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How Do Producers Decide the "Right" Moment to Price Their Crop? An Investigation in the Canadian Wheat Market

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This research investigated the timing of marketing decisions in the Canadian wheat market. Cox proportional hazard models were estimated to explore how the timing of producers' decisions were affected by market-based variable, which included an indicator showing whether current prices were above producers' benchmark on a given day, 10-day average spread between current prices and producers' benchmark, 10-day price trend and price volatility over 10 days. Marketing data for 17,338 producers who executed 59,184 transactions between 2003/04 and 2008/09 were used in the analysis. Overall results indicate that all variables affected timing decisions in producers' marketing choices. However, the signs of the estimated coefficients tended to vary across contracts and years, suggesting that producers could change their pricing behavior over time and response to the covariates could also depend on characteristics of the contracts and how they relate to producers' marketing strategies.

Keywords: grain marketing, decision making, timing, wheat

INTRODUCTION

Agricultural economists have long been interested in how producers make marketing decisions and what variables influence their decision-making process. One of the main points in this field has been how producers choose the exact day to sell their crop. Previous studies have explored factors that explain how producers select marketing instruments (e.g. cash or futures contracts), such as price signals, farm size, past performance, education, among others (Isengildina and Hudson, 2001; McNew and Musser, 2002; Meulenberg and Pennings, 2002; Dorfman and Karali, 2010). However, little work has been done to investigate how producers choose the "right" moment to sell their crop. Two studies that have explored this point were Anderson and Brorsen (2005) and Cabrini de Colonna (2006).

Anderson and Brorsen (2005) obtained data on wheat purchases and prices paid from three Oklahoma elevators between 1992 and 2001 and investigated whether producers followed any short-run pattern in selling their grain. They found evidence that producers would sell grain after price increases and hold it after price decreases, and that seasonality and day of the week would also play a role in their choices. Cabrini de Colonna (2006) investigated how market advisory services developed marketing recommendations focusing on advisory programs tracked by the University of Illinois' AgMAS project between 1995 and 2004. Results suggested that programs tended to deliver sell (buy) recommendations after price increases (decreases), but this behavior was found to exhibit small magnitude. In addition, Cabrini de Colonna (2006) explored the existence of loss realization aversion but found no evidence that the holding period of advisory programs' futures positions was related to whether they represent a gain or a loss.

The objective of this research was to explore variables that affect producers' marketing decisions related to the time when they price their crop. The grain marketing system in Canada offers a unique opportunity to explore how producers make decisions. During the period encompassed in this research, all wheat produced in Western Canada and sold for human consumption and export had to be marketed through the Canadian Wheat Board (CWB), which was the largest grain marketing agency in Canada and offered several pricing alternatives providing distinct combinations of return, risk and cash flow. The pool was the most traditional program and worked by pooling all wheat from producers to be traded by the CWB. Pool revenues were then distributed such that all producers received the same final price per unit regardless of when and to whom their grain was sold. During the crop year the CWB provided an expected price, which was its estimate of what the pool price would be at the end of the crop year and was often seen as a benchmark to alert producers as to whether to keep their wheat in the pool or to price their grain outside the pool. Marketing contracts (collectively known as Producer Payment Options–PPO) were offered by the CWB in the 2000/01 crop year, allowing producers to make their own marketing decisions in terms of when and how to price their grain. Producers could sell their wheat using any combination of these marketing contracts and the pool.

Since all producers had to market their grain through the CWB, it was possible to follow exactly when they chose to market their grain, what market conditions were prevalent when they made their decisions, and what price they received. Data was made available by the CWB for the crop years 2003/04 through 2008/09 for all producers growing Canada Western Red Spring (CWRS) wheat. There were data on all producers with information indicating (i) type of contract used to market wheat, (ii) tonnes delivered, (iii) date when producer priced grain, (iv) final price received by each producer and (v) province. Another data set was also obtained with additional information on harvest pace showing how much of the crop was harvested on a weekly basis in each province and daily prices in the wheat market.

This study uses a unique data set of wheat producers to perform a comprehensive analysis of marketing decisions. Results from this research can shed more light on the decision-making process in grain marketing, particularly on the importance of reference prices, trends and volatility in marketing decisions. As indicated by Hagedorn et al. (2005), despite the importance of marketing in farm management it is alarming to realize that prevalent ideas about marketing decisions and performance still do not rely on a large body of evidence. This study aims to fill in these gaps and move us towards a more complete understanding of grain marketing.

BACKGROUND

The CWB has been the largest grain marketing agency in Canada and sole marketer for wheat produced in Western Canada. This region encompasses the provinces of Manitoba, Saskatchewan, Alberta and the Peace River area of British Columbia, accounting for approximately 90% of all wheat produced in the country. The CWB ceased to be the sole marketer of wheat following the 2011/2012 crop year[1], but during the time period encompassed by this study it centralized all wheat sales in Western Canada. The CWB offered different

[1] The Canadian government introduced Bill C-18 on October 18, 2011 to remove the CWB as the sole seller of wheat produced in Western Canada. The Marketing Freedom for Grain Farmers Act passed on November 28, 2011 ratifying this change.

marketing alternatives allowing producers to choose a program that met their own needs and preferences regarding return, risk and cash flow.

