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FORMATION AND ADAPTATION OF REFERENCE PRICES IN GRAIN MARKETING: AN EXPERIMENTAL STUDY

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Formation and Adaptation of Reference Prices in Grain Marketing: An Experimental Study

Abstract

This study examines formation and adaptation of reference prices by Manitoban grain producers. Research shows that preferences are reference-dependent and marketing decisions are affected by reference prices. Results suggest that Manitoban producers' reference prices are formed primarily by an average of recent prices and the highest price to-date in the marketing window. Reference prices are found to adapt in the same direction as market prices, with adaptation to increasing prices being larger than adaptation to decreasing prices. When deciding to sell grain, producers are more likely to sell when they expect prices to decrease over the next month and when their reference price adjusts downwards towards the current price.

Résumé

Cette étude porte sur le développement et l'adaptation de prix de référence par des producteurs de grain du Manitoba. Des travaux antérieurs ont démontré que les préférences sont conditionnées par des points de référence et que les décisions de mise en marché sont influencées par des prix de référence. Nos résultats suggèrent que les prix de référence des producteurs Manitobains sont définis par une moyenne de prix récents et du prix le plus élevé observé durant la dernière période de mise en marché. Les prix de référence s'ajustent dans la même direction que les prix du marché, avec de plus grands ajustements lorsque les prix du marché sont en hausse et de plus petits ajustements lorsque les prix du marché sont en baisse. Lorsque la décision de vendre arrive, les producteurs sont plus enclins à vendre lorsqu'ils anticipent une baisse de prix dans le mois suivant et lorsque leur prix de référence s'ajustent à la baisse vers le prix actuel du marché.

Keywords: grain marketing, reference prices

JEL codes: C93, D03, D81, Q13

INTRODUCTION

Decisions under uncertainty have traditionally been examined under the expected utility framework, where all decisions are rational and lead to utility maximization. However, empirical evidence has challenged the traditional framework. For example, studies have found that decisions are often guided by the presentation of the opportunity, rather than by the probable outcome, and individuals' risk attitudes may change according to how the same situation is presented to them (Kahneman and Tversky, 1979).

Prospect theory has grown rapidly in popularity over the past two decades to model decision making under risk and uncertainty as an alternative to expected utility theory. Developed from empirical observations, the model assumes that behavior is driven by deviations from a reference point and that each economic opportunity is evaluated separately rather than as a collective whole. Theoretically, value received from each economic transaction is derived from the interaction of a value function and a probability weighting function. The origin of the value function is the reference point and distinguishes a transaction as a gain (values above the reference point) or loss (values below the reference point). It is the point where an individual is indifferent between taking an opportunity or letting it pass. According to prospect theory, risk attitudes will change as the transaction is perceived as a gain or a loss. Further, the difference between the reference point and selling price will cause more emotional pain for losses than pleasure for gains. Given the vast effects of reference points, it is critical to understand how reference points form and adapt.

In this framework, references points have a significant impact on decision making under uncertainty. McNew and Musser (2002), Meulenberg and Pennings (2002) and Fryza (2011) investigate marketing decisions accounting for the idea that producers use reference prices, i.e. they would compare market prices to a certain reference level when deciding whether or not to sell their grain. However, these studies mostly assume certain reference prices and consider that they do not change over time. There is evidence that reference prices vary largely across individuals and that they are adjusted over time (Meulenberg and Pennings, 2002; Lee et al., 2009), which calls for further research in agricultural marketing to investigate how producers determine and update their reference prices.

The objective of this study is to understand how Manitoban grain producers form and adapt reference points while marketing their grain. The research explores how market prices influence reference points, how price expectations affect producer's decisions to price their grain, how reference points adapt to changes in market prices, whether adaptation to gains is faster than to losses, and how reference point adaptation is affected by how much and how long market prices are above or below the reference point. Data for this research were obtained by a questionnaire and experiment administered to grain producers across Manitoba.

Studies have explored the formation and adaptation of reference points in an investment context (Baucells et al., 2011; Lee et al., 2009), but not in the context of agricultural marketing. Reference points have been applied to decision making analysis in marketing using economic theory to select the reference point as opposed to experimental evidence (McNew and Musser, 2002; Meulenberg and Pennings, 2002; Fryza, 2011). Exploring the formation and adaptation of reference points in agricultural marketing will help fill this gap in empirical research.

This study uses a unique data set of grain producers to perform a comprehensive analysis of reference prices in marketing decisions, shedding more light on the decision making process in grain marketing. Findings from this study will be helpful for government agencies, marketing boards and producers to evaluate and improve current marketing programs and strategies as well as develop new ones. For example, government can position prices within programs to encourage behavior that is targeted by its programs or that is expected to be beneficial to producers. Market advisors may be able to improve their services to producers using results from this research, emphasizing the effects of reference prices on marketing decisions and help producers minimize biases from reference prices. And grain companies can strategically price above (below) producers' estimated reference price to encourage (discourage) them to market their grain when demand is high (low).

THEORETICAL BACKGROUND

It has become widely accepted in the fields of behavioral economics, behavioral finance, and marketing that reference points have a significant effect on behavior (Baucells et al., 2011). Deriving value from changes in wealth, relative to a reference point, gained popularity after Kahneman and Tversky (1979)'s article presenting prospect theory. Reference points are frames of reference which create the feeling of gains or losses when compared to prospects and are critical determinants of risky behavior (Baucells et al., 2011).

The value of the reference point in relation to the prospect's outcome can affect the evaluation process based on the position of the prospect or outcome relative to the reference point and also the distance between both values. A reference point above the market price will create a feeling of loss, which is felt more acutely than that of similar sized gains when the reference point is below the market price (Kahneman and Tversky, 1979). Purchasing a good for $10 when the expected price was $12 will feel like a good deal, whereas purchasing the good for $14 will seem like it was overcharged. The $2 'loss' will be felt more acutely than the $2 'gain'. The distance between the reference point and the outcome is also relevant because of diminishing marginal sensitivity to changes. From a reference point of zero, receiving a fine of $200 feels much worse than a fine of $100, whereas a fine of $1,500 does not feel much worse than a fine of $1,400. A greater distance from the reference point to the prospects outcome will decreases sensitivity to changes.

Changes such as these, which are created by different reference points, can alter risk preferences. Kahneman and Tversky (1979), Tversky and Kahneman (1981) and Sullivan and Kida (1995) conducted experiments showing reversal of preferences caused by distinct reference points. The disposition effect and the equity premium puzzles are two examples of phenomena commonly observed in financial decisions that are related to reference points (Shefrin et al., 1985; Forbes, 2009).

Another dimension in the discussion of reference points is their dynamics. Reference points are not static and can change over time (Helson, 1964). Expectations of prospects are continuously adapting to our environment's new and old stimuli and how they are perceived relative to a reference point. Reference levels do not fully adapt immediately to new stimuli because past values and trends remain applicable. It is continuous process where full adaptation is rare.

Adaptation most likely arises from physiological and biological levels. Our bodies are quick to respond if our core temperature deviates slightly from its normal value of 98.6 degrees, or if the pH content of our blood strays from 7.4. Socially, periods of peace indicate a state of equilibrium; conversely, danger and unrest are commonly products of imbalance (Helson, 1964).

As environments continuously change, adaptation leads to dynamic equilibriums. A changing equilibrium is desirable in many circumstances; it allows us to become better adapted to new environments, creates variety and novelty, and encourages us to reach our potential. An individual with nothing will work towards saving $1,000, will work towards $10,000 when they have $1,000, and $1,000,000 when they have $500,000 (Helson, 1964). This behavior is not striving for equilibrium, but for new pleasure and possibilities. Helson (1964) emphasizes that the reference point is the point from which behavior is measured, predicted and understood, not what behavior is attempting to achieve.

Several studies have found evidence that reference points are formed and updated by numerous factors. Reference levels may be determined by a combination of the original purchase price (Arkes et al., 2008), the status quo, social norms and aspirations (Kahneman and Tversky, 1979), the historical peak (Zwick and Rapoport, 2005), purchase price, current price, intermediate prices (Baucells et al., 2011) and non-action (had they not been involved at all) (Lin et al., 2006). Prices at which investors made a decision, bought or sold, may also carry more influence than other prices (Baucells et al., 2011).

