with portfolio management techniques nor justified by the subsequent portfolio returns (Odean, 1998). In addition, the strong correlations between trading volume and prices that has long been documented for stock markets (e.g. Griffin, Nardari, and Stulz, 2007) are also stylized facts in agricultural commodities futures markets. While maintaining most axioms of prospect theory, Barberis and Xiong (2012) suggest that people derive utility from only *realized* gains and losses and develop a theory that rationalizes some of these stylized facts in financial markets that would otherwise be identified as anomalies under expected utility theory. The reference effect is also found in the real estate market where movers from more expensive cities tend to rent pricier apartment (Simonsohn and Loewenstein 2006) and home sellers are using expected selling price and the original purchase price as reference prices when setting asking prices (Genesove and Mayer 2001).

The identification of the reference price effect hinges on the efficient market hypothesis that the position change of hedgers doesn't affect the futures price on nearby contracts. This hypothesis finds empirical support among literature that there is little "hedging pressure" effect in futures markets for agricultural commodities. It's also reasonable to assume that present positions of participants in futures markets would not affect the difference between nearby futures prices and that of last year, which is rather determined by the fundamental demand and supply in spot markets. (Irwin et al. 2009).

Thus the price series of concatenated nearby futures contracts are mimicking very closely the dynamic of spot prices (Tomek and Peterson, 2001).

What does the reference price effect mean is of great importance for the future research. There is generally consensus that futures markets for agricultural commodities are efficient, so we don't expect farmers' reference-dependent behavior to affect the return on futures prices. However, if producers in aggregate sell too earlier as a result of pricing being above their reference points from last year, there might be less inventory towards harvest thus contributing to the volatility in spot markets (Kauffman and Hayes, 2011).

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Table 1. Weekly aggregated hedge ratios for corn and soybean, 06.2006 – 08.2014

	Corn	Soybeans
Mean	0.1734	0.3426
Median	0.1691	0.3414
Range	(0.079, 0.273)	(0.139, 0.701)
Std. Dev	0.049	0.112
DF-test	-1.0005575	-0.8064158

Note: The critical values of the Dickey- Fuller test are -1.62, -1.95 and -2.58 at 10%, 5% and 1% respectively.

Table 2. Monthly change in firm-level hedge ratios for corn and soybean, crop year 2010-2014

	Corn	Soybeans
Mean	0.04724	0.0412
Median	0.03045	0.03206
Range	(0.0007, 0.1853)	(0.0011, 0.1330)
Std. Dev	0.0457832	0.03463148

Table 3. Weekly Returns on the Nearby Futures Contracts for corn and soybean, 06.2006 – 08.2014

Mean	1.00	3.75
Median	0.25	0.70
Range	(-107.7, 95)	(-172.8, 130)
Std. Dev	23.25	45.42
lag_1	-0.0232	-0.0478
	(0.0463)	(0.0463)
lag_2	0.0560	0.0340
	(0.0462)	(0.0463)
lag_3	0.0640	-0.0011
	(0.0462)	(0.0463)1990

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

Table 4. Estimate the effect of reference prices, model 5.