The oldest pricing alternative was pool pricing, which has been the main marketing program for Western Canada wheat since the 1930s. The pool worked by pooling all wheat from producers in Western Canada to be traded by the CWB, giving the organization more market power to obtain higher prices.[2] Pool revenues were then distributed such that all producers received the same final price per unit regardless of when and to whom their grain was sold. With the pool, producers received an initial payment when deliveries were made to the grain handling facility, and additional payments as sales were completed throughout the crop year. The final pool price was known only after the end of the crop year, which goes from August 1 to July 31. However, during the crop year the CWB provided a projected price–the Pool Return Outlook (PRO)–which was its best estimate of what the pool price would be at the end of the crop year.[3] The PRO price was often seen as a benchmark that could be used to alert producers as to whether to keep their wheat in the pool or to price their grain outside the pool using marketing contracts.

Marketing contracts collectively known as PPO were developed by the CWB to allow producers to price their own grain and provide them flexibility to manage their cash flow. These contracts were first offered in the 2001/02 crop year and allowed producers to make their own marketing decisions. However, the execution of these contracts still had to go through the CWB. PPO contracts also differed from pool accounts in terms of payment schedule. Producers still received an initial payment when they delivered their wheat to the grain handling facility, but their final payment would come within 10 business days of delivery. Hence producers who used these marketing contracts could receive their full payment before the end of the crop year.

PPO contracts encompassed five marketing contracts for wheat developed by the CWB: Early Payment Options (EPO), Fixed Price Contracts (FPC), Basis Price Contracts (BPC), Daily Price Contracts (DPC) and FlexPro. The EPO was mainly used for cash flow management and its price was just a fixed proportion of the expected pool price. The FPC offered a daily fixed price that was derived from the wheat futures contract traded at the Minneapolis Grain Exchange (MGE). In principle, the FPC resembled a forward contract by offering a fixed price for producers which already incorporated a futures price and basis. The BPC allowed producers to lock in a futures price (based on the MGE) and basis at different times during the marketing window, so their final price was only known after both components were determined. Thus the BPC was fundamentally a basis contract. The DPC and FlexPro offered producers a daily cash price based on wheat traded at the port of Vancouver. Note that the DPC was terminated after the 2007/08 crop year and the FlexPro was offered in the 2008/09 crop year. For the purpose of this paper, since the DPC and FlexPro were very similar in their functions and specifications; they are combined into one contract and generally referred to as “DPC”.

Producers could sell their wheat using any combination of these marketing contracts and the pool. The marketing window during which producers could allocate their wheat to each marketing program varied across contracts. The marketing window for the FPC started about five

[2] As a single agent selling Western Canadian wheat in the domestic and world markets, the CWB was able to consistently trade larger volumes than any individual producer in Canada.
[3] A new PRO was usually released on the fourth Thursday of each month.

months before the beginning of the crop year and ended approximately three months into the crop year and it was essentially a pre-harvest contract.[4] The marketing window for the BPC also started several months before the beginning of the crop year and it would extend towards the end of the crop year. As for the DPC and FlexPro, the marketing window corresponded to the crop year. In addition, these two contracts had an extra characteristic: producers needed to indicate the total tonnage they wanted to price prior to the beginning of the crop year.

RESEARCH METHOD

The Cox proportional hazard model was used to estimate the effect of independent variables on producers' selling decisions, following similar procedures by Coval and Shumway (2005), Feng and Seasholes (2005) and Seru et al. (2010). This method provides a way to interpret the conditional probability of selling wheat and how this probability changes due to changes in the independent variables. The model describes how long producers wait until they decide to sell their grain assuming that the probability of selling wheat over the marketing window was not constant. The hazard rate was the conditional probability of selling grain on day *t* (conditional on not having sold it until day *t-1*). Hazard ratios obtained from the estimated model indicate the change in the hazard rate for a given change in the covariates, i.e. how much the conditional probability of selling wheat on day *t* changes as the values of covariates change.

In this study the covariates include a gain/loss indicator showing whether the wheat price on day *t* was above or below the benchmark price adopted by producers, measures of price trend and price volatility in recent days, a price spread and dummies for days of the week. Thus the hazard ratio was modeled as in equation (1):

$$h(t) = h_0(t)\left[\exp\left(\beta_1 GI_t + \beta_2 Spread_t + \beta_3 Trend_t + \beta_3 Vol_t + \sum_{j=1}^{4}\theta_j D_{jt}\right)\right] \quad (1)$$

where $h_0(t)$ represents the baseline hazard function, *t* the number of days the producer took to sell wheat since the beginning of the marketing window, GI the gain/loss indicator for producer *i* on day *t*, Spread was the difference on day *t* between current market price and the price expected to be paid in the pool, Trend represents the measure of price trend on day *t*, Vol the measure of price volatility on day *t*, and D represents dummy variables for days of the week.

The gain/loss indicator was a binary variable that takes a value of 1 (0) when the current market price on day *t* was above (below) producer's benchmark. The benchmark adopted in this study was the expected CWB pool price (known as the PRO price). Thus it was assumed that producers compare current prices offered by marketing contracts with the price that the CWB expects to pay the pool. The price spread was calculated as the 10-day average of the difference between the current price and the PRO price. For example, the spread variable on day *t* was given by the average of the price spread in the previous 10 days. Positive (negative) values for this variable indicates current market prices were above (below) the expected pool price, and larger (smaller) values imply current prices increase (decrease) relative to the expected pool price. The measure of price trend was calculated as the difference between the current price on day *t* and the

[4] The crop year goes from August 1 to July 31.

average price in the previous 10 days. Positive (negative) values of *Trend*–i.e. price on day *t* above (below) the 10-day average price–suggest recent uptrend (downtrend) in market prices. The measure of price volatility on day *t* was the standard deviation of current prices in the last 10 days, such that higher (lower) values of *Vol* indicate more (less) price volatility in the wheat market.

