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Transparency and Bidding Competition in International Wheat Trade

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

One of the major trade policy problems identified by U.S. interests, including grower groups, traders, and policymakers, is that of pricing transparency. This has been a gnawing issue generally related to the pricing practices of competitor exporting countries with state trading enterprises (STEs). The transparency problem generally refers to the inability to observe rivals' terms of trade (including price, quality, credit, etc.) and is normally associated with commercial exporters competing against STE rivals. The perception being the less transparent competitors (STEs) would have a strategic advantage. A game theory model of bidding competition was developed to simulate the effects of information asymmetry amongst rivals. A Bayes-Nash equilibrium was used to derive equilibrium solutions. Several stylized examples were used to illustrate aspects of competition and to analyze effects on bidding strategies.

Results indicate that: 1) anything that reduces uncertainties among rivals would reduce equilibrium bids and prices; 2) bidding situations in which there is less transparency have the effect of increasing bids and prices to buyers, and payoffs to sellers; and 3) increases in the number of rivals have the effect of reducing bids and mitigating the informational advantages of STEs. In all cases, less transparent sellers have an advantage in bidding competition relative to more transparent sellers. That advantage in our stylized case was in the area of 1-2$/mt. However, that advantage is mitigated with an increase in the number of transparent rivals and in the case where more transparent players have acted as agents for an STE and have more information about costs of an STE. Further, cessation of exports under U.S. EEP programs should have decreased the transparency of U.S. firms, increasing their competitiveness in the international grain trade.

Key Words: Price Transparency, Strategic Bidding, Game Theory, Bayesian-Nash, State Trading Enterprises, Export Enhancement Program, Wheat.

HIGHLIGHTS

One of the gnawing issues identified by U.S. interests in recent trade negotiations is the price transparency problem. This emerged as a problem following the CUSTA and NAFTA and persisted throughout the last round of GATT negotiations. Transparency problems generally refer to the inability to observe rivals' terms of trade (including price, quality, credit, etc.). This is normally associated with the effects of commercial exporters competing against STE rivals and the perception that by being less transparent, the latter would have an advantage. However, issues related to the lack of transparency, though normally discussed in the context of price, are prevalent in other terms of trade. These include credit terms and allocations, quality specifications, and suspicion that excess quality is shipped to importers, as well as logistical terms. Transparency is also sometimes used interchangeably with another perplexing and controversial trade practice called price discrimination. These concepts and their effects differ substantially. In addition, though issues of price transparency are discussed in this paper in the context of international grains competition and the effects of STEs, it is important that similar problems are emerging throughout the agribusiness sector.

This paper explores strategic implications associated with the transparency of prices for competition among sellers in the international grains sector. First, the concept is defined and characteristics of the market place that facilitate and detract from transparent prices are described. Then, a game theory model of bidding competition was developed to simulate the effects of information asymmetry amongst rivals. A Bayes-Nash equilibrium was used to derive equilibrium solutions. Numerous stylized examples were used to illustrate aspects of competition and to analyze effects on bidding strategies.

In all cases less transparent sellers have an advantage relative to more transparent sellers. Indeed, this is an important analytic result of many previous game theory analysis of auctions. These results generally confirm this; however, in addition, it puts into perspective the prospective impacts of informational advantages and disadvantages. Below are some of the significant findings.

In the base case model with symmetric information, i.e., in which all rivals were similarly transparent (mean cost of $150/mt and standard deviation about rivals' cost of $3/mt), equilibrium bids were $151.26 and expected payoffs for all firms were identical. An increase in uncertainty about all rivals' cost to $10 results in an increase in equilibrium bids to $154.30, or by $3.04/mt. In addition, expected payoffs for all rivals increase. Further, if any firm were able to lower their costs relative to rivals, this would yield advantages, as expected.

An asymmetric model was also solved to assess the prospective impacts of opaque rivals. In the base asymmetric case there were four rivals, two of whom were assumed to be less transparent, as typical of STEs (i.e., STEs have better information about commercial rivals, that the latter have about STEs). Results were particularly interesting. Relative to the equilibrium results with symmetric rivals, the results indicate: 1) all rivals increase their bids; and 2) the more transparent rivals increase their bids more than the less transparent STEs. As a result of these, the less transparent STEs gain a competitive advantage, increasing their probabilities of winning, and their expected payoffs. In our stylized case this amounts to an advantage of about $0.49/mt.

The effect of EEP was to increase transparency about U.S. sellers relative to STE rivals. Simulations constructed to examine the effects of EEP indicate that increasing the transparency of the more transparent players increases the advantage of the more opaque players. As expected, eliminating EEP which had the effect of reducing the transparency of U.S. sellers, enhances the advantage of U.S. firms and reduces that of STEs.

The number of bidders has important effects on the structure of competition among sellers. However, this is also affected by the composition of sellers. Results illustrate that as the number of rivals increases, competing against two STEs, the optimal bids diminish and the advantage of the opaque players declines. However, as the composition of sellers that are less transparent increases, the equilibrium bids increase. Finally, the model was used to simulate the informational implications of STEs selling through agents or accredited exporters. In this case, the agent is able to reduce the informational advantage of the STE.

These results have numerous implications for participants in the international grain trading industry. First, buyers of grain are particularly influenced by the form of competition because it affects the prices (or bids) they pay for grains bought through bidding competition. These results indicated:

1) anything that reduces uncertainties among rivals would reduce equilibrium bids and prices;

2) bidding situations in which there is less transparency have the effect of increasing bids and prices to buyers, and payoffs to sellers; and

3) increases in the number of rivals have the effect of reducing bids and mitigating the informational advantages of STEs.