PREVIOUS STUDIES

Reference points were originally assumed to be the status quo by Kahneman and Tversky (1979). Subsequent empirical research to verify this hypothesis has been generally supportive. When conducting experiments with reference points in financial decisions, prices of goods and services are often used. Purchase prices are often assumed to be the status quo, and have been found to carry significant weight in many studies. As time progresses and prices change, reference points have been found to adapt to these changes. Kahneman and Tversky (1979) also hypothesized that future expectations will affect reference points.

Several studies have explored how reference prices are formed, mainly using controlled experiments, and have found that the purchase price of an asset is commonly used as a reference price. Baucells et al. (2011) presented 55 subjects with graphs of stock prices in several time periods and instructed them to imagine that they had purchased the stock in the first time period and the price had evolved in a given pattern. Subjects were then asked to indicate at which selling price they would be neither happy nor unhappy about the sale, indicating their reference price, for different price sequences. Results indicate that the first and last prices held the greatest influence in determining the reference price. Baucells et al. (2011) suggest this is a reflection of the salience created for prices at which investors acted. Intermediate prices each held similar influences on the reference price, but less weight overall than the first and last prices. The effect of the highest price in the sequence on the reference price was found to be statistically insignificant.

Determining the importance of peak prices in reference price formation was also found to be difficult by Langer et al. (2005) when subjects evaluated numerical sequences. However, Gneezy (Zwick & Rapoport, 2005) explored reference prices in a different setting and showed distinct findings with respect to the importance of the highest price to-date. He designed the experiment as a dynamic decision to sell a risky asset over time and used area theory developed by Selten (1991) to investigate the determinants of reference price. In contrast to previous findings, results suggest that the highest price to-date was the most relevant factor to determine when individuals would choose to sell their assets.

The experiments discussed above are examples of studies exploring reference prices and generally find that the first price and the highest price (in a dynamic context) appear to hold the greatest weight in determining the reference price. Still, reference prices are not necessarily static and they can change over time. Studies have explored if and how reference prices change over time by adapting to new information and an evolving environment. Helson (1964) originally specified adaptation level as the average of all prices. This framework implies that each new piece of information is just as important as the last and that each has an equal effect on change in reference price. Further research has shown that extreme stimuli have smaller effects than initially predicted and that more recent prices hold greater influence than older prices (Sarris, 1967; Parducci, 1968). Therefore, a stimulus that is very far from the reference price and is not expected to occur again will have a smaller effect on adaptation than new stimuli that is expected to become the norm. Chen and Rao (2002) suggest that reference price adaptation occurs immediately but incompletely (the reference price is not replaced by the most recent price) and Arkes et al. (2008) have shown that reference prices adapt faster to gains than to losses.

Even though empirical evidence largely suggests that individuals are reluctant to sell losing investments, they eventually do sell if losses persist. Lee et al. (2009) sought to determine how and at what point this psychologically painful decision is made. They found that the tendency to exit a losing position occurs more often when the investment has negative expectations, as the total loss becomes larger and as time in the losing position becomes longer. The effects of negative expectations were observed to be greater when investors had not fully adapted to their losses. Investors who have relatively maintained their high reference price after a loss are more likely to sell an investment when their expectations are negative because there is a smaller chance it will return to their reference price (avoiding the feeling of a loss). Therefore, an individual who has not yet adapted to losses is more likely to sell the investment. Results were also consistent with the assumption that the initial purchase price is a good proxy for the reference price, particularly soon after the investment is purchased.

Despite the limited literature on reference prices in agricultural marketing, there are a few studies that suggest producers use reference prices to make selling decisions. McNew and Musser (2002) examine producers forward pricing decisions based on pre-harvest pricing activity of six marketing clubs. The authors hypothesize that producers are expected to use less (more) forward pricing if the current price is below (above) their reference price. Results suggested that producers use current price trends as their reference, such that low prices or negative price movements encourage forward pricing and high prices or positive price movements discourage forward pricing.

Meulenberg and Pennings (2002) investigate factors which contributed to the use of futures contracts for risk management purposes in the Dutch hog industry. They hypothesise that futures prices become more (less) attractive as they increase (decrease) relative to reference prices stated by the managers in the hog industry. Reference prices were positively correlated to the cost of raising hogs and were found to have a statistically significant effect on the decision to initiate futures contracts. Heterogeneity in the reference price across producers was also found, indicating that particular futures price levels do not carry the same attractiveness across producers. Reference prices have also been used in a model designed to identify relevant variables in marketing decisions of Canadian wheat producers (Fryza, 2011). Two groups of explanatory variables incorporated the notion of reference prices in decision making theory. One of them was the spread between the price in the futures market and the expected price for their wheat. The other was based on recent trends in futures prices. Results indicated that both the price spread and the price trend were relevant to explain producers' marketing decisions, suggesting that they follow market prices and compare them to reference levels before making a decision to sell their wheat.

RESEARCH METHOD

Survey and experiment

A dynamic experiment was developed to test how Manitoban grain producers' reference prices are formed and updated. The main focus is to determine which market prices are the primary contributors to a producers' reference price and how the reference price adapts to new price changes. The experiment was conducted with a sample of 75 grain producers across southern Manitoba. These producers were identified through Manitoba Agricultural Food and Rural Initiatives (MAFRI). Their business development specialists contacted producers and those who agreed to participate were later contacted by the researchers. The participants were responsible for marketing the grain produced on their farm. They may or may not be advised on marketing decisions by an external party, but they make the final pricing decision for their grain.

The producers took part in the experiment during July and August of 2012. The experiment was administered with pen and paper and took approximately 25 minutes to complete, ranging from 15 minutes to 45 minutes. Most experiments were completed in individual producers' homes. The only exceptions were a group of six producers which completed the experiment in their local MAFRI office and a group of fifteen producers which completed the experiment during their weekly marketing meeting. Before the experiment began, each producer was asked background information such as age, farm size, and risk preferences. They were not able to discuss the experiment amongst themselves and completed each sequence without interruption. To encourage participation in the experiment, producers received an equal opportunity in a draw for a cash prize of $400. Each producer received one ticket with a number between 00 and 99. The winning number was determined by the final two numbers of the lotto 649 extra on September 1st, 2012. The questionnaire which was presented to the producers can be found in the Appendix. Overall, producers were enthusiastic to complete the survey and eager to view the results.

Grain producers were presented with the problem of marketing their wheat over ten months and were encouraged to behave as they would on their own farms. The scenario began on September 1st 2012, where producers were asked how much wheat they expected to have available for sale in the cash market this crop season (excluding any sold in forward, futures, or options contracts) and were given the current market price. A series of four questions, adapted from Lee et al. (2009), was presented. The first two questions addressed producers' goals for marketing their wheat. The first was to measure the price at which they would be satisfied ('In the next period, what is the price of wheat which would make you feel satisfied if you were to sell the rest of your wheat') and the second was to estimate a selling price ('In the next period, if the price of wheat increases, what is the price you would sell the remainder of your wheat at?'). Producer's expected price changes were assessed by the third question ('How do you think the price of wheat will change over the next month?'). The fourth question determined producers desire to hold onto or sell their wheat ('Do you want to hold or sell wheat now and what amount?'). On the next page they were told that one month had passed and were given the new market price, a graph with the simulated price history to-date for that year (beginning in September), and the same series of four questions.[1] This process continued until June 1st 2013, over which there were ten opportunities for sale, four questions in each period, for a total of 40 questions.

The prices used in the marketing year presented to producers were simulated based on the distribution of hard red spring wheat futures price over the period 2001/02–2010/2011. Six distinct price sequences were simulated for this experiment, three with an overall increasing trend and three with an overall decreasing trend. Price movements reflected historical volatility in the wheat market, but were not a replication of any particular year. The mean and standard deviation of monthly price changes were calculated for each month over the past ten years, and were used to generate monthly price changes. The price ranges of the sequences remained within the range of market price for the last four years of the data sample.

Each producer went through this experiment twice and in each one they were presented with a different price sequences over the 10-month period simulated in the marketing year. The two price sequences presented to producers were selected randomly from the group of six

[1] Producers were instructed not to flip back through the pages during the experiment.

sequences generated for the experiment. Before each experiment, producers were encouraged to think of the price sequences as an 'average' year. Between each price sequence, producers were given a few minutes to refocus their attention in order to minimize the effects of memories from the first price sequence on the second price sequence. In addition, a small experiment was used as a distraction between sequences.

