STORAGE RETURNS OF INDIANA CORN AND SOYBEANS

by

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To God, family and farmers

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ABSTRACT

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Most of Indiana corn and soybeans are placed into storage at harvest time to be delivered to market at a later date. Indiana farmers have many options regarding how and when to sell this grain. The present research addresses the issue of how to maximize the expected net returns to storage. The three central questions are: (i) which crop produces better returns? (ii) should the grain be stored unpriced or hedged using futures? and (iii) how long should grain be stored? Expected net returns for corn were maximized by storing unpriced until spring. However, unpriced corn storage provided positive returns less frequently than storage hedging. Unpriced soybean storage was better on average, and also produced positive returns more frequently than storage hedging. Returns were higher for soybeans than corn.

CHAPTER 1. INTRODUCTION

Corn and soybean farmers have a variety of options when it comes to when and how they merchandise their grain. A common practice on Indiana farms is to store at least a portion of their grain at harvest and deliver it to market later. Over the last decade, on average, 82% of Indiana´s corn production and 72% of Indiana's soybean production is in storage on December first (USDA, 2019). Over half of that is stored in on-farm storage.

The amount of merchandising tools and options available can be overwhelming. In addition, market fluctuations can make it difficult for farmers to evaluate and select marketing strategies. The optimal strategy one year may not be the optimal strategy the next. By analyzing the returns to storage for Indiana corn and soybeans, the present research can aid in both explaining and informing farmer behavior.

The present study evaluates general storage return trends over a thirty-year time horizon in Indiana. Evaluating various merchandising tools requires some expectation of changes in futures price and basis, the two components of the farmer's local cash price. When storing grain, farmers face a series of decisions, including where and how to store the grain. Storage costs include; cash storage costs, opportunity costs and physical storage losses (Black, Rister & Seeks, 1984). Of these, cash storage costs and physical losses can be influenced by how and where grain is stored even if the interest costs on stored grain, opportunity cost, is not. In addition to where and how to store grain, farmers also face decisions on how long to store grain and how to merchandise the grain they have in storage. Though costs and operational efficiencies play a role in farmer decisions, this research emphasizes the revenue side and merchandising actions involved in the storage decision.

This research draws on the legacy of seminal publications such as that of Working (1949). The *Working Curve* plots the difference between the short-term futures price and the long-term futures price against inventories. Working (1949), also addresses the problem of inter-temporal price relations and their impact on storage returns, as well as the value hedging offers as a way to enable basis speculation. The present research has also benefited greatly from results shown in extension research and other more current storage returns literature, such as Hurt (2017) and Knorr (2017). Methodologically innovative research and pragmatic empirical results have both enlightened the problems addressed here.

Recent storage returns studies in regions other than Indiana have offered a bleak outlook on storage returns. In analyzing returns to wheat storage in Kansas, Ward (2015) found that returns for both hedged and unhedged wheat were slightly negative across most months, but hedging significantly lowered risk in comparison to storing unhedged grain. Though these results may seem to discourage storing grain, her research also points out that there are other advantages to storage, such as tax deferrals. In his study on corn storage in Mississippi, Milstead (2017) concluded that the market carry and basis increase between September and March did not cover the combined cost of the facility and the economic opportunity cost of capital to justify the upfront investment in on-farm storage. In spite of the discouraging results of these studies, as shown previously, Indiana farmers store a substantial amount of their soybeans and corn. It is valuable to understand how Indiana storage returns may differ from returns elsewhere. It is also important to understand the nature of the returns that have motivated farmers to store their grain.

As grain inventories cannot be replaced until the next harvest, Fackler and Livingston (2002) describe post-harvest storage decisions as akin to an irreversible investment, and thus similar to exercising a financial option. Thus, the optimal decision rule takes the form of a cutoff price. If the market price is below the cutoff price, storage should continue, if above, all stocks should be sold. Merely analyzing net present value is an insufficient form of selecting optimal pricing as each additional period of storage includes an option value of having the grain available for one more period. While Fackler and Livingston (2002) approached the decision to sell as an "all or nothing" rule, and modeled the behavior of risk neutral farmers, Lai et al. (2003) allowed for partial sales and modeled risk-averse farmers.

Hurt (2017) evaluates speculative storage of Indiana corn and soybeans on a ten-year time horizon from 2006-07 to 2015-16. While he comments on returns and risks of storage throughout the storage season, he does not compare speculative storage to hedged storage. On the other hand, Knorr (2017), compares across multiple storage merchandising strategies in multiple locations, but imposes storage until July, and thus, does not evaluate the effectiveness of storage strategies throughout the storage season. The present research evaluates both hedged and speculative storage, throughout the storage season. It also sheds light on the nuances of pricing risks, makes comparisons between corn and soybean returns and evaluates the adjustment of actual inventories to pricing incentives.

Farmers annually make decisions regarding how long to hold their grain for, whether to store corn or soybeans and which to sell first. They also make decisions about whether or not to storage hedge or store grain unpriced. This research objectively looks at the returns to the decisions which farmers who store are obligated to make annually. Knowledge gained from the results of this research can have a meaningful economic impact for farmers as they design their grain marketing plans and select the portfolio of merchandising tools that best fits their operation.

CHAPTER 2. OBJECTIVE STATEMENT

The objective of this research is to evaluate storage decisions for corn and soybean farmers in Indiana from the standpoint of maximization of expected net returns to storage. This research focuses on three primary decisions: 1) which crop to store; 2) how long to store it for; and 3) whether or not to hedge stored grain.

CHAPTER 3. DATA

Chicago Board of Trade futures prices were used. The prices used were monthly average of daily settlements. Each respective futures contract was used up to, but not in to the month of expiration. Previous research, as well as typically diminished liquidity of futures contracts as they enter the month of expiration contributed to this decision. The primary source of cash price data was the USDA average monthly cash prices (USDA, 2019). Though Indiana was the focus of the study, results were compared to Michigan, Ohio and Illinois. Robustness checks were also conducted to validate results across different regions of Indiana. The data for cash prices used in regional analyses were collected from the first week of 2004 to the last week of 2017 from ProphetX (DTN, 2019). Regional analysis was an average of the locations in a given Indiana crop-reporting district. USDA data was also used as a source of stocks, production and yield history for corn and soybeans in Indiana (USDA, 2019).

The default interest rate used was 3.0% per year, and the default custom storage cost used was $0.03 per bushel per month. The opportunity cost of capital may vary between farmers, for instance, some may have low subsidized interest rates, while others may have some capital with a higher rate, thus 3% APR models a blended low rate. A typical storage rate arrangement is to charge 9-16 cents per bushel of storage for the first three months and 2-4 cents per bushel each consecutive month (Iowa State Extension, 2019). The cost of storage for soybeans and corn was the same. The interest rate was the also the same, however, given that the value of a bushel of soybeans is higher than that of corn, the interest cost per bushel for soybeans is higher even if the rate is the same. The same costs of storage were imposed for both unpriced and hedged storage. Costs of futures margin calls were not considered.

The thirty-year time horizon used in the current research captures major events such as the 2008 financial crisis, structural change from ethanol and the drought of 2012. Though these events are outliers, outlier events occasionally occur. By including these years in our sample, we can observe how outlier events affect storage returns.

CHAPTER 4. METHODOLOGY

The farmers merchandising options have been limited to storing hedged or unhedged corn or soybeans. For a hedged position, we have imposed that the futures position be taken in October as this is the beginning of the storage season. Given that corn and soybean prices tend to be lowest, on average, at harvest, we may be imposing that hedges are placed at seasonal lows. On the other hand, farmers may be hesitant to place a hedge until they have the physical grain, and thus, imposing this period for placing a hedge is reasonable. A well-managed crop insurance policy could mitigate much of the crop failure risks. In addition, simply unwinding futures positions to lift hedges could mitigate risks from overselling or over hedging production. Nevertheless, even if this risk is more perceived by farmers than actual, it may still affect their decisions. Either way, as the focus is returns to storage, the hedge is imposed at the beginning of the storage period.

In focusing on expected net returns to storage, it is important to clarify a few limitations of this analysis. The analysis does not focus on costs of production of corn and soybeans. Consequently, profitability and overall optimal farm management strategy are beyond the scope of this research project. Farmer´s cash flow needs and equity position are also not variables tested in this analysis. Some farming operations may have tight cash flow needs and a thin equity position and capturing a few extra cents per bushel on their storage may be costly to their credit, cash flow or liquidity. This research endeavor also does not aim to address optimal merchandising strategy of the crop in general. The focal point of this research is limited to the merchandising of post-harvest stored corn and soybeans in Indiana, and the objective of maximizing expected net returns to storage.

In this analysis, farmers can store their grain from October through September of any given crop year, but not beyond one year. The futures contracts analyzed include those that expire during the respective storage season. Hedges evaluated include those placed against any of the futures contracts available in a given year up to the month of expiration, but not entering it. Farmers can store either corn or soybeans. In addition to using a storage hedge, they can also store unhedged. That is, the storage of unpriced corn or soybeans to capture change in cash price.

We have considered the storage season as beginning in October – “harvest” – and lasting through September. Gross returns to storage for unhedged grain are given as the difference in cash price between the current value at a given point in time and the value in October. In the same way, the gross returns to storage for hedged grain are given by the change in basis, the spot cash price minus the futures price, for any given month minus the basis value in October.

To obtain a value for net returns, costs are subtracted. The relevant cost is marginal cost, where marginal is defined as the cost of storing for one additional time period, in our case, a month. Economies of scale in the storage of corn and soybeans can be expected (Schnake and Stevens, 1983). Furthermore, the bulk of storage cost involves fixed cost. According to Schnake and Stevens, (1983) 64% is fixed cost, while for Anderson and Kenkel, (1992) 77% of costs are fixed. Given the nature of this high fixed cost, profitability of elevators can be greatly impacted by throughput. Davis and Hill, (1974), point out how competition for volume of corn forces price matching between elevators such that margins are driven to economically efficient levels. Finally, the costs of storing a bushel of corn or a bushel of soybeans are very similar (Schnake and Stevens, 1983).