Competition among sellers has always been intense and firms have pursued different strategies. These results illustrate and confirm that being low-cost relative to rivals is an immense advantage. In addition, as the number of rivals increases, the equilibrium bids and expected payoffs diminish. However, this conclusion depends on the composition of competitors. As the number of rivals increases, the advantage of STEs diminishes. Information has always had an important role in competition amongst sellers in international grain trading. Commercial sellers seek to develop comprehensive and efficient information systems about demand, competition, prices, etc. Similarly, an important source of alleged disadvantage in the past for STEs has been their less developed/comprehensive information systems. In both cases information is critical. These results illustrate that more uncertainty about costs among rivals results in increases in equilibrium bids (for selling) and expected payoffs for sellers. However, an increase in less transparent competitors has the effect of reducing the advantage of the transparent sellers, though the overall price level is increased.

The effect of less transparent sellers in international transactions on sales prices is clear. Specifically, the incidence of less transparency among sellers has the effect of raising prices to buyers. However, at least from this analysis, we are unable to discern the impact on producer prices.

One of the motivations for this study was to understand the impacts of lack of transparency in international grains on producers. Allegedly producers in countries with highly transparent market systems (e.g., U.S.) view that they are disadvantaged in bidding competition relative to rivals that are less transparent--typically STEs. These results confirm this allegation. In all cases less transparent sellers have an advantage in bidding competition relative to more transparent sellers. That advantage in our stylized case is in the area of 1-2$/mt. However, that advantage is mitigated with an increase in the number of transparent rivals and in the case where more transparent players have acted as agents for an STE and have more information about costs of an STE. Further, cessation of exports under U.S. EEP programs should have decreased the transparency of U.S. firms, increasing their competitiveness in the international grain trade.

Transparency and Bidding Competition in International Wheat Trade

William W. Wilson, Bruce L. Dahl, and D. Demcey Johnson*

1. Introduction

One of the major trade policy problems identified by U.S. interests, including grower groups, traders, and policymakers, is that of pricing transparency. This has been a gnawing issue for some time and generally relates to the pricing practices of competitor exporting countries with state trading enterprises (STEs). It has been particularly problematic in trying to reconcile and resolve differences between the United States and Canadian grain trading interests as the systems are converging toward harmonization under freer trade. The transparency problem generally refers to the inability to observe rivals' terms of trade. Though the focus of this paper is on international grain trading, it is important to point out that similar problems are emerging in many agribusiness sectors. Certainly with the escalation in vertical integration, contracting, and concentration in many sectors, there has been less public information about prices and terms governing transactions.[1] While there are broader concerns, including distortion of producer allocation decisions, more important are the strategic implications for competition among rivals.

In the case of international grains, it is interesting that despite the industry being relatively concentrated among a few players, there seems to be a strong desire by trading firms and organizations to be less transparent. This is contrary to some conventional dynamic rivalry models, which suggest that more open or non-secret transactions should be desirable (Besanko, Dranove, and Stanley, p. 376). More recently, Dutta concluded that "every type of firm, and not just the more efficient ones, will find it in its best interest to reveal information about its costs." (Dutta, p. 338). Yet we observe 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. Similarly, an important element of competition among multinational firms is their apparent appetite for developing extensive and proprietary information networks. Indeed, firms without extensive information are thought to be disadvantaged (see below).

The purpose of this paper is to analyze the strategic implications of price transparency in the international grain trade. The focus is on competition within this sector, including the effect of STEs. However, the model and results are general and could be applied in other agribusiness sectors. The first section below provides a description of what is meant by price transparency and how it relates to other trade issues. The following section develops the model. Section 4 presents the results of simulations using a game theory model of competitive bidding. Simulations

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[1]See Beurskens; Boehlje; and Scheid for discussions of these problems in the agribusiness sectors.

are conducted on several stylized problems typical of the international grains sector and comparisons are made to illustrate the effects of alleged transparency on competition. The final section provides a summary and set of conclusions relevant to the evolution of this problem.

2. Elements of Problem

Prior to defining price transparency, it is important to distinguish it from several related concepts. First, transparency is frequently used to describe price discrimination which is another practice in international grain trade about which there are concerns. Indeed one of the more thorny issues emerging in current trade discussions relates to price discrimination. Though the terms price transparency and discrimination are often used interchangeably; they differ in concept and effect. Price discrimination is defined as "the same commodity is sold to different customers for different prices" (Phlips 1985, p. 5). Equivalently, price discrimination may occur when/if different quality products are sold to different customers at the same price. Skully; Goodwin and Smith; and Smith, Goodwin, and Holt analyze the economics of price discrimination in the international grains trade.

Second, among U.S. policymakers, much of the discussion about transparency concerns questions about the extent that STEs engage in unfair trading practices.[2] Specifically, prospective violations of international and bilateral trade agreements are nearly impossible to detect without disclosure of pricing information.[3] It is argued, that the lack of pricing transparency allows unfair trading practices to go unchallenged, or hidden subsidies to remain undetected.

Finally, though the focus of this paper is strictly on transparency with respect to price, it is important to note that similar problems exist with respect to other terms of trade. These include, for example, quality specifications, premiums and discounts, and credit and logistics terms. In addition, exporting countries differ in their reporting of export sales and credit allocations, thereby making their sales less transparent than those of the United States.

2.1. Competition in Grain Trading, Information, and Transparency

Much of the world grain trade is conducted using some form of competitive bidding. Tenders are one of the more important mechanisms of bidding competition, especially for foreign

[2]For reference to discussions of these problems among U.S. policy makers, see as example: Ackerman (1996); Chadwick (1992); Fegley (1999); Rominger (1996); and the U.S. Government Accounting Office (1992, 1994, 1995, and 1998).

[3]For discussion, see Ackerman 1998.

buyers of U.S. grains, oilseeds, and related products.[4] Information is a crucial element in determining bids among competitors in export tenders, as in other bidding situations.[5] Firms with more refined information enjoy a competitive advantage.