This small experiment between the two price sequences was aimed to assess risk preferences and its outcome will complement the survey applied before the experiment in terms of producers' background information.[2] Producers were offered a hypothetical opportunity to choose between a gamble offering the chance to win either $100 or $0 with equal probability or a fixed amount for certain (Gonzalez and Wu, 1999). They were presented with a table shown in Figure 1 and asked to indicate their preference for either a sure gain or the gamble, with the values of the sure gain being $100, $80, $60, $40, $20, or $0. After producers completed the table in Figure 1, the interval between sure gains where producers shift from "prefer sure thing" to "prefer gamble" (or vice versa) was identified (e.g. between $40 and $60 or between $80 and $100) and another table with the same format was given to them based on this more refined interval. This new table was generated in four-dollar increments spanning from the lowest to the highest value in the interval where preferences switch from the sure amount to the gamble (or vice versa). The same process was repeated and a third and final table was then presented with one dollar increments within an even more refined interval. The midpoint of the shift in preferences in the third table indicated the certainty equivalent of the gamble, which was used as a measure of risk preferences. A value larger (smaller) than 50 for the certainty equivalent represents risk seeking (averse) behaviour, while a value equal to 50 indicates risk neutrality.

[2] On-farm risk attitudes have been found to be significantly related to producers global risk attitudes (Pennings and Garcia, 2001).

Figure 1: First table in the experiment to assess risk preferences

Money (no gamble)	Prefer Sure Thing	Prefer Gamble
100		
80		
60		
40		
20		
0		

Regression analysis

The information generated from the experiment allowed for investigation of how reference prices are formed and adjusted as producers make marketing decisions. Two prices are assumed to be proxies for the reference price: the satisfy price and goal price. Both were obtained in the experiment as producers answered the questions presented in each marketing period. The satisfy price is the price of wheat which would make the producers feel satisfied selling the rest of their wheat in the next period. The goal price is the price at which the producer would sell the remainder of their wheat in the next period given an increase in price. A regression model based on Baucells et al. (2011) is adopted to explore the determinants of reference prices. Since the satisfy price and the goal price are used as proxies for the reference price, the model is estimated twice as there are two datasets for the dependent variable. Independent variables, which were selected based on previous studies, are the same in both estimations. The model is given by equation (1):

$$\begin{aligned} RP_{it} = {} & \alpha + \beta_1 FP_i + \beta_2 CP_{it} + \beta_3 HP_{it} + \beta_4 LP_{it} + \beta_5 WP_{it} \\ & + \beta_6 E_{it} + \beta_7 IPS_i + \beta_8 AI_i + \beta_9 AD_i + \sum_{j=1}^{9} \gamma_{ij} M_{ij} + \varepsilon_{it} \end{aligned} \tag{1}$$

where RP is the reference price for producer *i* in decision point *t* (month of the marketing year), FP is the first price in the price sequence (price in September) for producer *i*, CP is the current price for producer *i* in decision point *t*, HP is the highest price to-date for producer *i* in decision point *t*, LP is the lowest price to-date for producer *i* in decision point *t*, WP is the recency-weighted average price for producer *i* in decision point *t*, E is the price expectation for the next month for producer *i* in decision point *t*, IPS is a dummy variable for increasing price sequences for producer *i*, AI is a dummy variable for the second experiment when it follows a sequence with increasing prices in the first experiment for producer *i*, AD is a dummy variable for the second experiment when it follows a sequence with decreasing prices in the first experiment for producer *i*, M is a set of nine dummy variables representing each month of the marketing year from October to June (so they all show effects relative to September).

All prices are obtained from the experiment and are expressed in log form. The reference prices (represented by satisfy and goal prices) are reported by producers during the experiment. The first, current, highest and lowest prices come directly from the randomly selected price sequences assigned to each producer in the two rounds of the experiment. The recency-weighted average price is calculated from each price sequence and is a simple average of the current price and the price in the previous period.

The price expectations are elicited in the experiment as producers report their expectations for price change in the next month. Values of –1, 0 and 1 are respectively assigned to "price will decrease", "price will remain about the same" and "price will increase", and a weighted average of these three values are calculated for each producer in each decision point. The weights are the probabilities assigned by producers to each possible price scenario. If a producer indicated a probability of 10% that price will decrease (value= -1), 50% that price will remain about the same (value=0) and 40% that price will increase (value=1), the value of E for this producer is 0.3.

IPS, AI, AD are control variables to account for possible effects of specific price trajectories on producers' decisions. IPS equals 1 if the price sequence shows an overall increasing trend and 0 otherwise. AI and AD are both equal to 0 in the first round of the experiment. AI (AD) equals 1 when the price sequence in the second round follows a sequence with overall increasing (decreasing) trend in the first round and 0 otherwise. The monthly dummies (M) are included to account for time effects during the marketing year.

Two other regression models are estimated to investigate the direction and magnitude of reference price adaptation. The literature on adaptation theory indicates that reference prices adapt upwards as gains accrue and downwards as losses accrue.[3] Reference prices have also been shown to adapt faster to gains than to losses since loss aversion is expected to prevent subjects from coming to terms with their losses, creating deviations in adaptation levels for gains and losses (Arkes et al., 2008). Reference price adaptation is also analysed using the satisfy price and the goal price as proxies for the reference price, so the regression model with the incremental change in reference price as the dependent variable is estimated twice.[4] Equation (2) shows the regression model used to explore price adaptation:

$$IA_{it} = \alpha + \beta_1 \Delta IP_{it}^{+} + \beta_2 \left| \Delta IP_{it}^{-} \right| + \beta_3 E_{it} + \beta_4 IPS_i + \beta_5 AI_i + \beta_6 AD_i + \varepsilon_{it} \quad (2)$$

where IA denotes the incremental adapted reference price for producer *i* in decision point *t*, ΔIP_{it}^{+} is the incremental change in current price for producer *i* in decision point *t* if the price change is positive (0 otherwise), $\left| \Delta IP_{it}^{-} \right|$ is the incremental change (in absolute value) in current price for producer *i* in decision point *t* if the price change is negative (0 otherwise), E is the expectations of price change over the next month for producer *i* in decision point *t*, IPS is a dummy variable for increasing price sequences for producer *i*, AI is a dummy variable for the second experiment when it follows a sequence with increasing prices in the first experiment for producer *i*, AD is a dummy variable for the second experiment when it follows a sequence with decreasing prices in the first experiment for producer *i*.

The variable IA is calculated as the monthly change in the reference price (satisfy and goal prices) reported by producers during the marketing year in the experiment. The variables ΔIP^{+} and ΔIP^{-} are calculated as the monthly change in the market price observed during the marketing year (so it is based on the price sequences generated for the experiment) and are used to assess possible asymmetries in the reaction to positive and negative price changes. Variables E, IPS, AI and AD are determined in the same manner as discussed in equation (1). The statistical significance and magnitude of estimated coefficients β_1 and β_2 will be used to discuss the impact and relative importance of positive and negative price changes on reference prices.

In addition to incremental adaptation, total adaptation is also explored for reference prices. Reference prices are expected to adapt upwards (downwards) as total gains (losses)

[3] In the context of this study, gains (losses) refer to positive (negative) changes in market prices.
[4] The set of dependent variables is the same in both estimations.

accrue, while adaptation to gains over the duration of the series is also expected to occur faster than adaptation for losses. Total reference price adaptation is given by the change in reference price between September (first month of the marketing year in the experiment) and decision point *t*. Total gains (losses) represent the change in current market price between September and decision point *t*. Further, the passage of time has also been shown to impact reference prices adaptation (Lee et al., 2009). As time passes, subjects are expected to come to terms with previously occurring gains and losses, therefore adapting their reference price. Adaptation to gains over time is expected to occur faster than adaptation to losses over time, because loss aversion makes it harder for subjects to come to term with their losses. These points are investigated using the model in equation (3):

$$TA_{it} = \alpha + \beta_1 \Delta TP_{it}^{+} + \beta_2 \left| \Delta TP_{it}^{-} \right| + \beta_3 T_{it}^{+} + \beta_4 T_{it}^{-} + \beta_5 E_{it} + \beta_6 AI_i + \beta_7 AD_i + \varepsilon_{it} \qquad (3)$$

where TA denotes the total adaptation of the reference price for producer *i* between September and decision period *t*, ΔTP^{+} is the change in current price for producer *i* between September and decision point *t* if the price change is positive (0 otherwise), $\left|\Delta TP^{-}\right|$ is the change (in absolute value) in current price for producer *i* between September and decision point *t* if the price change is negative (0 otherwise), T^{+} and T^{-} are variables indicating the passage of time (September=1, October=2, … , June=10) for respective sequences with an overall increasing and decreasing trends, E is the expectations of price change over the next month for producer *i* in decision point *t*, AI is a dummy variable for the second experiment when it follows a sequence with increasing prices in the first experiment for producer *i*, AD is a dummy variable for the second experiment when it follows a sequence with decreasing prices in the first experiment for producer *i*. Variables E, AI and AD are determined in the same manner as discussed in equation (1).