Given the reasons above, for the purpose of modeling, we have simplified the cost of storage as being the cost paid for an additional month of storage, plus interest costs. The underlying assumption is that in paying a storage fee, any physical loss of grain is accounted for in the storage charge, and economies of scale do not play a role. Interest costs vary per bushel based on price levels at harvest in each respective year. Storage costs are the same across all years. Thus, we are not evaluating actual observed net returns in a given year, but rather observed prices of a given year minus the imposed uniform storage cost used for all periods. Another way of stating this is to say, we subtracted current costs from expected gross returns where expected gross returns are a simple average of the years of the relevant time horizon.

Finally, the fixed cost for storing grain should, from the purpose of this research, be viewed more like a necessary production cost, which must take place regardless of length of storage and merchandising options. More technically, fixed costs do not impact the optimization problem through the first order conditions. The only difference between the cost of storing corn and the cost of storing soybeans is the interest cost difference between storing a commodity with a lower per unit price, corn, and one with a higher per unit price, soybeans.

Once these average prices were obtained, the remainder of the research was done in Excel (Microsoft Office, 2013). Columns of futures and cash prices were used to generate the respective basis values, basis change and cash change values. Manipulations for production, inventory, and yield data were also done in Excel (Microsoft Office, 2013).

The following results section will emphasize results from a thirty year time horizon in Indiana, but robustness checks were conducted for ten and three year time horizons, with negligible changes to the qualitative findings. The same three time horizons were used for Ohio, Illinois and Michigan with little qualitative change in results. Though storage returns are different in each of these states, the answers to the three central questions of this research were virtually the same for Indiana, Michigan, Illinois and Ohio.

Regional analysis of the nine crop reporting districts of Indiana was done using a separate data set with a lesser number of sample years. Though caution must be taken to not overstep this limitation, the qualitative findings across regions should similar results to the Indiana state average. Levels of returns and basis, as well as rate of basis appreciation varied. However, none of these changed the answers to the three central question. Though the quantitative levels changed, the qualitative patterns did not.

CHAPTER 5. RESULTS

5.1 Pricing Strategy

The first issue addressed in the results section is pricing strategy. Specifically, whether to storage hedge or store grain unpriced. Results are discussed below separately for both corn and soybeans.

5.1.1 Corn

Expected net returns to storage for corn in Indiana were maximized by storing unpriced into the spring. Figure 5.1 shows the expected net returns to storage over the last thirty years, 1988/89-2017/18. In the months of October through December, the storage hedge strategy and unpriced storage strategy have performed similarly. In the first six months of the calendar year, January-June, unpriced storage outperforms hedged storage. From July onward, hedging is preferable. Thirty-year expected net returns of unpriced Indiana corn storage reach their maximum in April and May.

Though on average, the maximizing strategy is unpriced corn storage, it is worth comparing the frequency of these results with those of storage hedging. Figure 5.2 shows the net returns of storing unpriced corn and storage hedging against the July futures until the month of May over a thirty-year time horizon. Unpriced storage was positive 15 of 30 years and hedged storage was positive 22 of 30 years. Regardless of whether returns were positive or negative, hedged net returns were better than unhedged net returns 60% of the time. That is, hedged returns minus unpriced returns to may yielded a positive number 18 out of 30 years.

Though expected net returns to corn storage in Indiana are maximized by storing unpriced corn, this strategy produces positive results less frequently than hedged. In the last three years, 2015/16-

2017/18, the storage hedge approach has outperformed unpriced storage, on average. Over this time horizon, hedging returns were maximized by storing until January and unpriced storage was maximized by storing until May or June. That being said, the decision rule of storing unpriced corn until May, would only have been \$0.07/bu worse than following the optimizing hedged strategy of the last three years. Thus, even though the decision to store unpriced corn until May was not the optimizing strategy in recent years, it has been quasi-optimal over the past three years. Storing unpriced corn until May would have generated a positive return to storage 15 of the last 30, 5 of the last 10 and 2 of the last three years with average net returns of \$0.20/bu, \$0.18/bu and \$0.11/bu respectively.

The degree to which unpriced returns to storage outperformed hedged returns was unexpected at the onset of this research endeavor. As hedging reduces risk, it seemed natural that over time the more consistent gains of hedging would likely outperform, or perform as well as the sporadic gains and losses of unpriced storage. Though it is true that hedging reduces the standard deviation, narrows the confidence interval, and thus reduces risk, the most telling way to observe the data is by observing the maximum, minimum and average net returns to storage.

Figure 5.3 shows how the minimum net returns to storage are similar for both hedged and unpriced storage into the spring. On the other hand, maximum expected net returns to storage are not comparable; unpriced storage provides markedly better upside potential than the hedged strategy. While unpriced storage captures improvements to both basis and futures prices, hedged returns are capped at the improvement of basis.

The Maximum, Minimum and Average trends shown in Figure 5.3 are exemplary of much of the data analysis conducted and shed light on some general perceptions gleaned from this data. At the risk of oversimplification, consider the Indiana corn storage season as having three distinct sub-periods with particular characteristics.

The first period, October – January, is marked by low risk and low returns to storage. Hedging is optional, but pragmatically, makes little difference. The second period, February – May, shows minimal increases to downside risks with significant gains to upside potential, especially for unpriced storage. Finally, the third period, June – September, shows strong upside potential for unpriced storage returns, but these are accompanied by significant downside risk. Given the increase to both upside and downside risks, it is often preferable to hedge if corn is to be stored late into the season.

These three stages of the storage season may also be understood by considering uncertainty regarding inventories. In the months following the Indiana harvest, inventories are plentiful and risk is minimal. The basis appreciation and future contract spreads aim to cover the costs of storage. There are minimal unknowns and ample supplies. Consequently, returns in the first part of the season tend to be low and reliable.

The second phase of the storage season, roughly February – May, is the period of least certainty regarding grain availability. Without knowing new crop data, it is difficult to know how valuable current inventories are, thus, there is a systematic premium built in to futures and basis values, which produce typically higher cash prices. This premium does not tend to carry very much downside risk with it. As the crop season progresses through the spring and into the summer, uncertainty diminishes as inventory and new-crop estimates improve. In some years, summer months bring expectations of a bumper crop, in other, of a short crop. Either way, after planting, more is known about inventories than prior to planting.

The diminished uncertainty of the last four months of the storage season can produce two extremes. Entering the final months of the storage season, the ever-improving precision of expectations on actual quantities of grains available pushes storage returns dramatically in one direction or the other. On the one hand, it is possible that inventories are scarce, and ever-greater premiums must be paid to secure corn, on the other hand, inventories may be plentiful, and old-crop inventories less desirable.

Based on the argument in the previous paragraphs as well as the evidence of the data analyzed, it appears the maximum expected net returns to storage for corn occurs near the limit of the maximum level of corn availability uncertainty. As the crop season progresses and estimates regarding old-crop inventories and new-crop availability gain precision, storing unpriced corn becomes much riskier with risk exposure to both upside and downside risks. On the other hand, unpriced storage into the spring appears to have an uncertainty premium built in, but without the large downside risks. This dynamic may be behind the strong performance of unpriced storage.

Changing interest and storage costs does not qualitatively change results on whether or not to storage hedge, it merely shifts the expected net returns for both unhedged and hedged storage. Hedged storage produces positive results more consistently than unhedged. It has also produced better results than unhedged 18 of the last 30 years. Though positive returns occur less frequently, unpriced storage has historically maximized net returns to storage.

5.1.2 Soybeans

The strategy to maximize expected net returns to storage for soybeans was also unpriced, rather than hedged storage. Figure 5.4 shows how unpriced soybean storage outperforms hedged storage across the entirety of the storage season. Expected net returns to storage for Indiana soybeans are historically maximized by storing until June. This held true over the thirty, ten and three-year time horizons yielding returns of $0.66/bu, $0.92/bu and $0.49/bu respectively.

Not only are unpriced soybean returns higher than hedged returns on average, they also occur more frequently. Figure 5.5 shows the returns of storing unpriced until May and storage hedging against the July futures over a thirty-year time horizon. Unhedged storage has produced positive returns 21 out of the 30 years, 7 out of 10 years and 2 out of 3 years. Unpriced soybean storage has produced better returns than hedged two-thirds of the time, regardless of whether positive or negative. Unpriced storage returns are better on average and more frequent than those of hedged.

On a three-year time horizon, in the months of August and September, hedged expected net returns to Indiana soybean storage outperformed unpriced storage. These were the only time periods, across all three time horizons, where an Indiana soybean storage hedge outperformed unpriced storage, on average. The strong performance of unpriced soybean storage throughout the year differs qualitatively from that of corn, in which hedged storage tended to perform well earlier and later in the storage season.

Figure 5.6 shows the maximum, minimum and average net returns for unpriced and hedged storage of soybeans in Indiana on a thirty-year time horizon. The minimums, or downside risk, are often worse with hedging than storing unpriced. This occurs when futures prices rally, but basis does not. Conversely, the upside potential, shown as the maximum, is comparable in the early part of the storage season, but favors unpriced storage from February onward. Neither the Maximum nor Minimum were driven by a single outlier year, both were driven by a sub-set of atypical years. Though abnormally large payouts are not frequent, they do exist. History indicates these years will likely occur at some point over the duration of a given farmer’s career. Acknowledging that high payout years exist is a first step in developing a merchandising plan which positions an operation to capture these payouts when they occur.

The minimums, or downside risks, of unpriced storage until late in the storage season are comparable to those of hedged soybeans on a thirty and ten-year time horizon. The last three years have been somewhat different. The minimum returns of storing soybeans late into the season on a three-year time horizon were greater for unpriced storage than hedged. But this was the exception. Typically, downside risks of speculative storage were comparable to those of hedged.

Hedging appears to curb the potential for upside gains, while offering virtually no improvement to the mitigation of downside risks, at least through June. Basis appreciation and the carry of the futures market compensate storage. Even though price levels may change, these mechanisms tend to mitigate, in part, the downside risks of storage. The greatest upside potential is obtained by capturing rallies in both basis and futures prices. Unpriced soybean storage exposes farmers to this upside potential while hedging only captures basis improvements.

