Optimal Cash Purchase Strategies to Reduce Fertilizer Price Risk

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Abstract

Fertilizer price volatility has increased dramatically. This research examines cash purchase and warehouse strategies. Seventeen years of Oklahoma fertilizer prices are examined. The results indicate that mechanical cash purchase strategies can be used to reduce the average cost or variance for fertilizer. Optimal purchase dates are also identified.

Introduction

Fertilizer costs account for 40-50% of the variable production costs for most grain crops and up to 85% of variable expenses for some forage crops (Oklahoma State University). Between the spring of 2002 and the spring of 2008 fertilizer prices increased dramatically. The farm-level price of nitrogen formulations has increased 300-375% and increased 95% during 2007-2008 (USDA). The price of phosphate products increased 400% during 2002-2008 and almost 100% during 2007-2008. During the summer of 2008 fertilizer prices decreased dramatically with both nitrogen and phosphate products falling over 50% (Laws). As these price changes demonstrate, fertilizer price volatility has increased dramatically. Historically, the price variation within a marketing year was $15-$20/ton. Within year price changes for anhydrous ammonia fertilizer of $100/ton have occurred during the last three seasons and price levels for both nitrogen and phosphate products have changed over $500/ton during the past 12 months.

Fertilizer price volatility has impacted all levels of the supply chain. Historically, farm supply firms have attempted to limit retail volatility, covering the risk of price swings in their margin structure. Supply firms have also historically stockpiled fertilizer for peak demand periods. Because of increasing price volatility, the timing of fertilizer purchases has become a major risk factor for fertilizer dealers. Some dealers attempting to shift price risk to producers through advance purchases. Both producers and fertilizer retailers are seeking new strategies manage fertilizer price risk. There is also increased interest in decision rules for timing fertilizer purchases.

Risk management options with futures or over the counter (OTC) derivatives are limited. . Fertilizer contracts on the Chicago Mercantile Exchange were discontinued due to a lack of liquidity (Bollman, Garcia and Thompson) while transactions on the Direct Hedge Exchange, based in Switzerland, has a 5,000 ton contract size for fertilizer that is not workable for many retailers, much less producers. OTC strategies require relationships with a brokerage firm or OTC derivate provider and the expertise to manage the required transactions. Basis risk, the difference between the closing future market contract price and the farm level price for fertilizer, can also be substantial (Bollman, Garcia and Thompson). Cross hedging fertilizer with natural gas contracts has been found to be ineffective (Dhuyvetter, Albright and Purcell).

Because opportunities to control fertilizer price risk through futures market instruments are limited, dealers and producers rely on cash purchase and storage strategies to manage price risk. Cash purchase strategies attempt to diversify price risk by distributing purchases across the year and/or timing purchases to take advantage of seasonal price trends. Every fertilizer dealer or producer who inventories fertilizer must implement some strategy for purchasing their fertilizer inventory. The objective of this research is to investigate if strategies to systematically purchasing fertilizer at pre-determined calendar periods impact the average level and year-to-year variability of fertilizer prices.

Data and Methods

A number of scenarios of systematically purchasing fertilizer during consistent calendar periods were analyzed using historical price data. The scenarios considered were designed to represent alternatives available for a typical fertilizer dealer or a producer who is advance purchasing fertilizer from a dealer. Annual fertilizer usage was assumed to be split evenly across fall and spring application seasons. Spring application of fertilizer was assumed to occur in the first week of February while the fall application period was timed for the second week of August. Warehouse capacity constraints of 25%, 50%, 75% and 100% of annual usage were incorporated into the scenarios considered. The remaining amount of fertilizer usage in excess of warehouse capacity was assumed to be purchased during the application season.

Seventeen scenarios were analyzed. The first four scenarios represented the minimum average fertilizer price that could be achieved by systematically purchasing 25%, 50%, 75% and 100% of annual fertilizer usage in advance of the application period at a consistent annual date or dates selected by the model. The second four scenarios were similar except that the consistent annual day or dates were selected to minimize the variance in fertilizer price over the historical data period. In order to provide a benchmark as to the possible impact of purchase dates on price and variance, eight companion scenarios representing the purchase dates generating the maximum average price and maximum variance at each warehouse capacity constraint were also included. Another value of these scenarios is that they identify the time periods that dealers and producers should avoid purchasing fertilizer. The final scenario consisted of purchasing a even amount of annual usage during every week of the year. This scenario provided a benchmark by which the other sixteen scenarios could be measured.

