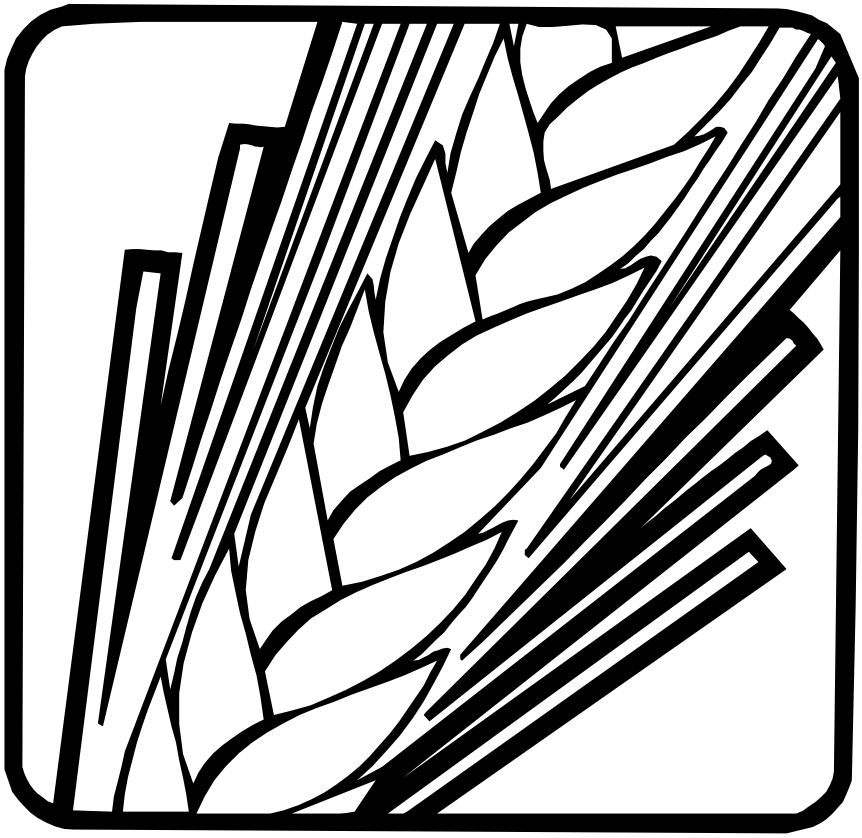
Agricultural Economics Report No. 441 June 2000

Import Tenders and Bidding Strategies in Wheat

William W. Wilson
Bruce L. Dahl



Department of Agribusiness and Applied Economics
Agricultural Experiment Station
North Dakota State University
Fargo, ND 58105

Acknowledgments

We wish to acknowledge Jon Lee, a former Graduate Research Assistant, for his research assistance on earlier versions of this analysis. Comments on an earlier version were obtained from Matt Diersen, Demcey Johnson, William Nganje, and Wesley Wilson, as well as by participants at seminars on this topic at North Dakota State University and the University of Western Australia. However, errors and omissions are the responsibility of the authors. This research was conducted under a National Research Initiative project titled *Strategic Effects of Transparency in International Wheat Markets* (NRI Project Number 97-35400-4436).

We would be happy to provide a single copy of this publication free of charge. You can address your inquiry to: Carol Jensen, Department of Agribusiness and Applied Economics, North Dakota State University, PO Box 5636, Fargo, ND 58105-5636, (Ph. 701-231-7441, Fax (701-231-7400), (e-mail: cjensen@ndsuext.nodak.edu) or electronically from our web site: http://agecon.lib.umn.edu/ndsu.html

Information on other titles in this series may be obtained from: Department of Agribusiness and Applied Economics, North Dakota State University, P.O. Box 5636, Fargo, ND 58105. Telephone: 701-231-7441, Fax: 701-231-7400, or e-mail: cjensen@ndsuext.nodak.edu.

Table of Contents

Item — Page

List of Tables ii

List of Appendix Tables ii

List of Figures iii

List of Appendix Figures iii

Abstract iv

Introduction and Scope 1

Bidding Models 2
- Theroretical and Analytical Models 2
- Derivation of Optimal Bids 3
- Stochastic Simulation of Bidding Strategies 4

Statistical Analysis of Bidding in International Wheat Contracts 4
- Data Sources and Characteristics 4
- Statistical and Graphical Analysis of Bidding Behavior 5
- Bid Functions 11
- Impacts of Canadian Offers on Bidding Behavior 15

Analysis of Bidding Strategies 18
- The Optimal Bid 19
- Number of Bidders 19
- Random Bidders 21
- Effects of Relative Cost Structure on Strategies 21
- Effects of Bidder Information on Strategies 21
- Impacts of Canada Option on Bidder Strategies 22
- Effect of Correlated Bidders on Optimal Bid 23
- Prospective Effects of Winner's Curse in Grain Tenders 24

Summary/Implications 26

References 28

Appendix 33

List of Tables

Table		Page
1	Sample Characteristics for Wheat Tenders	5
2	Sample Statistics for Wheat	9
3	Bid Functions by Firm for HRS, HAD, and HRW Tenders	12
4	HRS Tenders: Significance of Individual Bid Functions Relative to Pooled Estimates	15
5	Impact of Canadian Offers on HRS Bid Functions	16
6	HRS Tenders: F-test Results	16
7	Optimal Bids: Base Case Results for HRS, HAD, and HRW	19
8	HRS Tenders: Effect of Additional Competitors	20
9	HRS Tenders: Effect of Cost Structure	21
10	HRS Tenders: Effect of Information	22
11	Estimated Correlations Between Firm Bids, HRS	23
12	HRS Tenders: Winner's Curse	26

List of Appendix Tables

Table		Page
1	Impact of Canadian Offers on HAD Bid Functions	37
2	HAD Tenders: F-test Results	37
3	HAD Tenders: Winner's Curse	38

List of Figures

Figure		Page
1	HRS Tenders: Number of Bids and Bidders by Tender	6
2	HRS Tenders: Value of Bids	6
3	HRS Tenders: Bid Values Relative to C&F	7
4	HRS Tenders: Variation of Bids	7
5	HAD Tenders: Number of Bids and Bidders by Tender	10
6	HRW Tenders: Number of Bids and Bidders by Tender	10
7	HRS Tenders: Estimated Bid Functions	13
8	HAD Tenders: Estimated Bid Functions	13
9	HRW Tenders: Estimated Bid Functions	14
10	Relationship Between Bids for U.S. and Canadian Spring Wheat and Mpls. Futures Prices	17
11	Relationship Between Bids for U.S. and Canadian Durum Wheat and Mpls. Milling Prices	17
12	HRS Tenders: Effect of Number of Competitors on Expected Payoff	20

List of Appendix Figures

Figure		Page
1	HAD Bid Values	34
2	HRW Bid Prices	34
3	Relationship Between HAD Bids and Mpls. Milling Durum Prices	35
4	Relationship Between HRW Bids and KC HRW Futures Prices	35
5	HAD Standard Deviation of Bids Within Tenders	36
6	Standard Deviation of HRW Bids, by Tender	36

Abstract

Bidding competition plays an important role in price discovery and the determination of suppliers in international grains. In this paper we analyze international bidding competition for wheat for a specific importer. Tender data over the period 1993-1999 were analyzed and bid functions estimated by class of wheat (hard red spring, hard amber durum, and hard red winter denoted as HRS, HAD, and HRW, respectively) and by selling firm. A stochastic simulation model was developed to determine the optimal bid and to analyze factors affecting bidding behavior and competition.

The tender data indicated there was a surprisingly wide range of bids. Variation of bids across firms submitted for individual HRS tenders had standard deviations that ranged from $5/mt or less in a number of tenders to as high as $22/mt. Tenders for HAD show similar variability. Tenders for HRW showed higher variability yet with standard deviations of bids between $30 and $40/mt. These results show much greater variability than is normally ascribed to competition among international grain sellers. The spread between participants' bids and cost indicators ranged widely across firms.

Optimal bids and expected payoffs were derived for a prototypical bidder competing against the existing incumbents. Using this as a base case, we analyzed the impacts of the number of competitors, information, and cost differentials. In each case, we quantified the likely impact on optimal bids and expected payoffs.

In addition, there were three particularly interesting extensions from conventional auction models that were examined. One was the impact of the option to the seller of supplying wheat from Canadian origins. Effects of Canadian offers in bid functions were not statistically different from U.S. origins. The effect however, was interpreted as an increase in the number of random bidders within a tender. The effect of this was to reduce optimal bids for HRS by $0.50/mt. This suggests that the effect of Canadian origin as an option is minimal when the Canadian Wheat Board (CWB) sells through accredited exporters. The second interesting effect was that of correlated bids. Results indicated a high degree of correlation among bidders which had the effect of increasing the probability of winning, optimal bids, and expected profits. Finally, we explored the prospective impacts of the winner's curse on optimal bids. Results suggest that in light of the winner's curse, bidders should raise their bids; in the case of HRS, from a high of 1.9% to 7.7% to correct for bias in value estimation, to a low of 0.2% to 3.1% when considering money left on the table.

These results have a number of implications. The simulations improve our understanding of a very important mechanism of procurement and competition in international grain trading. For buyers, tendering is useful particularly if there is temporal variability in costs and they vary across supply firms, if the number of bidders is large, and if information about bidders is transparent and bidders' offers are less correlated. Finally, for sellers, auctions can result in intense competition among participants. Being low cost is essential to success in this form of competition. Sellers that are not low cost should avoid auctions to be successful, and bidders should make adjustments to their bids to account for the winner's curse.

Key Words: auction, bidding, wheat tenders, optimal bid, U.S., Canada

Import Tenders and Bidding Strategies in Wheat

William W. Wilson and Bruce L. Dahl*

Introduction and Scope

An important form of inter-firm and inter-country rivalry is bidding competition. Buyers use auctions extensively in the procurement of agricultural products to identify the low-cost supplier, and to promote competition among rivals. In the case of grains, auctions are used extensively, no doubt because they are a very efficient means to determine the low-cost supplier when suppliers' costs cannot be observed by the buyers. Given that costs vary randomly through time, across competitors, and cannot be directly observed by buyers, auctions are an effective way to identify the low-cost suppliers. For these reasons, auctions have always been and continue to be an important form of competition in this industry.[1] In the case of grains there are numerous examples of auctions playing an integral role in marketing. These include not only import tendering as described in this study, but also auctions for EEP allocations, for rail rates and service (Wilson, Priewe, and Dahl), and import tendering for barley in Japan (Rampton). Auctions have also been proposed as an alternative in Canadian grain marketing (Estey and Kroeger).

Inter-country competition is also discerned through bidding. This has taken on particular relevance in recent years with concerns about the prospective impacts of transparency between U.S. grain exporting firms and state trading enterprises.[2] The latter do not release details of their transactions and (it is alleged) thereby gain a competitive advantage.[3, 4] In addition, there are

---

*Wilson is a Professor and Dahl is a Research Scientist in the Department of Agribusiness and Applied Economics at North Dakota State University, Fargo.

[1] With the escalation in vertical integration, contracting, and concentration in many sectors, there has been less public information about prices and terms governing transactions. While there are broader concerns of interest, including distortion of producer allocation decisions, here are the strategic implications for competition among rivals. See Beurskens, Boehlje, and Scheid for discussions of these problems in the agribusiness sectors. Maixner recently summarized issues and proposals to make price reporting in livestock mandatory, which fundamentally is a transparency issue.

[2] Noting that auctions have an important impact on suppliers, an important element of competition among multinational firms is their apparent appetite for developing extensive and proprietary information networks. Indeed, selling organizations without extensive information are thought to be disadvantaged. It is also interesting that STEs seem to fight very hard (both within their countries as well as in international trade negotiations) for retaining the ability to be non-transparent.

[3] Several aspects of the world grain trade affect transparency. In the U.S. marketing system, prices and costs for marketing functions vary somewhat across domestic rivals, but are highly transparent to rivals. These result from public reporting of prices, basis, export tender sales (all sales made under export assistance are reported publicly), and public tariffs for transportation and handling services. Further, the vast majority of transactions for U.S. domestic and offshore sales are made through formal or informal bidding processes which are reported to the trade. Generally, these dissemination mechanisms do not have counterparts in Canada or Australia. Observed prices do provide an indication of costs incurred by firms in the United States, whereas in countries with STEs these are less useful as indicators of current pricing levels. As a result, in many cases rivals have more refined information about reservation values (or replacement costs as used by the trade) of U.S. trading firms than they do for STEs. This is particularly true during periods when a large portion of sales are made under public assistance (e.g., EEP sales). See Wilson, Dahl, and Johnson for a discussion of transparency in international grains competition.

[4] See Wilson and Dahl for a description of the economies of information and the impacts of EEP on the evolving international grain trade.

periodic claims and concerns of the role of price leadership among selling countries (Mohanty, et al. 1995, 1996). Each of those studies use fairly aggregate data, assume the country is the seller, and completely ignore the fact that a large portion of world grain is procured using tenders, which seriously undermines prospective seller market power.

There are a number of important aspects in the analysis of bidding competition in the international grain market. Of particular interest are the behavior of bidders in formulating bids and/or bidding strategies, the impact of participation, the role of information, the winner's curse, and the impact of Canadian grain as a seller's option being offered. In addition, correlation of bids among bidders has an interesting impact on auction results. Each of these aspects affects bids and bidding competition in an interesting way.

The purpose of this paper is to analyze bidding competition and strategies in grain trading and to assess the impacts of these effects on auction results. Specifically, data are analyzed from the results of tenders conducted by a private firm in a specific importing country. Bid functions are derived for each rival and various tests are conducted. A stochastic simulation model was used to determine the optimal bid for a prototypical bidder competing against existing rivals in this market. Simulations were conducted to analyze the impacts of a number of variables on the optimal bid and other characteristics of the auctions. The section below provides a description of the analytical model. The following section describes the auction results and bidder behavior. Optimal bids are derived in the next section, and effects of several factors on optimal bids are analyzed. The final section provides a summary and discussion of implications.