As was the case with corn, storage costs did not change optimal strategy from the standpoint of whether or not to hedge. Also, the general findings for soybean returns held true across analyzed regions, states and time horizons. Unpriced soybean storage performed remarkably well compared to hedged storage of soybeans. Unpriced soybean returns were better on average and more frequent than hedged.

5.2 Length of Storage

This second section of the results focuses on optimal length of storage. That is, how long should crops be stored until to maximize expected net returns to storage? The results for corn and soybeans were similar; however, corn results were somewhat nuanced, while those of soybeans were surprisingly clear.

5.2.1 Corn

As demonstrated previously, storing unpriced grain until the spring, is the optimal strategy for maximizing expected net returns to corn storage in Indiana. The precise month of optimality of Indiana corn storage varied slightly depending on time horizon. Over the last thirty years, storage until April was optimal, over the last ten, storage until June and over the last three years, returns were maximized in May. Choosing between which of these three months to store until may be somewhat inconsequential in the long-run as returns, on average, are quite similar. Having said that, May is a fair decision rule. When May was not optimal, it was quasi-optimal.

Spring can be among the most intense times of the year for farmers. The idea of hauling corn to market precisely during planting may be viewed as infeasible for many operations. From a pragmatic operational standpoint, two points are worth consideration. First, data suggests that markets have historically paid a premium for this operational discomfort. Second, though May tends to be nearly optimal, April and June have produced similar returns on average. Though it may be uncomfortable to haul during springtime, it is certainly not impossible to move a substantial amount of corn over this three-month period. Markets have historically appreciated those willing to do so.

Though the default cost of storage used was 3 cents per bushel per month, robustness checks were done for monthly storage costs ranging between $0 per bushel per month and 6 cents per bushel per month. Changes to the cost structure altered the quantitative level, but not qualitative, optimality points for unpriced storage. On the other hand, optimal storage length of hedged returns was impacted by costs.

With lower variable costs, optimality of storage hedging occurs later in the storage season, and with higher variable costs, it is earlier. The sensitivity of hedged returns to costs sheds light on an interesting point worth emphasizing. Positive returns to storage can come from changes in price levels, as well as efficiencies in storage costs.

Some farming operations have lower variable storage costs than what is priced by futures markets and basis improvement. These operations can earn positive returns to storage by storing grain cheaper than the market is willing to pay for storage. If the corn is stored with a storage hedge, cost structure dictates optimal length of storage and gains are capped by changes in basis. But these returns are limited and will always be squeezed as markets seek ever more efficient storage costs.

The other type of storage return has more potential, but also more risk, as it aims to capitalize on changes in price levels. Optimal length of unpriced storage is less sensitive to storage costs and provides opportunities to capture changes in price levels in cash markets. These nuances once again emphasize how Indiana corn farmers must carefully consider the pricing points and costs unique to their operation in making decisions.

The qualitative findings for changes to interest rate were similar to changes in costs of storage. However, results were more sensitive to changes in storage costs than changes in interest rate. Between the interest rate ranges of 1.5% - 7.0% per year, hedged storage did not perform well, except at the very beginning of the storage season. Decision rules for unpriced storage were unchanged.

A key takeaway for Indiana corn farmers from these findings is the concept of a hierarchy of returns. Lesser returns can be obtained by storing at a lower marginal cost than what is priced by futures market carry and basis changes. Greater returns can be earned by capturing changes in pricing levels, but this adds risk. For unpriced grain, storage costs should not be the driving decision rule on how long to store grain. On the other hand, optimal length of storage for hedged corn is dictated by cost structure.

Hypothetically, if an Indiana farmer has a portfolio of storage options and wishes to sell their corn throughout the year, they should have different strategies for different times of year. For the first four months of the storage season, hedging is optional and hedged corn should be sold out of the highest variable cost storage. In the middle four months, they should sell corn which was stored unpriced, variable cost of storage does not change optimal timing of these sales. Finally, to store late into the season they should have storage with negligible marginal costs and they should hedge.

Indiana farmers can likely profit from multiple storage arrangements, merchandising strategies and delivery times of year. This research shows that there are better and worse ways to capitalize on each of these. Technically, the optimizing strategy for maximizing net returns is to store unhedged corn until the spring, but this strategy must fit into a larger portfolio of tools and demands specific to each operation. Each operation should deliberately establish how much of their corn they wish to store unpriced and haul in the spring and how much they will dedicate to alternative strategies.

5.2.2 Soybeans

In Indiana, unpriced storage of soybeans until June was the maximizing strategy. The clarity and consistency of this finding across time and space was surprising. Prior to observing the data, a more nuanced result was expected.

The typical shape for speculative returns is a build up to a June maximum and then a fall over the following months. Though unpriced net returns to storage were maximized by storing until June, storing until May, and to some extent July, often offered similar returns. Quantitatively the returns to storage for soybeans were also greater than for corn.

Changes in storage costs and interest rates had a negligible impact on optimal timing of unpriced soybean storage. Optimal timing of hedged soybeans storage is more sensitive to cost structure. With lower storage costs and interest rates the optimal storage period tends towards August, but with higher costs, the optimal storage period occurs in the months shortly after harvest.

5.3 Crop Comparison

Some operations may face a tradeoff between storing corn and storing soybeans. If ample custom storage is available this constraint may be more perceived than real. Even if the storage of these two crops are not mutually exclusive, in practice, however, there may be a decision constraint tradeoff between storing the two crops on many Indiana farms.

For instance, let us assume that an Indiana farmer has a given financial commitment, and, in order to meet this obligation, feels compelled to sell part of his stored crop. Assuming corn and soybeans are in storage, he must then choose between these two crops to determine which sales to close. Though there are countless other ways for the farmer to meet a given financial obligation, pragmatically speaking, the farmer’s mental accounting may be such that the only practical option in consideration is which crop to sell in order to meet the commitment. Though this example is anecdotal, considering this type of behavioral decision rule is valuable in grasping the nuances underlying the findings of this research project.

Additionally, at harvest a farmer may face pragmatic decisions regarding where to store the corn and soybeans coming out of the field. Some of the production may go to custom storage, some to on-farm storage, some to rental storage and so on. These operational decisions could affect the variable costs and storage decisions of corn and soybeans. Regardless of whether the tradeoff between corn and soybean storage is actual or perceived, comparing the returns of each is insightful.

Figure 5.7 shows the expected net returns of a storage hedge against the July futures contract and unpriced storage of both corn and soybeans on a thirty-year time horizon. The storage hedge of corn outperforms that of soybeans and unpriced storage of soybeans outperforms corn. However, a qualitative ordinal description of these results does not capture the magnitude of this difference. Figure 5.8 shows the difference between each of these strategies, that is, unpriced soybean returns minus corn, and soybean storage hedge minus corn storage hedge.

An initial reaction to this dominance of unpriced soybean returns over corn may attribute the high returns of soybeans to the fact that a bushel of soybean is more valuable than a bushel of corn. But, recall that opportunity costs already account for this difference by attributing higher interest costs to soybeans than corn, even as the rate is the same.

Net returns to unpriced soybean storage outperforms those of corn in both frequency and magnitude. Unpriced storage until May was the quasi-optimal strategy for both soybeans and corn. Imposing the decision rule of unpriced storage until May, returns to soybean storage have outperformed those of corn for 19 of the last 30 years, 8 of the last 10 and 2 of the last 3 years. By this decision rule, on average, soybeans net returns have been \$0.42/bu, \$0.68/bu and \$0.37/bu better than corn over the last thirty, ten and three-years, respectively.

At lower levels of marginal costs, hedged soybean returns peak later in the storage season than hedged corn. Soybean returns also peak after corn with unpriced storage. In addition, the gap between them tends to widen as the storage season progresses towards the expected seasonal maximization point, Figure 5.8. Cash markets have paid, on average, an increasing premium for storing soybeans over corn as the storage season progresses.

The answers to the three central questions of this research project were surprisingly pronounced and robust. Unpriced storage was the maximizing strategy. Unpriced soybean storage outperformed corn, and June is the optimal month for unpriced soybean storage. Thus, the clear answers to the questions asked in this research project is unpriced storage of soybeans until June. However, simply because unpriced soybean storage until June has historically performed well does not mean it should replace all other strategies. While this research makes a strong case that unpriced soybean storage until June should be considered by farmers, this should be but one of many positions in a portfolio of merchandising tools used by Indiana farmers.

5.4 Comparing Results to Previous Findings

Results similar to those found in our research were reported by (Hurt, 2017). The studies differ on a few points. The present study is more robust in the sensitivity checks on locations, time horizons and costs. While (Hurt, 2017) correctly demonstrates how risks to storage increase as the year progresses, the specific timing and distribution of these risks may be more nuanced than suggested by (Hurt, 2017). Additionally, the strong performance of unpriced soybean storage returns appears to be more frequent than implied by (Hurt, 2017). Both research efforts are complementary and aligned, but each emphasizes different important aspects of returns to storage in Indiana.

The strong performance of unpriced storage is in line with the findings of (Knorr, 2017), who compared various merchandising tools and used a thirty-two, sixteen, and three-year time horizons. However, the present study goes beyond that of (Knorr, 2017) by evaluating the performance of storage returns throughout the storage seasons. (Knorr, 2017) imposes corn and soybeans be stored to July. Our findings show that unpriced corn storage in Indiana is maximized prior to July and storing unpriced corn to July is even ill advised. In the case of soybeans, the July storage imposition is more acceptable even though optimality is technically June.

Findings of this research differed from those of (Ward, 2015) and (Milstead, 2017) who studied returns to storage in Kansas and Mississippi. This research demonstrates multiple ways to own positive returns to storage for corn and soybeans in Indiana. The difference between the findings of this research and those of research in other geographies and commodities shows that storage returns do not all perform the same. Geography and commodity play a role in storage returns. Having said that, recall that general qualitative findings persisted across regions in Indiana and surrounding states.

The strong performance of unpriced soybean storage is one of the key findings of this research. Though this result is in line with previously cited publications, it tends to be underemphasized. The frequency and magnitude of unpriced soybean storage returns merit further attention.

