The Preference for Round Number Prices

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Abstract

This study determines if a preference for round prices exists in the wheat market and how wheat sales react to price movements around whole dollar amounts. The results show round prices are slightly more prevalent than non-round prices and that transactions increase when price moves above a whole dollar amount.

Keywords: price preference, round prices, threshold prices, wheat market

Introduction

Recent empirical research indicates that not all prices are viewed as equal. Studies show that round prices (prices ending in zero or five) appear to be more popular than non-round prices in many financial markets, such as IPO markets, stock markets, and foreign exchange markets (Kandel, Sarig, and Wohl; Harris; Fischer). Technical analysts take this price clustering one step further by assessing its relationship to market trends. Results of technical analysis suggest that trends tend to increase after certain prices levels (specifically round prices) are crossed (Osler). While there have been studies regarding price clustering at round numbers and its relationship to market trends done in financial markets, there has been little done to address the possibility of round prices being preferred in non-financial markets. Since psychological biases, such as price preference, may result in increased risks and unexpected outcomes (Kahneman and Riepe), it is important to research whether this particular bias exists in markets outside of the financial industry.

The first objective of this paper is to determine if a preference for round prices exist within the Oklahoma wheat market. Descriptive statistics will be used to test whether round

prices have a greater relative frequency than that of non-round prices. If a preference for round prices exists it may suggest that producers are making marketing decisions based on psychological biases and further education on the consequences of these biased decisions may be required. It is also possible that the preference for round prices is not coming from producers, but from the grain elevators. Elevator managers could be using management practices that may influence price.

The second objective relates to the technical analysis theory that market trends increase or decrease when round price thresholds are crossed. Specifically, the objective is to determine whether whole dollar prices are viewed as round price thresholds. This will be accomplished using a regression model that examines the change in number of market transactions (wheat sales) when price moves above or below a whole dollar amount.

Conceptual Framework

If a preference for round prices in the Oklahoma wheat market does exists, it likely results from either management practices at the elevator level or psychological biasness on the part of the producer. Management practices that could influence prices include such things as negotiated prices, adjusting margins to account for market uncertainties, and producer use of sell orders. Producer psychological biasness simply indicates that producers may have an irrational inclination towards round prices.

An overview of how elevators determine producer price is needed in order to better understand the possible causes of round price dominance in the Oklahoma wheat market. Elevator managers typically determine producer price by subtracting their margin to the market price that the elevator receives. According to elevator managers, the margins they use to calculate producer price are usually based on historical margins and competitor prices and

seldom change from year to year, though elevator managers may adjust the margin if significant changes in transportation costs occur. Elevator managers do not round the price they receive from the market. Elevator managers may occasionally use round margins that could affect producer price if rounding already exists in the market prices that elevators receive. However, elevator managers usually set the margin close to, but not at, round numbers.

Financial market research often attributes lower negotiation costs as one factor of price clustering at round numbers (Harris; Neiderhoffer). If a producer met with an elevator manager in order to negotiate a better price, it is possible that there would be a tendency to round to the nearest five or ten cent increment. Interviews with elevator managers indicate that prices are very seldom negotiated, however, if price is negotiated rounding to the nearest five or ten cent increment typically occurs. Since, negotiated prices are very rare it is unlikely that this would result in a prevalence of round prices. As for elevator managers adjusting margins to account for market uncertainties, managers report that margins are only adjusted for changes in transportation and even then the adjustment is slight. Therefore, it is also unlikely that this would cause round prices to be more dominant.

The most likely cause of any round number pricing in the wheat market is producers' use of sell orders that are placed at round prices. According to elevator managers, sell orders are a common wheat marketing tool (Smith). Sell orders are placed by the producer and give the elevator manager permission to sell a given amount of the stored crop when price reaches a certain level (Osler). The agreed upon sell price is known as the target price. Evidence from sell orders in the currency and stock markets indicate that target prices are commonly set at round prices (Harris; Osler; Fischer). Elevator managers agree that target prices on sell orders are almost always set at round prices (Smith).

The preference for setting target prices at round numbers is often attributed to the memory-economizing tendencies of individuals (Kahn, Pennachi, and Sopranzetti). Individuals tend to be better able to remember round numbers which results in a preference for round prices. Even elevator managers say that producers seem to be more "round number minded". This preference for round prices is an example of a psychological bias. Research in behavioral finance indicates that people may unknowingly incorporate certain psychological biases (errors in intuitive judgment) into their decision-making process (Kahneman and Riepe; Odean). Evidence of psychological biases have been found in both the financial and agricultural markets and include such things as overconfidence in the ability to predict the future, maintaining losing market positions, and remembering successes and forgetting failures (Brorsen and Anderson; Kahneman and Riepe; Odean). If producers do have a psychological inclination towards round numbers, it could very well cause round prices to occur more frequently.