	month		*year*	
	corn	soybean	corn	soybean
Δhr_{t-1}	*0.1029***	*0.3269***	*0.1149***	*0.3320****
	(0.0198)	(0.0000)	(0.0104)	(0.0000)
ΔP_t *10^3	0.1257***	0.1753***	0.1252***	0.1752***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
PR_t^y	-13.7137***	-17.1974**	-11.6078**	-16.0054**
	(0.0073)	(0.0347)	(0.0175)	(0.0536)
PR_t^{20}	27.8797***	5.1933	26.9651***	4.7362
	(0.0000)	(0.5523)	(0.0000)	(0.5889)
Jan	0.0011	0.0047	0.0009	0.0047
	(0.3139)	(0.0561)	(0.3564)	(0.0511)
Feb	0.0016	0.0061	0.0015	0.0059
	(0.1270)	(0.0167)	(0.1738)	(0.0206)
Mar	-0.0001	0.0064	-0.0001	0.0061
	(0.9927)	(0.0106)	(0.9623)	(0.0100)
Apr	-0.0057	0.0009	-0.0058	0.0010
	(0.0000)	(0.7021)	(0.0000)	(0.6582)
May	0.0013	0.0037	0.0011	0.0037
	(0.1697)	(0.1144)	(0.2336)	(0.1241)
Jun	-0.0022	-0.0012	-0.0023	-0.0010
	(0.0546)	(0.6874)	(0.0422)	(0.6952)
Jul	0.0017	0.0020	0.0015	0.0024
	(0.0926)	(0.3731)	(0.1156)	(0.3052)
Aug	0.0013	0.0083	0.0011	0.0086
	(0.1756)	(0.0004)	(0.2460)	(0.0004)
Sep	-0.0042	-0.0040	-0.0044	-0.0042
	(0.0002)	(0.1155)	(0.0001)	(0.0920)
Oct	-0.0019	-0.0054	-0.0023	-0.0059
	(0.0879)	(0.0235)	(0.0391)	(0.0205)
Nov	-0.0046	-0.0060	-0.0050	-0.0061
	(0.0001)	(0.0223)	(0.0000)	(0.0229)
R^2	0.36	0.44	0.36	0.44
Number of Obs.	448	448	448	448

P-value in the parentheses. Significance levels indicated as: * p<0.1; ** p<0.05; *** p<0.01.

Table 5. Estimate the effect of reference prices, model 6.

	Month		*year*	
	corn	soybean	corn	soybean
Δhr_{t-1}	0.0527	0.3141***	0.0670	0.3262***
	(0.2477)	(0.0000)	(0.1393)	(0.0000)
$\Delta P_t *10^3$	0.0511***	0. 0286	0.0511***	0.0301
	(0.0005)	(0.1308)	(0.0006)	(0.1139)
PR_t^y	-0.0019***	-0.0044***	-0.0014**	-0.0031**
	(0.0023)	(0.0037)	(0.0244)	(0.0440)
PR_t^{20}	0.0051***	0.0117***	0.0049***	0.0112***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Jan	0.0003	-0.0016	-0.0001	-0.0019
	(0.8141)	(0.5569)	(0.9587)	(0.5001)
Feb	0.0016	0.0012	0.0013	0.0006
	(0.1787)	(0.6757)	(0.2682)	(0.8289)
Mar	-0.0007	0.0008	-0.0008	0.0001
	(0.5157)	(0.7772)	(0.4398)	(0.9808)
Apr	-0.0063	-0.0039	-0.0066	-0.0040
	(0.0000)	(0.1575)	(0.0000)	(0.1476)
May	0.0005	-0.0004	0.0003	-0.0009
	(0.6569)	(0.8852)	(0.8150)	(0.7527)
Jun	-0.0030	-0.0060	-0.0032	-0.0062
	(0.0080)	(0.0343)	(0.0038)	(0.0325)
Jul	0.0011	-0.0032	0.0008	-0.0030
	(0.3129)	(0.2205)	(0.4662)	(0.2664)
Aug	0.0006	0.0049	0.0003	0.0049
	(0.5822)	(0.0621)	(0.7636)	(0.0668)
Sep	-0.0056	-0.0112	-0.0060	-0.0121
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Oct	-0.0025	-0.0098	-0.0031	-0.0107
	(0.0247)	(0.0003)	(0.0048)	(0.0001)
Nov	-0.0053	-0.0112	-0.0057	-0.0115
	(0.0000)	(0.0001)	(0.0000)	(0.0001)
R^2	0.3240	0.3442	0.3175	0.3378
Number of Obs.	448	448	448	448

P-value in the parentheses. Significance levels indicated as: * p<0.1; ** p<0.05; *** p<0.01.