The role of information has been a very important element in understanding the sources of economies and competitive advantage among grain marketing firms. Caves identified information as a crucial source of competitive advantage in commodity-based business such as the grain trade. In fact, during much of the period from the 1970s through the mid-1980s, grain trading firms sought to develop competitive advantage based on their informational networks. During this period these firms likely had informational advantages relative to STE rivals that relied less on their own overseas agent network. Information has a number of important characteristics which influence the grain industry. Most important is that it involves a high fixed cost, thus yielding substantial economies. Second, it is perishable. Generally, grain trading firms have pursued strategies to build extensive overseas networks (through either direct sales or agents) and vertical integration. In each case information procurement is an important element motivating these strategies.[6]

Despite much public interest in the topic of price transparency, there have been few attempts to give it rigorous definition, or to interpret its strategic effects for firms or economic implications for policymakers. We define price transparency relative to the information symmetry among rivals. Specifically, if rivals have symmetric information about each other none would have an informational advantage in bidding competition. In this case, each rival would be transparent. In contrast, if one firm has better information about rivals than the rivals have, it would be less transparent, or *opaque*. In this case, the opaque rival would have an advantage in bidding competition.

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[4]Recently, W. Weisensel (Head of corporate policy at the CWB) described CWB operations to a court challenge in Federal Court in Calgary, Nov. 6, "Bidding is common in Japan ...When making an offer, the price has to be competitive with what Americans offer for equivalent grains" (Duckworth). This emphasizes the importance of bidding as a transaction mechanism. Auctioning is also used as a form of selling in several important segments of international grain. Bourgeon and LeRoux, (1996a,b) discuss the use of auctions to allocate EU export restitutions.

[5]The popularity of import tenders is likely due to the large volume of commodities being procured, which means that small deviations in price can have a large impact on total cost. Another reason is that importers are uncertain about the value of marketing costs, which vary through time and across potential exporters; this discourages a priori selection of an individual supplier. In many cases there are institutional mechanisms that favor a tendering process. Examples include the administration of export programs, international financing arrangements, and internal import control mechanisms (e.g., exchange controls) in some countries.

[6]Cook suggested that the grain exporting industry would likely evolve to include two strategic groups. One was physical asset intensive, the other was more informationally intensive.

Others have described this concept, in a similar vein. In its simplest terms, price transparency is a "lack of price disclosure" (Sosland Publishing Co., 1994). Furtan described transparency as "the extent that details of transactions made by a purchasing or selling agent are available to the public. These transaction details may include unit selling prices and acquisition costs, volumes bought and sold, and any other contract terms indirectly affecting the transaction such as financing arrangements, commodity specifications, and other stipulations" (Furtan, p. 1- 2). In defining transparency to be a major trade problem to a Canadian audience Glickman stated (as quoted in Wilson 1999) indicated that transparency in the global world trading system is "So people know the market prices and volumes and producers know on a fairly instantaneous basis what's happening, who's getting what for what dollars." He went on to indicate that transactions in the United States. "Are more transparent than they are in most places in the world, including Canada." But Minister Goodale responded by indicating that the CWB is subject to audits, bids on some public tenders and makes more financial information available than do private companies."

2.2. Factors Contributing to the Price Transparency Problem

Several aspects of the world grain trade affect the transparency problem.[7] First, it is important that many aspects of the U.S. marketing system make their prices and costs for marketing functions highly transparent to rivals. These include public reporting of prices, basis, export tenders, sales and inspections, and public tariffs for transportation and handling services. Second, in many cases, rivals have more refined information about the reservation values of U.S. trading firms than they do for single-seller agencies. The vast majority of transactions for U.S. domestic and offshore sales are made through formal or informal bidding processes. Further, results of all sales made under export assistance, including PL480 and EEP, are reported publicly. These dissemination mechanisms do not have counterparts in Canada or Australia. The cumulation of these generally makes U.S. exporters more transparent than their rivals.

The U.S. EEP also had important effects on inter-country competition and on the structure of competition among grain firms.[8] One was that it increased the level of price and demand transparency in the market, affecting both inter-firm and inter-country competition (Wilson and Dahl, pp. 40-42). The auctioning mechanism used to execute EEP transactions resulted in demand (quantity, quality, timing) and prices being publicly released and revealed to all competitors. Administration of the bidding mechanism resulted in near instantaneous disclosure

[7]Though the focus here is on transparency with respect to prices, similar problems exist with respect to other strategic variables. Notably these include credit allocation decisions and quality supplied (i.e., protein in excess of specification, etc.). In each of these cases, the United States appears to be much more transparent than STE rivals.

[8]Sosland indicated "... the cessation of export subsidies has exerted a tremendously beneficial effect not just on the competitive pace of export business, but on the economics of the grain trade itself. Eliminating the stultifying impact of daily subsidy decisions has lifted a weight from the industry's shoulders..." (Sosland Publishing Co., Feb. 1996).

of bids by importers and EEP allocations to winning bidders (exporters). This information, along with a fairly public knowledge of market values and transformation costs, resulted in U.S. export prices being publicly disclosed and, therefore, highly transparent. Competing countries gained tremendous informational advantages (relative to a less transparent system), making their sales decisions relatively easy. In addition, information asymmetries among grain exporting companies were reduced, and firms who had previously established informational advantages saw these advantages reduced. Firms or selling organizations not having extensive informational networks gained advantage relative to incumbent firms.[9]

A second factor contributing to the transparency problem is particularly acute for the types of grains that are contentious in North America, barley and durum wheat. Neither of these had a futures market (facilitating price discovery)[10] and the cash markets have become highly decentralized, inhibiting accurate price reporting using conventional methods.[11] In addition, these are grains in which the potential for large premiums and discounts for quality deviations is substantial. Taken together, this has created a high degree of uncertainty about reservation values (or procurement costs) for all market participants.

There are some unique and important characteristics of STEs that both exacerbate and mitigate the transparency problem. Comparable mechanisms that result in highly transparent prices in the United States do not exist in countries where STEs dominate. Open price discovery and dissemination, marketing costs, and public reporting of exports are generally lacking in these countries, in contrast to the United States. An exception is the establishment of a single North American price by the CWB (which replaced the two-price policy as a result of CUSTA) in which prices are offered weekly and widely distributed.[12] The extent that actual transaction prices conform to these values is not clear, but it is a direct example of the CWB becoming more transparent, at least for transactions within North America. This would have the effect of mitigating the transparency problem. In contrast, because of the price pooling system and initial payment guarantee, the CWB does not have to compete in procurement against other traders. The combined effect is to give the CWB a strategic advantage in competitive bidding relative to U.S. trading firms. These differ subtly in Australia, given the changes that have occurred in that system since 1992 (Condon; Ryan). In particular, pooling and guarantees were eliminated and

[9]It is notable that in July 1995 the USDA GSM proposed some alternative mechanisms for executing EEP and sought public comment. However, comments were not published; likely due to the reduction in the utilization of EEP since then, changes have not yet been adopted.