The current market prices used in the analysis were different for each contract, reflecting their distinct characteristics. The FPC and DPC offer a specific price on any given day, i.e. there was a certain price that all producers who price with these contracts receive on day *t*, namely the fixed price for the FPC and the daily price for the DPC. Therefore, the fixed and daily prices were used to calculate the variables GI, spread, trend and volatility in the models for the FPC and DPC respectively. The BPC requires producers to lock in a futures price and a basis, which can be chosen from different maturities of the futures contract traded in the MGE. Since the data set provides no information on which maturity was chosen by producers, the nearby futures price was adopted as a reference and used to calculate all variables in the BPC model.

Finally, there were four dummy variables for days of the week, ranging from Tuesday to Friday. When wheat was priced on a Tuesday (j=Tuesday), $D_{Tuesday}=1$ and $D_{Wednesday}= D_{Thursday}= DFri_{day}=0$. If wheat was priced on a Monday, all four dummy variables were equal to zero. The values of their estimated coefficients show the effect of each day of the week relative to Monday.

DATA

Data for this research were provided by the CWB and includes all producers who grew CWRS wheat from 2003/04 through 2008/09.[5] The dataset contains transactions made by each producer that indicates (i) what contracts they used to market their wheat, (ii) how many tonnes of wheat were allocated to each contract, (iii) dates when producers priced their wheat with contracts, and (iv) final price received by each producer for each marketing contract. Additional information on CWB pool prices for each crop year and daily prices for the PRO and MGE futures prices were also provided by the CWB.

The sample used in the hazard model only includes producers who grew CWRS wheat in at least one of the six crop years and marketed their wheat using at least one of the three marketing contracts (FPC, BPC, DPC) considered in this study. The sample that meets these criteria contains 17,338 producers who executed 59,184 transactions.[6] The largest number of producers and transactions was concentrated in the FPC, followed by the BPC and DPC (Table 1). Note that, as opposed to the FPC and BPC, the DPC was developed in 2005/06 and thus there was only four years of data for this contract. On average, producers made approximately three transactions when using these contracts to price their wheat.

[5] Marketing contracts were first offered by the CWB in 2000/01. However, very few producers used contracts in 2000/01 and 2001/02 and therefore these first two years were not included in the analysis.

[6] The total number of producers who grew CWRS wheat between 2003/04 and 2008/09 was 67,798, thus the sample used in this study represents roughly 26% of all producers.

Table 1: Descriptive statistics of number of transactions, producers and quantity contracted

	All contracts	FPC	DPC	BPC
Transactions	59,184	36,826	8,324	14,034
Producers	17,338	15,556	2,761	4,981
Transaction/producer				
average	3.4	2.4	3.5	2.8
median	2.0	2.0	2.0	2.0
maximum	88	28	69	39

The length of the marketing window varies across contracts and varied also within contracts during the sample period (Table 2). The FPC had the shortest marketing window at about eight months (except for 2003/04). The DPC had a marketing window corresponding to the crop year and thus spanned for 12 months in all years of the sample. The BPC had the longest marketing window which ranged from approximately 16 to 22 months during the sample period.

Table 2: Length of marketing window (number of days)[a]

	FPC	DPC[b]	BPC
2003/04	158	-	492
2004/05	248	-	489
2005/06	246	365	487
2006/07	247	365	487
2007/08	248	366	666
2008/09	250	365	665

(a) Numbers indicate total length of marketing window from the first to the last day contracts were available, but they could only be signed on business days during that period. (b) DPC was first offered in 2005/06.

Preliminary analysis of the data suggests that producers were more willing to price their wheat when current prices were going up and were above the PRO price (benchmark). Figure 1 shows charts with quantity of wheat contracted with the FPC during the marketing window (bars), along with the fixed price offered by the contract and the PRO price in each day (lines). An initial visualization of the charts suggests larger quantity of tonnes contracted during periods increasing prices and positive spreads between market price and PRO price. Figures 2 and 3 show similar charts for the BPC and DPC, respectively, and generally suggest the same type of response to prices.

Figure 1: PRO price (benchmark) and quantity contracted and price offered by Fixed Price Contracts (FPC)