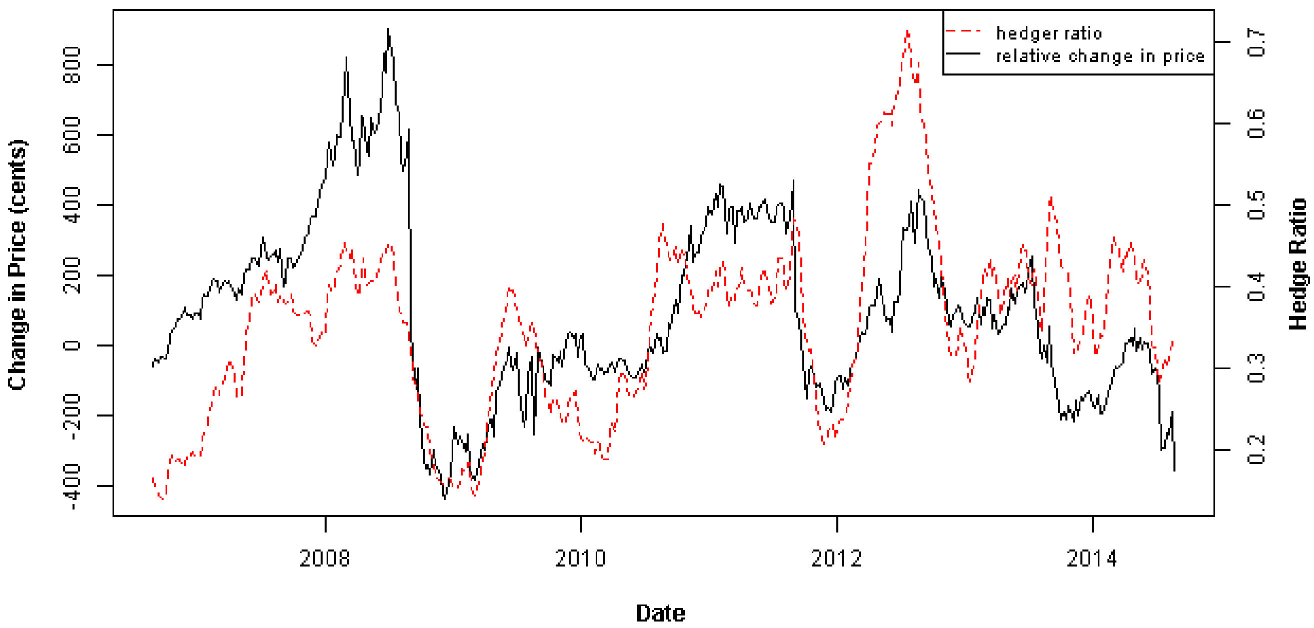

Figure 2. Soybean: Producer’s hedge ratio and the relative change in futures prices, 06.2006 – 08.2014