[10]However, it was notable that with the advent of the Minneapolis Grain Exchange durum futures, price transparency has improved.

[11]As examples, prices for these grains are typically quoted/reported in large ranges and the frequency of *nq* (for not quoted, as in the *Wall Street Journal* and electronic data services).

[12]See *Milling and Baking News* (Sosland Publishing Co.) as an example in which these prices are quoted.

domestic competition has given growers alternatives, forcing AWB prices into greater alignment with alternatives. However, in the offshore market the problem persists.

Ultimately, these problems will be challenged and addressed via the WTO, and potentially in bilateral trade negotiations. However, the GATT states that "contracting parties are not required to disclose confidential information that would prejudice the legitimate commercial interest of particular enterprises." In addition, the NAFTA requires disclosure to facilitate trade "and exchange information, subject to considerations of confidentiality, related to technical regulations, standards, and testing." Each of these may seem vague for interpreting policy.

To summarize, lack of transparency (or opaqueness) presents problems for both public policy and private strategies. For now there are a number of important characteristics related to the transparency problem: 1) it differs substantially from price discrimination; 2) the transparency problem is reflective of informational asymmetries which have conventionally been exploited to the advantage of larger multinational trading firms--to the disadvantage of STEs (because the former have more extensive information networks); 3) the transparency problem was likely worsened due to EEP which had the effect of making the U.S. highly transparent and rivals opaque; 4) since EEP has been eliminated, the U.S. trading firms have likely regained their informational advantage relative to rival STE exporting countries.

3. Transparency and Bidding Competition: Model Development

The transparency problem (or the *opaqueness* problem) can be interpreted as a problem of asymmetric information. Phlips (p. 94) characterizes bidding games as "incomplete" when other bidders' reservation values are not known. In these games the bidder with more refined information has a strategic advantage. Rasmusen (1989, p. 53) defines asymmetric information as a situation in which some player has useful "private information." Dutta (p. 331) defines it as "when one firm does not know the correct payoff matrix, but the other firm does." A game of incomplete information is one in which "players lack some relevant information about their opponents" (Dutta, p. 312). Incomplete information can be interpreted when nature moves first (in this case defining firm type), and that move is unobserved by at least one of the players. Competitive bidding games where one player has more refined information than others are characterized by incomplete and asymmetric information. Thus, the price transparency problem should be interpreted as a bidding game with incomplete and asymmetric information.

3.1. Previous Literature on Bidding and Information

There has been increased attention to the strategic role of information among economists in the past decade due to advances in game theory. The literature on auctions is particularly relevant.[13] Cassady provides a historical overview of auction strategies and mechanisms and

[13]Another vein of research on asymmetric information has been experimental economics. Anderson et al. 1998, developed an experimental trading exercise which analyzed transparency of information and asymmetry of information among vertical players (feeders and packers) in the hog marketing channel.

recent bibliographies [(McAffee and McMillan (1987); Engelbrecht-Wiggans (1980); Milgrom (1985 and 1989); and Rothkopf and Harstad] review the literature on auctions and bidding strategies. Recent texts (including Monroe; Nagle and Holden; Lilien and Kotler; Rasmusen (1989, 1994 in Chapter 11), Dutta; Kottas and Khumawata; and Sewall) provide some practical motivations for auctions and analytical approaches to bidding strategies. Numerous recent studies have applied these techniques. Examples include Brown; Hausch and Li; Crampton (1995); Hendricks and Porter; Hendricks, Porter and Wilson; Hughart; Ioannou; McMillan; McAfee and McMillan (1986, 1996a,b); Oren and Rothkopf; Reece; Riley and Samuelson; and Wilson (1967, 1969, 1981, 1985, and 1992). Recent examples in agriculture are summarized in Sexton (pp. 189-95) and include Bourgeon and LeRoux (1996a and 1996b) for EU export tenders and Latacz-Lohmamm and Hamsvoort for the Conservation Reserve Program (CRP).

Game theory models of auctions encompass strategies of all players simultaneously and summarize players' a priori information on the distribution of each rivals' bids. Greater transparency is associated with a smaller variance for the bid distribution, as seen by opponents.[14] The transparency problem can be characterized as the ability of STEs to underbid U.S. offers due to information asymmetries. In a bidding game, several sellers compete in an export tender; strategies are limited to sellers' offer prices, and the winner is the seller with the lowest price. In developing their bids, players take into account the expected bids of their opponents, and uncertainty about those are summarized as probability distributions. The transparency problem is a situation in which uncertainty about one player's bid (or reservation price, or as commonly used in the trade, replacement cost) is larger than that for other players. Arguably, that is the case when one bidder represents a country with a single seller agency, whose transaction prices are not released (or are released selectively).

3.2 Game Theory Models of Competitive Bidding Using Bayesian-Nash Equilibrium

Since there is no single dominant strategy in these types of games, the Bayes-Nash equilibrium is used to determine optimal strategies. Dutta (p. 326) defines Bayes-Nash equilibrium as one in which "each type of player plays a best response against a type-dependent strategy vector of his opponent." In the normal-form representation of an n-player static Bayesian game, players have action spaces $A_1,..., A_n$, type spaces $T_1,...,T_n$, beliefs $p_1,..., p_n$, and payoff functions $u_1,..., u_n$. Player i's action space represents the range of actions for player i. Player i's type, t_i, is privately known by player i and determines his payoff function, $U_i(a_1,...,a_n;t_i)$, and is a member of the set of possible types, T_i. Player i's belief $p_i(t_{-i}|t_i)$ describes i's uncertainty about the n-1 other players' possible types, t_{-1}, given i's own type, t_i.