A 17 year time series of weekly fertilizer prices at two Oklahoma delivery points (Enid Oklahoma and the Tulsa Port of Catoosa) were obtained from fertilizer industry sources. Enid Oklahoma is in the center of the Oklahoma wheat belt and receives fertilizer by truck and rail. The Tulsa Port of Catoosa is located on the McClellan-Kerr Arkansas River Navigation System which received barge shipments from New Orleans and other ports on the Gulf of Mexico. The data included prices for the three nitrogen products (NH_3, Urea and UAN) and one phosphorus formulation (DAP) that constitute the majority of Oklahoma fertilizer products. Prices within each year were adjusted to reflect the interest costs associated with purchase and storage strategies. The fixed costs of warehouse ownership were not considered.

An optimization model was used to determine the purchase date (week of the year) or multiple dates that minimized or maximized the average price or price variance for the 17 year period.

The purchase date selected by the model was applied to the entire 17 year price series. The selected dates represented mechanical cash purchase strategies that could be used by a fertilizer dealer or producer.

Results

The impacts of the mechanical purchase strategies selected by the model in reducing the average price of fertilizer are shown in Table 1. Compared to a base strategy of purchasing an even amount of fertilizer each week, systematically purchasing during the weeks selected by the model reduced the average fertilizer price by 3-7%. The results generally showed a benefit from increased warehouse capacity. There was no additional benefit of increasing warehouse capacity from 75% to 100% of annual needs for some product forms. The mechanical purchase strategies had a greater impact on the average price of the UAN formulation relative to urea or DAP. The results were similar for the Tulsa (river port) and Enid (inland manufacturing point) location.

Table 1: Impact of Mechanical Purchase Strategies on Average Fertilizer Price for Various Warehouse Capacity, Locations and Product Forms

	Urea-Tulsa	Urea-Enid	UAN-Tulsa	UAN-Enid	**DAP-Tulsa**
25%	.98	.98	.96	.97	**.97**
50%	.97	.97	.95	.96	**.97**
75%	.96	.96	.94	.94	**.96**
100%	.96	.95	.93	.93	**.96**
Even Weekly	1.00	1.00	1.00	1.00	**1.00**

Prices shown relative to a base strategy of purchasing an even amount each week

The impact of the mechanical cash purchase strategies designed to reduce the year-to-year variance in fertilizer prices are shown in Table 2. While the baseline strategy of purchasing an even amount each week might be expected to reduce the year-to-year price variation, the results indicated further benefits from purchasing on the dates selected by the model. The results were most dramatic for DAP where year-to-year variance assuming 100% warehouse capacity was only 43% of that of the baseline scenario. Not surprisingly, additional warehouse capacity increased the ability to reduce price variance.

Table 2: Impact of Mechanical Purchase Strategies on Price Variance for Various Warehouse Capacity, Locations and Product Forms

	Urea-Tulsa	Urea-Enid	UAN-Tulsa	UAN-Enid	**DAP-Tulsa**
25%	1.07	1.03	.82	.85	**.70**
50%	1.05	.99	.72	.73	**.55**
75%	.85	.83	.68	.69	**.47**
100%	.74	.83	.66	.67	**.43**
Even Weekly	1.00	1.00	1.00	1.00	**1.00**

Prices shown relative to a base strategy of purchasing an even amount weekly

The difference between the average price resulting from purchase dates selected to generate the minimum fertilizer price and the average price resulting from purchase dates selected to generate the maximum fertilizer price are shown in Table 3. As before, the prices are shown as an index relative to price resulting from purchasing an even amount each week. The results in Table 3 help to answer the question "how important are purchase dates on determining the average cost of fertilizer?" The results indicated that there was a substantial difference (7% to 16%) difference in fertilizer price between a fertilizer dealer that had systematically purchased during the highest price dates relative to a dealer who systematically purchased on the lowest price dates. These results suggest that fertilizer dealers can use historical data to determine the optimal dates to purchase fertilizer and to identify calendar periods during which they should avoid purchases.