Bidding Models

Auctions and bidding models have been the topic of numerous recent books and studies. Cassady provides a historical overview of auction strategies and mechanisms, and recent bibliographies (McAffee and McMillan 1987; Engelbrecht-Wiggans; Milgrom 1985, 1989; Rothkopf and Harstad; Klemperer) review the literature on auctions and bidding strategies. Some of this recent interest has been on auction design for the sale of state-owned assets (*The Economist*). Recent texts (including Monroe; Nagle and Holden; Lilien and Kotler; Rasmusen; Dutta; Kottas and Khumawata; Phlips; and Sewall) provide practical motivations for auctions and analytical approaches to bidding strategies. Numerous recent studies have applied these techniques. Examples include Hausch and Li; Crampton; Hughart; and McAfee and McMillan 1996. Analytical models and studies in agriculture are summarized in Sexton (pp.189-95) and include the more recent studies by Bourgeon and LeRoux (1996a,b) for European Union (EU) export tenders and Latacz-Lohmann and Hamsvoort for the Conservation Reserve Program (CRP).

Theoretical and Analytical Models

Bidders seek to maximize their expected payoff associated with alternative bids. The objective function is defined as: $E(\delta) = (B - C)\cdot P(W)$ where $E(\delta)$ is the expected payoff, B is the bid, C is cost, and P(W) is the probability of winning with alternative bids. The crucial variable is P(W), the probability of winning.

Conventional approaches to deriving the P(W) are discussed in Monroe; Lilian and Kotler; and Nagle and Holden. The approach closest to that used in this study is the *specific opponent approach* (Monroe; Nagle and Holden pp. 203-204) where information exists on past bidding

behavior of individual (i.e., specific) bidders. Procedures conventionally prescribed for determining P(W) in the specific opponent approach are to: 1) assess competitor bids as a percentage of own cost on past bidding occurrences; 2) categorize these in discrete intervals; and 3) compute the fraction of each competitor's previous bids which exceed B. This is interpreted as the probability that B is less than a competitor's (j) bid for each bidder i, $P_{ij}(W)$. This approach is a discrete method for computing the probability of underbidding an opponent using own costs as a reference. It can be expanded to handle multiple opponents and random opponents (i.e., those that randomly compete in each tender). A common theme of these approaches is that competitor's bid distributions are based on (derived from) own costs. These are ultimately used to predict bidder behavior, however, they are unobserved in most cases, which is the major shortcoming.

In this study, regression is used to estimate specific suppliers' bid functions and the results are used to predict, or to derive, the likelihood of different opponents' bids. Of particular importance is the relation among bids of specific bidders during individual tenders, B_{it}, and some price used as a cost indicator, C_t. A bid function from a linear regression, $B_{it} = \alpha_i + \beta_i C_t + \varepsilon_{it}$, where ε is $N(\mu, \sigma^2)$, can be used to predict future bids conditional upon an observable C_t.[5]

Derivation of Optimal Bids

These parameters are used to estimate expected bids of rivals. These results are used in a stochastic simulation model to determine the optimal bid. First, the probability of underbidding each specific opponent, $P_{ij}(W)$ across a range of potential bids is derived. Then, the joint probability of underbidding all opponents is computed. Since there are multiple opponents which are assumed to be bidding independently, then

$$P_i(W) = P_{i,1}(W) \bullet P_{i,2} \bullet, \ldots, \bullet P_N(W) = \prod_{j=1}^{N} P_{ij}(W)$$

where $P_i(W)$ is the joint probability of underbidding each opponent individually, and $P_{i,j}(W)$ is the probability of bidder i winning against competitor j. These are used in determining the optimal bid, which is found by identifying that bid yielding the highest expected profit, defined as $E(\delta) = (B - C) \cdot P(W)$. In a special case where the opponents do not bid in each tender, but with some probability, then $P_i'(W) = p_{jc} \bullet P_i(W) + (1-p_{jc}) \bullet 1$ where $P_i'(W)$ is the probability of winning against a random bidder; p_{jc} is the probability that competitor j bids, and $P_i(W)$ is the probability of winning. $1-p_{jc}$ is the probability that competitor j does not bid.

There is a fundamental tradeoff in determining the optimal bid. Higher bids result in a greater payoff, but also, a lower probability of winning. The product of these two functions yields the $E(\delta)$ payoff, the maximum of which is the optimal bid. Deviations from this would affect both the probability of winning and the payoff, and would result in a lower $E(\delta)$. An important parameter affecting bidding competition is the number of bidders, the effect of which is elaborated in the empirical analysis. Reduction in the number of bidders increases the P(W), and as a result the $E(\delta)$ increases, as does the optimal bid and expected payoff to the bidder.

[5] Use of bid functions has been discussed and used recently in analyzing bidding strategies in experimental auctions in Avery and Kagel (pp. 588-589).

Stochastic Simulation of Bidding Strategies

Optimal bids were derived in this study using stochastic simulation[6] (Winston). Specifically, a prototypical bidder is posed to compete against rivals based on past bidding behavior. This is depicted in estimated bid functions, one for each competitor. There are two important sources of uncertainty. One is the error associated with the expected bid of rivals. The other is whether they submit a bid. In this case, N, the number of bidders, is a random variable and has important impacts on bidding strategies and competition. Stochastic simulation was used to simulate bidding and incorporated these sources of uncertainty. The probability of winning and expected profits were derived from simulation results for a range of prospective bids. Then, optimal bids were defined using a search procedure across prospective bid values.

Statistical Analysis of Bidding in International Wheat Contracts

Data Sources and Characteristics

The data used in this study were for a private importer of hard wheats from the United States and Canada. The importer purchased wheat individually (as opposed to as an association), on a regular basis (typically quarterly), and the data reflects tenders covering the period from August 1993 to May 1999. Three wheat classes were imported separately during this period [hard amber durum (HAD), hard red spring (HRS), and hard red winter (HRW)]. All bids were flat priced and on a C&F (cost and freight) basis. The buyer allowed for U.S. or Canadian wheats to be offered at the sellers' option. In some cases, exporters offered only Canadian wheat, in others they offered only U.S. origin, and in others they offered both U.S. and Canadian, at sometimes different values but in each case they were represented as buyer's option. It is important that sales of Canadian wheat to this buyer were not made directly by the CWB, but instead were made through accredited exporters (AE), an important distinction in sales strategies.

Summary statistics for tenders are presented for each of the wheat classes in Table 1. There were 21 tenders for HRS wheat, 23 for HAD, and 17 for HRW. Each tender consisted of a different number of suppliers as well as different numbers of offers made by each supplier. Multiple bids were provided by suppliers that offered wheat from both origins. Ten firms submitted bids for HRS, while 11 firms submitted bids for HAD, and 12 firms submitted bids for HRW wheat. Each class of wheat averaged five firms bidding per tender. The maximum number of firms submitting offers in any one tender was seven. The average number of bids per tender was nine for HRS, eight for HAD, and seven for HRW.

Alternative cost indicators were examined to represent the time series variability in price levels throughout the period covered by the tender data. Ultimately, these are taken to represent the opportunity cost for suppliers, and the variability through time reflects its changes. Several cost indicators were considered including: 1) futures in the case of HRS (Minneapolis) and HRW (Kansas City); 2) the cash price for Minneapolis HAD Choice Milling; 3) FOB Gulf values (U.S. Wheat Associates); and 4) C&F prices, where the C&F value was defined as: $P^{C\&F} = F_t + B_t + O_t$, where F_t is the futures price, B_t is the basis value, and O_t is the ocean freight rate to the importing country (USDA-AMS).

---

[6] An alternative would be to use a Bayesian transformation similar to Wilson and Diersen which was used recently to analyze international oilseed tenders.

Table 1. Sample Characteristics for Wheat Tenders

	HRS	HAD	HRW
Number of Tenders	21	23	17
Bidders			
Total firms	10	11	12
Average firms per tender	5	5	5
Maximum firms per tender	7	7	7
Offers			
Total	181	189	118
Averaged across tenders	9	8	7

Bid functions were estimated separately for each class with each of these potential cost indicators to identify that best reflecting bidder behavior. These were used to account for differences in costs over time, and the estimated function captures the bidder's behavioral relationship. The cost indicators were selected among the alternatives based on R^2s. That selected for HRS was the C&F value; for HRW, the Kansas City futures was chosen; and for HAD, the FOB Minneapolis price was chosen. These indicator values are the basis for the results presented in the following sections.

Statistical and Graphical Analysis of Bidding Behavior

The number of bids and bidders varied across HRS tenders (Figure 1). Most of the tenders are characterized with more bids than bidders, reflecting that multiple bids were submitted by some participants. The number of bidders fluctuated slightly from three to seven across tenders. Figure 2 shows the time-series of bid distributions and mean for each tender. This indicates a general trend toward tighter bid distributions in more recent tenders.

Bid distributions were plotted against the C&F value (cost indicator) for each tender date (Figure 3). Results indicate the offers in each tender relative to a simple regression line typifying a pooled bid function. Variability in bid distributions across tenders was measured by the standard deviation and has varied widely across tenders (Figure 4). In earlier tenders, the standard deviation across offers was greatest, ranging to over $20/mt, but in more recent tenders it was in the area of $5/mt.