In equation (3) the statistical significance and magnitude of estimated coefficients β_1 and β_2 will be used to discuss the impact and relative importance on reference prices of positive and negative total changes in market price. Similarly, the statistical significance and magnitude of estimated coefficients β_3 and β_4 will be used to discuss the impact and relative importance on reference prices of the passage of time when market prices are increasing or decreasing.

Finally, one last model is estimated to investigate the role of price expectations on producer's decisions to sell their grain. Standard finance theory predicts that individuals will sell an investment if the expected increase in price is not sufficient to compensate for the risk of holding the investment, and they will hold the investment if the expected increase in price is sufficient to compensate for its risk. In the context of this study, larger (smaller) quantities of wheat are expected to be sold in the current period if future prices are expected to decrease (increase) and as the reference price decreases (increases) relative to the current price. These issues are explored using a regression model with the proportion of wheat sold at a given point in time as the dependent variable. The model is presented in equation (4):

$$\begin{aligned} \%S_{it} = \alpha + \beta_1 E_{it} + \beta_2 (CP - RP)_{it} + \beta_3 E_{it} \cdot (CP - RP)_{it} \\ + \beta_4 IPS_i + \beta_5 AI_i + \beta_6 AD_i + \sum_{j=1}^{9} \gamma_{ij} M_{ij} + \varepsilon_{it} \end{aligned} \tag{4}$$

where %S denotes the proportion of crop sold by producer *i* at decision point *t*, E is the expectations of price change over the next month for producer *i* in decision point *t*, (CP–RP) is the difference between the current price and the reference price for producer *i* in decision point *t*, IPS is a dummy variable for increasing price sequences for producer *i*, AI is a dummy variable for the second experiment when it follows a sequence with increasing prices in the first experiment for producer *i*, AD is a dummy variable for the second experiment when it follows a sequence with decreasing prices in the first experiment for producer *i*, and M is a set of nine dummy variables representing each month of the marketing year from October to June (so they all show effects relative to September). The statistical significance and magnitude of estimated coefficients β_1, β_2 and β_3 will be used to discuss the impact and importance on reference prices of price expectations and the spread between current and reference prices.

RESULTS

Survey findings

Table 1 shows descriptive statistics of the variables collected in the survey before the experiment. Producer's average age is 47 years, ranging from 19 to 78 years. Their education ranges from middle school to post graduate degrees, with half having completed a post-secondary degree or diploma. In terms of experience with hedging (i.e. pricing grain with forward, futures or options contracts), on average they used hedging contracts in 3.5 years out of the last 5 years, with half of the producers reporting to have hedged every year in the last 5 years.

The average proportion of their crop hedged during the last 5 years was 25% and the 3rd quartile was 35%, indicating that the majority of producers would typically hedge less than half of their crops.

Table 1: Descriptive statistics for variables obtained in the survey

	Average	Min.	1st quart.	Median	3rd quart.	Max.
Age	47	19	37	49	56	78
Gender (1=male, 0 =female)	0.99	0	1	1	1	1
Education [a]	2.5	1	2	3	3	4
Number of years using hedge in last 5 years	3.5	0	2	5	5	5
Average proportion of crop hedged in past 5 years (%)	25	0	15	25	35	85
I have a larger farm than most farmers in Manitoba [b]	2.8	1	2	3	3	5
Compared to other farmers, I have above average skills at predicting price movements [b]	2.8	1	2	3	3	5
My primary marketing strategy is to reduce risk [b]	3.5	1	3	4	4	5
My primary marketing strategy is to obtain a high price [b]	4.1	2	4	4	5	5
I am willing to take higher financial risks in order to realize higher average returns [b]	3.6	1	3	4	4	5
When selling my wheat, I prefer financial certainty to financial uncertainty [b]	3.6	1	3	4	4	5
I prefer less risk than most farmers [b]	2.9	1	2	3	4	5
Certainty equivalent of a gamble (100,50%; 0,50%)	57.6	20.0	48.0	54.5	70.5	80.5
Price expected for wheat in September (Cdn$/bu)	8.8	5.5	8.1	9.0	9.5	12.0
Break-even price for wheat (Cdn$/bu)	5.5	3.0	4.7	5.5	6.1	8.5

(a) 1=middle school, 2=high school, 3=post-secondary, 4=post-graduate; (b) 1=strongly disagree, 2=disagree, 3=neither agree nor disagree, 4=agree, 5=strongly agree

Producers' perceptions about farm size suggest that they generally believe their farm is smaller or about the same size as most producers in the province (Table 1). Similarly, they perceive their skills in predicting price movements to be mostly below or at the average compared to other producers (Table 1). Answers to the two questions about their primary marketing objective may appear ambiguous since, on average, producers seem to agree that their primary marketing objective is to reduce risk and obtain a high price. A closer look at the individual responses reveals that 37 out of 75 producers either agreed (scale 4 or 5) with both statements about their primary marketing objectives or disagreed (scale 1 or 2) with both, 19 producers agreed with one statement and neither agreed or disagreed (scale 3) with the other, 11 producers agreed with one statement and disagreed with the other, 4 producers disagreed with one statement and neither agreed or disagreed with the other, and 3 producers neither agreed or disagreed with both statements. Thus half of producers indicated that their primary marketing objective is to reduce risk and obtain a high price, while 40% of them indicated that their primary objective is to either reduce risk or obtain a high price.

Survey answers also suggest that producers are generally willing to take higher financial risks to realize higher returns, but they still seem to prefer financial certainty to financial uncertainty when selling their crop (Table 1). When asked whether they prefer less risk than most producers, the average answer is just below "neither agree nor disagree", while the average certainty equivalent ($57.6) assessed in the gamble experiment suggests some level of risk seeking behavior (Table 1). Again, a closer look at individual answers provide further insights, showing that producers who disagree (scale 1 or 2) with the statement "I prefer less risk than most farmers" exhibit higher certainty equivalents compared to those who agree (scale 4 or 5) with that statement. Finally, producers' expectations for the price of wheat in September 2012 ranged from Cdn$5.50/bu to Cdn$12.00/bu, with an average of Cdn$8.80/bu. Those values were larger than their self-reported break-even prices for wheat, which ranged from Cdn$3.00/bu to Cdn$8.50/bu with an average of Cdn$5.45/bu (Table 1).

Experiment: formation of reference prices

All 75 producers in the experiment completed two hypothetical marketing seasons with different price scenarios. Each scenario spanned from September until June, 10 months (decision points), for a total of 20 possible time periods. Producers could choose to sell their entire crop before the end of the marketing season (in which case they would finish the experiment earlier and thus show less than 10 decision points in the season), and could also choose not to sell the entire crop before the end of the marketing period in June. On average, 17.3 time periods were completed with a maximum of 20 observations per individual and a minimum of 4. Seventy producers completed at least 12 time periods and 44 producers completed at least 19 time periods. The data set contains a total of 1,297 observations (decision points) for the 75 producers, with 567 representing sell decisions made by producers. On average, producers sold 85% of their crop during a marketing season, with relatively larger proportions being sold in the fall months and in June (Table 2).