This research did not focus on causality or implications of these results. However, the results were unique enough to merit further discussion. The discussion section provides evidence and insights to help inform further research efforts on this subject and to facilitate application of findings.

CHAPTER 6. DISCUSSION

Though this research project does not address causality of results, a hypothesis that must be entertained is the possibility of a corn bias. This bias could be leading to suboptimal functioning of the Indian soybean market and, consequently, opportunity for exceptional soybean returns to storage until these inefficiencies are corrected.

One would expect that quantities of stored grain in Indiana should react appropriately to the payouts of returns to storage. For instance, higher returns to soybeans over corn should lead to increasing volumes of soybeans being stored relative to corn. The laws of supply and demand and the demonstrated expected net returns to storage in Indiana should lead to three trends in quantities stored of Indiana corn and soybeans.

First, the positive expected net returns to storage should lead to a larger percentage of the crop being stored. Second, the higher returns to unpriced storage of soybeans over corn should cause volumes of soybean storage to rise faster than those of corn. Third, the fact that the difference between unpriced soybean and corn expected net returns increases throughout the storage season, until July, means the ratio of soybeans to corn stored should increase as the storage season progresses.

Figure 6.1 shows that the percentage of corn and soybean crop stored until December has been trending upward in Indiana since 2008. This graph was generated by diving the bushels of stored corn and soybeans in Indiana on the first of December, by the amount of bushels produced in the respective crop year (USDA, 2019). This upward trend in percentage of crop stored is in line with the positive returns to storage experienced over the period. Due to positive returns to storage over the last decade, it makes sense that a larger percentage of the crop would be stored, as confirmed by data.

The second expected inventory reaction to storage returns stems from the fact that unpriced soybean storage outperforms that of corn. Due to this difference, it is reasonable to assume that growth in storage quantities of soybeans should outpace those of corn. One way to visualize whether this trend is occurring is by simply dividing the soybean bars in Figure 6.1 by corn bars in the same Figure. If this ratio is increasing, it means that the percentage of soybeans being stored relative to corn is increasing. Surprisingly, however, Figure 6.2 shows that this has not been the case.

Although cash markets have paid a premium for soybean storage over corn, the relative volume of soybeans in storage is not increasing. This inventory reaction is contrary to the economic incentive provided by markets for unpriced storage. It does not appear farmers have correctly responded to the returns of soybean storage in Indiana.

Maybe Indiana soybeans are primarily stored with storage hedges, in which case marketing strategies should be revisited as unpriced storage outperforms hedged in both magnitude and frequency. On the other hand, it may be the case that quantities in storage have not adequately adjusted to the market premiums offered soybean. Either way, there is reason to believe some degree of market inefficiency is taking place, and abnormal profits may exist until corrections take place.

Finally, as the storage season progresses, soybean inventories fall faster than those of corn do. This is the exact opposite of what would be expected from the economic incentives. In the case of unpriced soybean storage, as well as hedged soybean storage with low marginal costs, soybean maximum returns occur later in the storage season than corn. Figure 6.3, shows that without exception, over the previous decade, the ratio of soybeans to corn in storage in Indiana fell between December and June, in spite of contrary pricing signals.

This inventory trend may be a consequence of the pattern of aggressive U.S. soybean exports in the months following harvest juxtaposed with the smoother internal demands of corn throughout the year. However, even if these patterns help explain why Indiana corn and soybean inventories behave the way they do, it is still not justification for why more economic agents have not adjusted to the premiums offered for soybeans stored later into the storage season.

These findings add credence to the fact that soybean returns may be, at least in part, overlooked or under prioritized in the merchandising plans of Indiana farmers. The apparent discrepancy between the pricing signals and inventory behavior of Indiana soybean storage merits further attention. Exploring this discrepancy goes beyond the focal point of this research. The consistency in results of unpriced soybean storage until June as the maximizing strategy may be related to this potential blind spot of the Indiana soybean markets. Furthermore, the geographic robustness of this find may indicate that Indiana is not the only state with this issue.

To the extent that June soybean premiums are due to shortsighted merchandising behavior, it may be fair to expect these returns to continue somewhat consistently until markets adequately perceive and adjust to them. As this research and similar voices expose this potential merchandising shortcoming, it is only natural that behavior will adjust and the premiums will vanish.

A simple metric for accompanying market adherence to this insight is simply to track soybean inventories or even soybean to corn ratio of inventories in Indiana. Based on historic return trends, the ratio of inventories of soybeans to corn stored in Indiana should increase as the storage season progresses. The storage numbers are reported quarterly for the first of December, March, June and September. If the ratios are not increasing, between December and March, it may be that markets are not adjusting. In which case, continuing to store unpriced soybeans until June, may be reasonable. However, if this ratio is markedly higher than previous years, or increasing as the year progresses, unpriced soybean storage until June may be ill advised. Besides inventory ratios, soybean inventory levels are also important.

CHAPTER 7. IMPLICATIONS FOR PRODUCERS

This research endeavor is not without consequence. Indiana farmers must make decisions regarding the storage and merchandising of their corn and soybeans. By way of facilitating the transition from research to practice, a few considerations are in order as farmers look to apply the results of this research.

Each year has its own unique challenges. For instance, concerns about the trade wars between the USA and China are at the forefront of discussions in the 2018-19 storage season and beyond. Though news moves markets, it is important to acknowledge that many of the results found in this research have persisted over the last three, ten and thirty years. Most certainly newsworthy events have influenced agricultural markets during these timeframes, and yet, findings persist. Certainly, some newsworthy events will require farmers to adjust their course of action, for instance, if an event threatens positive returns, farmers should consider not storing.

As Indiana farmers develop their merchandising strategy, they should build their plans on a dual foundation. Firstly, they must know their own numbers and the pricing values and timing critical to the financial wellbeing of their operation. Secondly, they must be mindful of the seasonal historic patterns of basis and futures markets and must implement the appropriate strategy at the appropriate time of year. News driven market movements have their place in grain merchandising, but they are not an adequate foundation for planning a strategy. These events provide unique executional opportunities to help farmers capture market movements and lock in critical prices, but plans and strategies need to be in place beforehand to recognize these opportunities when they arise, and these plans need to be built on internal demands and seasonal characteristics.

As long as seasons exist, some degree of seasonal characteristics are bound to impact markets. This research, along with others, show the importance of being mindful of where in the season one is when making merchandising decisions. For instance, speculative storage late into the storage season tends to add considerable upside and downside risks, while speculative storage through the spring is more reasonable.

Farmers must know the pricing levels that matter for their operation. In a simplistic way, this involves being aware of the annual budget and breakeven price. In a more complex approach, multi-year cash flows and exposure of financial health to grain prices can inform critical values to be included in a merchandising plan. For some operations, it may be helpful to merchandise grain to line up with multi-year costs beyond merely annual profitability.

(Hart, 2019) presents a matrix of merchandising strategies to be used by farmers, Figure 7.1. The interesting aspect about this merchandising matrix is that all merchandising strategies hinge on expectations regarding basis and futures direction. Historically between harvest and late spring or early summer, futures prices strengthen on average. Also, between harvest and July for corn and August for soybeans, Indiana basis tends to strengthen. By basing expectations on historic trends, one can easily select which set of strategies tend to be more suitable at each point in the year.

For example, with soybeans, consider being in the top left quadrant of the matrix between October and June, the bottom left quadrant in July and August and on the right side of the matrix in September. Selecting between whether to be in the upper quadrant or lower quadrant of the right hand side while merchandising soybeans stored to September may be somewhat dependent on year specific analysis.

Combining these general strategies regarding which tools to use at a given time of year with the specific financial demand of each operation creates a strong foundation for developing a suitable merchandising portfolio. Once the merchandising portfolio plan is complete, newsfeeds, informational improvements as the crop year progresses and other pertinent factors provide opportunities to take executional action and make needed adjustments.

The results of this research project have very tangible implications to be considered by Indiana farmers, some of these implications include:

- Include an appropriate degree of unpriced storage in the portfolio of tools used to merchandise grain.
- Recall that the optimizing strategy for maximizing expected net returns to storage was storing unpriced soybeans until June.
- Be wary of unpriced storage beyond June for corn and July for soybeans.
- Consider storing soybeans later into the storage season than corn, especially if marginal costs are low or if an unpriced storage strategy is used.
- Make sure soybeans are getting sufficient attention in merchandising programs.

CHAPTER 8. CONCLUSIONS

The strategy for maximizing expected net returns to storage for Indian corn and soybeans, was unpriced storage. In the case of corn, unpriced storage into the spring was optimal, with May being consistently optimal or quasi-optimal. For soybeans, unpriced soybean storage until June was consistently optimal. Though unpriced corn storage was optimal, it produced positive returns less frequently than hedged corn storage.

Soybeans provided stronger optimality signals than corn. Unpriced soybean storage returns were larger and more frequent than those of corn were. The straightforward answer to the three questions posed in this research is to store unpriced soybeans until June. This unique result merits further attention. From an academic standpoint, causality of these returns poses many fascinating questions. From a pragmatic standpoint, farmers should consider how the returns to unpriced soybeans fit into their merchandising strategy.

Based on the reported returns to storage, three inventory responses can be expected for Indiana corn and soybeans. The first is that positive returns should lead to an increase in the proportion of the crop being stored. This has occurred. The second is that growth in proportion of the soybean crop stored should be outpacing that of corn. Surprisingly, this has not occurred. Thirdly, and most dramatically, as the storage season progresses, soybeans inventories consistently tend to fall faster than those of corn in spite of market returns rewarding the exact opposite behavior. The dissonance between market payouts and inventory response merits further consideration as the soybean market may be under prioritized relative to corn and this bias may be creating exceptional returns for unpriced soybeans.

The nature of returns of unpriced soybeans may be linked to export markets, Latin American crop production, and farmer behavior, among other things. Though causality can be an elusive question to answer, exploring the issue of causality of these returns may shed light on farmer behavior, domestic impacts of foreign trade, functioning of futures and basis markets and numerous other meaningful economic factors. Additionally the general perceptions of these results demonstrate that though no two years of storage returns are the same, there are better and worse ways to be positioned in these markets. The insights of this research, combined with further research can move farmers closer to discovering the optimal portfolio of tools and strategies to include in their merchandising plans.