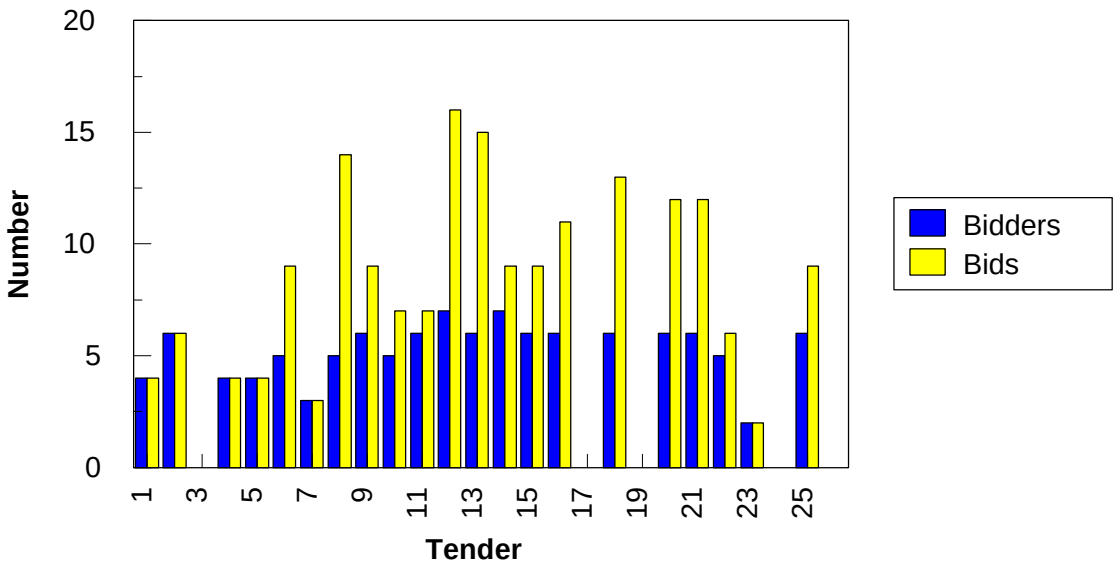


Figure 1. HRS Tenders: Number of Bids and Bidders by Tender

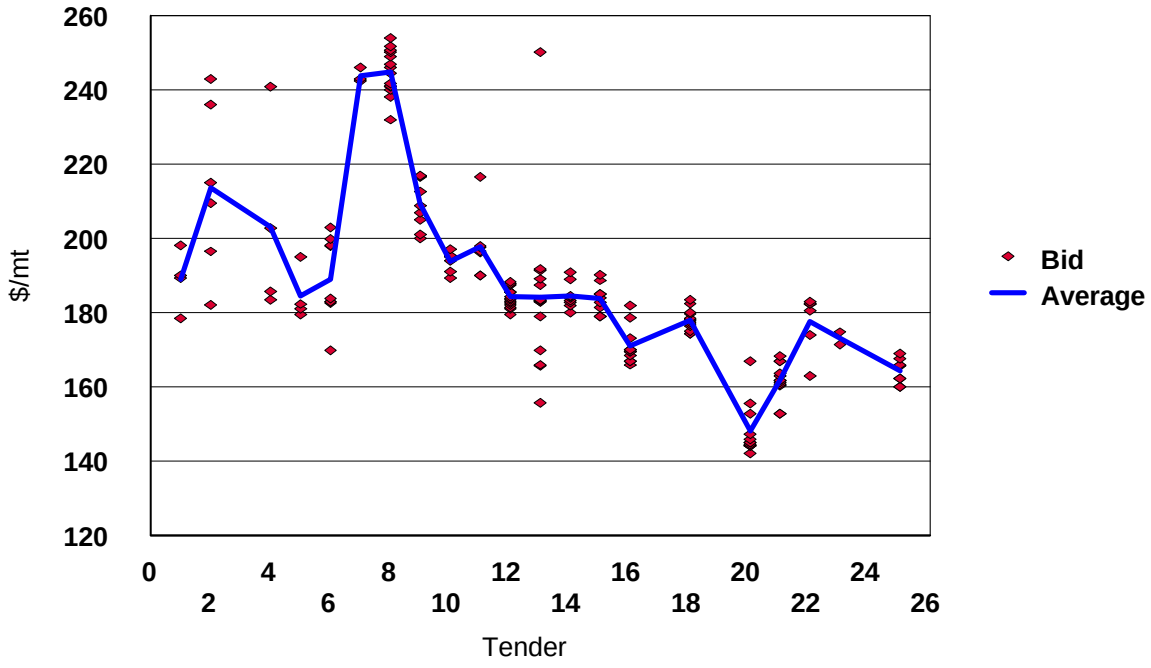


Figure 2. HRS Tenders: Value of Bids

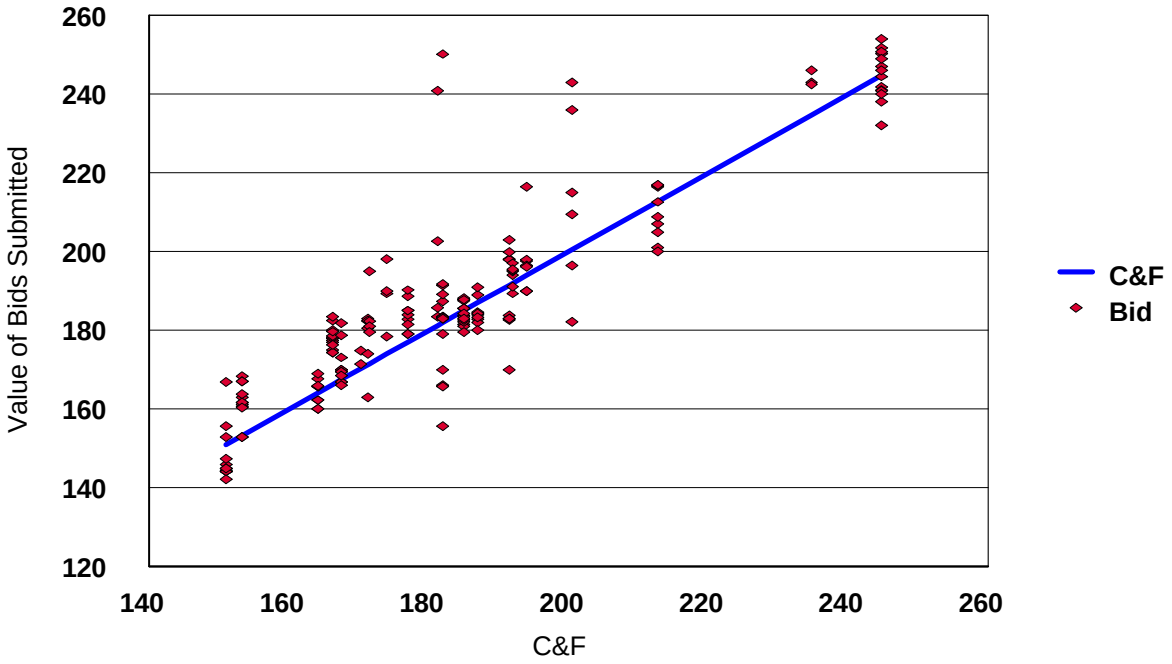


Figure 3. HRS Tenders: Bid Values Relative to C&F

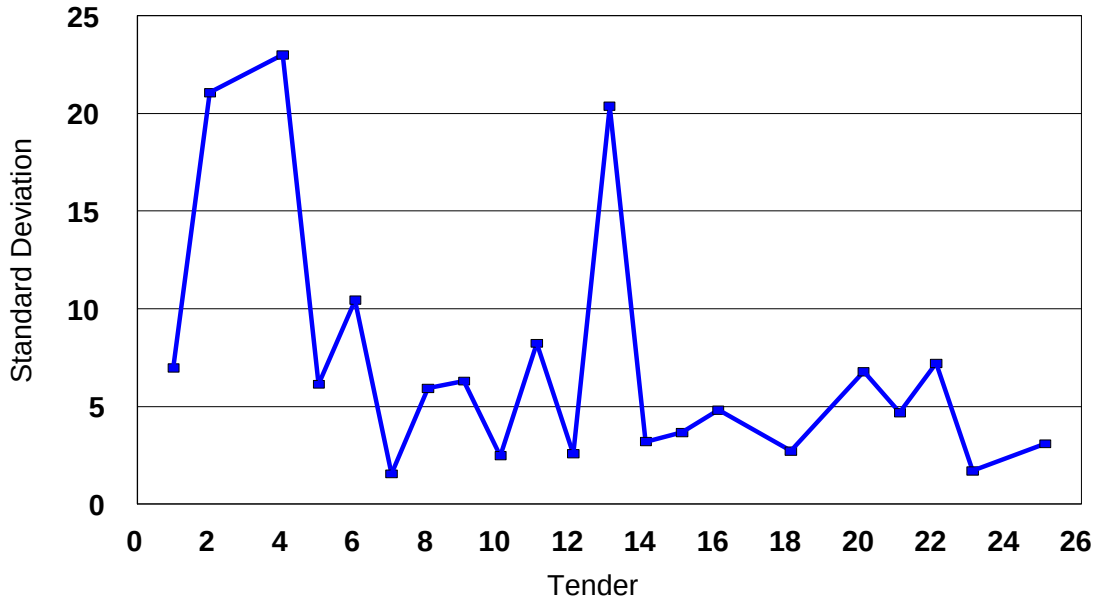


Figure 4. HRS Tenders: Variation of Bids

Tender data were also examined for individual suppliers (Table 2). For the HRS tenders, the number of bids submitted ranged from 11 to 35. Supplier E was the most active bidder with 35 bids. There appears to be two distinct groups of bidders based on their participation. The more active group consists of Suppliers D, E, G, and I, while the other group is made up of C, F, and H.

Supplier F had the highest average bid at $204.5/mt and a standard deviation of $26/mt. Supplier H had the lowest average bid of $167.36/mt and standard deviation of $13.66/mt, but participated in only 11 of the tenders. A more relevant comparison across suppliers can be drawn by evaluating the difference (spread) between bid prices and the cost indicator. For HRS, Supplier F has the highest average bid over the cost indicator ($10.48/mt). The variability of the spread between bids and indicator values was also largest for Supplier F (standard deviation of $22.89/mt), indicating more random behavior than other suppliers. The bidder with the lowest spread between bids and indicator values was Supplier I, with a mean value of $0.82 and standard deviation of $9.84. The remaining bidders had average spreads between bids and cost indicators of $5.28/mt or less. Variability of the spread for bidders other than Supplier F had standard deviations less than $10.00/mt.

The percent of time suppliers won tenders is also shown (Table 2). Supplier E won 33% of the time, with G and I slightly lower. The other competitors won less than 15% of the time, with Supplier H not winning at all. Generally, these are reflective of the implied margin for each of the bidders. Note that Suppliers E, G, and I had the greatest frequency of winning and had the lowest deviation from the cost indicator (B-C) averaged across their individual tenders.

Participation in tenders was also examined for durum tenders (Figure 5, Table 2). Supplier E made the most offers at 36, while H made the least at 14. Suppliers F and H are the only competitors who submitted less than 25 offers. The deviation of the bid from the cost indicator suggests slightly higher values due in part to the greater cost differential relative to HRS, as well as the greater risk in durum trading versus other grains (Table 2). Supplier F had the lowest deviation at $9.57/mt. However, Supplier F's standard deviation is the highest of the group at $21/mt. This is an indication of the degree of randomness in the bidding behavior of Supplier F. Other competitors had a deviation from the cost indicator within a few dollars of each other, ranging from $12-16/mt. Supplier E has the lowest combination of mean deviation and standard deviation, indicating more predictable bidding behavior.[7]

Tenders for HRW had the fewest tenders of the three classes (Figure 6). Suppliers E and G are the most prevalent competitors, with C, E, G, and I submitting more than 15 bids, while Suppliers D, F, and H all submitted less than 15 bids. Suppliers F and I had the highest average bids ($190/mt and $158/mt, respectively) and the highest variability in bids ($25/mt and $28/mt, respectively). Suppliers G and H have the lowest spreads between bids and the cost indicator ranging from $29/mt to $33/mt (these are larger because the cost indicator in this case was the KCBT futures value). However, firms H, C, and D have the lowest variability for the spread between bids and indicator costs ($8/mt-$11/mt). Finally, in the HRW tenders, three of the firms did not win any of the tenders in contrast to only one firm for either HRS or HAD.

[7] Similar figures to those for HRS (Figures 2 through 4) were developed for HAD and HRW and are in the Appendix.

Table 2. Sample Statistics for Wheat

Bidder	Number of Tenders	Number of Bids	Bid Value Mean ($/mt)	Bid Value Std. Dev. ($/mt)	$B\text{-}C_i$ Mean ($/mt)	$B\text{-}C_i$ Std. Dev. ($/mt)	C/O Winning Bid (%)*
----------HRS----------							
C	14	21	180.31	19.05	4.74	7.82	13
D	16	31	194.78	25.24	5.28	5.95	12
E	18	35	184.48	24.76	1.03	8.35	33
F	13	18	204.46	26.00	10.48	22.89	8
G	19	31	184.53	23.56	2.25	7.96	28
H	7	11	167.36	13.66	3.86	6.18	0
I	19	28	189.21	27.04	0.82	9.84	25
----------HAD Tenders----------							
C	18	26	207.38	31.60	15.86	12.03	11
D	18	26	223.89	37.68	15.75	14.45	16
E	21	36	220.54	35.82	12.20	11.80	27
F	12	16	238.25	23.24	9.57	21.06	31
G	22	33	217.98	37.13	15.46	14.24	9
H	9	14	201.77	33.00	14.06	11.97	0
I	21	29	220.93	33.81	14.39	15.43	33
----------HRW Tenders----------							
C	11	17	155.92	14.72	41.14	10.02	0
D	11	14	155.39	11.63	34.72	12.97	45
E	14	23	154.44	17.46	33.85	10.74	27
F	8	9	189.83	24.95	47.76	19.57	0
G	11	19	149.46	15.49	29.73	14.07	25
H	6	11	144.59	12.82	32.92	8.21	0
I	12	15	158.46	28.46	35.88	11.46	40

* Percent of times the bidder had the lowest bid. The values do not sum to one because these were derived using only values when the bidder participates.

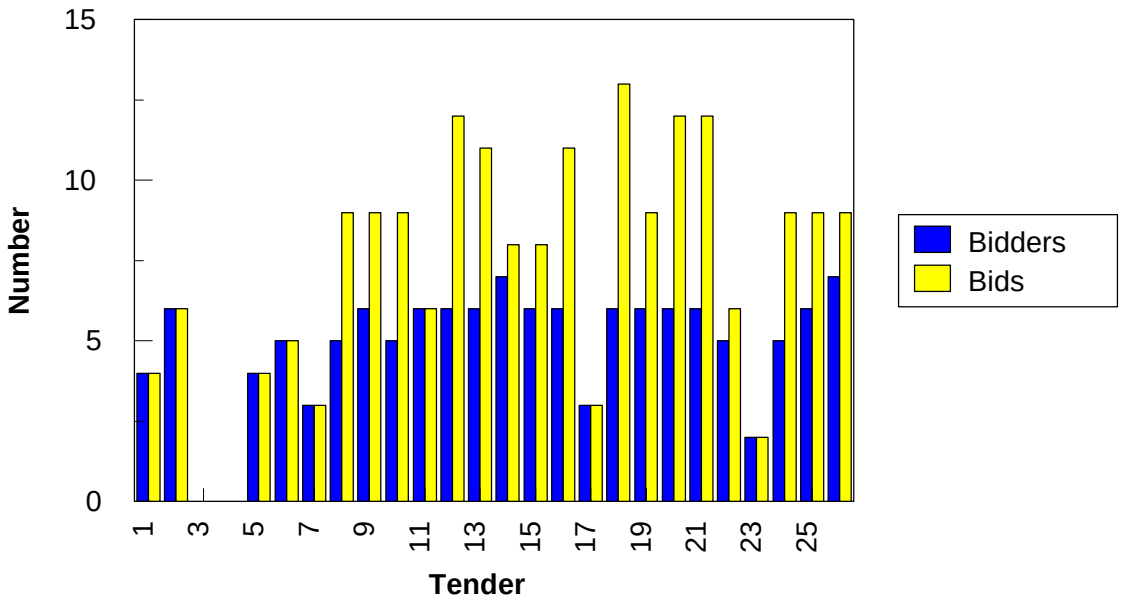


Figure 5. HAD Tenders: Number of Bids and Bidders by Tender

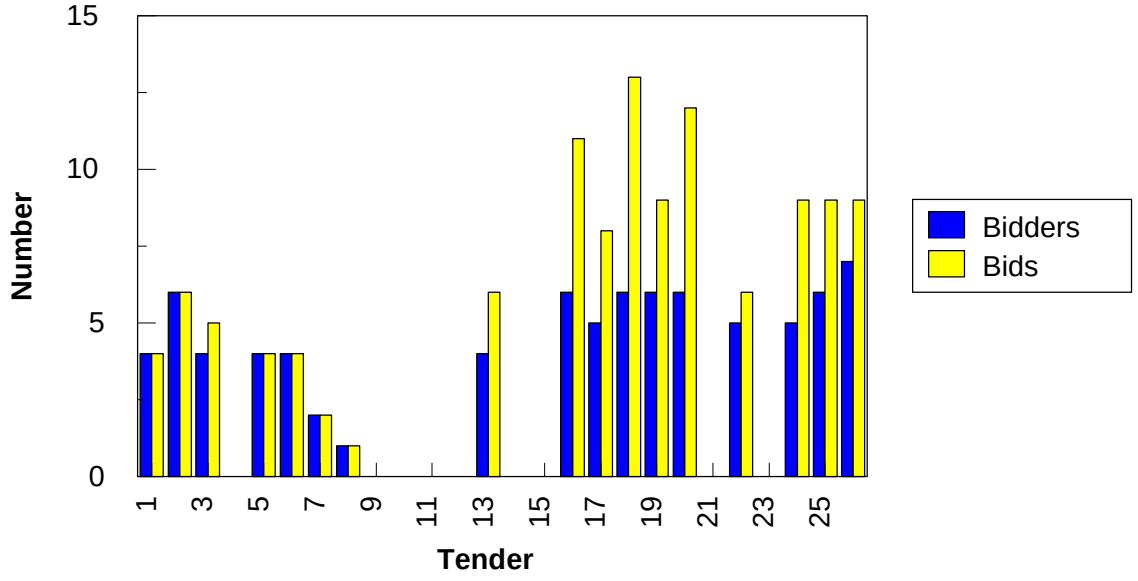


Figure 6. HRW Tenders: Number of Bids and Bidders by Tender

Bid Functions. Bid functions were estimated for the pooled sample and for each firm separately within each wheat class. The general form of that function was $B_t = á_0 + â_0 \cdot C_t + å_t$, where B_t is bid in tender on date t, C_t is the corresponding cost indicator (as described above) for date t, $á_0$ and $â_0$ are estimated coefficients, and $å_t$ is the error term. A simple linear form was used for all three classes.