Following Gibbons, the n-player static Bayesian game is denoted as:

$$G=\{A_1,...,A_n; T_1,...,T_n; p_1,...,p_n; u_1,...,u_n\}.$$

[14] The variance with respect to expected profits is discussed in McAfee and McMillan (1987).

The timing of the game proceeds as follows: 1) nature draws a type vector $t=(t_1,...,t_n)$, where t_i is drawn from the set of possible types T_i; 2) nature reveals t_i to player i but not to any other player; 3) the players simultaneously choose actions, player i choosing a_i from the feasible set A_i; and then 4) payoffs $u_i(a_1,...,a_n;t_i)$ are received (Harsanyi 1967).

In this formulation, player type (in essence how player i's payoffs would be affected by different information sets for opposing players) is revealed to player i. Player i then chooses an appropriate strategy (action) a_i (in this case a vector of bid fractions for each player type). Bayesian-Nash equilibrium is obtained then by finding strategies $s^* = (s_1^*,...,s_n^*)$ where for each player i and for each of i's types t_i in T_i, $s_i^*(t_i)$ solves

$$\max_{a_i \in A_i} \sum_{t_{-i} \in T_{-i}} u_i(s_1^*(t_1),\ldots,s_{i-1}^*(t_{i-1}),a_i,s_{i+1}^*(t_{i+1}),\ldots,s_n^*(t_n);t)\,p_i(t_{-i}|t_i)$$

This means no player wants to change his or her strategy, even if the change involves only one action by one type.

In the export tender game, players choose a strategy [a vector of strategies (bid fractions) for all possible player types] to maximize expected profit. Strategies available to a player for each of the possible player types (t_i) are a continuous set of bids (b_i), expressed as a multiple (s_i) of the player's cost, C_i . Thus, player i's bid for type t_i is $b_i = s_i * C_i$. Nature is a non-player and takes random actions at specific points in the game with specified probabilities. Players' actions are modeled endogenously, while nature's actions are exogenous. Players' beliefs of opponents types are represented by a probability distribution of potential payoff functions for opponents (pt). Nature moves first choosing player types. These types are chosen according to a prior distribution that is assumed to be common knowledge among participants. Second, nature reveals to players their type (how they view opponents payoff functions). With this second step, player i is able to estimate posterior probabilities for their belief ($p_i(t_{-i} | t_i)$) given Bayes rule. In addition, opponents can also calculate the various beliefs that player i might hold given player i's type. If we assume that players' types are independent, then players' beliefs $p_i(t_{-i})$ are estimated from the prior probability distribution pt. This allows opposing players to know player i's beliefs about their types (Gibbons, p.148-149). Third, players simultaneously choose a strategy (in this case bid fractions) and then payoffs are determined.

Payoffs are determined by objective probabilities (conditional) which represent players' uncertainty about opponents' types/payoff functions. Specifically, distributions reflect players' beliefs about their and each other's valuations of costs of supplying the export tender and are assumed to be normally distributed. The expected value and standard deviations are denoted μ_{ij} and σ_{ij}, respectively, for the i^{th} player's assessment of the j^{th} player's costs.

Player i seeks to maximize expected payoff:

$$E\ (\pi_i) = E\ (b_i - C_i) \cdot PW(b_i)$$

where $(b_i - C_i)$ represents the payoff from a winning bid and $PW(b_i)$ denotes the probability of winning. Let b_{-i} denote the bid of an arbitrary opponent, and let μb_{-i} and σb_{-i} denote (respectively) the mean and standard deviation of that bid. If there are n players whose costs are distributed independently, the probability that player i wins is given by

$$PW(b_i) = \prod_{-i=1}^{n} \left[1 - \int_{-\infty}^{b_i} \frac{1}{\sqrt{2\pi}\ \sigma b_{-i}} e^{-(1/2)[(b_i - \mu b_{-i})/\sigma b_{-i}]^2} db_i \right] \textit{ where } -i \neq i.$$

The probability of underbidding n-1 opponents is the product of the probabilities of underbidding each individually.

The expected payoff for player i is (implicitly) a function of all players' strategies. Let s_{-i} represent a vector of opponents' strategies; taking these as given, the "best response" for player i is the strategy s^*_i satisfying $E\ pb(s_i^*, s_{-i}) \geq E\ \pi(s_i, s_{-i}) \quad \forall s_i \neq s_i^*$ When all players adopt "best responses" to their opponents' strategies (and players' expectations are mutually consistent), a Bayes-Nash equilibrium is attained and no player has an incentive to deviate from his/her chosen strategy.

The Bayesian-Nash solutions presented in this analysis, were identified through a numerical search procedure using *Mathcad*. Optimal bid fractions for the mean level of player's costs were determined through simulations given the distribution of competing bidders' valuations and estimated bid fractions. Then each player's bid fractions were changed in subsequent iterations based on their expectation of over/under bidding opponents and profit. Bid fractions for all players were iterated until all players' bid fractions stabilized and an equilibrium was attained. This generally occurred within 20 iterations of the algorithm.

4. Simulation Results of Bidding and International Grains Competition

A game theoretic model of bidding competition was developed to analyze the effects of transparency on competition among international grain sellers. A base case representing a situation where players' information sets about each competitor's cost distributions are symmetric was developed first. Then alternate stylized scenarios representing asymmetric information sets among players were modeled with the intent of typifying alleged (stylized) situations in international grain trading.

4.1. Base Model-Symmetric Information

The base case bidding game assumes four players (grain exporters) with equal valuations of costs and symmetric information about competitor costs. All players have an expected mean cost of procuring wheat at a replacement cost of $150/mt and all players' views or opponents' costs were assumed to be represented by normal distributions with a standard deviation of $3/mt. Information sets for each player include their mean cost of procuring wheat (μ_i) and the distribution of opponents' costs (mean costs = μ_{ij} and standard deviation of costs = σ_{ij} where ij=information set for player i on opponent j).