Indiana farms face numerous decision constraints. Merchandising strategies must consider these. Unpriced storage should be seen as but one of many merchandising tools. A thoughtful and disciplined merchandising plan must consider factors important to each operation and the optimal strategy likely varies between operations. These results emphasize that Indiana farmers should take a serious look at unpriced storage as part of the portfolio of tools in their merchandising program. They should also consider whether soybeans are getting sufficient attention in their merchandising plans.

Figure 5.1

Expected Net Returns to Indiana Corn Storage, 1988/89-2017/18

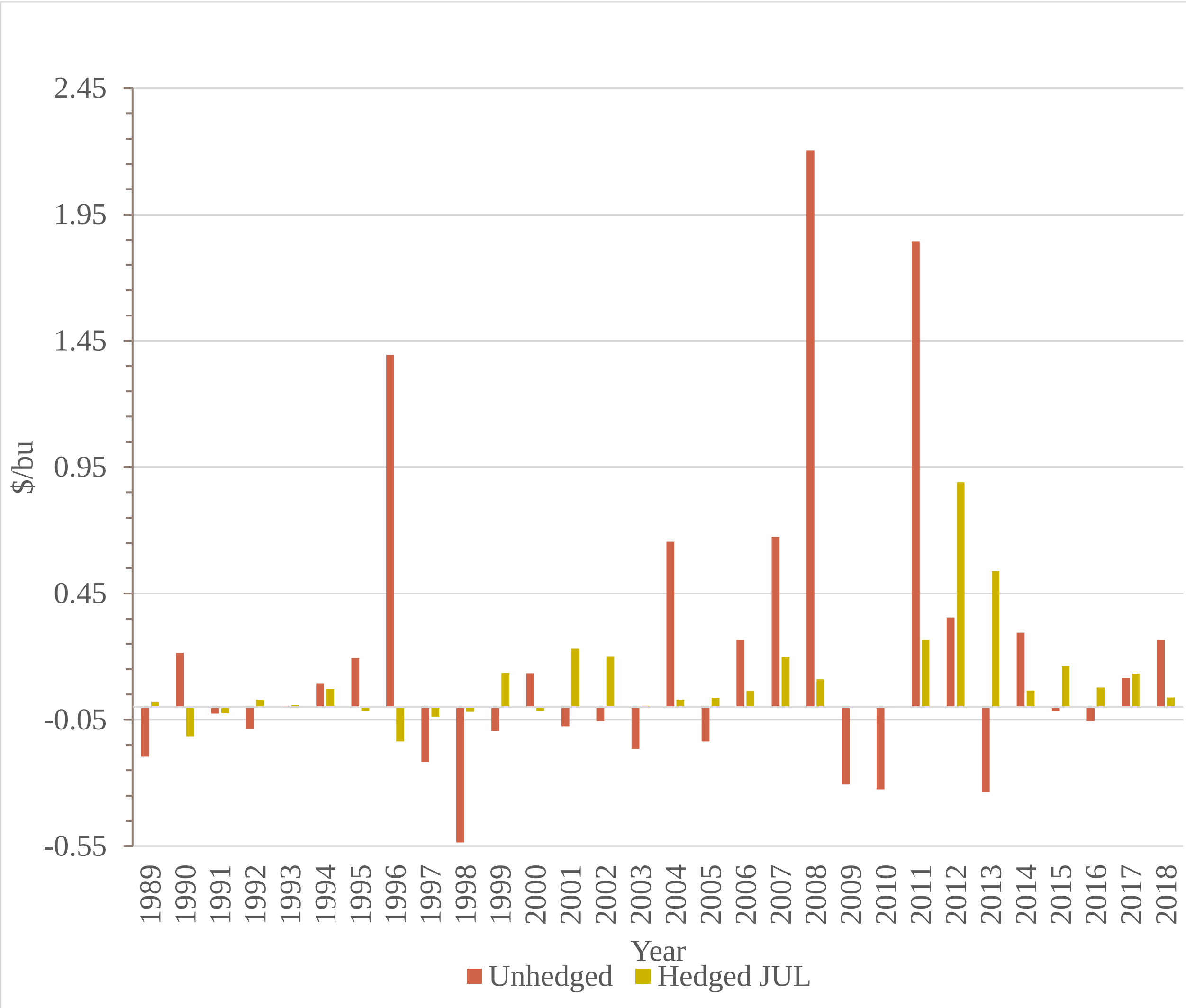

Figure 5.2

Net Returns of Storing Corn from October until May, 1988/89 – 2017/18

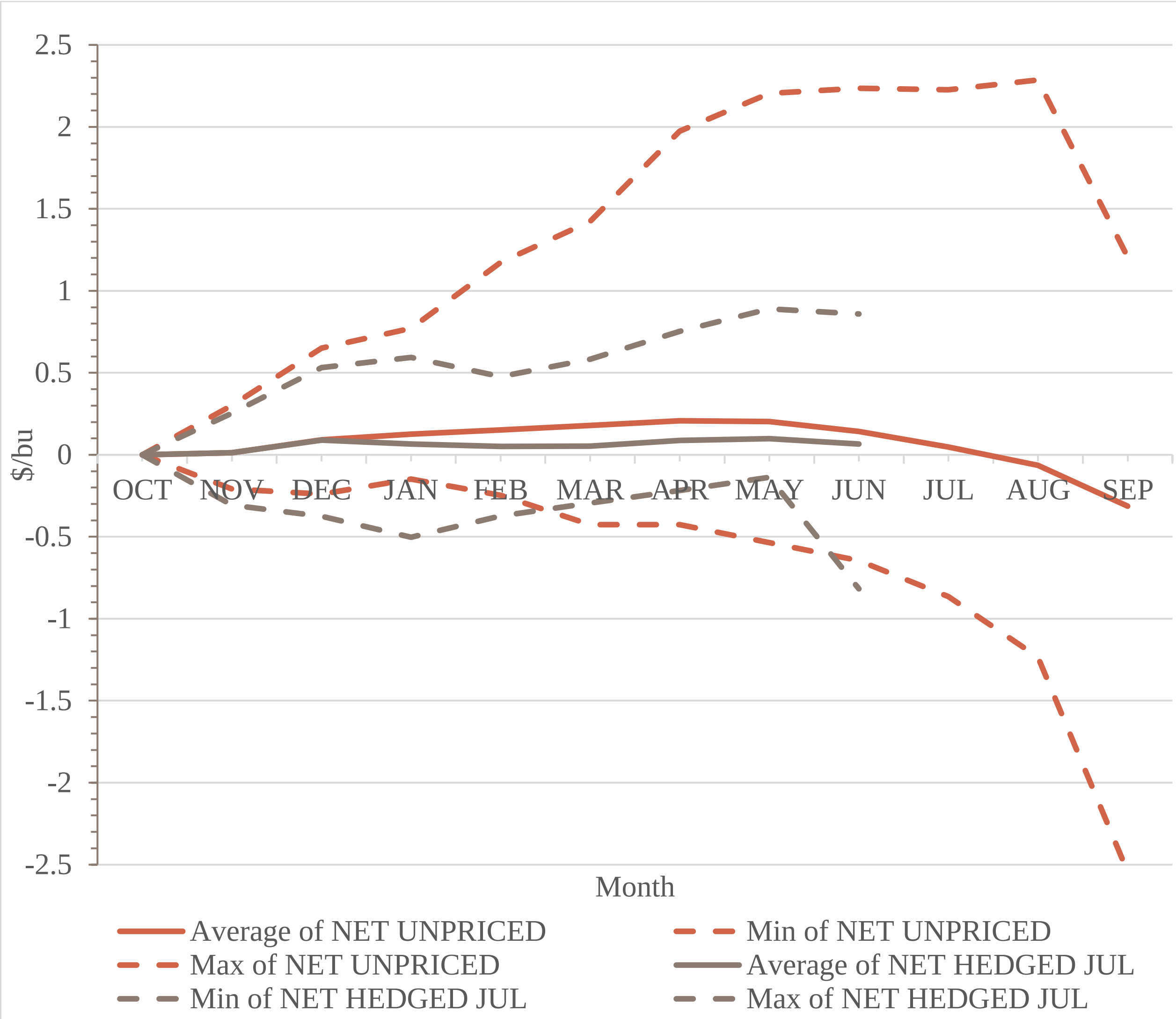

Figure 5.3

Average, Maximum, and Minimum Net Returns to Indiana Corn Storage 1988/89-2017/18