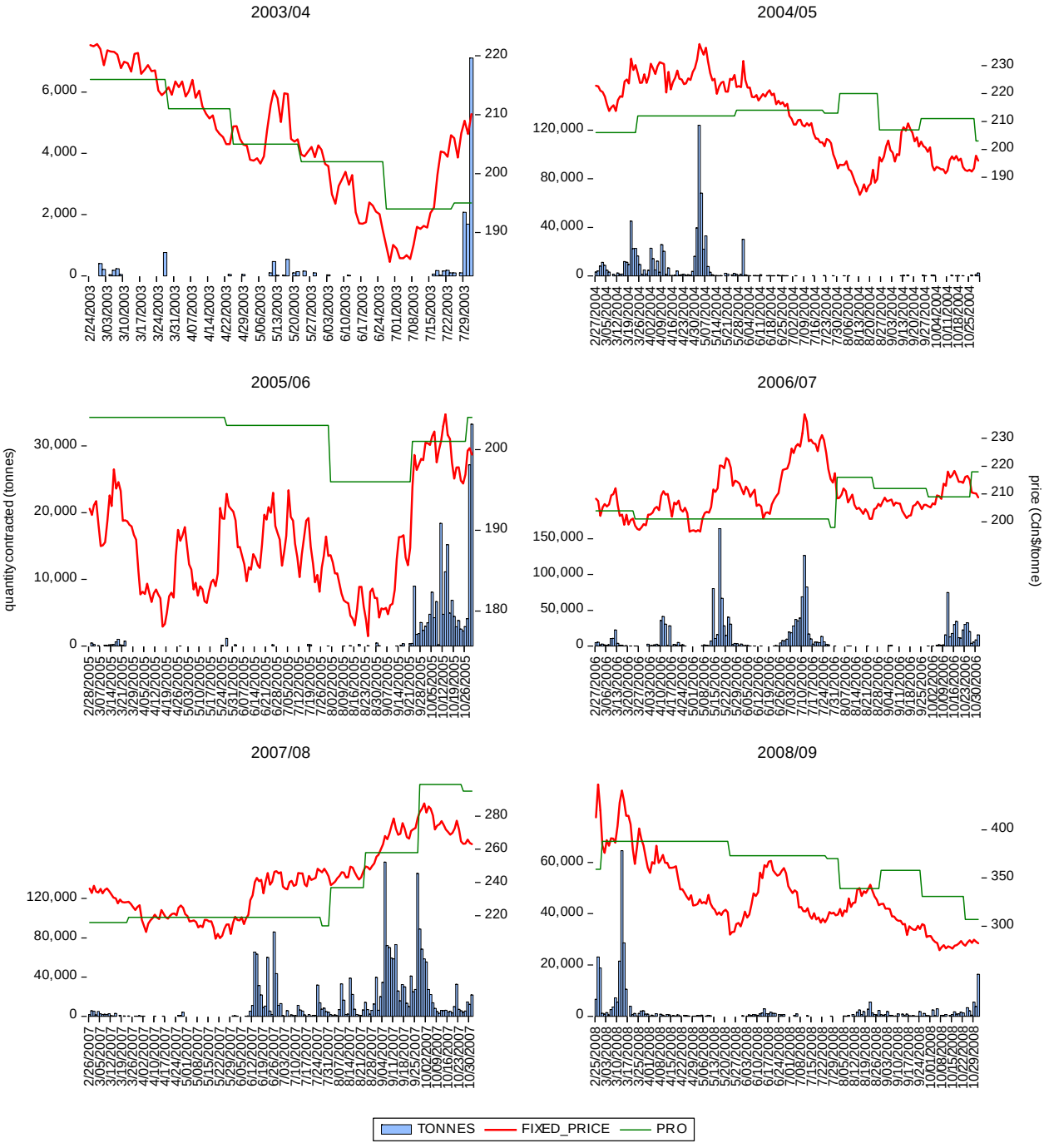


Figure 2: PRO price (benchmark) and quantity contracted with Basis Price Contracts (BPC) and nearby futures price