This base case results are summarized in Table 1. The optimal bid fraction of 1.008426 is shown in the top panel. Each player should bid 1.008426 times their cost. Given a mean cost of $150/mt, players should bid $151.26/mt. Each player perceives his probability of winning against opponents as p=.125 and expected profit as $0.16/mt.[15]

Comparisons are made to a market in which players would have greater uncertainty about opponents' costs (information is of lesser quality for all players). Increasing the standard deviation of all players' information on opponents' costs (σ_{ij} =$10/mt for all players) results in players shading (increasing) their bids to protect themselves due to uncertainty about opponents costs. Optimal bid fractions increase to 1.028649, resulting in equilibrium bids of $154.30/mt. Therefore, an increase in uncertainty about players' costs increases equilibrium bids by $3.04/mt and expected profit from $0.16/mt to $0.54/mt. This indicates that anything that increases uncertainty of information results in higher bids and expected profits for grain sellers.

Players may also have different costs which affect bidding strategies. If one player is able to reduce costs relative to other players, they would have a cost advantage which has important implications on the equilibrium of the game. For illustration purposes, a cost advantage of $1/mt for Player 4 was modeled (i.e., $149/mt). Optimal bid fractions for the three higher cost competitors declined from 1.008426 to 1.007945. However, the optimal bid fraction for Player 4 increased to 1.010213. Given mean costs for each of the players, the higher cost bidders would decrease bids to $151.19 (decrease $0.07/mt) while the lower cost player (Player 4 who has a $1/mt cost advantage) would reduce his bid to $150.52 (decrease of $0.74/mt). Therefore, the higher cost bidders shade their bids less in the presence of a lower cost bidder and their perceptions of the probability of winning and expected profits decline relative to the base case. In contrast, the lower cost bidder raises his bid over that in the base case. In addition, the low cost players' perceptions of the probability of winning and expected profit escalate relative to the base case and higher cost rivals.

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[15]Probabilities for individual bidders do not sum to one across competitors because they are individual player's assessments of their probability of underbidding competitors. Probabilities represent 12.5 % probability of player i underbidding opponents and 87.5% probability of player i not underbidding opponents (Ioannou).

Table 1. Base Case Results and Sensitivities under Symmetric Information

	Player 1	Player 2	Player 3	Player 4
Symmetric Information - Base Case				
μ_i	150	150	150	150
σ_{ij}	3	3	3	3
Optimal s_i*	1.008426	1.008426	1.008426	1.008426
Equilibrium b_i*	151.26	151.26	151.26	151.26
$PW(b_i*)$[1]	.125	.125	.125	.125
$E\pi_i$	.16	.16	.16	.16
Greater Uncertainty for Each Rival: Symmetric Information				
μ_i	150	150	150	150
σ_{ij}	10	10	10	10
Optimal s_i*	1.028649	1.028649	1.028649	1.028649
Equilibrium b_i*	154.30	154.30	154.30	154.30
$PW(b_i*)$[1]	.125	.125	.125	.125
$E\pi_i$	.54	.54	.54	.54
Lower Cost Competitor: Symmetric Information				
μ_i	150	150	150	149
σ_{ij}	3	3	3	3
Optimal s_i*	1.007945	1.007945	1.007945	1.010213
Equilibrium b_i*	151.19	151.19	151.19	150.52
$PW(b_i*)$[1]	.103	.103	.103	.203
$E\pi_i$	.12	.12	.12	.31

Equilibrium b_i, $PW(b_i*)$, and $E\pi_i$ are evaluated at player i's mean cost.

[1] $PW(b_i*)$s do not sum to one because they are each players perception of his probability of winning against opponents. For further clarification see Ioannou.

4.2. Asymmetric Information about Distribution of Costs

For comparison, a stylized version of the bidding model with asymmetric information about cost distributions was developed. Each player has equal costs and information about rivals' mean costs. However, two of the players (Players 3 and 4) are less transparent. These players, through mechanisms which might be attributed to STEs, reveal less information about the distribution of their replacement costs. Institutional mechanisms for other players, by assumption, provide more transparent information about their costs. Costs for each of the less transparent players, as seen by competitors, have a standard deviation of $10/mt ($\sigma_{i3}$ and σ_{i4} =10), while those of more transparent players remain at $3/mt ($\sigma_{i1}$ and σ_{i2} =3).

Results are summarized in Table 2. The equilibrium solution for this game with asymmetric information results in optimal bid fractions of 1.015664 for Players 1 and 2 and 1.012406 for Players 3 and 4. Given mean costs of $150/mt, this results in optimal bids of $152.35/mt and $151.86 for Players 1 and 2 and Players 3 and 4, respectively. Players 1 and 2 view their probability of winning as 0.116 and expected profit as $0.27/mt. Players 3 and 4 view their probability of winning as 0.159 and expected profit as $0.30/mt.

Comparing results from the base case with symmetric information to this case with asymmetric distribution leads to a number of observations. First, because less information is available to all players in the asymmetric case, all players increase (shade) their bids relative to the symmetric case. This results in buyers having to pay more for imported grains under asymmetric information than in the more symmetric case. Second, the more transparent players increase their bids more than the less transparent players. This is because they view their chances of winning against the less transparent players as lower and they shade their bids more, so that when they do win, they are able to make more profit on that transaction. This results in a competitive advantage to the less transparent players who shade their bids (increasing profit), but not as much as the more transparent players. These results exactly confirm those which would be expected from theoretical observations [Phlips; Rasmusen (1989, 1994)] and suggests the magnitude of price effects in the international grain trading business.