Table 3: Difference Between the Minimum and Maximum Average Fertilizer Price for Various Warehouse Capacity, Locations and Product Forms

	Urea-Tulsa	Urea-Enid	UAN-Tulsa	UAN-Enid	**DAP-Tulsa**
25%	.08	.08	.10	.07	**.07**
50%	.10	.10	.12	.10	**.08**
75%	.12	.12	.14	.12	**.09**
100%	.13	.14	.16	.15	**.09**

Prices shown relative to a base strategy of purchasing an even amount weekly

The difference in the variance in fertilizer prices between the prices created by systematically purchasing on the dates selected to minimize and maximize variance are provided in Table 4. The results indicated that the timing of fertilizer purchases has a major impact on the year to year variation in fertilizer price. The difference in variance ranged from 21% to 83% depending on warehouse constraint and product form. The results indicate that there are seasonal periods during which fertilizer prices are more stable relative to the same period in other years.

Table 4: Difference Between the Minimum and Maximum Fertilizer Price Variance for Various Warehouse Capacity, Locations and Product Forms

	Urea-Tulsa	Urea-Enid	UAN-Tulsa	UAN-Enid	**DAP-Tulsa**
25%	.29	.42	.25	.21	**.40**
50%	.35	.44	.71	.30	**.52**
75%	.54	.47	.82	.63	**.58**
100%	.55	.54	.83	.65	**.64**

Prices shown relative to a base strategy of purchasing an even amount each week

The optimal purchase dates identified by the model for the various objectives, product forms and locations are provided in Table 5. In the case of urea products purchasing in mid-summer achieved the lowest average price. Purchasing in spring yielded the highest price. For the UAN formulation purchasing in mid-November minimized price while purchasing in late April resulted in the highest price. The seasonal price patterns for DAP were similar with early November being the best time to purchase and late March was, on average, the worst date. The purchase date or dates which minimized the year-to-year variation in fertilizer price are more difficult to characterize. Spreading purchases throughout the year minimized variance for urea while purchasing in January and November achieved the lowest variance for the other formulations. Purchasing in mid-fall (urea-Tulsa) or late spring (other formulation and locations) resulted in the greatest year-to-year variation in prices.

Table 5: Optimal Time Periods to Purchase Fertilizer

	Urea-Tulsa	Urea-Enid	UAN-Tulsa	UAN-Enid	**DAP-Tulsa**
Minimum Average Price	2nd week of July	1st week in July	2nd week of November	2nd week of November	**1st week in November**
Maximum Average Price	4th week in March	1st week in April	4th week in April	4th week in April	**4th week of March**
Minimum Variance	Varying amounts over 50 weeks of the year	Varying amounts over 49 weeks of the year	4th week of November	2nd week in January plus 4th week in November	**2nd week in January plus 2nd week of November**
Maximum Variance	4th week of October	1st week in April	4th week of April	4th week in April	**4th week of March**

Prices shown relative to a base strategy of purchasing an even amount each week

Conclusions and Implications

The level and volatility of fertilizer prices is an area of great concern for producers and agribusiness firms. Hedging and option based strategies to management fertilizer price risks are limited. This study has examined the success of mechanical cash purchase strategies in reducing the average price or year-to-year price variability of fertilizer. The results indicate, that at least in the Southern Plains, there are seasonal patterns in fertilizer prices that dealers and producers can use in developing fertilizer purchase strategies. Purchasing and inventorying fertilizer in mid-summer or in late fall would have historically reduced the average price. While the results did not consider the fixed costs of warehouse ownership, increasing warehouse capacity had a significant impact on the effectiveness of strategies to decrease fertilizer price or variance.

In considering these results, two important limitations of the study should be emphasized. First, the fertilizer price data used represented locations in the Southern Plains. The application periods were modeled to represent the requirements of winter wheat. Fertilizer price patterns are likely affected by the usage in the corn belt. The optimal purchase times for dealers and producers in the Southern Plains appear to be the time periods out of cycle with corn belt usage. Dealers and producers in the mid-west, analyzing historical prices for their locations might find it more difficult to identify effective cash purchase strategies.

The second limitation is that the results are based on seventeen years of fertilizer price data. The purchase periods identified by the model represent the time periods that historically would have reduced fertilizer price or variance. The fertilizer supply chain has undergone significant structural change. Seasonal price patterns identified in the historical data may not extend to future periods. Nevertheless, these results provide a logical starting point for a fertilizer dealer or producer determining the timing of fertilizer purchases.

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