Table 2: Proportion of crop sold in each month of marketing season (average across producers)

	total	1st round	2nd round
September	11%	13%	9%
October	12%	11%	12%
November	12%	10%	13%
December	6%	5%	7%
January	7%	7%	7%
February	5%	5%	6%
March	7%	8%	6%
April	6%	5%	6%
May	7%	7%	8%
June	12%	8%	15%
Total	85%	80%	90%

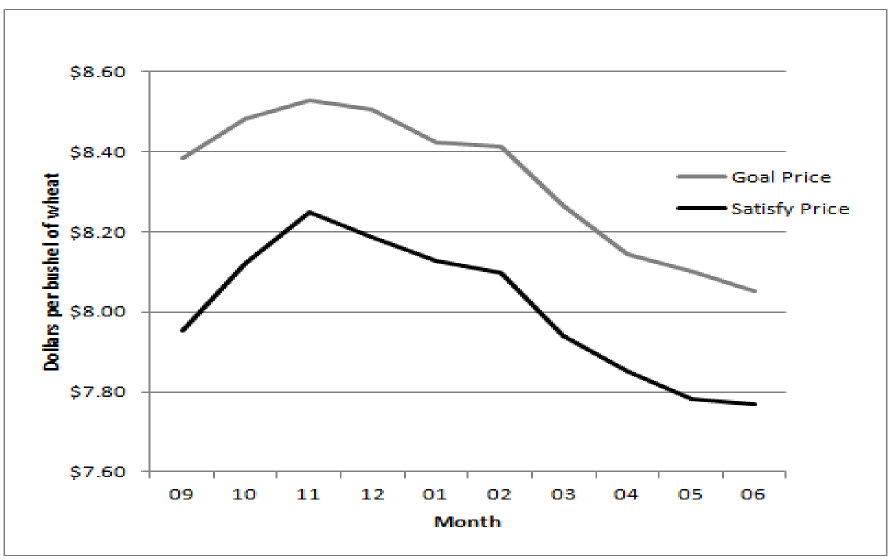
Table 3 shows descriptive statistics of satisfy and goal prices reported by producers during the experiments and also the prices presented to them in the price sequences. The satisfy and goal prices vary widely across producers, ranging between Cdn$5.50/bu and Cdn$10.50/bu (average=Cdn8.02/bu) and between Cdn$5.50/bu and Cdn$11.50/bu (average=Cdn8.37/bu) respectively. For each producer the goal price was generally above the satisfy price (Figure 2), and both were generally above the current price. The average trajectory of satisfy and goal prices during the marketing period shows an initial upward movement and then a decreasing pattern (Figure 2). The variable representing price expectations reported by producers indicate that, on average, they believed there was a 29% probability that the market price would increase over the next month (Table 3).

Table 3: Variables used in the experiment – descriptive statistics

	Average	Min.	1st quart.	Median	3rd quart.	Max.
Reference prices [a]						
satisfy price	8.02	5.50	7.50	8.00	8.50	10.50
goal price	8.37	5.50	7.50	8.50	9.00	11.50
First price [a]	6.77	6.66	6.68	6.78	6.88	6.88
Current price [a]	6.87	5.27	6.14	6.78	7.78	8.82
Highest price [a]	7.34	6.66	6.68	6.86	7.93	8.82
Lowest price [a]	6.40	5.27	5.96	6.78	6.88	6.88
Recency-weighted price [a,b]	6.85	5.51	6.17	6.78	7.47	8.46
Price expectation [c]	0.29	-1.00	0.00	0.20	0.60	1.00

(a) All prices in Cdn$/bu; (b) Simple average of price in period *t* and *t-1*; (c) 1=price will increase next month, 0=price will remain about the same next month, –1=price will decrease next month

Figure 2: Satisfy and goal prices (reference prices) – averages across producers



The formation of reference prices is investigated using two regression models, one assuming the satisfy price as the reference price and the other assuming the goal price as the reference price. Panel regression with individual fixed effects is adopted, while dummy variables for the months of the marketing period represent time-specific effects.[5] Table 4 presents the results of the estimated models. Robust covariance estimators are applied due to the presence of heteroskedasticity as indicated by the Modified Wald Test. All price variables are statistically distinguishable from zero, except for the first price (Table 4). The current, highest to-date and recency-weighted prices are found to have a positive effect on reference prices, i.e. an increase (decrease) in each of these variables in period *t* would lead producers to increase (decrease) their reference prices. For example, if the highest price to-date increases by 10% the satisfy price is expected to increase by 2.13% and the goal price is expected to increase by 2.31%.[6] Likewise, if the recency-weighted price decreases by 10%, the satisfy price and the goal price are expected to decrease by 3.3% and 2.7% respectively. On the other hand, the lowest price to-date was found to have a negative impact on reference prices, suggesting that producers would increase their reference prices as the lowest price to-date reaches lower levels. A possible explanation for this finding is that lower market prices may create feelings of loss and cause producer's to increase their reference price hoping to 'make-up' for the losses.

[5] Fixed effects were used due to a non-random sample from the given population.
[6] All prices are in log form; therefore estimated coefficients represent elasticities.

Table 4: Estimated panel regression model – formation of reference prices

$$RP_{it} = \alpha + \beta_1 FP_i + \beta_2 CP_{it} + \beta_3 HP_{it} + \beta_4 LP_{it} + \beta_5 WP_{it} + \beta_6 E_{it} + \beta_7 IPS_i + \beta_8 AI_i + \beta_9 AD_i + \sum_{j=1}^{9} \gamma_{ij} M_{ij} + \varepsilon_{it}$$

	RP=satisfy price [a]		RP=goal price [a]	
	coefficient [b]	std. error	coefficient [b]	std. error
Constant	2.038	1.339	1.630	1.339
First price (FP)	-0.474	0.717	-0.211	0.692
Current price (CP)	0.144***	0.061	0.171***	0.062
Highest price to-date (HP)	0.213*	0.114	0.231*	0.124
Lowest price to-date (LP)	-0.198*	0.112	-0.203*	0.103
Recency-weighted price (WP) [c]	0.330**	0.111	0.270**	0.118
Price expectation (E) [d]	0.024**	0.007	0.021**	0.009
Increasing price sequence (IPS) [e]	0.013	0.018	0.007	0.020
Second-round dummies				
after increasing sequence (AI) [f]	0.009	0.009	0.010	0.009
after decreasing sequence (AD) [g]	-0.039**	0.016	-0.036**	0.015
Monthly dummies (M) [h]				
October	-0.007*	0.007	-0.014*	0.008
November	-0.014**	0.013	-0.030**	0.013
December	-0.023**	0.014	-0.036**	0.015
January	-0.027***	0.015	-0.043***	0.015
February	-0.030**	0.018	-0.044**	0.017
March	-0.046***	0.019	-0.060***	0.019
April	-0.052***	0.020	-0.071***	0.020
May	-0.063***	0.023	-0.080***	0.023
June	-0.071***	0.022	-0.095***	0.023
R^2 within	0.472		0.440	
between	0.251		0.219	
overall	0.317		0.291	
Number of observations	1,277		1,287	
Number of producers	75		75	

(a) All prices are expressed in logs; (b) Statistically significant at 1% ***, 5% ** and 10% *; (c) Simple average of price in periods *t* and *t-1*; (d) Variable ranges from -1 (price will decrease next month) to 1 (price will increase next month); (e) Dummy variable: 1=sequence exhibits overall increasing trend, 0=sequence exhibits overall decreasing trend; (f) Dummy variable: 1=sequence presented in the second round which follows a first-round sequence with overall increasing trend, 0=otherwise; (g) Dummy variable: 1=sequence presented in the second round which follows a first-round sequence with overall decreasing trend, 0=otherwise; (h) Estimated effects are relative to September.

The estimated coefficient for price expectations is positive, implying that a producer's reference price will be higher (lower) if he expects the market price will increase (decrease) in the next month (Table 4). The dummy variable for sequences with an overall increasing trend was not statistically distinguishable from zero, indicating the general pattern of the price sequence had no impact on reference prices. The dummy variable for the second round was statistically distinguishable from zero only when it followed a sequence with a decreasing trend in the first round, which affected reference prices negatively (Table 4). This suggests that producers would carry the memory from the first round of the experiment into the second round, but only when they faced decreasing prices in the first round. The dummy variables for the months of the marketing season were all statistically distinguishable from zero and negative, suggesting producers tend to lower their reference prices as the marketing season progresses (Table 4).

The next step was to investigate the incremental adaptation of reference prices, exploring factors that influenced how producers update their reference prices at each new period *t*. The new variables generated in this section were the incremental (monthly) changes in reference prices and market prices. Descriptive statistics of these new variables can be found in Table 5. The average monthly change in reference prices across producers was –Cdn$0.01/bu for the satisfy price and –Cdn$0.03/bu for the goal price, but they ranged from –Cdn$2.00/bu to Cdn$1.50/bu and from –Cdn$2.00/bu to Cdn$1.80/bu, respectively (Table 5). Incremental variation in market prices was analyzed for positive and negative changes separately in order to account for possible asymmetric impacts of rising and declining prices. On average, incremental price changes were Cdn$0.16/bu and –Cdn$0.14/bu for positive and negative movements respectively (Table 5).