Results for HRS are shown in Table 3 and Figures 7 through 9 for Suppliers C-I and each class. Bid functions of the pooled sample and major suppliers are shown for comparison. The R^2s are relatively high for HRS tenders. Most of the participants are characterized with high R^2s (>.80), indicating they are highly predictable. However, Supplier F has an extremely low R^2 (.27), meaning F's bidding behavior is less predictable in relation to other participants. For HAD, the R^2s differ slightly from the HRS case, some being higher and some lower. The pooled sample is slightly higher at .84 versus .81 in the HRS market. For HRW, R^2 s were the lowest of the three classes. The pooled sample had an R^2 of .61. Bid functions for individual suppliers also had R^2s that were lower than for the other classes.

The RMSE (or $å_t$) is the measure of uncertainty about rivals' bids in our analysis. These values vary greatly both within wheat class tenders as well as between wheat class tenders. These range from a low of 6.44 for Supplier D in HRS to a high of 23.62 for Supplier F. Generally there was a greater RMSE for durum than the other classes.

Table 3. Bid Functions by Firm for HRS, HAD, and HRW Tenders

Bidder	# of Bids	Bid Function Intercept ($\acute{a}_0$)	Slope ($\hat{a}_0$)	RMSE	R^2	P(bid)
		----------HRS----------				
pooled	175	17.17	0.92	11.04	0.81	1
C	21	-4.77	1.05	8.24	0.83	.67
D	31	13.05	0.96	6.44	0.94	.76
E	35	21.73	0.88	8.10	0.90	.86
F	18	76.90	0.66	23.62	0.27	.62
G	31	18.07	0.91	8.01	0.89	.90
H	11	-27.34	1.19	6.48	0.82	.33
I	28	17.01	0.91	10.70	0.85	.90
		----------HAD----------				
pooled	180	35.37	0.90	14.03	0.85	1
C	18	39.29	0.88	11.76	0.87	.78
D	18	32.26	0.92	14.71	0.86	.78
E	21	24.64	0.94	11.94	0.90	.91
F	12	107.90	0.57	19.01	0.41	.52
G	22	30.73	0.92	14.40	0.86	.96
H	9	16.22	0.99	12.92	0.87	.39
I	21	40.77	0.87	15.31	0.81	.91
		----------HRW----------				
pooled	108	44.70	0.93	13.43	0.61	1
C	11	52.33	0.90	10.59	0.54	.65
D	11	106.94	0.40	11.24	0.20	.65
E	14	36.38	0.98	11.24	0.62	.82
F	8	84.60	0.74	21.19	0.44	.47
G	11	83.25	0.55	11.53	0.50	.65
H	6	37.29	0.96	9.07	0.59	.35
I	12	10.11	1.21	11.27	0.86	.71

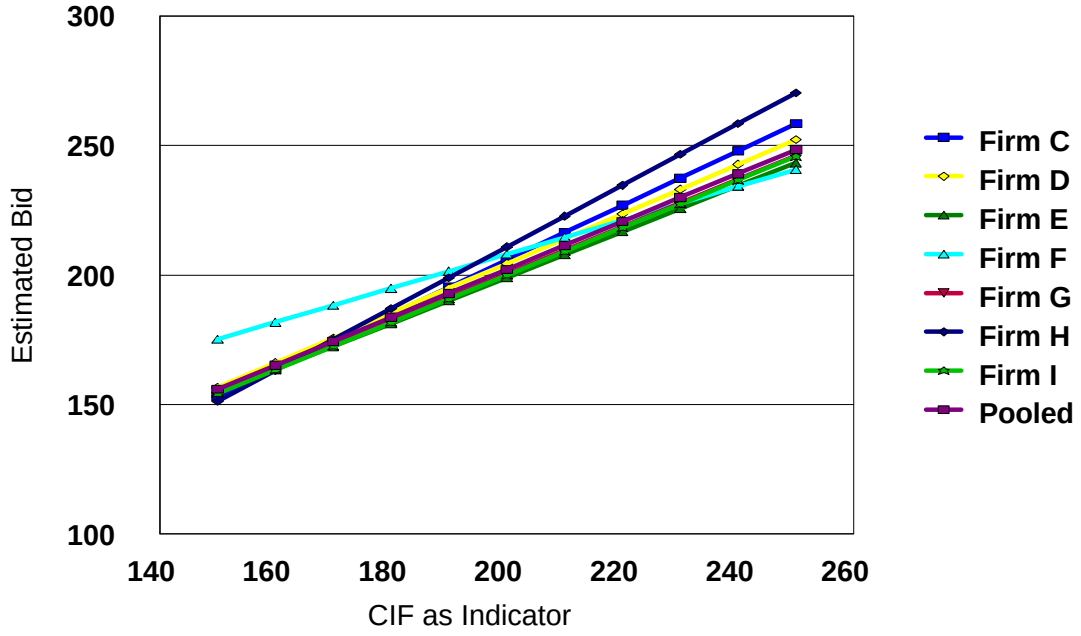


Figure 7. HRS Tenders: Estimated Bid Functions

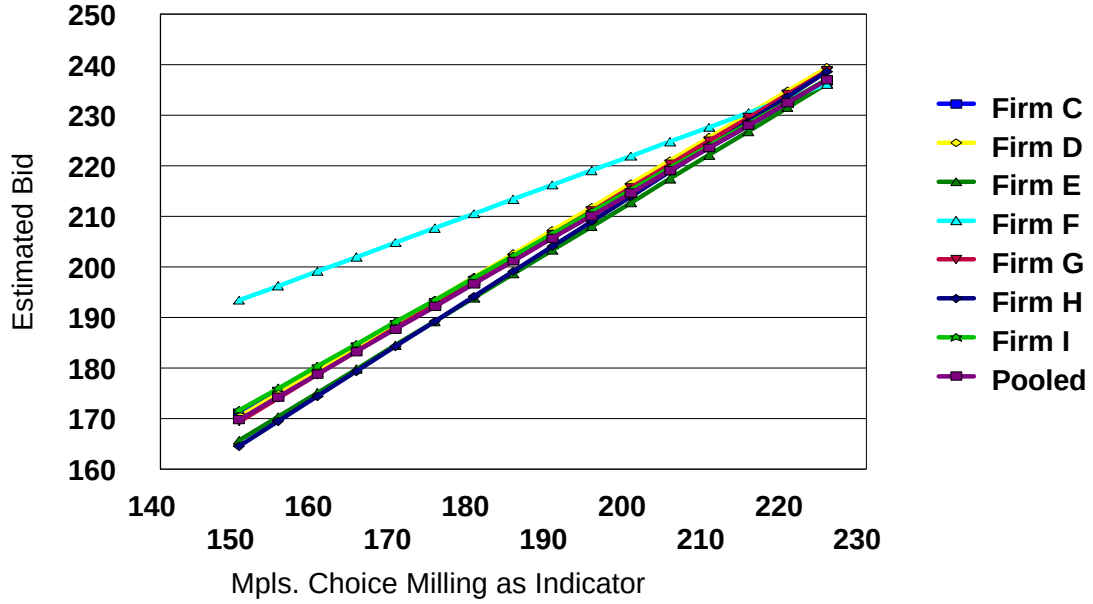


Figure 8. HAD Tenders: Estimated Bid Functions

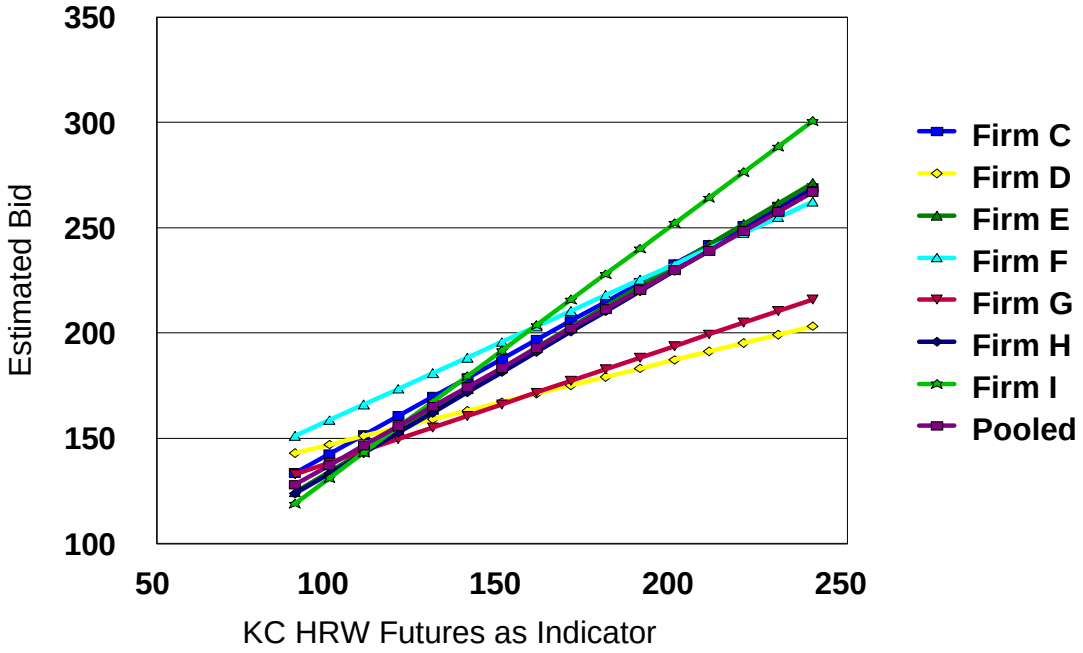


Figure 9. HRW Tenders: Estimated Bid Functions

Regression results indicate a few differences among competitors. In the case of HRS, Suppliers C and H have a negative intercept with slope ($\hat{a}_0$) being greater than one. Supplier F has a relatively high intercept of 76.90 with a relatively low $\hat{a}_0$ of .66. The other competitors vary only slightly from the pooled intercept and coefficient. Differences among these firms' parameters are likely a reflection of differences in fixed and marginal costs. T tests were conducted to test the individual estimates against the pooled estimates (Table 4). Estimates for Bidders G and E are not statistically different from the pooled sample. However, this is likely due to the number of bids these firms submitted. Their associated bids make up a large part of the pooled sample. For purposes of later analysis, their individual estimates are used.

The effect of random bidders is an important component in determining optimum bids. Not every supplier participated in each tender (Table 2). P(bid) is defined as the probability of submitting a bid in a particular tender. Most of the competitors in the analyses participated in more than 60% of tenders, with firms G and I bidding in 90% of tenders. Firm H only participated 33% of the time.

In the case of durum, Suppliers E and H have a slightly lower intercept and higher cost coefficient than the rest of the group. Supplier F has a large intercept of 107, low coefficient for the cost indicator of .57, low R^2 of .41, and a high RMSE of 19. The rest of the suppliers have nearly identical bid functions. Coefficients for most firms for HAD are close to the pooled results of 35 for the intercept term and 0.9 for the cost coefficient. Again, coefficients for the cost indicator (slope) were less than one. For HAD tenders, most firms participated more than 75% of the time with three firms participating more than 90% of the time (firms E, G, and I). Two firms (F and H) participated to a lesser extent (52% and 39%, respectively).

Table 4. HRS Tenders: Significance of Individual Bid Functions Relative to Pooled Estimates

Bidder	Critical T	Calculated T	Result H_0=0
C	1.96	8.45	Reject
D	1.96	-6.13	Reject
E	1.96	0.25	Fail to Reject
F	1.96	-9.45	Reject
G	1.96	1.43	Fail to Reject
H	1.96	19.59	Reject
I	1.96	-4.08	Reject

*Tests performed at 95% confidence level. Coefficients for E and G are not statistically different from the pooled estimate.

In the HRW market, the bid functions differ the most among competitors compared to the other markets. Most of the suppliers' bid functions had lower R^2 than did firms in the other wheat classes. Only two firms had bid functions with R^2 higher than .6 (Suppliers E and I). Coefficients for the cost indicators were .93 for the pooled sample and less than one for individual suppliers except for Supplier I (1.21). Of the suppliers, Suppliers D and F had the lowest cost indicator coefficients (.40 and .55, respectively).

Impacts of Canadian Offers on Bidding Behavior. An important competitive aspect in this market is that of U.S. and Canadian wheat being offered jointly by some suppliers during the same tender**.** To capture this potential effect on bidding behavior, a revised bid function was estimated as: $B = á_0 + á_R \cdot R + â_0 \cdot C + â_R \cdot C \cdot R + å$, where variables are as previously defined and R is a binary variable representing bids for grain from Canadian origins, C*R represents an interaction term between the cost indicator and wheat from Canadian origins, and $á_R$ and $â_R$ represent estimated coefficients. The binary and interaction terms were added to capture any potential slope and intercept effects of offering wheat from Canadian origins.

The statistical results are shown in Tables 5 and 6 for HRS. Results indicate the effect of Canada as an option for HRS is not statistically significant. For HRS, in no case were coefficients for intercept or slope effects of Canadian offers significant (i.e., both $á_R$ and $â_R$ were insignificant). This is somewhat evident in the data shown in Figures 10 and 11 which distinguishes offers of U.S. and Canadian origin wheats. To confirm this, a series of F-tests were performed to further test the significance of the Canada effect, $á_R$ and $â_R$. The critical and calculated F values indicate the Canada variables are not statistically different from zero at the 95% level. Thus, the estimated equation with only C&F as an independent variable is sufficient in predicting bidding behavior of competitors. The Canada effect is examined further in the sensitivity section.

Table 5. Impact of Canadian Offers on HRS Bid Functions

Bidder	# of Bids	Intercept ($á_1$)	Slope ($â_0$)	Int. Adj. ($á_R$)	Slope Adj. ($â_R$)	RMSE	R2
pooled	175	21.92	1.06	-12.80	0.06	12.60	.76
C	21	29.17	1.02	-5.21	0.01	12.60	.64
D	31	-14.96	1.30	26.58	-0.18	8.13	.91
E	35	23.85	1.02	-18.08	0.13	9.95	.86
F	18	106.10	0.59	21.91	*	25.03	.23
G	31	13.57	1.12	17.87	-0.16	10.13	.84
H	11	24.20	1.00	-22.37	0.18	7.83	.79
I	28	26.04	1.03	-22.28	0.12	12.30	.82

* Model not at full rank.

Table 6. HRS Tenders: F-test Results

Bidder	Critical F	Int. Adj. ($á_R$) F-calculated	Slope Adj. ($â_R$) F-calculated
C	4.41	0.45	0.21
D	4.20	0.56	0.92
E	4.16	2.42	0.37
G	4.20	2.82	1.22
H	5.32	1.32	1.42
I	4.24	0.02	0.63

*Fail to reject H_0: B_0 is not significantly different from zero.