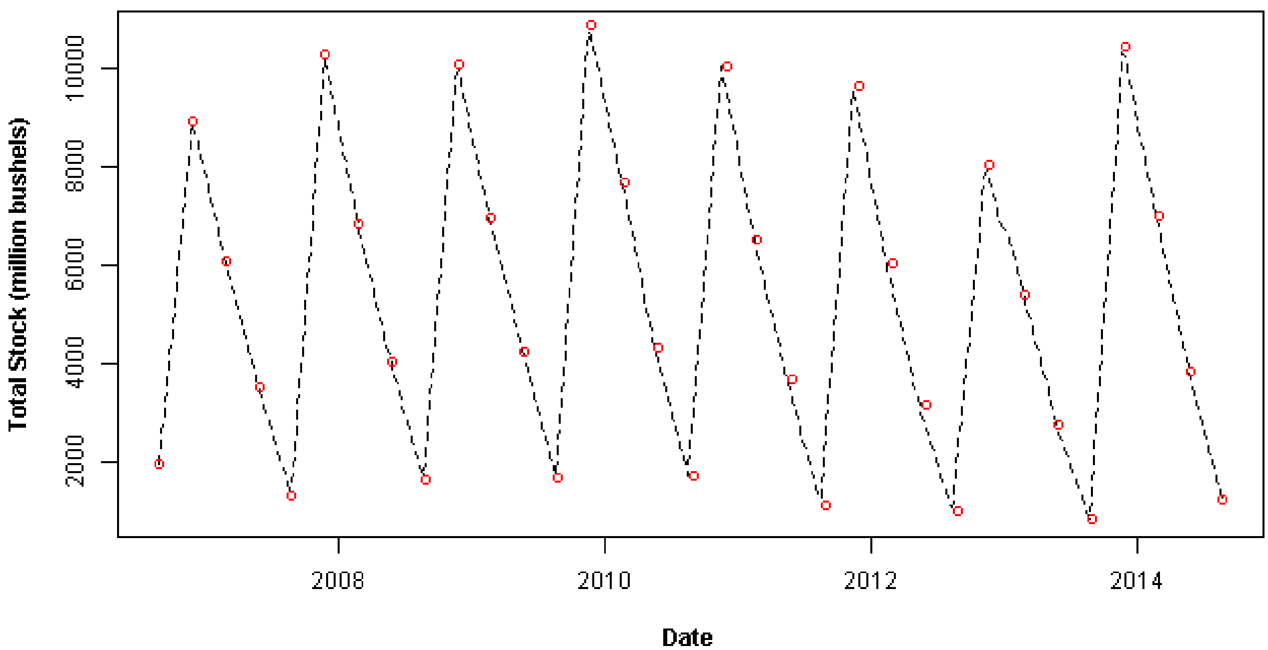

Figure 3. Corn: Total Stocks in U.S., 06.2006 – 08.2014

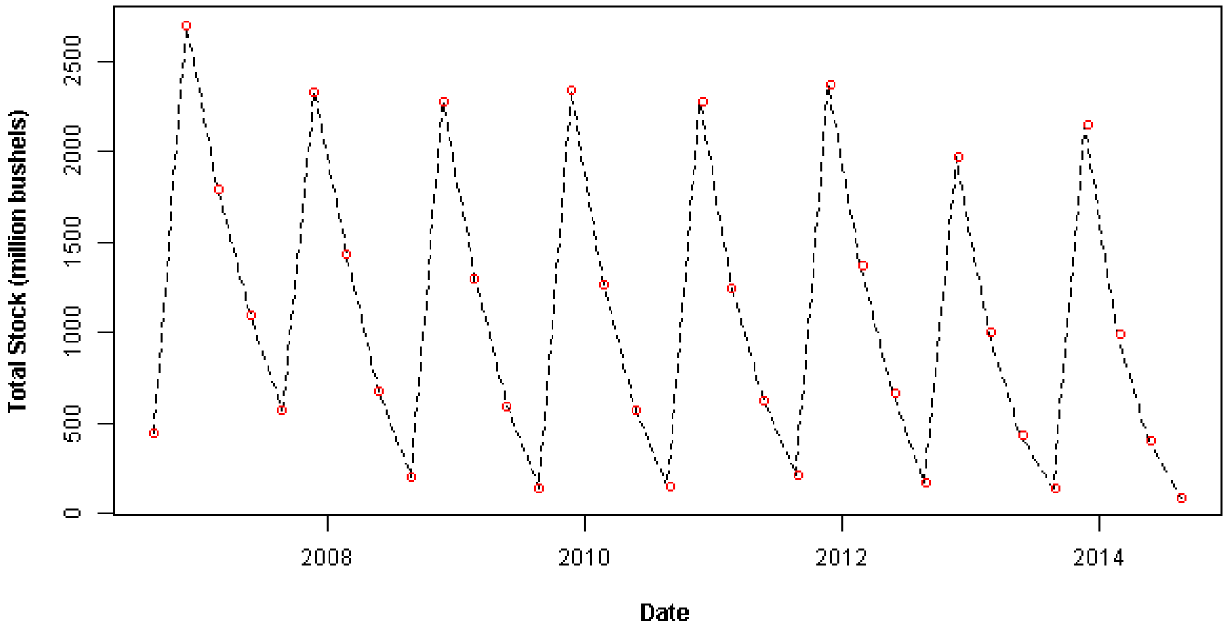

Figure 4. Soybean: Total Stocks in U.S., 06.2006 – 08.2014