Table 2. Results and Sensitivities under Asymmetric Information

Asymmetric Information - Base Case (Representative of Two STEs)				
	Transparent Competitors		Hypothetical STEs	
	Player 1	Player 2	Player 3	Player 4
μ_i and μ_{ij}	150	150	150	150
$\sigma_{i,1}$ - $\sigma_{i,4}$	NA, 3, 10, 10	3, NA, 10, 10	3, 3, NA, 10	3, 3, 10, NA
Optimal s_i*	1.015664	1.015664	1.012406	1.012406
Equilibrium b_i*	152.35	152.35	151.86	151.86
PW(b_i*)	.116	.116	.159	.159
$E\pi_i$	.27	.27	.30	.30
Asymmetric Information - EEP Introduction (Increased Transparency of Transparent Players)				
μ_i and μ_{ij}	150	150	150	150
$\sigma_{i,1}$ - $\sigma_{i,4}$	NA, 1, 10, 10	1, NA, 10, 10	1, 1, NA, 10	1, 1, 10, NA
Optimal s_i*	1.00692	1.00692	1.005053	1.005053
Equilibrium b_i*	151.05	151.05	150.76	150.76
PW(b_i*)	.119	.119	.188	.188
$E\pi_i$	.13	.13	.14	.14
Asymmetric Information - EEP Removal (Decreased Transparency of Transparent Players)				
μ_i and μ_{ij}	150	150	150	150
$\sigma_{i,1}$ - $\sigma_{i,4}$	NA, 5, 10, 10	5, NA, 10, 10	5, 5, NA, 10	5, 5, 10, NA
Optimal s_i*	1.020934	1.020934	1.01802	1.01802
Equilibrium b_i*	153.14	153.14	152.70	152.70
PW(b_i*)	.117	.117	.143	.143
$E\pi_i$	.37	.37	.39	.39

* Equilibrium b_i*, PW(b_i*), and $E\pi_i$ are evaluated at player i's mean cost.
$\sigma_{i,1}$ - $\sigma_{i,4}$ represents player i's perception of the distribution of costs for opponent 1-4.

4.3. Effect of EEP

Use of the U.S. EEP program affected the transparency of transactions in the international grain trade. The effect of this program was to increase transparency for U.S. exporting firms, which would also affect firm strategies in bidding competition. Two stylized scenarios were developed to examine the potential effects of EEP on bidding competition.

The first typifies the transparency implications of introducing EEP into a market which did not previously have such intervention. In this case the assumption is that uncertainty about Players 1 and 2's costs by all players is reduced from $3/mt to $1/mt. Thus, players 1 and 2 become even more transparent when competing against two opaque players. The middle panel of Table 2 illustrates these results. In this case, these players' optimal bid fractions are reduced (relative to the Asymmetric Information Base Case in the top panel). The players' assessments of their probability of winning is increased for the opaque players from those in the base asymmetric case. In addition, expected profit for all players is reduced. Increasing the transparency of the more transparent players increases the opaque players' perceptions of their probability of winning. However, their equilibrium bids and expected payoffs are reduced.

The second case represents the removal/suspension of EEP, which has the effect of reducing information about rivals' costs. In this case the uncertainty about Players 1 and 2's costs by all players increases from a standard deviation of $3 to $5/mt. Thus, these players (1 and 2), representative of U.S. firms, become less transparent when competing against two highly opaque firms (Players 3 and 4). In this case, both transparent and opaque players increase their bid fractions over the base case with asymmetric information. The transparent players perceive that they have a higher probability of winning and have increased equilibrium bids and expected profit relative to the asymmetric information base case. Alternatively, by reducing the transparency of players 1 and 2, the opaque players perceive their probabilities of winning as reduced. However, equilibrium bids and expected profits for all players are increased.

4.4. Effects of the Number of Bidders and STEs on Equilibrium Results

The number of rivals in any bidding game has important implications for equilibrium results. In addition, the composition of the rivals' types, i.e., transparent versus opaque, has particularly interesting implications. To illustrate these effects, the model was used to simulate the impact of: 1) the total number of players in a game with two opaque (STEs) players; and 2) number of opaque players in a four-player game.

As the number of players in a game with two opaque players increases, the optimal bid fraction decreases (Figure 1). For example, in a game with one transparent and two opaque rivals (i.e., a total of three bidders), the optimal bid fractions are 1.03817 and 1.027715, respectively. In all cases the less transparent bidders have a slightly smaller equilibrium bid than the transparent bidders. As the number of bidders increases the equilibrium bids for all players are reduced. In addition, the difference between the optimal amount that the transparent bidders shade their bids over what the two opaque players shade their bids diminishes with increases in the number of bidders. This indicates that as the number of bidders increases, the competitive advantage of opaque players decreases. In these stylized results, once there are about six bidders in total, the advantage to the opaque bidders associated with being less transparent becomes almost negligible. This is notable in that given there are a number of potential competitors, it is frequent in international wheat tenders that the actual number of rivals is substantially less. This is due to tenders being normally wheat class/grade and origin specific, and/or being for an individual country's needs. As a result, it is common in many import tenders in which U.S. firms compete with Canada, and/or in which U.S. firms compete with Australia, for the number of bidders to be in the range of three to six.