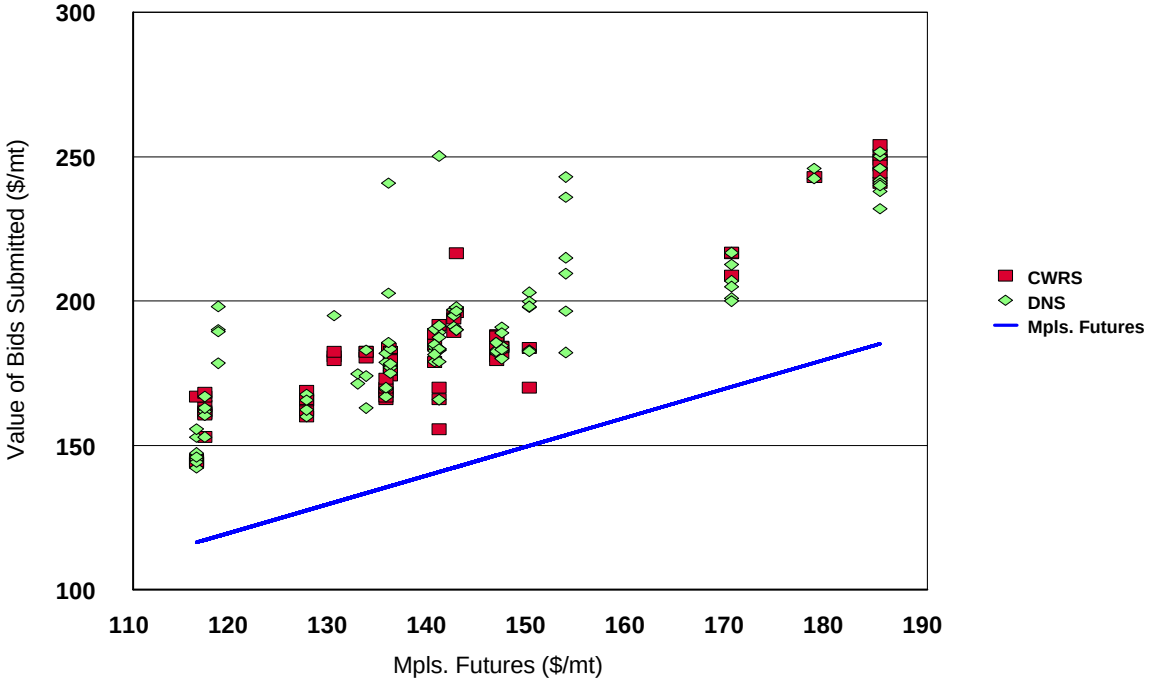


Figure 10. Relationship Between Bids for U.S. and Canadian Spring Wheat and Mpls. Futures Prices

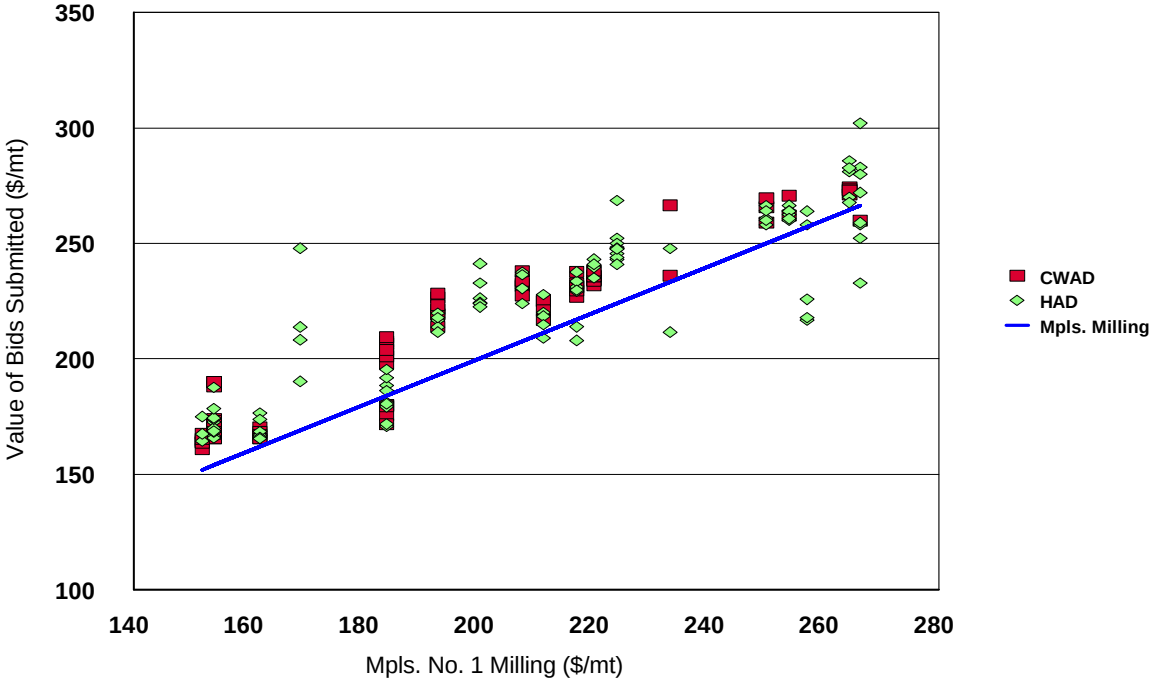


Figure 11. Relationship Between Bids for U.S. and Canadian Durum Wheat and Mpls. Milling Prices

For HAD, the effects of Canadian offers were significantly different from U.S. offers when examined using the pooled sample. Regression parameters indicated Canadian offers were more competitive at lower indicator values and less competitive at higher indicator values (lower intercept, higher slope) (Appendix Table 1). Estimated coefficients for Canadian effects on individual firms were not statistically significant for HAD. Results of F-tests were similar to those for HRS and indicated that effects of Canadian offers for HAD were not statistically significant (Appendix Table 2).

These results indicate that a supplier's bid function is not affected by whether Canadian origin is offered as an alternative. This suggests that the supplier's bidding behavior is the same for U.S. and Canadian wheats. Strategically, this suggests that at least in this market which uses very micro-data, there is no evidence that Canadian wheat is sold at a premium (as found in aggregate by Kraft, Furtan, and Tyrchniewicz). A fundamental reason for this is likely that this market is served by Accredited Exporters (AE) as opposed to CWB direct sales. Effectively, any potential premium would be captured by the AE through the tendering process.

Analysis of Bidding Strategies

Optimal bids for a prototypical bidder (Z) are developed in this section. These are derived using a stochastic simulation model (Winston, p. 91-94) based on past behavior of rivals (bid functions) and uncertainty about rivals' bids (prediction error or RMSE). Sensitivities are used to demonstrate effects of key variables on optimal bids and expected payoffs. Since effects of Canadian offers were not statistically different from bid functions representing both U.S. and Canadian origins, only bid functions representing firms' bids as a function of the cost indicator were utilized. However, as described below, the potential effect of offers of Canadian origin is interpreted as an increase in the number of offers, with an increase in random participation. The effects of other variables are examined including the effect of number of competitors, relative cost structures, informational uncertainty, and correlation of offers.

A base case bidding strategy for a prototypical supplier (Z) was derived and sensitivities conducted following Winston. The bid functions are used to generate bids by each competitor. The indicator value is a fixed value across competitors in estimating bids. Error terms for each rival are assumed to be normally distributed with a mean of zero and ó = RMSE. The uncertainty associated with the error term allows the bids of competitors to fluctuate over a representative range.

The effect of random bidders has an important impact on bidding strategies and auction results. In simple formulations (e.g., Monroe) these are captured by using a transformation including the portion of auctions in which the bidder participates. In the stochastic simulation, a binomial distribution was used to account for the randomness of each bidder participating. Specifically, each bidder was viewed as either bidding (1) or not bidding (0) with a distribution where the probability of bidding is from Table 2. For example, a binomial distribution with parameters (1, 0.75) indicates a bidder submits a bid 75% of the time. If the bidder submits a bid, their bid is represented by the function $B_t = á_0 + â_0 C_t + å_t$.

The probability of winning and expected payoff are derived for alternative bids submitted by Bidder Z. These values are derived over a range of alternative bids to determine that which maximizes expected payoffs, which is the optimal bid. Sensitivities are conducted to examine influences on the optimal bid. In the base case, C_Z=C=$205/mt for deriving bids for Bidder Z

(i.e., Z's cost is $205 and equal to the cost indicator applied to all rivals) for HRS and HAD and C_Z=C=$160/mt for HRW.

The Optimal Bid. The cost indicators, optimal bids, and the probability of winning for each class are shown in Table 7. These results indicate that in the case of HRS tenders, the cost for the Bidder Z and all rivals is C_k=C=$205/mt, and the optimal bid is $207.5/mt. The probability of winning at this level is .03 resulting in an expected payoff of $0.08/mt. That for durum is $211.5/mt with a probability of winning of .19 and expected payoff of $1.23/mt. For HRW, the optimal bid was $173.00/mt with a probability of winning of .38 and expected payoff of $4.91/mt. The reason for the apparent large difference in the expected payoff across classes is that different cost indicators were used.

Table 7 . Optimal Bids: Base Case Results for HRS, HAD, and HRW

Class	Cost (C_k) $/mt	Optimal Bid $/mt	Probability of Winning	Expected Payoff $/mt
HRS	205	207.50	.032	0.08
HAD	205	211.50	.189	1.23
HRW	160	173.00	.377	4.91

There are several important variables that affect these results. These include the number of bidders (n), the standard error of the bid functions (reflecting information), and the randomness of bidding.

***Number of Bidders*.** The impact of additional competitors reduces the probability of having the winning bid. Given the definition of P(W) (see p. 5); a reduction in the number of rivals would increase the probability of winning. Expected payoffs for different levels of competition are shown in Figure 12 and Table 8. To illustrate this effect, the probability of successfully underbidding all competitors was calculated. Each competitor is added successively based on their probability of participation.

The optimal bid, when competing against G was $211, with a probability of winning of .23 and expected payoff of $1.37/mt. Adding Competitor I reduces the optimal bid to $209/mt, probability of winning to .10, and expected payoff to $0.42/mt. For each additional competitor, the optimal bid, probability of winning, and expected payoff are decreased. If all competitors participate, the optimal bid is $206.5/mt, with probability of winning of 0.014, and expected payoff of $0.02/mt.

These results illustrate that the number of bidders has a critical effect on the optimal bid and expected payoff. In the case of import tenders represented by this data where an average of five firms submitted bids in each tender, there should be sufficient competition to assure intense rivalry.

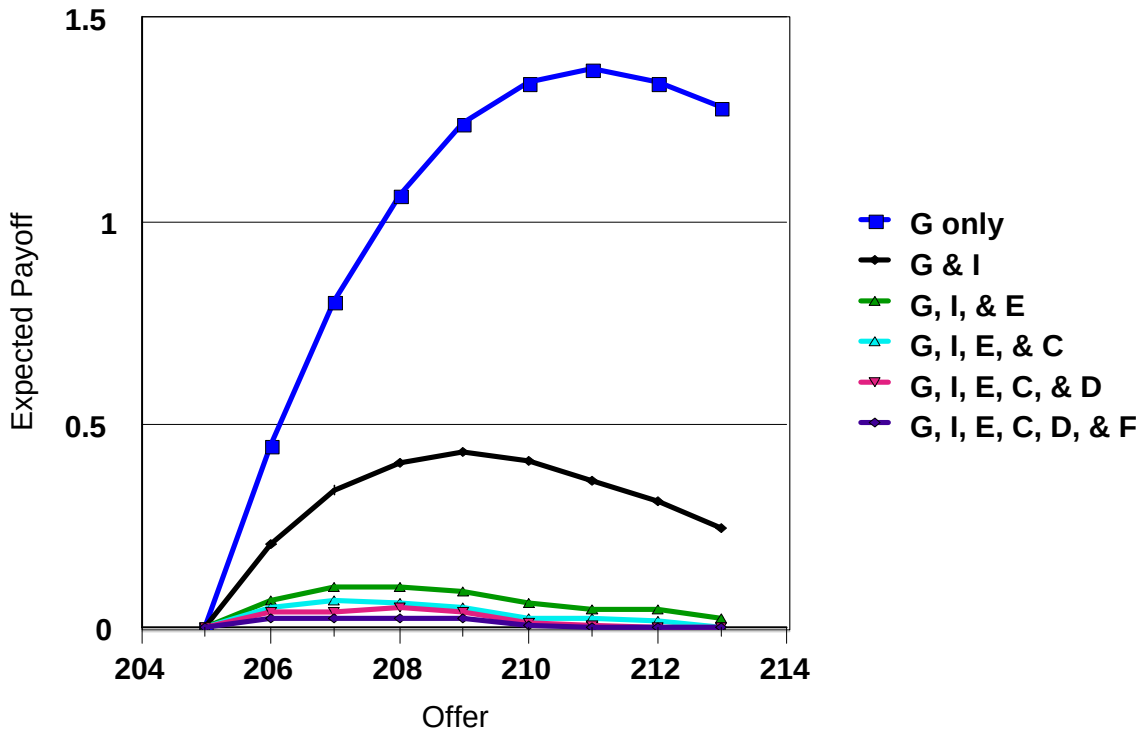


Figure 12. HRS Tenders: Effect of Number of Competitors on Expected Payoff

Table 8. HRS Tenders: Effect of Additional Competitors

Number of Bidders: Firms Included	Optimal Bid ($/mt)	Probability of Winning	Expected Payoff (Eð) ($/mt)
1: G	211	.229%	1.37
2: G, I	209	.104%	0.42
3: G, I, E	208	.036%	0.11
4: G, I, E, D	207	.036%	0.07
5: G, I, E, D, C	207	.025%	0.05
6: G, I, E, D, C, F	207	.015%	0.03
7: All Competitors	206.5	.014%	0.02

C_z=Cost=$205/mt

Random Bidders. Rivals do not participate in each tender. To examine the effect of random bidders, the base case results are compared to a case with 100% participation by all bidders (Table 7). The optimal bid in the base case is $207.5/mt, with a probability of winning of 0.032, and expected payoff of $0.08/mt. If all competitors bid in 100% of the tenders, these results are decreased to an optimal bid of $206.5, probability of winning of .014, and expected payoff of $0.02/mt. Thus, a reduction (increase) in randomness of bidding has the effect of reducing (increasing) the optimal bid and expected payoff.