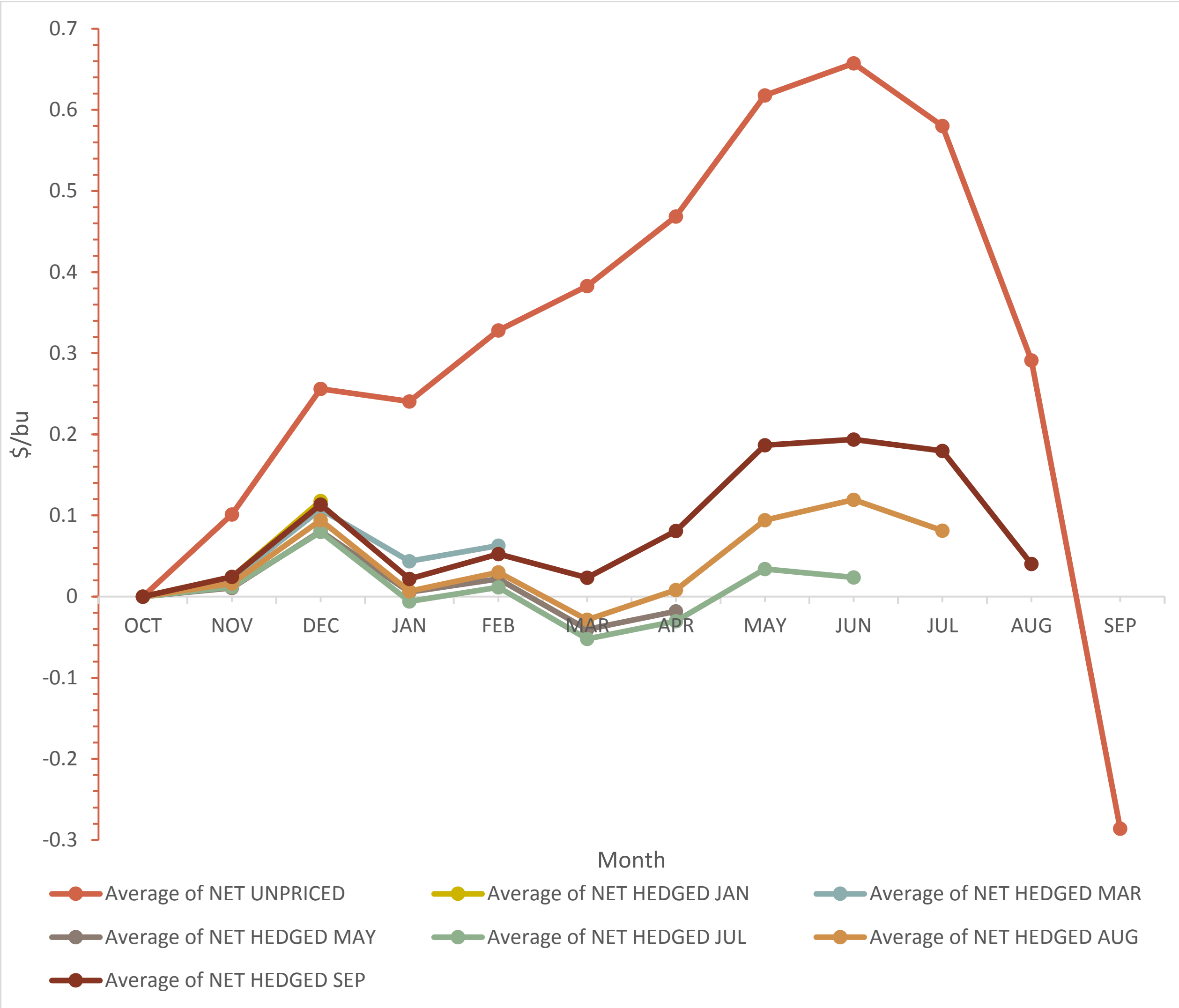

Figure 5.4

Expected Net Returns to Indiana Soybean storage, 1988/89-2017/18

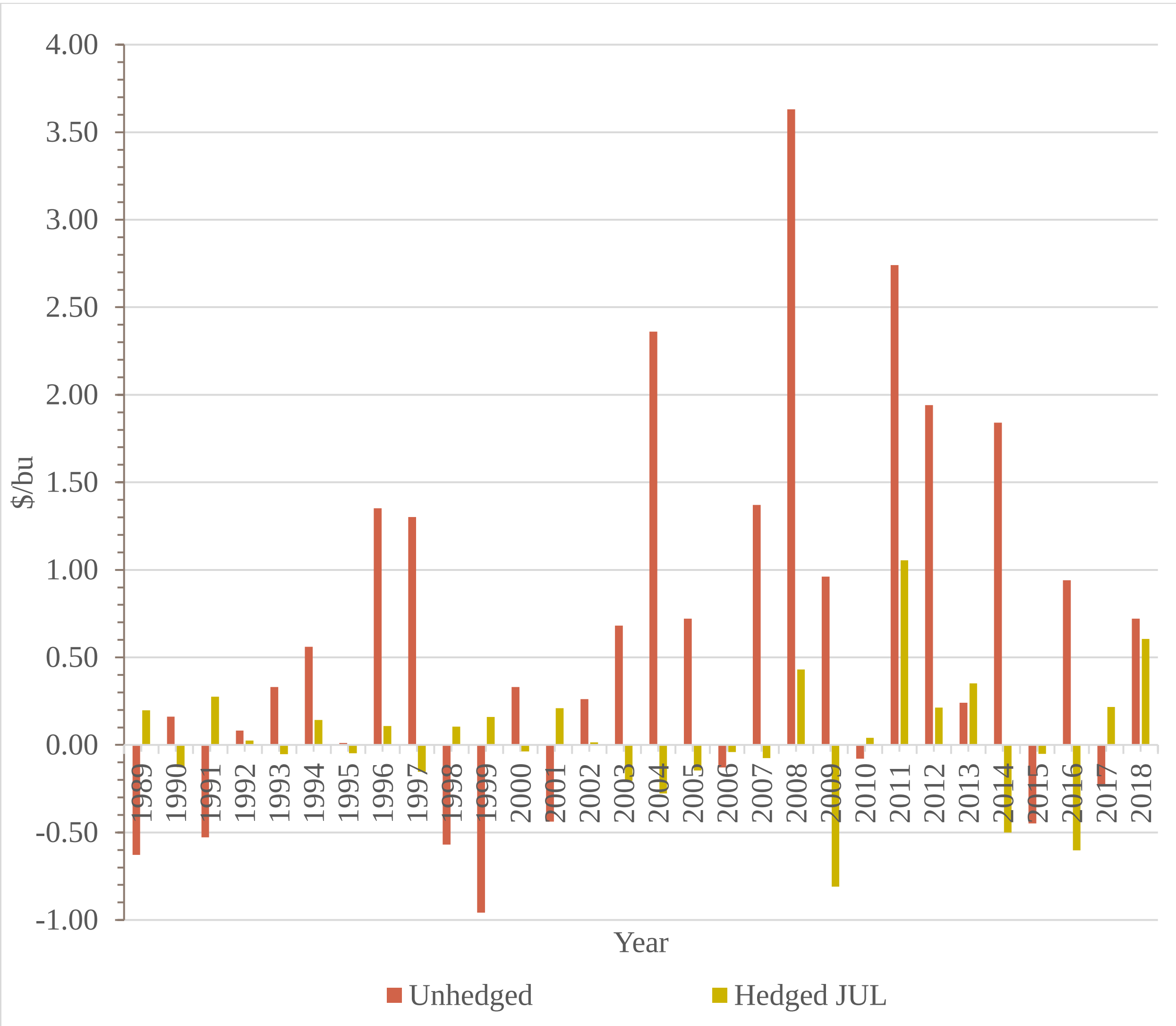

Figure 5.5

Net Returns of Storing Soybeans from October until May, 1988/89 – 2017/18

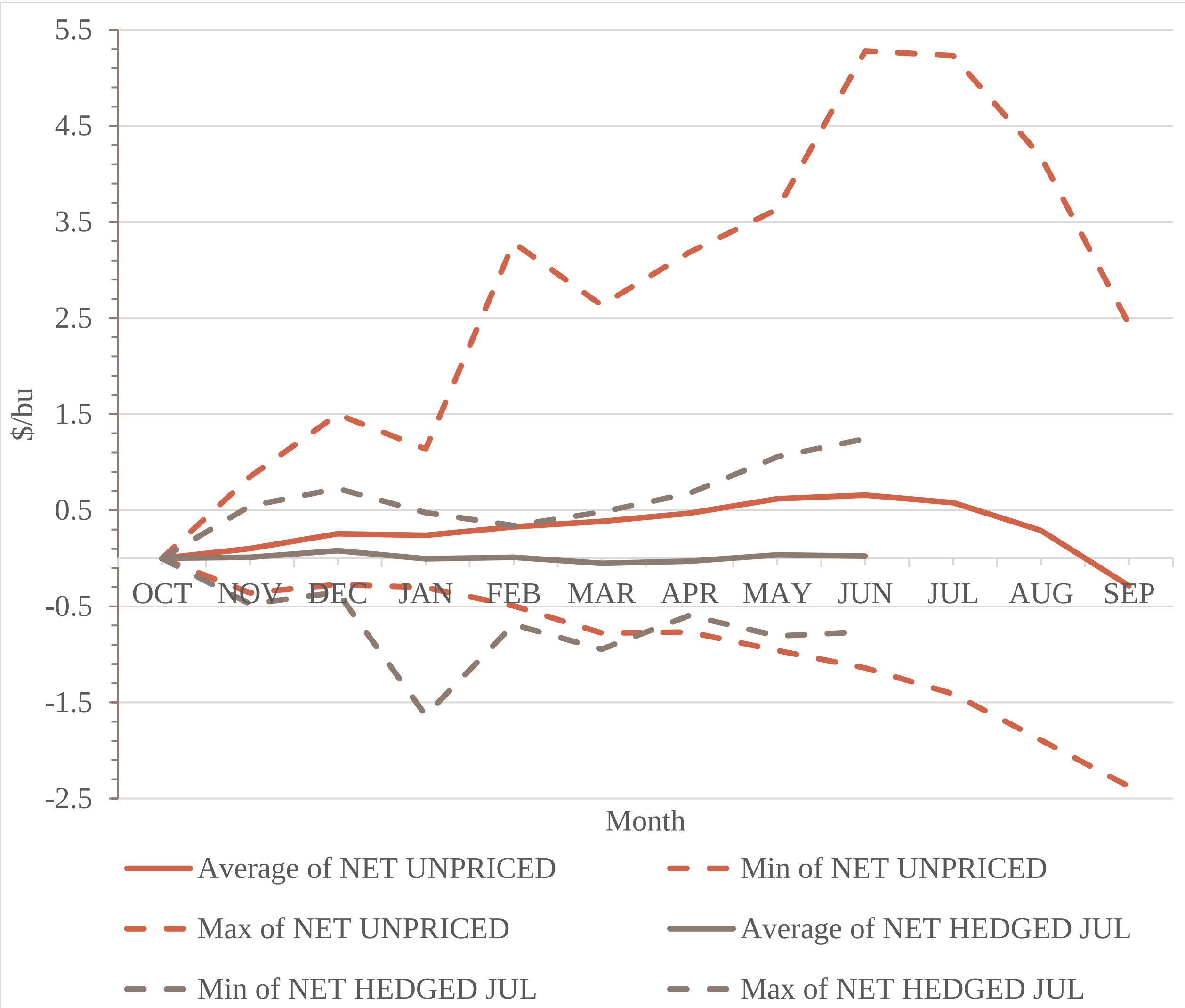

Figure 5.6

Average, Maximum, and Minimum Net Returns to Indiana Corn Storage 1988/89-2017/18