Data

Data are from three grain elevators located in the northern, southern, and central areas of western Oklahoma. The data span nine crop years, from the harvest of 1992 through the harvest of 2000, and contain individual producer transactions of wheat sales at each elevator. Each transaction includes the number of bushels sold, price per bushel, date of transaction, and the number of weeks after harvest that the transaction took place. Harvest is a four week period that is defined differently for each elevator depending on location. Beginning harvest dates for the southern, central, and northern elevators are May 25, June 1, and June 12 respectively.

Table 1 contains the descriptive statistics for each elevator. Average price is the nominal average price that producers received over the nine years of data. The average week after harvest is the average week that producers chose to market their wheat for all years. Percent

round number prices is the percent of individual daily prices that are round numbers (prices that end in zero).

The southern elevator has the highest price and lowest average number of weeks. According to Benirschka and Binkley, locations closer to the market (the Gulf) typically have higher negative returns to storage than locations further away from the market. Therefore, southern producers are more likely to sell at or close to harvest which results in a lower average number of weeks after harvest compared to the central and northern elevators. The higher average price at the southern elevator is likely due to the fact that the southern elevator is closer to the market (the Gulf), thus transportation costs are lower. Therefore, the average price is higher at the southern elevator. Another reason for the higher average price could be that harvest is slightly earlier at the southern elevator resulting in a slightly higher demand for wheat and a higher price per bushel.

Procedures

The procedures include descriptive statistics and regression analysis. The descriptive statistics are used to determine if round prices are more prevalent than non-round prices in the Oklahoma wheat market. The regression model assesses whether producers use whole dollar prices as threshold levels by estimating how the number of daily transactions changes when prices move above or below whole dollar prices.

Descriptive Statistics

In order to study the prevalence of round prices, descriptive statistics are computed and tested using methods like that of Kandel, Sarig, and Wohl and Osler. First, T_{jd} is computed, where T_{jd} is equal to the total number of transactions for each elevator j that occurred at each last

digit d (d = 0,1,…,9). Then the relative frequency of transactions occurring at each last digit is determined using the following equation:

(1) $$R_{jd} = \frac{T_{jd}}{\sum_{d} T_{jd}}$$

where R_{jd} is equal to the percentage of the total number of transactions at elevator j at prices that end with the last digit d. The null hypothesis is that round prices are not more prevalent than non-round prices. A chi-squared test for equal proportions is performed to determine whether a significant difference exists between the frequencies occurring at each last digit.

Regression Model

For the purpose of running the regression model the individual data were aggregated by day for each elevator, so that each observation contains the daily number of transactions, daily price per bushel, date, and number of weeks after harvest. The following regression is used to determine the effect of prices moving above or below whole dollar prices on the number of daily transactions:

(2) $$tr_{it} = \beta_0 + \sum_{k=1}^{8} \beta_{1k} cy_{kt} + \beta_2 wah_{it} + \beta_3 wah_{it}^2 + \beta_4 mpa_{it} + \beta_5 lmpa_{i-1,t} + \beta_6 mpb_{it} + \beta_7 lmpb_{i-1,t} + \varepsilon_{it}$$

where i is the day, t is the year, tr_{it} is the number of transactions that occurred on the i^{th} day in year t, cy_t is a dummy variable for each crop year, wah_{it} is the yearly bushel-weighted mean weeks after harvest when wheat was sold, mpa_{it} is a dummy variable for the movement of price above a whole dollar value, $lmpa_{it}$ is the lagged movement of price above a whole dollar value, mpb_{it} is a dummy variable for the movement of price below a whole dollar value, $lmpb_{it}$ is the lagged movement of price below a whole dollar value, and ε_{it} is the error term. The plots of error terms versus wah_{it} for the OLS model exhibited heteroskedasticity with variance increasing

for low values of wah_{it}, thus the regression is estimated using maximum likelihood. The error, ε_{it}, is defined to be heteroskedastic as

(3) $$\varepsilon_{it} \sim N(0, \sigma_{it}^2)$$

and the variance of $\varepsilon_{it}(\sigma_{it}^2)$ is defined as

(4) $$\sigma_{it}^2 = \exp(\alpha_0 + \alpha_1 wah_{it} + \alpha_2 wah_{it}^2).$$

It is expected that transactions will increase when price moves above a whole dollar value, therefore, β_4 and β_5 are expected to be positive. Conversely, transactions are expected to decrease when price moves below a whole dollar value, thus β_6 and β_7 are expected to be negative. Oklahoma producers typically sell the majority of their crop at or close to harvest. Therefore, as weeks after harvest increase fewer transactions are expected and β_2 is expected to be negative.