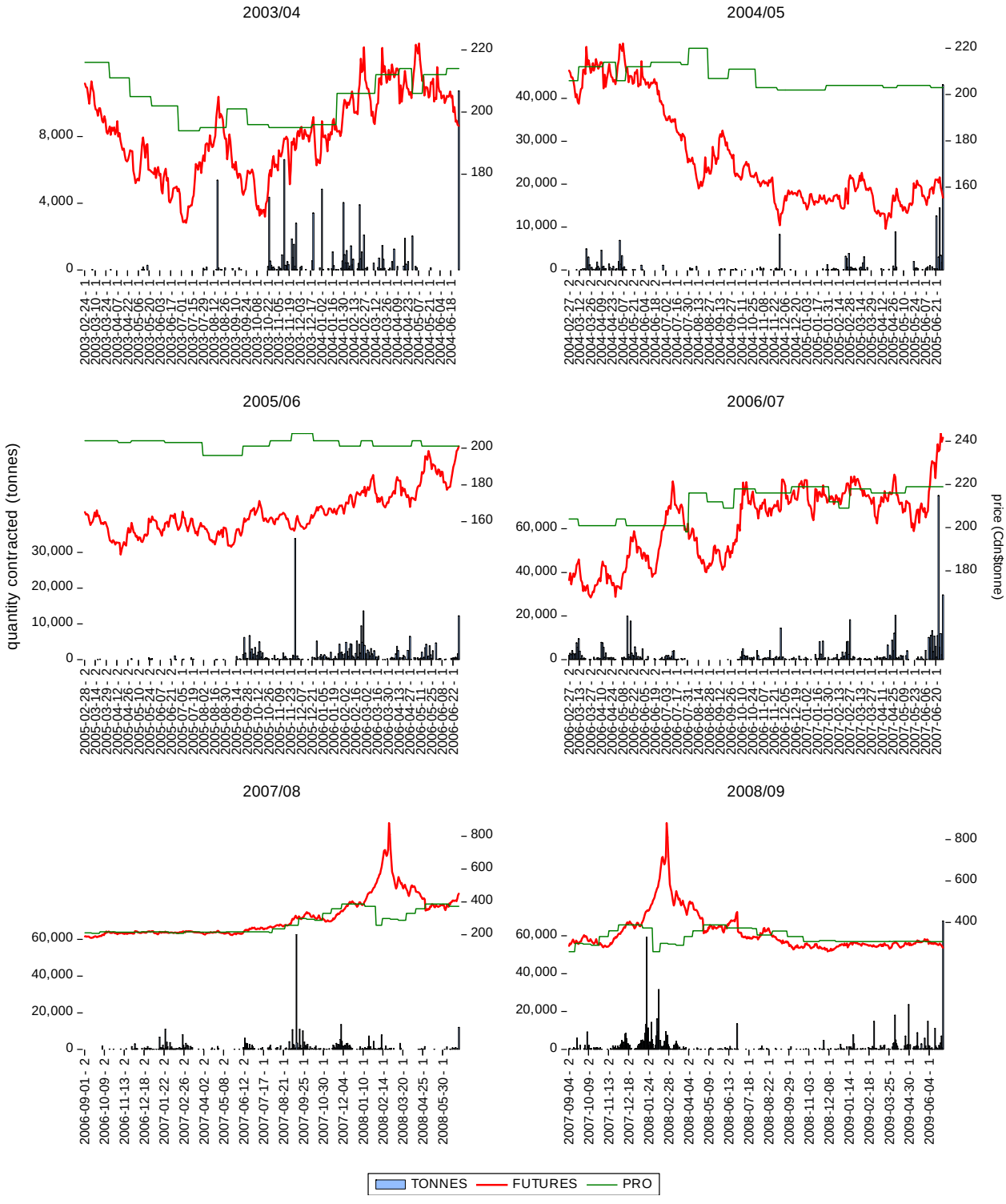
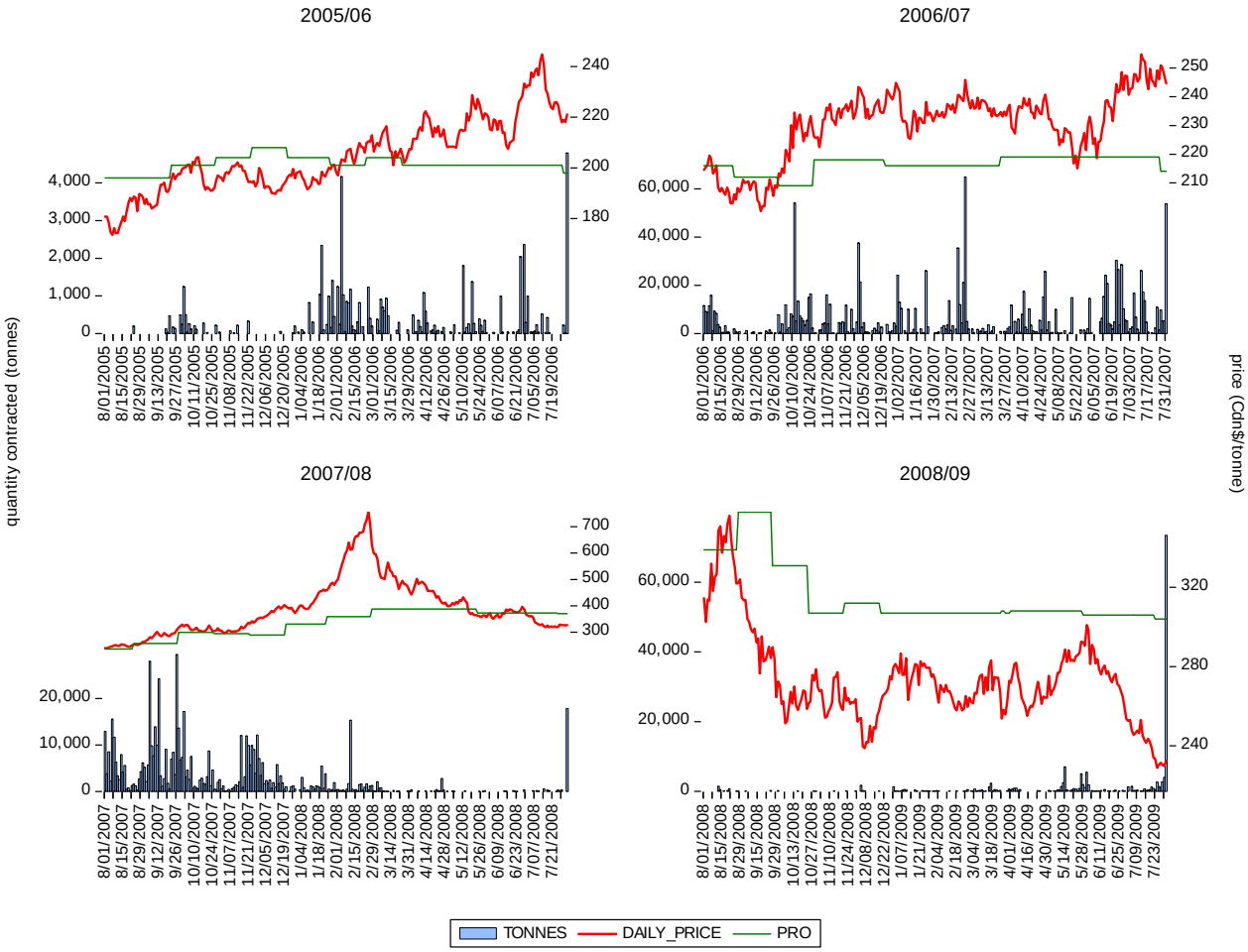


Figure 3: PRO price (benchmark) and quantity contracted and price offered by Daily Price Contracts (DPC)



RESULTS

Cox proportional hazard models were estimated for each marketing contract in each crop year of the sample, thus six models were estimated for the FPC and BPC and four models were estimated for the DPC. In general all variables were statistically significant across contracts, suggesting that they all affected timing decisions in producers' marketing choices. However, the signs of the estimated coefficients tended to vary across contracts and across years, suggesting that producers could change their pricing behavior over time and response to the covariates could also depend on characteristics of the contracts and how they relate to producers' marketing strategies.