Table 5: Incremental (monthly) price changes – descriptive statistics

	Average	Min.	1st quart.	Median	3rd quart.	Max.
Reference price [a]						
satisfy price	-0.01	-2.00	0.00	0.00	0.00	1.50
goal price	-0.03	-2.00	0.00	0.00	0.00	1.80
Market price [a]						
positive changes	0.16	0.00	0.00	0.00	0.25	0.96
negative changes (absolute value)	0.14	0.00	0.00	0.00	0.21	0.90

(a) All price changes in Cdn$/bu

The adaptation of reference prices was investigated using both satisfy and goal prices, thus two regression models were estimated. Panel regression with individual and time fixed effects was adopted. Table 6 presents the results of the estimated models. Robust covariance estimators were applied due to the presence of heteroskedasticity as indicated by the Modified

Wald Test. Incremental changes in market prices were found to be statistically distinguishable from zero for both positive and negative variations, with positive (negative) increments in market prices having a positive (negative) impact on reference prices (Table 6). The estimated coefficients suggest that the impact on reference prices of positive price changes is larger than that of negative price changes, i.e. producers adjust faster to price increases than to price decreases. A one dollar increase in the market price is expected to lead to a 49-cent (42.3-cent) increase in the satisfy (goal) price, while a one dollar decrease in the market price is expected to lead to a 24.7-cent (23.9-cent) decrease in the satisfy (goal) price (Table 6). The variable for price expectations is also found to be statistically distinguishable from zero, indicating that producers would adjust their reference price upward (downward) if they believe the market price will increase (decrease) next month. Similarly, the dummy variable for price sequences with an overall increasing pattern is positive and statistically distinguishable from zero, suggesting that producers tend to adjust their reference prices upward when market prices are trending up compared to when they are trending down (Table 6). Finally, no statistical significance was found for the dummy variables capturing possible effects of the first round into the second round of the experiment.

Table 6: Estimated panel regression model – incremental reference price adaptation

$$IA_{it} = \alpha + \beta_1 \Delta IP_{it}^{+} + \beta_2 \left| \Delta IP_{it}^{-} \right| + \beta_3 E_{it} + \beta_4 IPS_i + \beta_5 AI_i + \beta_6 AD_i + \varepsilon_{it}$$

	IA: satisfy price [a]		IA: goal price [a]	
	coefficient [b]	std. error	coefficient [b]	std. error
Constant	-0.111***	0.023	-0.126***	0.025
Positive incremental price change (ΔIP^{+}) [c]	0.490***	0.047	0.423***	0.052
Negative incremental price change ($\lvert\Delta IP^{-}\rvert$) [d]	-0.247***	0.046	-0.239***	0.054
Price expectation (E) [e]	0.087**	0.033	0.098***	0.037
Increasing price sequence (IPS) [f]	0.069***	0.026	0.064**	0.030
Second-round dummies				
after increasing sequence (AI) [g]	0.013	0.021	0.017	0.025
after decreasing sequence (AD) [h]	-0.007	0.030	-0.010	0.029
R^2 within	0.241		0.187	
between	0.103		0.075	
overall	0.223		0.172	
Number of observations	1,277		1,297	
Number of producers	75		75	

(a) Dependent variables are the monthly changes of satisfy and goal prices; (b) Statistically significant at 1% ***, 5% ** and 10% *; (c) ΔIP^{+} = monthly change in market price when change is positive and zero when change is negative; (d) $\lvert\Delta IP^{-}\rvert$ = monthly change in market price (in absolute value) when change is negative and zero when change is positive; (e) Variable ranges from -1 (price will decrease next month) to 1 (price will increase next month); (f) Dummy variable: 1=sequence exhibits overall increasing trend, 0=sequence exhibits overall decreasing trend; (g) Dummy variable: 1=sequence presented in the second round which follows a first-round sequence with overall increasing trend, 0=otherwise; (h) Dummy variable: 1=sequence presented in the second round which follows a first-round sequence with overall decreasing trend, 0=otherwise.

Next we investigate total adaptation of reference prices, i.e. which factors influence the cumulative change in reference prices between the first period (September) of the marketing season and each subsequent period *t*. The new variables calculated in this part are the total change in reference and market prices between the first month and month *t*. Descriptive statistics for these variables can be found in Table 7. The average total change in reference prices across producers is zero for the satisfy price and –Cdn$0.09/bu for the goal price, but they range from –Cdn$2.50/bu to Cdn$2.00/bu and from –Cdn$3.00/bu to Cdn$2.30/bu, respectively (Table 7). Total variation in market prices is also analyzed for positive and negative changes separately, so that possible asymmetric impacts can be explored. On average, total changes in market price are Cdn$0.40/bu and –Cdn$0.30/bu for positive and negative movements respectively, reaching as high as Cdn$1.94/bu and –Cdn$1.49/bu (Table 7).

Table 7: Total price changes [(a)] – descriptive statistics

	Average	Min.	1st quart.	Median	3rd quart.	Max.
Reference price [b]						
satisfy price	0.00	-2.50	0.00	0.00	0.00	2.00
goal price	-0.09	-3.00	-0.50	0.00	0.00	2.30
Market price [b]						
positive changes	0.40	0.00	0.00	0.00	0.96	1.94
negative changes (absolute value)	0.30	0.00	0.00	0.00	0.62	1.49

(a) Price change between September (first month) and month *t*; (b) All price changes in Cdn$/bu

Total adaptation of reference prices is investigated using both satisfy and goal prices in a panel regression model with individual and time fixed effects. Table 8 presents the results of the estimated models where robust covariance estimators were applied due to the presence of heteroskedasticity as indicated by the Modified Wald Test. All estimated coefficients for total price change are found to be statistically distinguishable from zero, indicating positive (negative) impact on reference prices when market price increases (decreases). A total increase (decrease) of one dollar in the market price between September and month *t* would cause a total increase (decrease) of, respectively, 47 (26) and 49 (19) cents in the satisfy and goal prices during the same time period (Table 8). These results suggest that adaptation is stronger for positive than for negative price changes. Estimated coefficients for the time variables are negative and statistically distinguishable from zero, particularly for price sequences with an overall decreasing trend (Table 8). This finding alludes to the idea that, on average, producers tend to reduce their reference price over time, especially when market prices are going down. Price expectations for the next month were found to be positive and statistically distinguishable from zero only when the reference price was represented by the satisfy price, while the dummy variables for the second round of the experiment were not statistically distinguishable from zero (Table 8).

Table 8: Estimated panel regression model: total reference price adaptation

$TA_{it} = \alpha + \beta_1 \Delta TP_{it}^{+} + \beta_2 \Delta TP_{it}^{-} + \beta_3 T_{it}^{+} + \beta_4 T_{it}^{-} + \beta_5 E_{it} + \beta_6 AI_i + \beta_7 AD_i + \varepsilon_{it}$

	TA: satisfy price [a]		TA: goal price [a]	
	coefficient [b]	std. error	coefficient [b]	std. error
Constant	0.035	0.051	0.016	0.068
Positive total price change (ΔTP^{+}) [c]	0.471***	0.047	0.492***	0.060
Negative total price change ($\lvert\Delta TP^{-}\rvert$) [d]	-0.255**	0.097	-0.188*	0.103
Time variables [e]				
sequences with overall increasing trend	-0.018**	0.009	-0.038***	0.011
sequences with overall decreasing trend	-0.058***	0.011	-0.073***	0.013
Price expectation (E) [f]	0.155**	0.060	0.085	0.079
Second-round dummies				
after increasing sequence (AI) [g]	-0.008	0.073	-0.005	0.108
after decreasing sequence (AD) [h]	0.001	0.111	0.090	0.119
R^2 within	0.480		0.416	
between	0.377		0.265	
overall	0.436		0.362	
Number of observations	1,277		1,297	
Number of producers	75		75	

(a) Dependent variables are the changes in satisfy and goal prices between September and period *t*; (b) Statistically significant at 1% ***, 5% ** and 10% *; (c) ΔTP^{+} = total change in market price when change is positive and zero when change is negative; (d) $\lvert\Delta TP^{-}\rvert$ = total change in market price when change is negative (but taken in absolute value) and zero when change is positive; (e) September=1, October=2, …, June=10; (f) Variable ranges from -1 (price will decrease next month) to 1 (price will increase next month); (g) Dummy variable: 1=sequence presented in the second round which follows a first-round sequence with overall increasing trend, 0=otherwise; (h) Dummy variable: 1=sequence presented in the second round which follows a first-round sequence with overall decreasing trend, 0=otherwise.