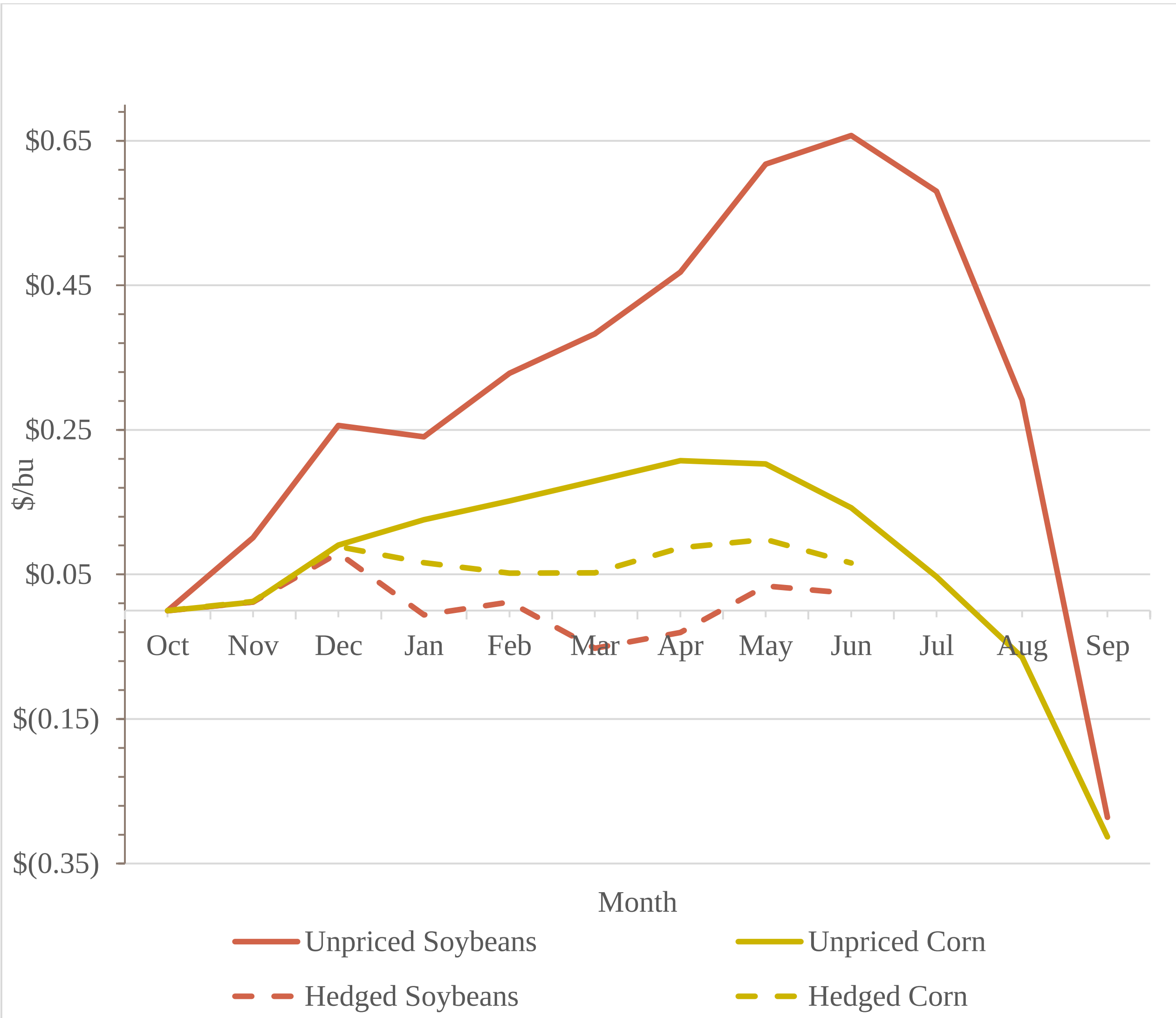

Figure 5.7

Comparing Expected Net Returns, 1988/89 – 2017/18

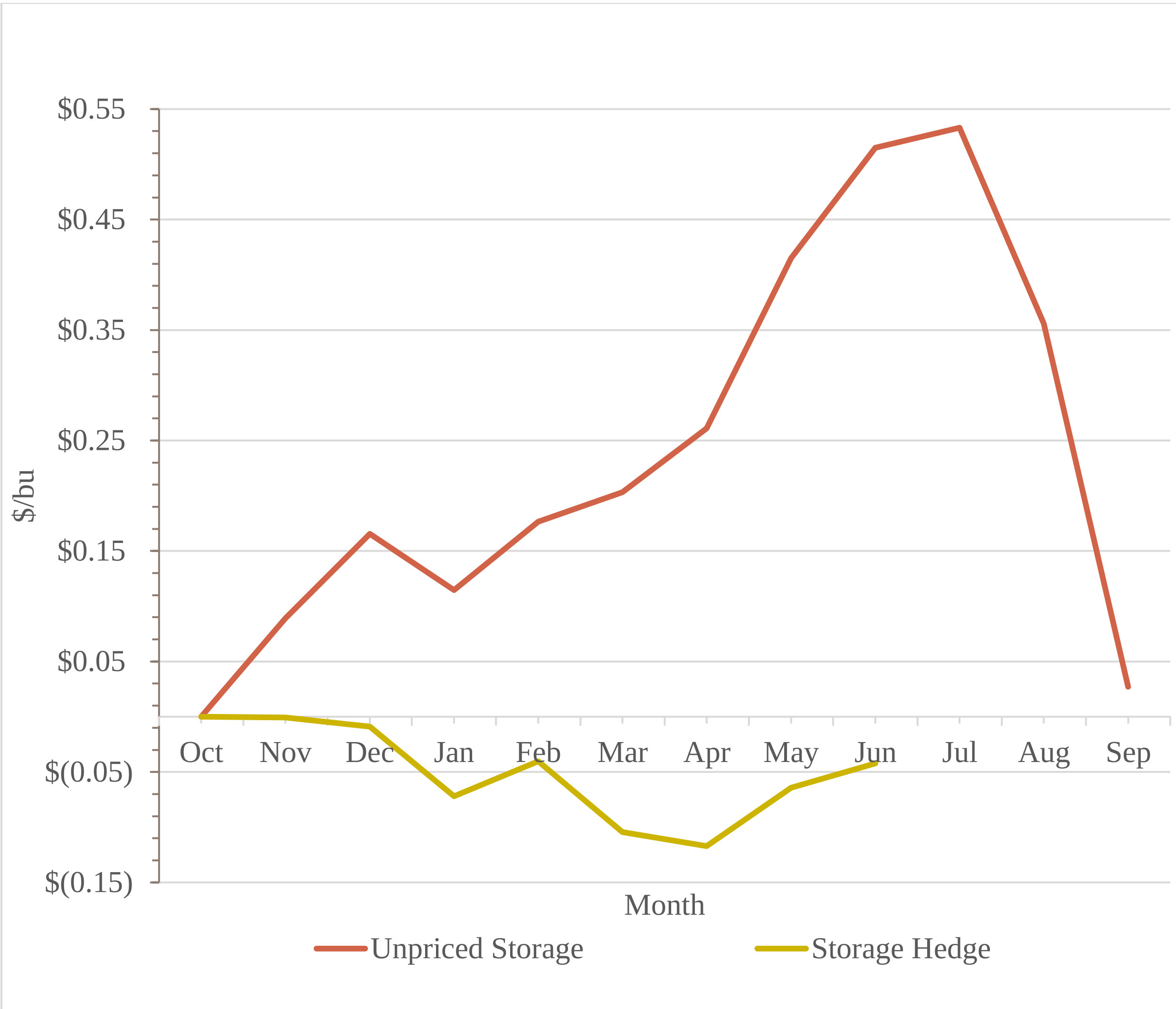

Figure 5.8

Difference in unpriced and hedged corn and soybean returns, 1988/89 – 2017/18

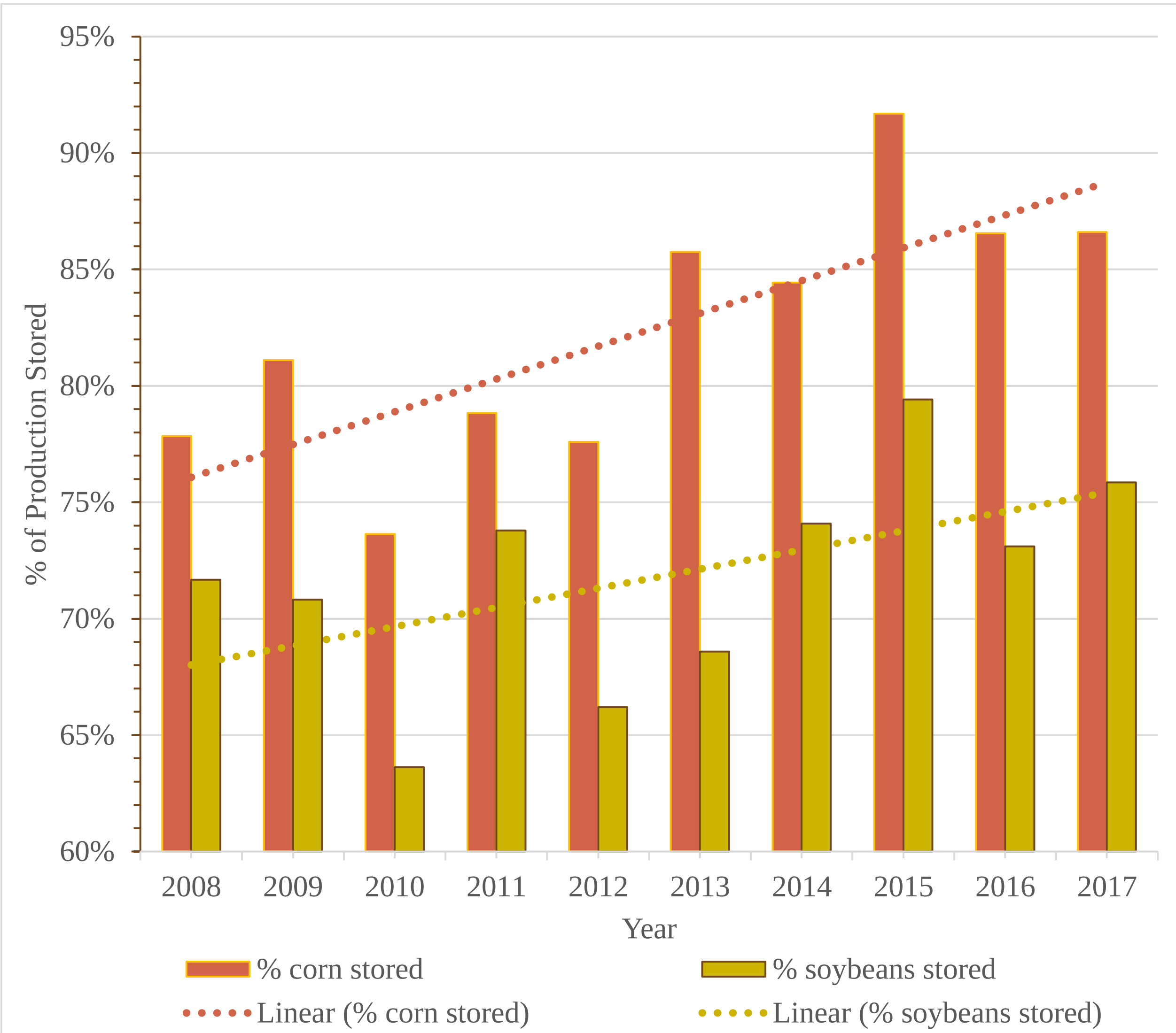

Figure 6.1

Percentage of Indiana Corn & Soybean Production Stored to December, 2008 – 2017

Source: USDA-NASS Grain Stocks and USDA-NASS Crop Production

Figure 6.2

Percentage of Indiana Soybean Production Stored to December Relative to Corn, 2008 – 2017