Effects of Relative Cost Structure on Strategies. A key variable in formulating bidding strategies is the competitor's cost relative to the rest of the participants. In the base case, these are fixed at the same C&F value ($C=C_z$=$205/mt) and was derived as $190 FOB plus $15 for ocean shipping. Since FOB values do not vary substantially across competitors, the ocean freight rate was adjusted to illustrate the effect of cost differentials among competitors; or more likely, source of interfirm variability. The base rate of $15 was adjusted for Competitor Z by factors of .8, .9, 1.1, and 1.2 to measure the effect on optimal bids.

Results are shown in Table 9. At 80% (C_Z=$202/mt), the optimal bid is $205/mt, the probability of winning is .077, and an expected payoff of $0.23/mt. The optimal bid at 90% (C_Z=$203.5/mt) is $206.5/mt, with a probability of winning of .048, and expected payoff of $.14/mt. If Competitor Z is at a cost disadvantage of 110% (C_Z=$206.5/mt), the optimal bid increases to $209.5, and the probability of winning decreases to .015 with an expected payoff of $0.04/mt.

Table 9. HRS Tenders: Effect of Cost Structure

Cost-Adjusting Basis/Freight	Optimal Bid ($/mt)	Probability of Winning (%)	Expected Payoff (Eð) ($/mt)
80% (202.0)	205.0	.077	0.23
90% (203.5)	206.5	.048	0.14
Base (205.0)	207.5	.032	0.08
110% (206.5)	209.5	.015	0.04
120% (208.0)	210.0	.012	0.02

*Base C&F = 205
*FOB = 190
*Basis & Freight =15 (Adjusted for sensitivity)

These results indicate a significant advantage to a competitor with lower costs relative to the other participants. This competitor has a higher probability of underbidding competitors resulting in higher expected payoffs. However, if a competitor has higher costs relative to other participants, the best action may be to stay out of the auction.

Effects of Bidder Information on Strategies. Another key variable in determining optimal bidding strategies is information about rivals. In practice, various means are used to discern likely rival bids. Of particular importance is the revelation of bids in previous tenders. If

past bidding behavior is observable, a competitor has information that can be used to predict a rival's future behavior. The buyer/auctioneer may or may not choose to reveal such information after each tender.

The RMSE is a measure of informational uncertainty about bidding behavior of rivals. In the base case, the RMSE was that from the original bid functions. This is adjusted using a scalar from .5 to 2 to represent lesser/greater informational uncertainty and to measure the effect of information about rivals in formulating bidding strategies. Optimal bids are derived assuming the base case binomial distributions for participation by competitors. Results are shown in Table 10. At .5·RMSE, the optimal bid is $206.50/mt. As the informational uncertainty (RMSE) increases, the optimal bid increases. At 2·RMSE, the optimal bid is $209/mt.

These results have important implications for bidders and importers. An increase in RMSE for all competitors has the effect of increasing the optimal bid and expected payoff. For buyers/auctioneers, higher optimal bids and payoffs are undesirable. It is in the buyer's interest to adopt mechanisms to the extent possible to reduce the RMSE, or enhance the predictability of bidding behavior among bidders to intensify competition. This can be achieved by releasing information on bid results to participants--note, this would not eliminate bidder uncertainty, but would reduce it substantially.

The RMSEs varied slightly across the three classes of wheat. The range for HRS was 6-10, with Supplier F at 23. The range was 9 to 11 for HRW, with F at 21. The largest RMSEs were for the HAD market, with a range of 12 to 19. This greater informational uncertainty would have the effect of raising bids and payoffs for durum relative to HRS.

Table 10. HRS Tenders: Effect of Information

RMSE Factor	Optimal Bid ($/mt)	Probability of Winning (%)	Expected Payoff (Eð) ($/mt)
0.50	206.5	.036	0.054
0.75	207.0	.033	0.067
1.00	207.5	.032	0.080
1.25	208.0	.029	0.086
1.50	208.5	.026	0.091
1.75	208.5	.030	0.106
2.00	209.0	.025	0.099

C_x=Cost=$205/mt

Impacts of Canada Option on Bidder Strategies. The statistical analysis of bid functions for each bidder (firm) offering U.S. and Canadian wheat indicated that slope and interaction terms to account for Canadian offers were not statistically different. However, the probability of Canadian wheat being offered varies over time and across firms. To account for this effect, simulations were conducted where bidders, representing Canadian offers and the proportion of

time they bid, were incorporated. Canadian offers were treated as random with the probability of being offered represented by a binomial distribution. Hence, the Canada effect is interpreted as 1) an increase in number of bids (i.e., by the number of incumbents now offering U.S. and Canada); and 2) a component of randomness for offers being submitted. This means that the effect of Canadian origins is for an increase in randomness in bidding by firms offering Canadian origin.

Given N is already relatively large, the Canada effect should be viewed as highly minimal. The same bid functions are used by each competitor. The probability of each firm submitting an offer for Canadian wheat is calculated and incorporated into a binomial distribution. Probabilities were derived from the data to account for participating firms submitting U.S. origin, Canadian origin, or both.

Results are similar to the base case. The optimal bid is now $207/mt versus $207.50 in the base case, and the probability of winning is reduced from .032 to .017. The expected payoff is reduced from $0.08/mt to $0.03/mt. Thus, the effect of Canadian offers is to reduce the optimal bid by about $0.50/mt.

Effect of Correlated Bidders on Optimal Bid. In most cases values for bidders are different, but may be correlated (Rasmusen, p. 294).[8] To account for this effect, the model was modified to include the impact of correlations among bids and to determine their effects on optimal bids and probability of winning. This was simulated by imposing a correlation in the random draws of the errors in the estimated bid functions within the simulation. Correlations were estimated from the tender data for HRS by firm and are shown in Table 11. The model was simulated and results were then compared to the base case values for HRS.

Table 11. Estimated Correlations Between Firm Bids, HRS

	Firm C	Firm D	Firm E	Firm F	Firm G	Firm H	Firm I
Firm C	1.00	0.87	0.88	0.64	0.94	0.95	0.81
Firm D		1.00	0.86	0.64	0.78	0.74	0.69
Firm E			1.00	0.47	0.95	0.94	0.81
Firm F				1.00	0.84	1.00	0.79
Firm G					1.00	0.99	0.90
Firm H						1.00	0.98
Firm I							1.00

Estimated correlation coefficients between bidder's bids indicate a high degree of correlation exists among bidders. Many of the estimated correlation coefficients were greater than .8. Simulation results indicate that when the correlations among rival's bids are accounted for, the results change quite substantially. Specifically, the probability of winning increases (Figure 13) and the optimal bids increase from $207.5/mt in the base case to $210/mt when firms' correlated bids are included in the simulation. The expected profit for optimal bids also increased from less than $0.10/mt in the base case to more than $0.60/mt when bids are correlated. This is

[8] Typically auctions are categorized as "private" or "common" value (Rasmusen, P. 294). For "common" value auctions, the cost/value of the item is the same for all bidders and each bidder makes independent estimates of this uncertain value. For private value auctions, each bidder has their own independent valuation for an object which is unaffected by opponents' valuations.

caused by the greater correlation among firms' bids, which if incorporated, reduces the probability of an individual firm extending a bid widely divergent from opposing bidders' offers, thereby increasing the probability of winning.

Prospective Effects of Winner's Curse in Grain Tenders. The winner's curse has been used to describe outcomes of bidding situations whereby the result of winning the auction leads to extremely low or even negative profits. In the context of this auction, each rival submits a bid based on their expected cost of delivering the grain and expectations of rivals' bids. If the bidder wins the tender, he may have done so by having the lowest cost estimate relative to other competitors. This ultimately would be due to his cost estimate being biased relative to the true cost, and the winner is said to be "cursed" with negative profits (Wilson 1992; Thaler; Crampton). The problem of the winner's curse has been persistent in auction literature beginning with analysis of Outer Continental Shelf (OCS) oil leases (Capen, Clapp, and Campbell), and recently in auctioning of airwaves (Crampton), in virtual auctions and the sale of state-owned assets, and was highlighted as a major issue in risk analysis (Bernstein p. 244).[9] As noted by Coy in a recent *Business Week* article, the winner's curse is considered a part of doing business in many virtual auctions with one participant indicating it was analogous to "Collecting money from newbies who overbid because they're ill-informed," (Coy).

In a buyer's auction, bidders make offers based on cost expectations of rival behavior. The winner ends up offering it for less than expected costs. In other words, the winner's estimate of cost is biased downward. Winning means the bidder underestimated the cost. Though the estimate was originally unbiased, the winner's bid is biased once the winner finds out they won. Thus, the true value is likely more than originally estimated. Recognizing this problem should induce bidders to adjust their bids to account for the winner's curse. In import tenders, this should result in shading the bid upwards. The relevant estimate is the value "conditional on winning" (i.e., that your estimate was lowest among the rivals).

Wilson (1987), Crampton, and Winston outline procedures to measure the effect of the winner's curse in the case of buyers' auctions. Each rival has their estimate of the value of a tender with an unbiased error term. By winning the auction, a bidder may infer a bias in the error term. Wilson derives this normal bias factor, which is then divided by the standard deviation to obtain the standardized bias which indicates how much the estimated value is over (under) stated in a seller's (buyers') auction. This bias is then applied to the equilibrium bidding strategy to determine how much the bid should be shaded to account for this bias. The effect is impacted by the number of rivals and the amount of uncertainty.

We applied similar procedures to our wheat tender data to estimate the prospective impacts of the winner's curse.[10] Results are shown in Table 12 for HRS.[11] To illustrate the

---

[9] This is one of the motivations of the concerns about selling state-owned assets. As a result of the winner's curse, buyers pay more for the asset than they can recoup which may shift further investment in the industry (*The Economist*).

[10] Wilson (1987) applies this in a Nash Equilibrium setting, which is not necessarily the case in the current tender data for wheat. A key variable that is missing is the true cost for the winning competitor, which ultimately determines the degree of the winner's curse.

[11] A similar analysis was done for HAD and is presented in Appendix Table 3.

interpretation of these results, we refer to Competitor E that has the highest normal bias (sum of deviations between winning bid and competitors' bids is an average of $14.16/mt). This amounts

Thus, if E were to increase their bids by 7.7%, their estimate would be unbiased. In order to correct for the winner's curse, bidders should adjust their bids by this amount. The bias

However, this estimate of bias may overstate effects due to consideration of non-serious bidders as developed below.

winning bid and the next lowest alternative following Dyer and Kagel. This reduces the effect of non-serious bidders and also has a more direct economic interpretation (money left on the table).

Appendix Table 3 for HAD. Compared to results for the initial bias estimation, these should provide a prospective range for the effects of the winner's curse. Average differences between

the table varies widely across bidders. Average differences range from $0.40/mt for Bidder F to a high of $5.96/mt for Bidder D. This amounts to 0.2% to 3.1% of the value of the tender left on

however, the extent of change varies across bidders. For example, bias for Bidder E declines from 7.7% of value for the initial bias estimation to 1.8% when compared to the next lowest

alternative, respectively). These results suggest that the effect of the winner's curse in these wheat tenders could be as little as 0.2% of bid value to as large as 7.7%. Using this approach,

the winner's curse. Results for the normal bias estimations and comparisons to the next lowest competitor for HAD were similar to those for HRS, although bias as a percent of average bids

Table 12. HRS Tenders: Winner's Curse

Bidder	Bidder Characteristics		Derived Using All Rivals			Derived Using Next Lowest Rival	
	Avg Bid	Std. Pred. Bid	Normal Bias	Std. Bias	Percent Bias	Dif. Next Lowest Alternative	Percent Low Alt.
	$/mt	$/mt	$/mt	Std. Units	Percent	$/mt	Percent
C	180.31	8.24	6.58	0.80	3.7%	5.44	3.0%
D	194.78	6.44	10.24	1.59	5.3%	5.96	3.1%
E	184.48	8.10	14.16	1.75	7.7%	3.32	1.8%
F	204.46	23.62	9.38	0.40	4.6%	0.40	0.2%
G	184.53	8.01	3.57	0.45	1.9%	1.34	0.7%
I	189.21	6.48	11.16	1.72	5.9%	5.23	2.8%

*H never won a tender, so no bias could be calculated.

Summary/Implications

Auctions are used frequently in agricultural marketing, typically as a mechanism in procurement strategy. As such, auctions play two important roles, price discovery (or determination) and supplier selection (allocation). One of the more common forms of auctions in agriculture is by importers tendering for the purchase of grains. This study developed an analytical model of bidding and used actual firm and auction tender data to draw inferences about the effect of crucial variables on the tendering strategies and results. Though applied to the case of wheat importing, the results are generally applicable and provide some important insight into the form of competition and implications for buyers and sellers of these mechanisms (which, as it turns out, have escalated in importance in recent years, in part due to the Internet).

Wheat tender data were analyzed and bid functions generated by class of wheat (HRS, HAD, and HRW) and by firm. There were a number of characteristics of the bids and strategies that were interesting. First, there was a surprisingly wide range of bids. Variation of bids across firms submitted for individual HRS tenders had standard deviations that ranged from $5/mt or less in a number of tenders, to as high as $22/mt. Tenders for HAD show similar variability. Second, the spreads between bids and observed costs varied substantially among rivals. Third, it was common that some bidders only bid periodically. Fourth, the estimated bid functions were mostly significantly different among bidders. These results confirm that rivals have differing expectations of each other's bids, and also suggests that their fixed and marginal costs differ. Finally, the option of allowing the supplier to provide Canadian or U.S. wheat did not have a statistically significant effect on the bid functions.