The estimated coefficient for the gain indicator was generally positive for the FPC and DPC, suggesting that producers using these two contracts would be more likely to sell when prices were above the benchmark (Table 3 and 5). For the BPC results were mixed, with estimated coefficients exhibiting negative signs in three years and positive signs in two years

(Table 4).[7] The magnitude of the estimated coefficients was large compared to the other variables, suggesting an important role of this variable in marketing timing decisions. Findings that producers were more likely to sell with the FPC and DPC when current prices were above the benchmark may be related to the characteristics of the contracts. The FPC was essentially a pre-harvest contract, so producers who use it had not yet harvested and in some cases might not have finished planting. Thus they might be more tempted to quickly lock in a price above their benchmark if they want to sell in that period and reduce price uncertainty. In addition, the FPC had the shortest marketing window among the three contracts and producers might feel they cannot wait too long to use it. With respect to the DPC, this contract requires the quantity to be committed before the beginning of the marketing window, such that producers know they must price a certain quantity with this contract during the marketing window and if they failed to price the committed quantity a penalty fee was incurred. In this case, they might be interested in pricing as soon as the current price was above the benchmark, even though the marketing window lasts the entire crop year. On the other hand, the BPC had the longest marketing window among the three contracts, covering pre- and post-harvest periods. Hence producers might feel they had enough time to follow the market until they decide to price. In addition, there was no pre-commitment with respect to quantity to be priced with the BPC.

[7] This variable was not used in the BPC model in 2005/06 because the contract price was below the benchmark during the entire marketing window.

Table 3: Estimated Cox proportional hazard models – Fixed Price Contracts (FPC)

	2003/04		2004/05		2005/06		2006/07		2007/08		2008/09	
	coef[a]	exp(coef)	coef[a]	exp(coef)	coef[a]	exp(coef)	coef[a]	exp(coef)	coef[a]	exp(coef)	coef[a]	exp(coef)
GI[b]	2.452	11.609	-0.645	0.525	3.576	35.717	3.325	27.807	3.212	24.994	-0.448	0.639
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
Spread[c]	-0.377	0.686	0.927	2.527	0.055	1.056	-0.026	0.974	0.103	1.109	0.076	1.079
	(0.000)		(0.000)		(0.284)		(0.000)		(0.000)		(0.000)	
Trend[d]	-0.176	0.839	0.434	1.544	0.205	1.228	-0.008	0.992	0.124	1.132	0.017	1.017
	(0.000)		(0.000)		(0.000)		(0.012)		(0.000)		(0.000)	
Volatility[e]	-0.581	0.559	-2.564	0.077	1.553	4.725	0.577	1.780	-0.009	0.990	0.093	1.098
	(0.000)		(0.000)		(0.000)		(0.000)		(0.142)		(0.000)	
Day dummies												
Tuesday	-0.676	0.508	-0.009	0.990	2.769	15.951	-0.211	0.809	0.165	1.179	-0.249	0.779
	(0.202)		(0.846)		(0.000)		(0.000)		(0.000)		(0.004)	
Wednesday	-2.522	0.080	0.633	1.883	2.252	9.508	-0.161	0.851	-0.396	0.673	-0.608	0.544
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
Thursday	-3.647	0.026	0.491	1.634	1.580	4.857	0.026	1.026	1.005	2.731	-1.220	0.295
	(0.000)		(0.000)		(0.000)		(0.483)		(0.000)		(0.000)	
Friday	-0.737	0.478	-0.550	0.577	1.239	3.456	0.421	1.524	0.606	1.833	-1.336	0.263
	(0.225)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
Obs.[f]	136		4,980		923		11,297		16,999		2,491	
R^2	0.772		0.915		0.832		0.403		0.765		0.756	
LR test	201.2		12,251		1,645		5,821		24,637		3,518	
Wald test	116.2		4,932		959.3		4,042		12,514		1,930	
Score test	251.6		4,682		1,594		4,464		14,004		2,487	

(a) p-values are presented in parentheses. (b) GI=gain indicator. Dummy variable equals 1 if current market price was above PRO price (benchmark) and 0 otherwise. (c) Price spread was the average difference between futures price and PRO price (benchmark) during the 10-day period prior to the day when grain was priced. (d) Price trend was calculated as the difference between current market price on the day that grain was price and the average market price during the 10-day period prior to the day when grain was priced. (e) Volatility was calculated as the standard deviation of current market price during the 10-day period prior to the day when grain was priced. (f) Number of observations refers to quantity of transactions made during a marketing window, which is not equal to the number of producers who priced with marketing contracts.