Source: USDA-NASS Grain Stocks and USDA-NASS Crop Production

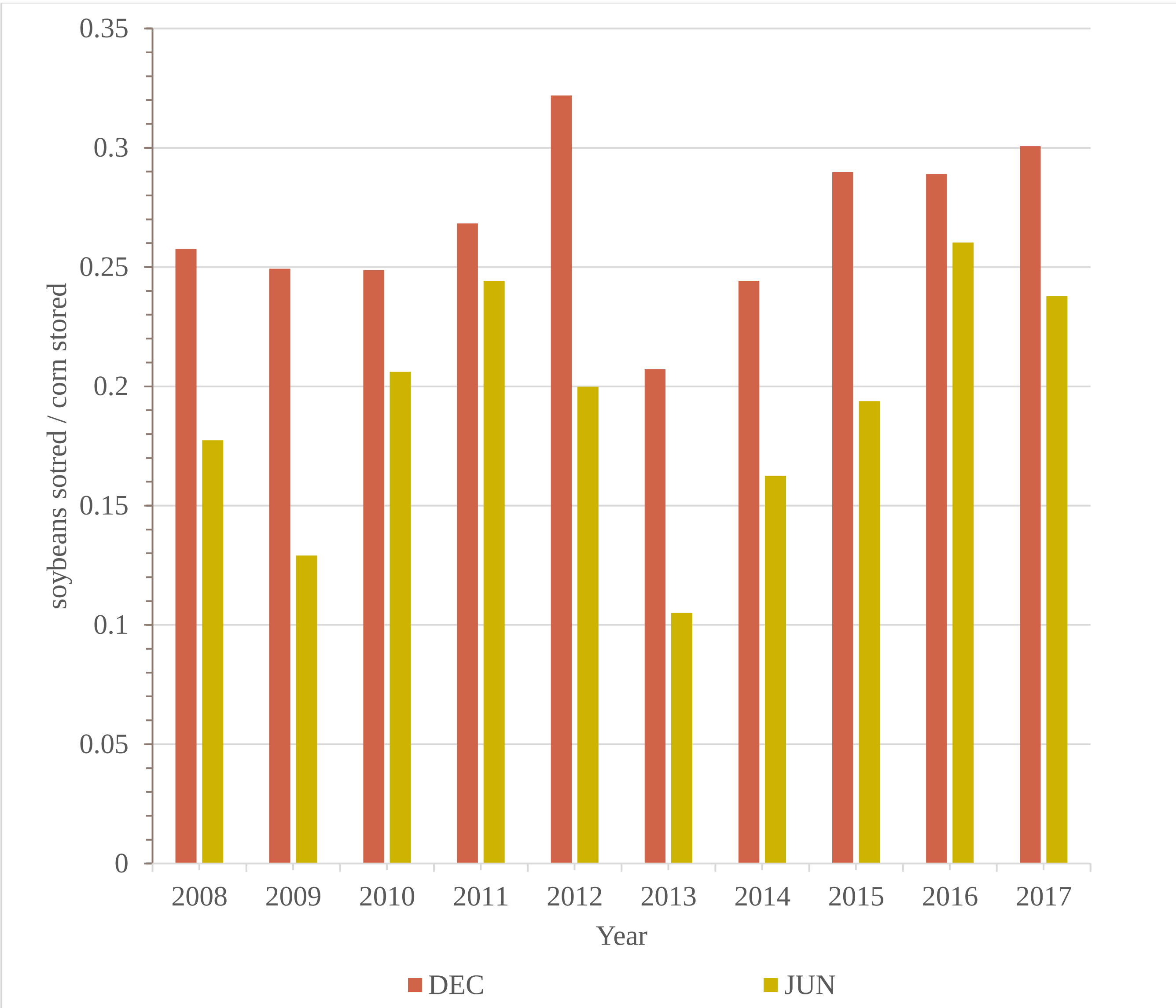

Figure 6.3

Ratio of Soybeans to Corn Stored in Indiana in December and June, 2008/09 – 2017/18

Source: USDA-NASS Grain Stocks

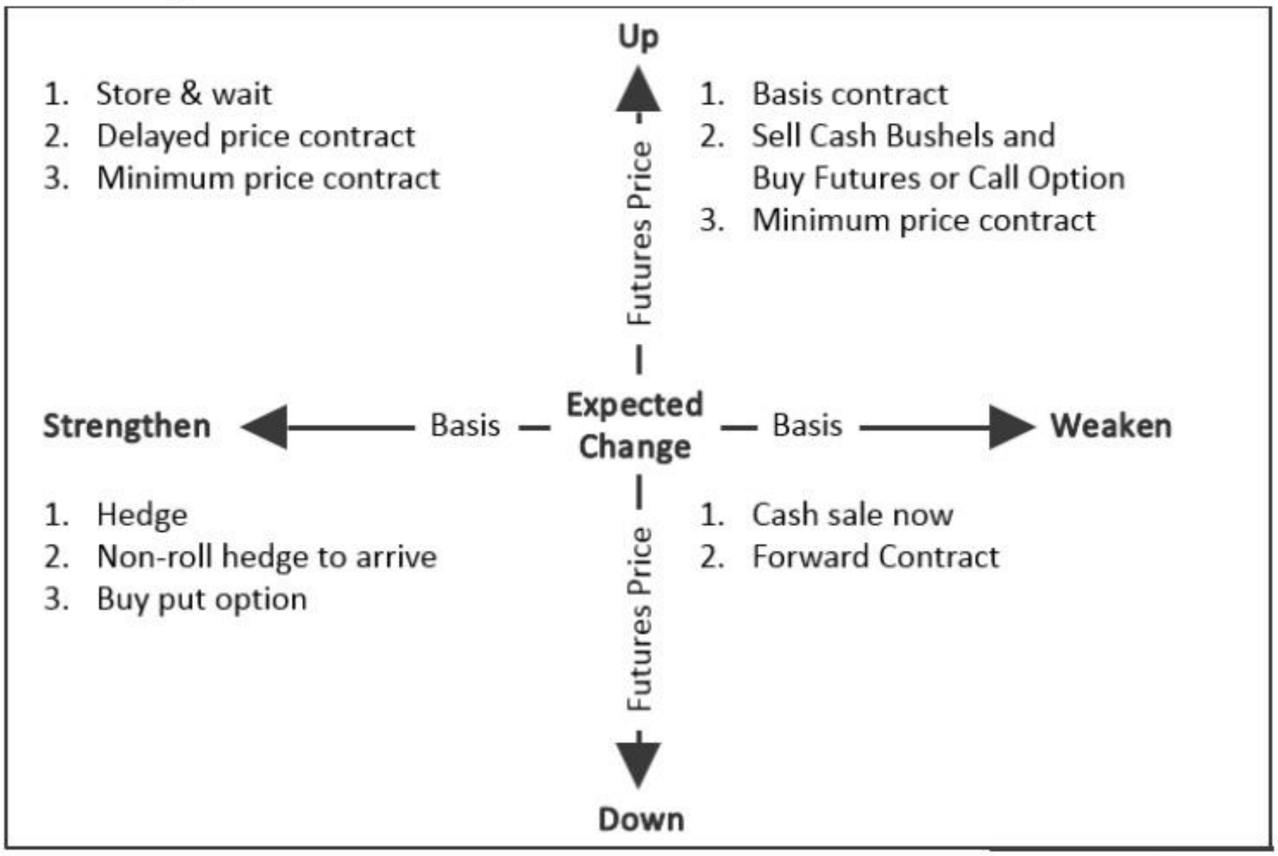

Figure 7.1

Crop Marketing Matrix

Source: Hart, C. "Marketing Tools Workbook", Iowa Commodity Challenge,
https://www.extension.iastate.edu/agdm/info/icc/iccbook2017-18.pdf , 2019

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