A stochastic simulation model was used to analyze bidding strategies and optimal bids. Simulations were then conducted on some of the interesting variables to draw implications. Several results are of interest. First, optimal bids varied across the wheat classes and through

time, as expected. Expected payoffs were from as low as $.08/mt for HRS, to 1.23$/mt for durum, and even higher for HRW. These optimal bids were affected by a number of variables including the number of bidders (optimal bids fell with a larger number of bidders), the randomness of bidder participation (less frequent and more random bidding had the effect of increasing the optimal bid), relative supplier costs (firms with lower costs would have lower optimal bids), and information bidders have about their rivals' behavior. In the latter case, optimal bids decrease as bidders' information about each other increases.

The results are obvious, though the magnitude of the effects are interesting. There were three impacts that we analyzed that provide a little more insight into international wheat auctions. One was the impact of Canadian wheat being solicited as an option to U.S. wheat. Given the bid functions were not significantly impacted by this option, it was inferred that the effect was to provide an increase in the number of offers and by the randomness of Canadian wheat being offered. Taking these into account indicated that the impact of this Canadian option was to reduce the optimal bid by about 50c/mt relative to the base case. The second interesting effect was that of correlated bids among rivals which had the effect of raising the optimal bid. Finally, there is the effect of the winner's curse--a common problem in bidding competition whereby winning, a bidder likely has underestimated their cost and the probability of a negative payoff increases. Accounting for this effect illustrated the extent that bidders' costs are biased and by how much they should shade their bids in anticipation of the winner's curse.

These results have a number of implications for researchers trying to understand inter-firm and inter-country rivalry in this industry for buyers and for sellers. A few are identified. The results illustrate the effect that tendering has on inter-firm as well as inter-country competition. Specifically, even with as few as four to five suppliers, tendering has the effect of instilling intense competition among suppliers. From a buyer perspective, tendering is attractive, and in fact critical, given that buyers cannot observe costs and that suppliers' costs vary among each other and through time. The value of using a tender escalates as the number of bidders increases (even though it appears that a very large number is not critical), as information about bidders is more transparent, and as bidders' offers are less correlated. From a seller perspective, auctions can result in brutal competition among participants. To be successful in markets that take this form, it is essential that firms are low cost, that they have extensive information about their rivals' behavior and costs, and that they adjust their bids to reduce the effects of the winner's curse. Finally, in this case, there is no evidence that the single seller, selling through accredited exporters, is capable of significantly influencing the results.

References

Avery, C., and J. Kagel. 1997. "Second-Price Auctions With Asymmetric Payoffs: An Experimental Investigation." *Journal of Economics and Management Strategy* Vol. 6(3):573-603.

Bernstein, P. 1998. *Against the Gods: The Remarkable Story of Risk*. New York, NY: Wiley & Sons.

Beurskens, F. 1995. "Hog Producers Form Issue of Producer Independence." *Feedstuffs* November 25, pp. 14-17.

Boehlje, Michael. 1996. "Industrialization of Ag: What is it? What does it mean?" *Feedstuffs* November 25, pp. 14-17.

Bourgeon, J., and Y. LeRoux. 1996a. "Optimal Auction Theory and EC Grain Export." I. Sheldon and P. Abbott, ed., *Industrial Organization & Trade in the Food Industries*. Boulder, CO: Westview Press.

Bourgeon, Jean-Mark, and Yves LeRoux. 1996b. "Tenders for European Cereal Export Refunds: A Structural Approach." *European Review of Agricultural Economics* Vol. 23:5-26.

Capen, E. C., R. V. Clapp, and W. M. Campbell. 1971. "Competitive Bidding in High-Risk Situations." *Journal of Petroleum Technology* Vol. 23:641-653.

Cassady, R. 1967. *Auctions and Auctioneering*. Berkeley, CA: University of California Press.

Coy, P. 2000. "Going, Going, Gone...Sucker!: How ‹winner's curse' could undermine online auctions." *Business Week* March 20, pp. 124-125.

Crampton, P. 1995. "Money Out of Thin Air: The Nationwide Narrowband PCS Auction." *Journal of Economics & Management Strategy* Vol. 4(2):267-244.

Dutta, Prajit. 1999. *Strategies and Games: Theory and Practice*. Cambridge, MA: The MIT Press.

Dyer, Douglas, and John H. Kagel. 1996. "Bidding in Common Value Auctions: How the Commercial Construction Industry Corrects for the Winner's Curse." *Management Science* October(1):463-75.

Engelbrecht-Wiggans, Richard. 1980. "Auction and Bidding Models: A Survey." *Management Science* Vol. 26:119-142.

Estey, W. 1998. *Grain Handling and Transportation Review: Final Report*. Report to the Honorable D. Collennette, Minister of Transport, Canada, Dec. http://www.grain.gc.ca.

Hausch, Donald B., and Lode Li. 1993. "A Common Value Auction Model with Endogenous Entry and Information Acquisition." *Economic Theory* Vol. 3:315-334.

Hughart, D. 1975. "Informational Asymmetry, Bidding Strategies, and the Marketing of Offshore Petroleum Leases." *Journal of Political Economy* Vol. 83(5):969-985.

Klemperer, Paul. 1999. "Auction Theory: A Guide to the Literature." *Journal of Economic Surveys* Vol. 13(3):227-286.

Kottas, J., and B. Khumawata. 1973. "Contract Bid Development for the Small Businessman." *Sloan Management Review* Vol. 14(Spring):31-45.

Kraft, D., H. Furtan, and E. Tyrchniewicz. 1996. *Performance Evaluation of the Canadian Wheat Board*. Winnipeg, Manitoba.

Kroeger, A. 1999. *Stakeholder's Report.* Letter to the Honorable D. Collennette, Minister of Transport, Canada, Sept. http://www.tc.gc.ca/railpolicy/kroeger .

Latacz-Lohmann, Uwe, and Carel Van der Hamsvoort. 1997. "Auctioning Conservation Contracts: A Theoretical Analysis and an Application." *American Journal of Agricultural Economics* Vol. 79(May):407-418.

Lilien, Gary L., and Philip Kotler. 1992. *Marketing Models.* Englewood Cliffs, NJ: Prentice-Hall.

Maixner, E. 1999. "Mandatory Price Reporting Will Change Industry Structure." *Feedstuffs* Vol. 71(26):8, June 18.

McAfee, R. P., and J. McMillan. 1987. "Auctions and Bidding." *Journal of Economic Literature* 25:699-738, June.

McAfee R. P., and J. McMillan. 1996. "Analyzing the Airwaves Auction." *Journal of Economic Perspectives* Vol. 10(1) Winter:159-175.

Milgrom, Paul. 1989. "Auctions and Bidding: A Primer." *Journal of Economic Perspectives* Vol. 3(3) (Summer):3-22.

Milgrom, Paul. 1985. "The Economics of Competitive Bidding, A Selective Survey." In L. Jurwicz, D. Schmeidler, and H. Sonnenschein (eds.) *Social Goals and Social Organizations*. Cambridge, UK: Cambridge University Press. pp. 216-289.

Moharty, S., W. Peterson , and N. Kruse. 1995. "Price Asymmetry in the International Wheat Market." *Canadian Journal of Agricultural Economics* Vol. 43(November):355-366.

Moharty, S., W. Peterson, and D.B. Smith. 1996. "Relationships between U.S. and Canadian Wheat Prices: Cointegration and Error Correction Approach." *Canadian Journal of Agricultural Economics* Vol. 44(November):265-276.

Monroe, Kent B. 1990. "Developing Competitive Bids." Chapter 17 in *Pricing: Making Profitable Decisions*. New York, NY: McGraw-Hill.

Nagle, T., and R. Holden. 1994. "Pricing with uncertainty: Techniques for analyzing complex pricing decisions." *The Strategy and Tactics of Pricing: A Guide to Profitable Decision Making*, 2nd Edition. Englewood Cliffs, NJ: Prentice Hall.

Phlips, Louis. 1988. *The Economics of Imperfect Information*. New York, NY: Cambridge University Press, p. 281.

Rampton, Roberta. 1999. "CWB not tiled by new Japanese tendering system." *The Western Producer*. Modern Press, Saskatoon, (July 8):15.

Rasmusen, Eric. 1994. *Games and Information: An Introduction to Game Theory*, 2nd Edition. Cambridge, MA: Basil Blackwell, Inc.

Rothkopf, M. H., and R. M. Harstad. 1994. "Modeling Competitive Bidding: A Critical Essay." *Management Science* Vol. 40(3)(March):364-384.

Scheid, J. 1995. "Price Discovery Changes with Meat Industry." *Feedstuffs* Vol. 67(10) (March 6):1,4.

Sewall, M. 1976. "A Decision Calculus Model for Contract Bidding." *Journal of Marketing* Vol. 40(October):92-98.

Sexton, R.J. 1994. "A Survey of Noncooperative Game Theory with Reference to Agricultural Markets: Part 2. Potential Applications in Agriculture." *Review of Marketing and Agricultural Economics* Vol. 62(2):183-200.

Thaler, Richard H. 1992. *The Winner's Curse: Paradoxes and Anomalies of Economic Life*. Princeton, NJ: Princeton University Press.

The Economist. 2000. "What am I Bid?" *The Economist* May 6. pp. 80.

USDA-AMS. Various Issues. Grain Transportation Report. USDA-Agriculture Marketing Service. http://www.ams.usda.gov/tmd/grain.htm#1999 Grain Transportation Reports.

Wilson, R. 1987. "Introductory Note: Trading Procedures," In *Analytical Foundations of Pricing Strategy*. Stanford, CA: Stanford Business School, Version 10, September 362-N2.

Wilson, R. 1992. "Strategic Analysis of Auctions." Chapter 8 in *Handbook of Game Theory with Economic Applications* Vol. 1:228-279, Edited by Robert Aumann and Sergiu Hart. North Holland, Amsterdam, 1992.

Wilson, W. W., and B. L. Dahl. 1999. *Transnational Grain Companies: Evolution and Strategies in North America*. Ag. Econ. Rpt. #412, Department of Agricultural Economics, North Dakota State University, Fargo.

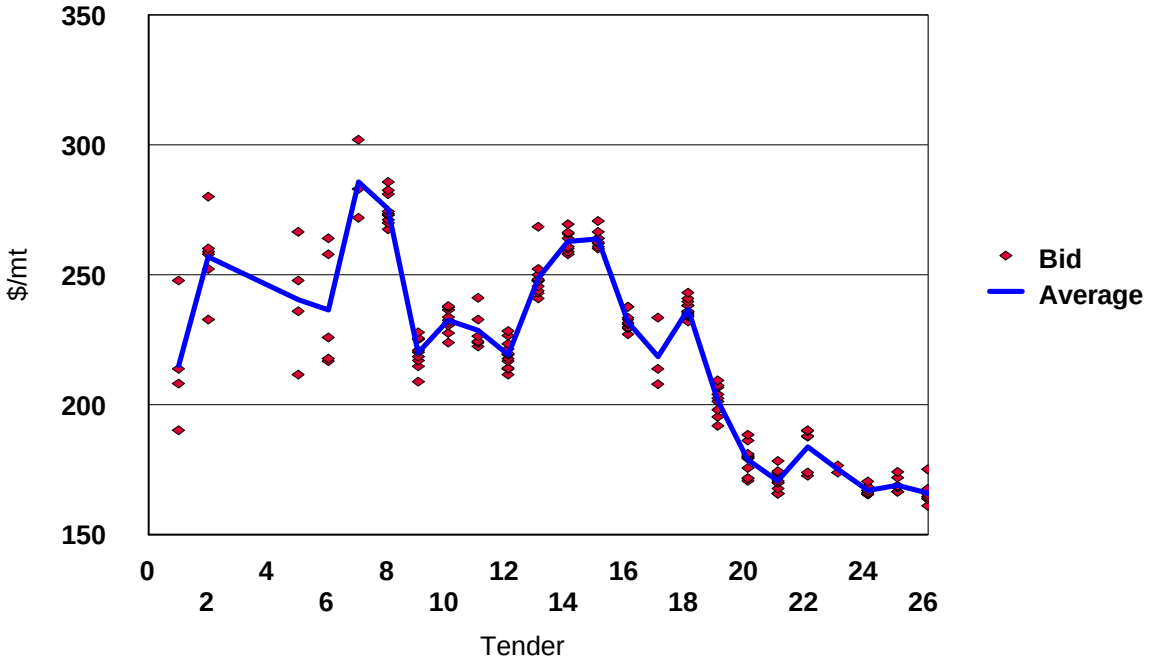
Wilson, William W., and Matthew A. Diersen. 1999. *Competitive Bidding on Import Tenders: The Case of Minor Oilseeds*. Ag. Econ. Rpt. #428, Department of Agricultural Economics, North Dakota State University, Fargo.

Wilson, W. W., B. L. Dahl, and D. Johnson. 1999. *Transparency and Bidding Competition in International Wheat Trade*. Ag. Econ. Rpt. #414, Department of Agricultural Economics, North Dakota State University, Fargo.

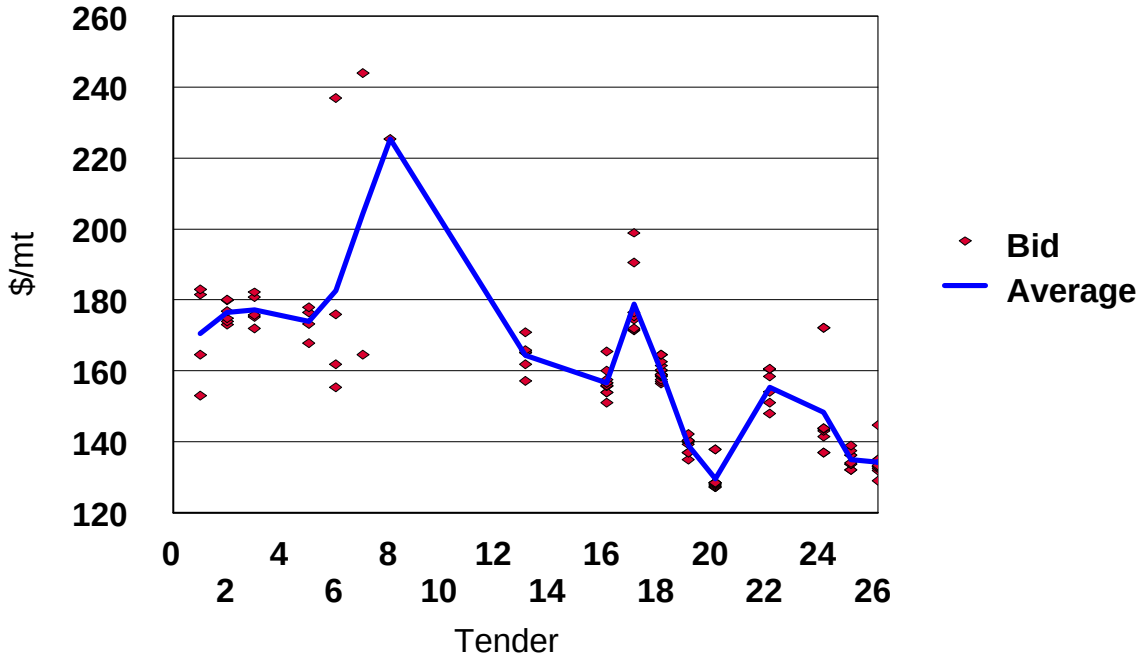
Wilson, William W., S. Priewe, and Bruce Dahl. 1998. "Forward Shipping Options for Rail: A Strategic Risk Analysis." *Journal of Agriculture and Resource Economics* Vol. 23(2):526-544.