Table 4: Estimated Cox proportional hazard models – Basis Price Contracts (BPC)

	2003/04		2004/05		2005/06		2006/07		2007/08		2008/09	
	coef[a]	exp(coef)	coef[a]	exp(coef)	coef[a]	exp(coef)	coef[a]	exp(coef)	coef[a]	exp(coef)	coef[a]	exp(coef)
GI[b]	-0.293	0.746	-0.788	0.455			0.712	2.039	-0.620	0.538	1.775	5.898
	(0.077)		(0.000)				(0.000)		(0.000)		(0.000)	
Spread[c]	-0.108	0.898	0.097	1.102	-0.265	0.767	-0.231	0.793	-0.006	0.994	-0.000	1.000
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.900)	
Trend[d]	0.103	1.109	0.033	1.034	0.038	1.039	-0.065	0.937	0.004	1.004	0.004	1.004
	(0.000)		(0.000)		(0.000)		(0.000)		(0.003)		(0.000)	
Volatility[e]	-0.144	0.866	0.422	1.525	-0.324	0.723	-0.038	0.962	-0.063	0.939	-0.002	0.998
	(0.001)		(0.000)		(0.000)		(0.009)		(0.000)		(0.341)	
Day dummies												
Tuesday	-1.001	0.367	-0.094	0.910	-0.202	0.817	0.271	1.311	0.286	1.331	0.045	1.046
	(0.000)		(0.459)		(0.013)		(0.000)		(0.000)		(0.382)	
Wednesday	0.344	1.411	-2.205	0.110	-0.203	0.816	0.358	1.430	0.539	1.715	0.385	1.470
	(0.076)		(0.000)		(0.016)		(0.000)		(0.000)		(0.000)	
Thursday	0.284	1.328	-0.048	0.954	-0.219	0.804	-0.132	0.876	0.321	1.379	0.226	1.253
	(0.078)		(0.724)		(0.009)		(0.053)		(0.000)		(0.000)	
Friday	0.619	1.858	-0.176	0.839	0.097	1.102	0.361	1.434	-0.214	0.808	0.469	1.599
	(0.000)		(0.169)		(0.225)		(0.000)		(0.004)		(0.000)	
Obs.[f]	450		921		1,783		3,247		2,678		4,955	
R^2	0.457		0.791		0.853		0.841		0.405		0.443	
LR test	274.5		1,442		3,413		5,978		1,389		2,899	
Wald test	254.7		736.4		1,827		4,108		1,075		2,325	
Score test	271.1		1,717		2,487		4,788		1,116		2,747	

(a) p-values are presented in parentheses. (b) GI=gain indicator. Dummy variable equals 1 if current market price was above PRO price (benchmark) and 0 otherwise. (c) Price spread was the average difference between futures price and PRO price (benchmark) during the 10-day period prior to the day when grain was priced. (d) Price trend was calculated as the difference between current market price on the day that grain was price and the average market price during the 10-day period prior to the day when grain was priced. (e) Volatility was calculated as the standard deviation of current market price during the 10-day period prior to the day when grain was priced. (f) Number of observations refers to quantity of transactions made during a marketing window, which is not equal to the number of producers who priced with marketing contracts.

Table 5: Estimated Cox proportional hazard models – Daily Price Contracts (DPC)

	2005/06		2006/07		2007/08		2008/09	
	coef[a]	exp(coef)	coef[a]	exp(coef)	coef[a]	exp(coef)	coef[a]	exp(coef)
GI[b]	-1.264	0.283	4.344	77.000	2.008	7.450	84.690	6.02e+36
	(0.000)		(0.000)		(0.000)		(0.048)	
Spread[c]	-0.320	0.726	-0.119	0.887	-0.013	0.987	-0.019	0.981
	(0.000)		(0.000)		(0.000)		(0.000)	
Trend[d]	0.156	1.016	0.079	1.083	0.009	1.010	0.061	1.063
	(0.349)		(0.000)		(0.000)		(0.000)	
Volatility[e]	-0.281	0.755	-0.480	0.619	-0.023	0.977	0.214	1.239
	(0.000)		(0.000)		(0.000)		(0.000)	
Last week[f]	-23.94	0.000	-1.199	0.301	-18.670	0.000	-16.360	0.000
	(0.980)		(0.000)		(0.941)		(0.792)	
Day dummies								
Tuesday	0.363	1.438	-0.394	0.674	0.206	1.229	0.841	2.319
	(0.055)		(0.000)		(0.000)		(0.000)	
Wednesday	-0.320	0.726	-0.249	0.779	0.295	1.343	1.214	3.367
	(0.087)		(0.000)		(0.000)		(0.000)	
Thursday	-0.054	0.947	-0.473	0.622	0.085	1.089	0.676	1.966
	(0.786)		(0.000)		(0.119)		(0.119)	
Friday	-0.046	0.955	-0.234	0.791	-0.222	0.801	-0.615	0.541
	(0.795)		(0.000)		(0.000)		(0.005)	
Obs.[g]	438		2,826		4,005		1,055	
R^2	0.945		0.465		0.597		0.831	
LR test	1,267		1,765		3,638		1,875	
Wald test	512.4		1,606		1,420		236.4	
Score test	980.7		4,978		2,427		3,471	

(a) p-values are presented in parentheses. (b) GI=gain indicator. Dummy variable equals 1 if current market price was above PRO price (benchmark) and 0 otherwise. (c) Price spread was the average difference between futures price and PRO price (benchmark) during the 10-day period prior to the day when grain was priced. (d) Price trend was calculated as the difference between current market price on the day that grain was price and the average market price during the 10-day period prior to the day when grain was priced. (e) Volatility was calculated as the standard deviation of current market price during the 10-day period prior to the day when grain was priced. (f) Dummy variable which equals 1 when wheat was priced with DPC in the last 10 days of the marketing window. (g) Number of observations refers to quantity of transactions made during a marketing window, which is not equal to the number of producers who priced with marketing contracts.