Results

Descriptive Statistics

Figures 1, 2, and 3 show the histograms for the relative frequency of transactions at the northern, central, and southern elevators for each possible last digit in price. As expected more transactions take place at prices with a last digit of zero. For the chi-squared equal proportion test, the null hypothesis that the frequency of transactions is equally distributed across all last digits was rejected at all locations. The frequency of occurrence across last digits is more evenly distributed in the northern and central elevators than at the southern elevator. The southern elevator has the highest percentage of transactions occurring at zero with almost 16% and has a high percentage of transactions occurring with a last digit of seven.

As expected, the results indicate that there is a preference for round prices in the Oklahoma wheat market. However, the preference found in this study is fairly small compared to that found in studies of financial markets. It is possible that producer biasness leads to the placing of a disproportional amount of sell orders at round prices which, then leads to a prevalence of round prices in the wheat market.

Regression Model

The results of the regression of number of transactions with respect to price movement above or below a whole dollar amount are shown in table 2. The results of the regression analysis show that the coefficients for the movement of price above a whole dollar amount and for the lagged movement of price above a whole dollar amount exhibit the expected positive sign and are significant. This indicates that as price moves beyond a whole dollar amount, the number of transactions increase. This could be interpreted as producers using whole dollar prices as threshold levels and selling when price moves across that threshold. For example, if price increases from $2.88 to $3.02 it would cross the $3.00 threshold and producers would increase their wheat sales (i.e. more transactions would occur). The coefficients for the movement of price below a whole dollar amount and for the lagged movement of price below a whole dollar amount are not significantly different from zero at the 95% confidence level, which suggests that price movement below a whole dollar amount does not significantly affect producers' decisions to sell their wheat. These results coincide with the results of technical analysis that show market trends (wheat sales) increasing after specific price levels (whole dollar prices) are crossed.

Conclusion

This study determined whether round prices are more common in the Oklahoma wheat market. The results show that round prices are slightly more common than non-round prices at all three elevator locations. This is likely due to producers using sell orders with a majority of the target prices set at round numbers. This inclination towards round numbers could be the result of producer psychological biases. If producers allow psychological biases to influence their marketing decisions then they may experience lower returns and unexpected outcomes. Therefore, additional steps may be required in order to educate producers about the psychological mistakes that they are prone to make.

Regression analysis was used to determine the effect of movements around specific price thresholds on wheat sales. The test showed that wheat sales increased slightly when price moved above a whole dollar amount, while the effect of price movement below a whole dollar amount was not statistically significant. These results indicate that producers may be using whole number prices as threshold levels, waiting to sell after price moves above these thresholds.

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Table 1. Descriptive Statistics for Each Elevator

Descriptive Statistics	South	Central	North
Average price ($/bu.)	3.41	3.32	3.39
Average week	5	16	18
Percent round number prices	15.39 %	12.37 %	11.65 %
Number of observations	14434	7089	6389