Winston, Wayne L. 1996. *Simulation Modeling Using @Risk*. Belmont, CA: Duxbury Press.

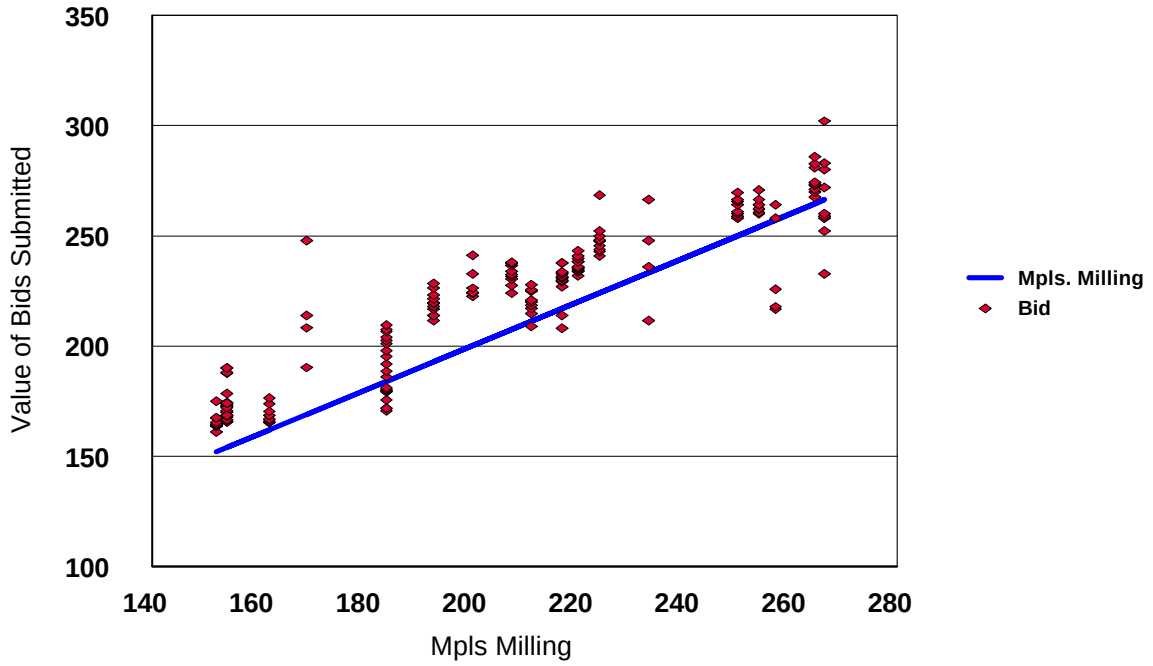
Appendix



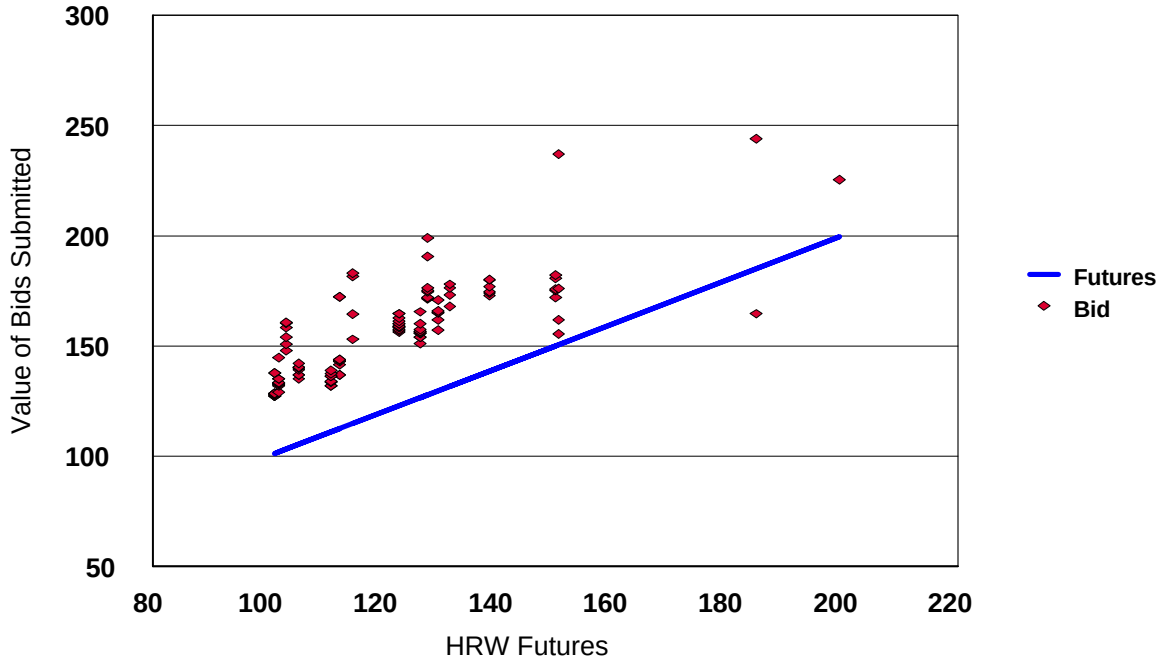
Appendix Figure 1. HAD Bid Values



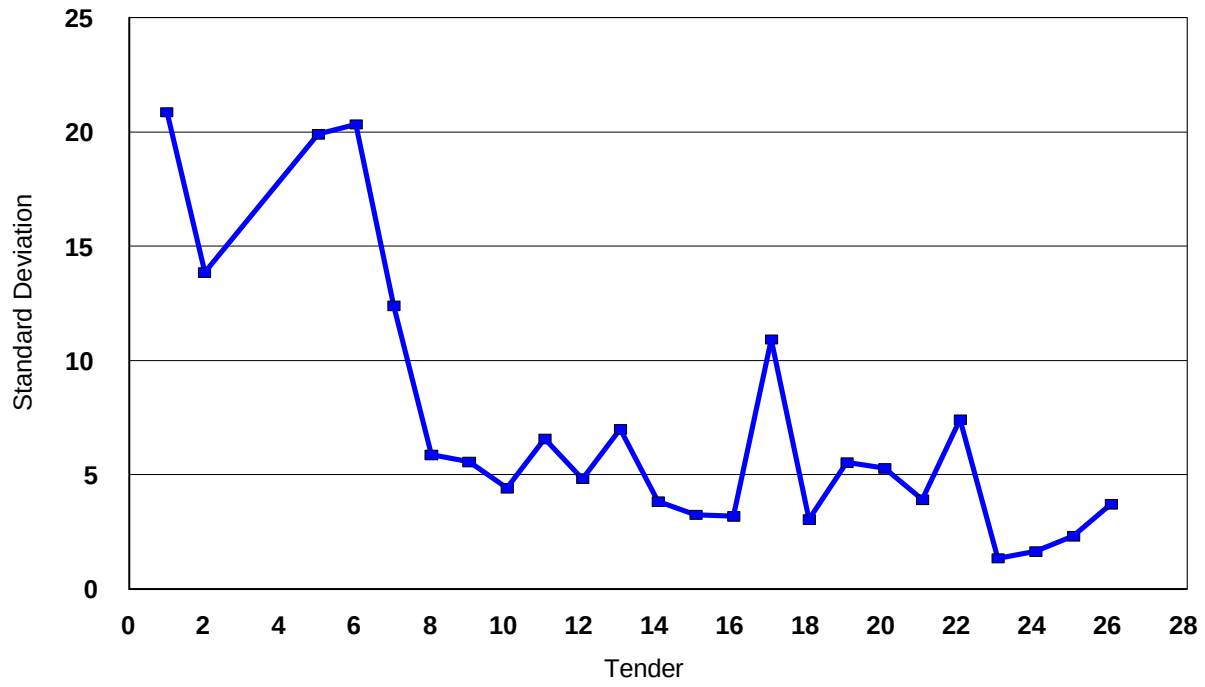
Appendix Figure 2. HRW Bid Values



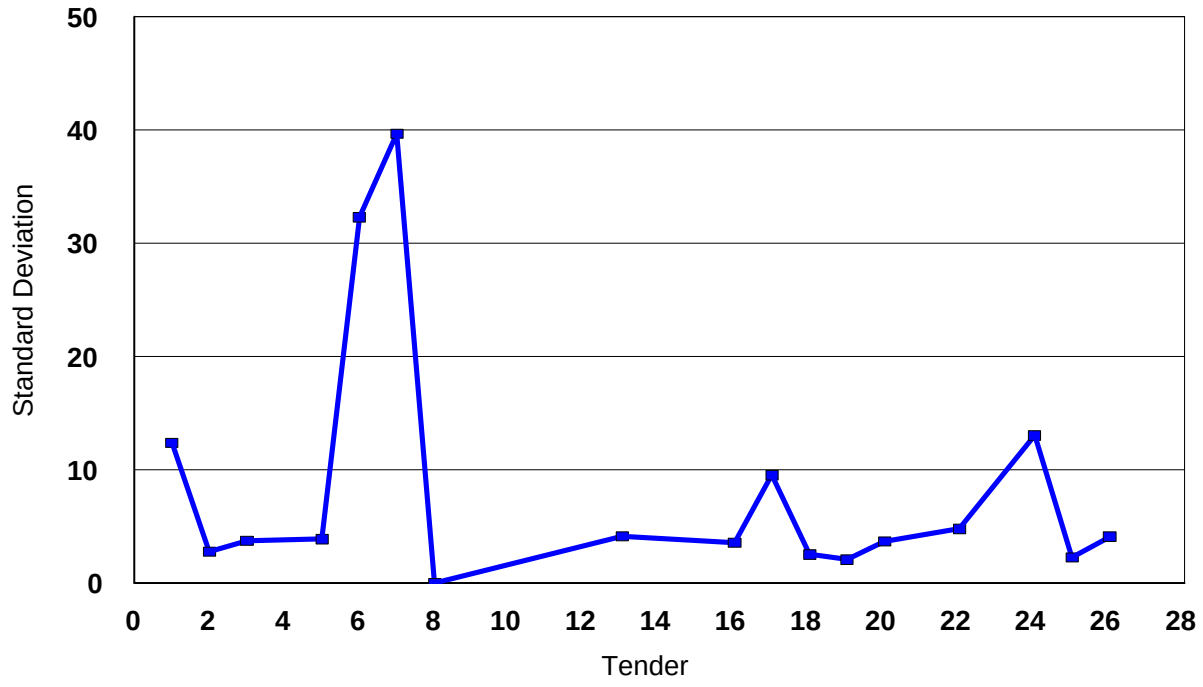
Appendix Figure 3. Relationship Between HAD Bids and Mpls Milling Durum Prices



Appendix Figure 4. Relationship Between HRW Bids and KC HRW Futures Prices



Appendix Figure 5. HAD Standard Deviation of Bids Within Tenders



Appendix Figure 6. Standard Deviation of HRW Bids, by Tender

Appendix Table 1. Impact of Canadian Offers on HAD Bid Functions

Bidder	# of Bids	Intercept ($á_0$)	Slope ($â_0$)	Int. Adj. ($á_R$)	Slope Adj. ($â_R$)	RMSE	R2
pooled	180	44.47	0.85	-25.36**	0.13**	13.9	.85
C	26	48.23	0.83	-41.90	0.24	11.8	.88
D	26	39.47	0.89	-22.18	0.10	15.2	.86
E	36	31.86	0.91	-16.62	0.07	12.2	.89
F	16	111.32	0.56	-8.02	*	19.6	.42
G	33	50.31	0.84	-50.57	0.24	14.1	.87
H	14	0.57	1.05	18.87	-0.07	13.9	.87
I	29	28.82	0.91	12.41	-0.03	15.5	.82

* Model not at full rank.
** Statistically significant p=.05.

Appendix Table 2. HAD Tenders: F-test Results

Bidder	Critical F	Int. Adj. ($á_R$) F-calculated	Slope Adj. ($â_R$) F-calculated
C	4.28	1.96	0.14
D	4.28	0.38	0.02
E	4.14	0.38	0.19
G	4.17	2.88	0.41
H	4.84	0.10	0.35
I	4.23	0.01	1.39

*Fail to reject H_0: B_0 is not significantly different from zero.

Appendix Table 3. HAD Tenders: Winner's Curse

Bidder	Bidder Characteristics		Derived Using All Rivals			Derived Using Next Lowest Rival	
	Avg Bid	Std. Pred. Bid	Normal Bias	Std. Bias	Percent Bias	Dif. Next Lowest Alternative	Percent Low Alt.
	$/mt	$/mt	$/mt	Std. Units	Percent	$/mt	Percent
C	207.4	11.76	4.34	0.37	2.1%	0.00	0.0
D	223.9	14.71	9.72	0.66	4.3%	2.02	0.9
E	220.5	11.94	6.52	0.55	3.0%	2.41	1.1
F	238.3	19.01	17.49	0.92	7.3%	10.83	4.5
G	218.0	14.40	20.50	1.42	9.4%	11.00	5.1
I	220.9	15.31	15.12	0.99	6.8%	7.44	3.4

*H never won a tender, so no bias could be calculated.