Finally, the last part of this study investigates factors that influence producers' decision of how much grain to sell each month. Three new variables are introduced in this section: proportion of crop sold each month, price spread between current market price and satisfy price (current price minus satisfy price) and price spread between current market price and goal price (current price minus goal price). Descriptive statistics for these variables can be found in Table 9. On average producer's sold 9% of their crop in each month of the marketing season. Since the median and 3rd quartile values are zero and 15%, respectively, these numbers suggest that producers tended to sell relatively small portions of the crop on a monthly basis. The average price spreads are –Cdn$1.14/bu and –Cdn$1.49/bu for the satisfy and goal prices, respectively, indicating that monthly market prices are generally below producers' reference prices (Table 9). The range of price spreads is wide though, with current prices reaching as low as Cdn$4.73/bu below the satisfy and goal prices and as high as Cdn$1.12/bu (Cdn$0.62/bu) above the satisfy (goal) price.

Table 9: Variables in the selling decisions model – descriptive statistics

	Average	Min.	1st quart.	Median	3rd quart.	Max.
Proportion of crop sold per month [a]	0.09	0.00	0.00	0.00	0.15	1.00
Spread current price–satisfy price [b]	-1.14	-4.73	-1.67	-0.91	-0.44	1.12
Spread current price–goal price [b]	-1.49	-4.73	-2.12	-1.29	-0.74	0.62

(a) Quantity sold in month *t* divided by total amount available for sale in the marketing season; (b) Prices in Cdn$/bu

Panel regression models with individual and time fixed effects are also used to explore the determinants of how much grain was sold on a monthly basis. Table 10 presents estimation results where robust covariance estimators are applied due to the presence of heteroskedasticity as indicated by the Modified Wald Test. Price expectations are found to be negative and statistically significant only when the reference price is represented by the satisfy price (Table 10), indicating that producers will sell smaller (larger) portions of their crop in the current month when they expect prices to increase (decrease) in the next month. The spread between the current market price and the reference price exhibits a positive and statistically significant effect, suggesting that producers will sell larger (smaller) amounts of grain when the spread becomes more (less) positive or sell smaller (larger) quantities when the spread becomes less (more) negative (Table 10).[7] The coefficient of the interaction terms for expectations and price spread, however, is not found to be statistically distinguishable from zero. Estimated coefficients are positive and statistically distinguishable from zero for the dummy variables for increasing price sequences and for the second round of the experiment (but only when following an increasing sequence in the first round), suggesting that producers tend to sell larger (smaller) portions of their crop when the market is trending up (down). The dummy variables for the months of the marketing season are found to be negative and statistically significant mostly for the period between December and April, indicating that producers tend to sell relatively smaller amounts of grain during the winter months (Table 10).

[7] Positive (negative) spread means the current market price is above (below) the reference price.

Table 10: Estimated panel regression model: selling decisions

$$\%S_{it} = \alpha + \beta_1 E_{it} + \beta_2 (CP - RP)_{it} + \beta_3 E_{it} \cdot (CP - RP)_{it} + \beta_4 IPS_i + \beta_5 AI_i + \beta_6 AD_i + \sum_{j=1}^{9} \gamma_{ij} M_{ij} + \varepsilon_{it}$$

	RP=satisfy price [a]		RP=goal price [a]	
	coefficient [b]	std. error	coefficient [b]	std. error
Constant	0.157***	0.022	0.167***	0.026
Price expectation (E) [c]	-0.041*	0.024	-0.042	0.027
Current price–reference price (CP–RP) [d]	0.059***	0.013	0.052***	0.012
E·(CP–RP)	-0.019	0.015	-0.015	0.014
Increasing price sequence (IPS) [e]	0.036**	0.015	0.040**	0.017
Second-round dummies				
after increasing sequence (AI) [f]	0.024**	0.009	0.023**	0.009
after decreasing sequence (AD) [g]	-0.018	0.016	-0.012	0.016
Monthly dummies (M) [h]				
October	-0.005	0.015	-0.006	0.015
November	0.002	0.019	-0.002	0.020
December	-0.052***	0.013	-0.055***	0.013
January	-0.040***	0.014	-0.043***	0.015
February	-0.047***	0.016	-0.049***	0.016
March	-0.034**	0.016	-0.036**	0.017
April	-0.040**	0.016	-0.044***	0.016
May	-0.024	0.017	-0.028*	0.016
June	0.019	0.023	0.013	0.022
R^2 within	0.122		0.121	
between	0.149		0.165	
overall	0.110		0.120	
Number of observations	1,277		1,287	
Number of producers	75		75	

(a) Reference prices refer to the variable (CP–RP); (b) Statistically significant at 1% ***, 5% ** and 10% * (c) Variable ranges from -1 (price will decrease next month) to 1 (price will increase next month); (d) Prices in Cdn$/bu; (e) Dummy variable: 1=sequence exhibits overall increasing trend, 0=sequence exhibits overall decreasing trend; (f) Dummy variable: 1=sequence presented in the second round which follows a first-round sequence with overall increasing trend, 0=otherwise; (g) Dummy variable: 1=sequence presented in the second round which follows a first-round sequence with overall decreasing trend, 0=otherwise; (h) Estimated effects are relative to September.

Categorical Subsamples

This last section explores whether producers exhibit different behavior based on some demographic information collected in the survey and experiment. A set of seven subsamples is created, splitting producers according to their (i) reported break-even price (above and below Cdn$5.50/bu, which was the mean and median of the sample data), (ii) risk attitude, based on certainty equivalents elicited in the experiment (above and below $50, indicating risk seeking and risk averse behavior, respectively), (iii) reported price expectation for September (above and below Cdn$9.00/bu, which was the median of the sample data), (iv) hedging activity in the past five years (hedge in all five years and hedging in less than five years), (v) age (50 or older and younger than 50; the median age was 49), and (vi) education (post-secondary and not more than high school). All the models discussed above are estimated for each subsample and results are compared across subsamples in each set (but not across sets). Results were qualitatively the same across subsamples in all sets, except for break-even price and risk attitude. For brevity, those differences will be briefly discussed below and no estimation results will be presented (but are available upon request).

In the subsamples divided according to break-even price, it is found that price expectations for the following month have a smaller (larger) effect on reference price for producers with break-even price above (below) Cdn$5.50/bu; incremental changes in market prices–both positive and negative–have a smaller (larger) effect on incremental change in reference price for producers with break-even price above (below) Cdn$5.50/bu; the time variable for decreasing price sequences have a larger (smaller) effect and total positive changes in market price have a smaller (larger) effect on total change in reference price for producers with break-even price above (below) Cdn$5.50/bu; and the spread between current and reference price has a larger (smaller) effect and increasing price sequences have a smaller (larger) effect on selling decisions for producers with break-even price above (below) Cdn$5.50/bu. These findings suggest that producers with higher break-even prices place less weight on price expectations in the formation of reference prices and on changes in market prices in the adaptation of reference prices, but their selling decisions are more impacted by the spread between current and reference price compared to those with lower break-even prices.

In the subsamples divided according to risk attitude, it is found that price expectations for the next month, the current price and the dummy variable for the second round following a decreasing price sequence have a smaller (larger) effect on reference price for risk-seeking (averse) producers; incremental changes in market price–both positive and negative–have a larger (smaller) effect and price expectations have a smaller (larger) effect on incremental changes in reference price for risk-seeking (averse) producers; the time variable for decreasing price sequences and total positive changes in market price have a larger (smaller) effect on total change in reference price for risk-seeking (averse) producers; and the spread between current price and reference price has a larger (smaller) effect on selling decisions for risk-seeking (averse) producers. These findings suggest that risk-averse producers are more influenced by price expectations and current market prices in the formation of reference prices and place less weight on changes in market price in the adaptation of reference prices compared to risk-seeking producers. In addition, risk-averse producers would respond more slowly to changes in the spread between current and reference prices when making selling decisions. This result may suggest that risk-averse producers pay closer attention to current events and expectations but tend to take longer to adjust to market changes.