Figure 1. Histogram of Last Digit in Price for Northern Elevator

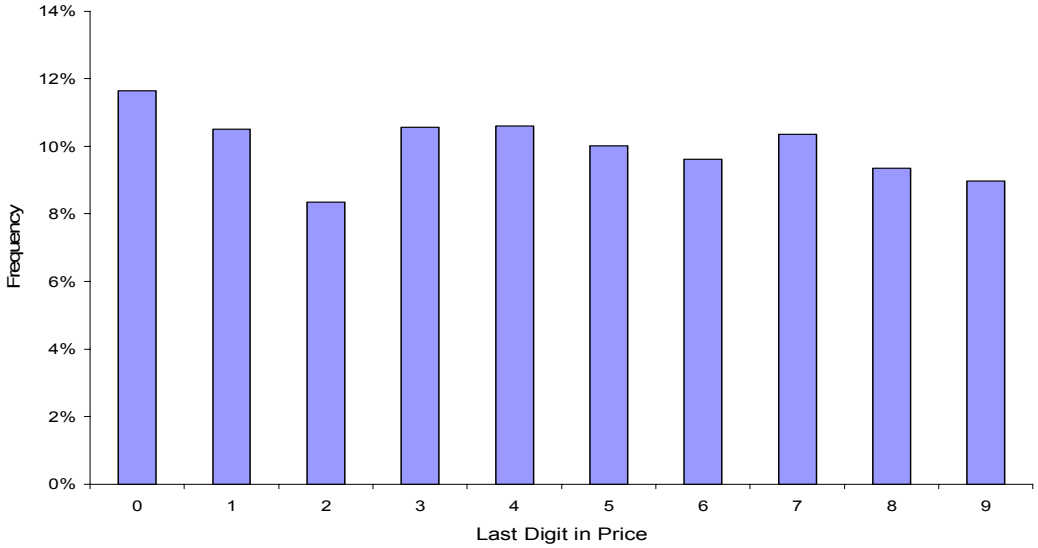

Figure 2. Histogram of Last Digit in Price for Central Elevator

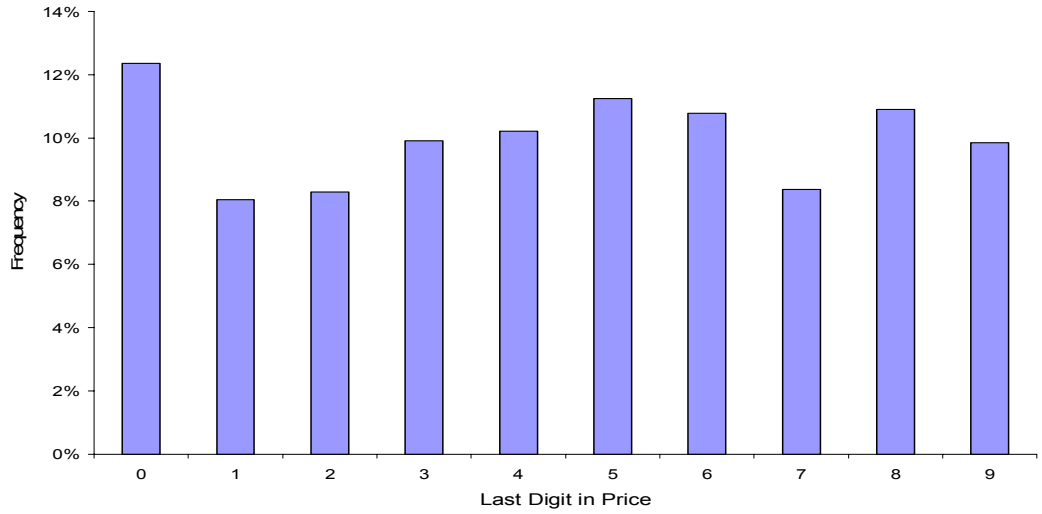

Figure 3. Histogram of Last Digit in Price for Southern Elevator

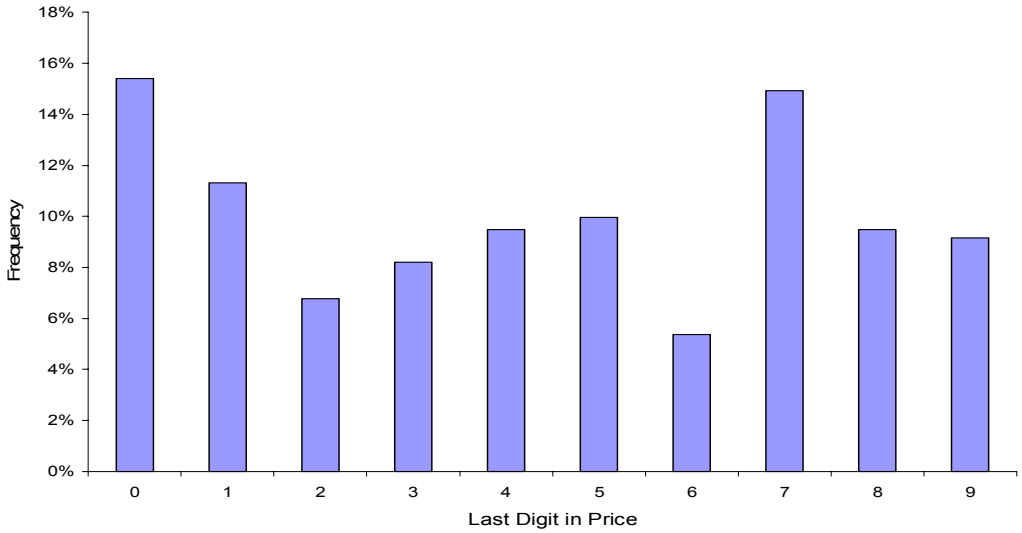

Table 2. Regression of Whole Dollar Prices on Number of Transactions

	Estimate	t-value	Pr > |t|
Intercept	5.5121	10.08	< .0001
1993 crop year	.1097	.38	.7023
1994 crop year	- .1450	- .63	.5254
1995 crop year	.3894	1.64	.1011
1996 crop year	.3935	1.64	.1017
1997 crop year	.7004	2.27	.0235
1998 crop year	.6370	1.82	.0692
1999 crop year	.4552	1.90	.0570
2000 crop year	.3915	1.67	.0947
Weeks after harvest (*wah*)	- .1507*	- 4.38	< .0001
Weeks after harvest squared (*wah2*)	.001727*	2.99	.0028
Movement above whole price (*mpa*)	.8041*	2.04	.0416
Lagged movement above whole price (*lmpa*)	1.3278*	3.00	.0027
Movement below whole price (*mpb*)	- .4029	- 1.75	.0806
Lagged movement below whole price *(lmpb)*	.3601	1.16	.2441

* Indicates significance at 95% confidence level