Estimated coefficients for the price spread were all negative for the DPC (Table 5), but mixed findings emerged for the other two contracts. For the FPC this variable had a positive sign in three years (2004/05, 2007/08 and 2008/09) and a negative sign in two years (2003/04 and 2006/07), in addition to one year without statistical significance (Table 3). For the BPC the sign of the estimated coefficients for the spread were negative in three years (2003/04, 2006/07 and 2007/08) and positive in two years (2004/05 and 2005/06), also in addition to one year when it was not statistically significant (Table 4). Since the spread reflects the difference between prices offered by the contracts and the price the CWB expects to pay the pool at the end of the crop year (PRO price), the impact of this variable on timing decisions may be interpreted as how much confidence producers have in the CWB forecast for the pool price. The negative sign in the estimated coefficients for the DPC indicates that larger positive spreads (current market price greater than PRO price) reduce the conditional probability of selling on a given day, suggesting that producers might not believe in the PRO price and thus expect the pool price to be greater than forecast by the CWB, choosing then to wait a while longer to sell. Alternatively, the negative sign can also indicate that larger negative spreads (current market price smaller than PRO price) increase the conditional probability of selling on a given day, suggesting that producers might also not believe in the PRO price and thus expect the pool price to be smaller than forecast by the CWB, opting then to sell soon at the current contract price.

Even though findings appear to be mixed within the FPC and BPC models, they were actually consistent across the two contracts in 2003/04 (negative sign) and 2004/05 (positive sign), when the DPC had not yet been created. In the next four years results were not as consistent across contracts, which may just reflect their distinct marketing windows. For example, in 2007/08 the sign was positive for the FPC and negative for the BPC and DPC. The FPC had the earliest and shortest marketing window, which ended before the large price spike that happened in that crop year. The BPC and DPC, on the other hand, had a longer window and most marketing with those contracts happened towards the end of the FPC window or even after it (Figures 1 to 3). Hence the change in sign for the estimated coefficients across contracts might imply changes in producers' beliefs about the accuracy of the PRO price with new market developments.

Results for the trend variable suggest a positive relationship with timing decisions. The majority of estimated coefficients for all contracts indicated an increase (decrease) in the conditional probability of selling wheat on a given day when there was an uptrend (downtrend) in the market. With respect to volatility, estimated coefficients were mostly negative for the BPC and DPC, suggesting a general risk-seeking behavior with these two contracts. Larger (smaller) price variability in the market would decrease (increase) the conditional probability of selling wheat on a given day, perhaps reflecting the notion that producers would wait and try to obtain higher prices in a more volatile market. On the other hand, results were mixed for the FPC, with a combination of positive and negative signs for this variable over the years (Table 3).

Estimated coefficients on dummy variables for days of the week were generally statistically significant, but there appears to be no clear pattern of behavior with respect to pricing on specific days of the week. The exception may be the DPC, for which producers seemed more likely to price on Tuesdays and less likely to price on Fridays during the four years of the contract (Table 5).

Finally, producers using the DPC know that they have to price a certain quantity that was committed before the beginning of the marketing window. In this arrangement it was possible that producers would hold their wheat too long because of market conditions and then approach the end of the marketing window with the obligation to price the grain regardless what was happening in the market. An extra dummy variable was included in the DPC model to account for this possibility. This dummy variable takes a value of one if producers used the DPC in the last 10 days of the marketing window. As can be seen in Table 5, this variable was statistically significant in only one year and exhibited a negative sign.

CONCLUSION

This research investigated the timing of marketing decisions in the Canadian wheat market. Cox proportional hazard models were estimated to explore how market-based variables affected the timing of producers' decisions. This method provides a way to interpret the conditional probability of selling wheat and how this probability changes due to changes in the independent variables. Four market-based variables were used in the analysis: an indicator showing whether current prices were above the producers' benchmark on a given day (gain indicator), 10-day average spread between current prices and producers' benchmark, 10-day price trend and price volatility over 10 days. Data were provided by the CWB and included all producers who grew CWRS wheat from 2003/04 through 2008/09, but the sample used in this study only included producers who grew CWRS wheat in at least one of the six crop years and marketed their wheat using at least one marketing contracts. The sample that meets these criteria contains 17,338 producers who executed 59,184 transactions.

Overall results show that all market-based variables were statistically significant across contracts, indicating that they all affected timing decisions in producers' marketing choices. However, the signs of the estimated coefficients tended to vary across contracts and across years, suggesting that producers could change their pricing behavior over time and response to the covariates could also depend on characteristics of the contracts and how they relate to producers' marketing strategies.

Further research can explore other benchmarks used to determine the gain indicator and the price spread. The present study assumes that producers would focus on the expected pool price (PRO price) when comparing current market prices, but there can also be other reference prices. In addition, the price spread, trend and volatility were calculated over a 10-day period prior to the day when a producer priced his grain. Other time horizons can also be explored.

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