CONCLUSIONS

This study aimed to explore how producers' reference prices are formed and adapt over time, and how they affect decisions to sell grain. Data was collected from 75 grain producers in Manitoba through a marketing simulation for the 2012-2013 crop year.

The first model was developed to investigate the effect of market prices on the formation of reference prices. Panel regression models were estimated to investigate how different types of market prices affect the reference price in each month. Regression results indicated that producers' reference prices were most influenced by the recency-weighted average price and the highest price to date. The lowest and the current prices were also found to contribute to reference price formation, but with smaller effect. Producers were also found to increase their reference price if they expected the market price to increase over the next month, and to decrease their reference price as the year progressed and if the simulation was preceded by a scenario with a decreasing price trend.

The second model investigated incremental effects of changing market prices on adaptation of reference prices. Incremental changes in reference price were found to be influenced more by positive than negative incremental price changes. Producers' reference prices were found to be higher when they expected the market price would increase over the next month and when the market prices are increasing. The third model quantified the effects of total price changes and time on total adaptation of the reference price. Producers' reference prices were found to be effected by positive total price changes to a greater extent than by negative total price changes. Thus, producers were more likely to accept new market prices during increasing sequences than to new market prices during decreasing sequences. As each month passed, producers were found to decrease their reference price regardless if the market price was moving up or down. Their adaptation due to time was found to have a greater negative effect for decreasing sequences than for increasing sequences. The expectation that the market price would increase over the next month was also found to have a positive effect on reference price adaptation.

The final model was developed to study producers' decisions to sell their wheat based on the relationship between their reference price and the market price, and on their price expectations. As producers became more confident that the market price would increase over the next month, they began to sell less grain. As producers adapted their reference price downwards toward the market price, they became more likely to sell their grain. When reference prices remained relatively high, producers behaved in a more risk seeking manner by choosing to sell less of their grain. Producers were also found to sell more grain if the current or previous price sequences followed upward trends.

Findings from this research can provide producers with additional tools for marketing their grain. Learning about implications of reference prices may help them isolate differences between psychological gains and losses against accounting gains and losses. Understanding how reference prices and formed and adjusted in sequential choices under uncertainty, along with their impact on selling decisions, may help producers improve their marketing decisions. Results from this research can also help the government reach program goals by guiding producers' decisions using their own reference prices. The government can position prices within programs to encourage behavior that is targeted by its programs or that is expected to be beneficial to producers. Market advisors may be able to improve their services to producers using results from this research; emphasizing the effects of reference prices on marketing decisions and helping producers minimize biases from reference prices. Tools which aid in estimating producers reference prices can help grain companies market to producers. Strategically pricing above the producers' estimated reference price may encourage producers to market their grain when demand is high, while strategically pricing below the producers' estimated reference price may discourage producers from marketing when storage is limited or when sales to processor or international markets are low.

Despite the efforts to make the marketing simulation as realistic as possible and results as general as possible, this research has some limitations. The number of producers interviewed for this study is small relative to the number of grain producers in Manitoba. This is due to the nature of the research, primarily conducted through one-on-one in person interviews or small groups also conducted in person. Producers who participated are generally more involved with MAFRI than the typical Manitoban producer and needed to be on farm with spare time to complete the interview. Therefore, producers in this study do not necessarily form a representative sample of all Manitoban producers. In addition, there are some factors which might have influenced producers' answers that were not controlled for in the study, such as storage capacity, cash flow needs, seasonal trends and personal characteristics. Another limitation is that the marketing scenarios are only set in 2012, thus the strong agricultural commodity price uptrend in the market at the time of the study could have affected producers' reference prices prior to the study.

Future research could aim to contact producers over a longer period of time. Collecting data about their reference prices over one or more marketing seasons with actual market prices, rather than simulated prices, can help increase the accuracy of the results and limit biases. Numerous data collection sessions would also allow for additional questions at each time period, allowing an increase in the scope of the study. Extensions can also include controlling for marketing habits, personality traits and other attributes that may affect individuals' reference prices.

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APPENDIX: SURVEY AND EXPERIMENT

Survey

What town is located nearest to your farm?

- ___________

What is your age?

- ___________

What is your gender?

- Male
- female

What was the highest level of education you completed?

- Middle school
- High school
- Post- secondary (diploma or degree)
- Post-graduate degree

What is your expectation for the price of wheat in September of 2012?

- ___________

What is your break-even price of producing one bushel of wheat this year (2012/13)?

- ___________

Over the past 5 years, how many years did you use any form of forward, futures, or options contracts?

- ___________

Of the years you used forward, futures, or options contracts, what percentage of your crop did you hedge on average?

- ___________

What do you recall to be the average market price in your area for #1CWRS wheat over the past 5 years?

- ___________

What do you recall to be the highest market price in your area for #1CWRS wheat over the past 5 years?

- ___________

What do you recall to be the lowest market price in your area for #1CWRS wheat over the past 5 years?

- ___________

Please indicate how much you agree or disagree with the statements below on the following scale.

1=strongly disagree 2=disagree 3=neither agree or disagree

4=agree 5=strongly agree

I have a larger farm than most producers in Manitoba.

Strongly Disagree Strongly Agree

1 2 3 4 5

Compared to other producers, I have above average skills at predicting price movements.

Strongly Disagree Strongly Agree

1 2 3 4 5

I prefer less risk than most producers.

Strongly Disagree Strongly Agree

1 2 3 4 5

My primary marketing strategy is to reduce risk.

Strongly Disagree Strongly Agree

1 2 3 4 5

My primary marketing strategy is to obtain a high price.

Strongly Disagree Strongly Agree

1 2 3 4 5

I am willing to take higher financial risks in order to realize higher average returns.

Strongly Disagree Strongly Agree

1 2 3 4 5

When selling my wheat, I prefer financial certainty to financial uncertainty

Strongly Disagree Strongly Agree

1 2 3 4 5

Experiment

The paragraph below was presented to each producer at the beginning of the experiment. Once it was read and understood, the marketing scenario for September (first month of the simulated marketing season) was presented as shown in the next page. After completing marketing choices for September, similar questionnaires were replicated for the subsequent nine months from October to June. Each new month was accompanied by a new price, a graph with the price trajectory to-date and the same set of questions concerning decisions to sell, price expectations and satisfy and goal prices.

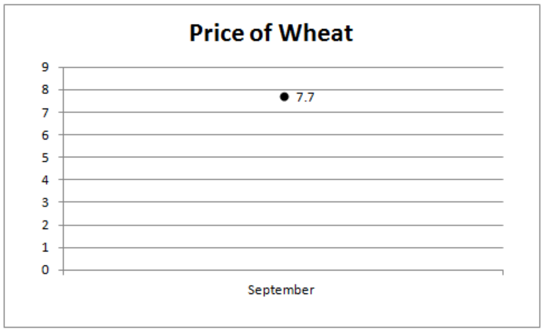
Presentation of the scenario:

It is September 1st 2012 and you would like to market the remainder of your wheat for this season. Over the next ten months, September to June, you will market your grain using strategies you would typically use on your own farm. On the 1st of every month, you will be presented with a new nearby futures price and will be asked a few short questions including how much of your wheat you would like to sell at the respective market price. In each month you can choose to sell no wheat, all of your wheat, or any quantity you like, you are not required to sell all of your wheat by the end of June. Once you have turned a page, please do not turn back to it. Once you have sold all of your wheat, please return the questionnaire to the experimenter.

If you have any questions, you are encouraged to ask them now.

September 1st

I expect to have ______ bushels of wheat to sell in the cash market this crop season.



The market price on September 1st is $7.70 for a bushel of wheat. Please answer the following questions.

In the next period, what is the price of wheat which would make you feel satisfied if you were to sell the rest of your wheat? __________

In the next period, if the price of wheat increases, what is the price you would sell the remainder of your wheat at? __________

How do you expect the price of wheat will change over the next month? Please enter the probability of each scenario in the space provided.

I expect the price will increase _________%

I expect the price will remain about the same _________%

I expect the price will decrease _________%

Total = 100%

Do you want to hold or sell wheat now?

Hold all _________

Sell all _________

Sell some _________ How many bushels? _________

You have _______ bushels of wheat available to market in the next period.