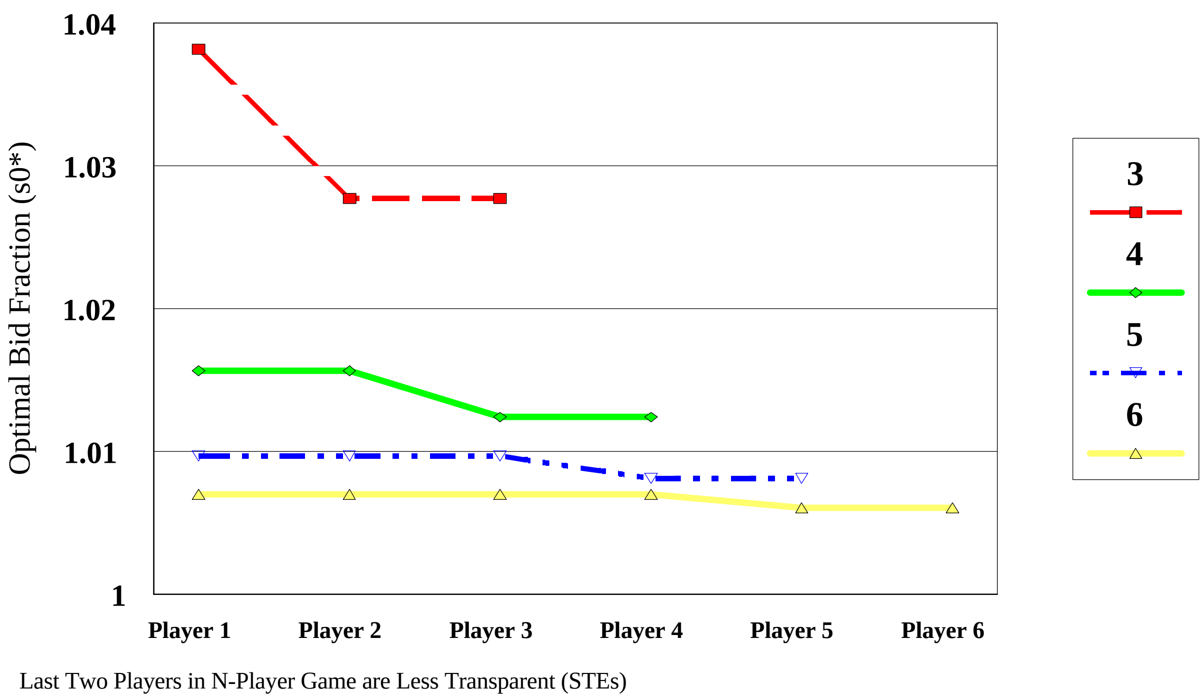
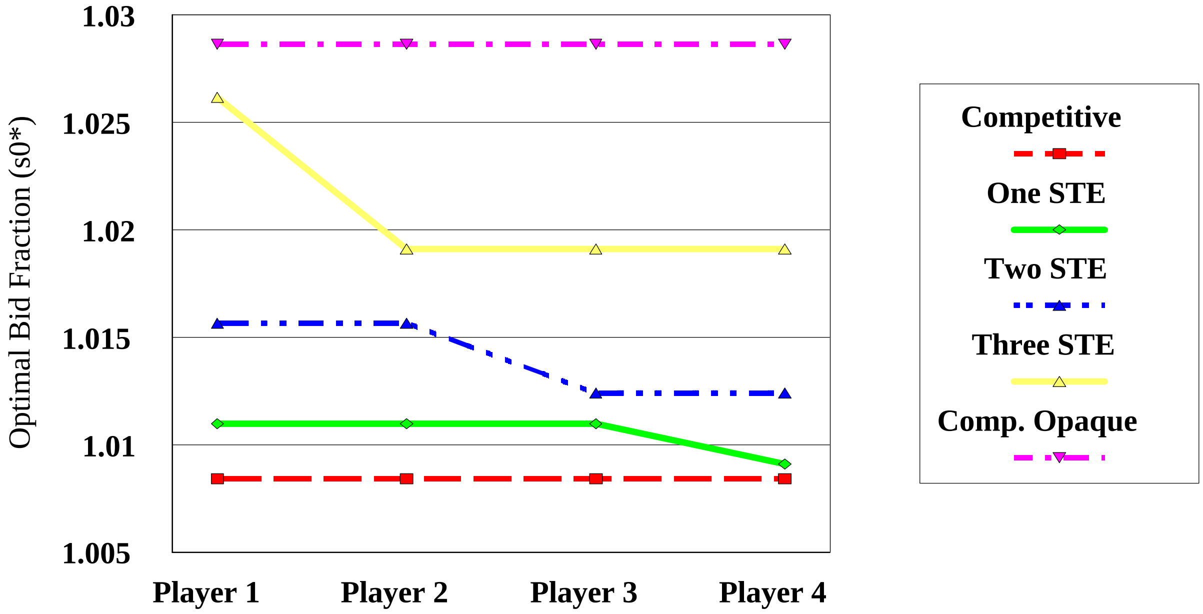


Figure 1. Optimal Bid Fractions for N-Player Games with Two Less Transparent Players (STEs), Mean Expected Costs = $150/mt.

In the second case (Figure 2), the total number of rivals is held at four, but the composition varies from no STEs, to all rivals having information structures similar to the lesser transparent STEs. Optimal bid fractions for players increase as the number of opaque players increases from zero in the competitive case to four in the competitive opaque case (Figure 2). Further, as the number of opaque players increases the degree that opaque players shade their bids in comparison to transparent players increased (spread between bid fraction for opaque and transparent players increased). Thus, as the number of players who are less transparent (opaque) increases, the competitive advantage these opaque players have over less transparent players increases.



In one STE, Players have higher uncertainty about distribution of player 4
In two STE's players have higher uncertainty about distribution of players 3 and 4

Figure 2. Optimal Bid Fraction for Four Player Game under Alternative Scenarios, Mean Expected Cost = $150/mt.

4.5. The Effect of an Agent to a STE in Bidding

Typically, STEs sell a portion of their exports through accredited export grain merchandising agents. The portion sold directly versus that sold through agents is a continual source of friction, giving rise to principal-agent types of problems. However, there are a number of characteristics of this relationship that can be analyzed in the context of bidding and information. Of particular interest is that these agents also compete directly with the STEs in sales to other importers. Thus, in practice, the agent may have better information about the replacement costs of the STE than other rivals (i.e., rivals that are not agents of the STE).

Two stylized formulations are used to depict this phenomenon. In the first, the agent is able to discern information about the STE's costs. This results in the agent having the same information set on the STE's costs as they do for other transparent players. The second was modeled so that the agent was able to reduce the level of uncertainty about the STE's costs, but not to the level of other more transparent competitors. The logic of these two stylizations is that in the first case, an agent may have very recent and/or repeated knowledge about past activities with a STE in which case, his uncertainty about costs for the STE may be the same or possibly lesser than his uncertainty about the costs of other transparent competitors. In the second case, the information that the agent is able to glean about the STE's costs, while significant, are not to the degree that he has information about other transparent competitors (e.g., the agent may still have a high degree of uncertainty about replacement costs of the STE even though it has made repeated and recent transactions with an STE).

Results are summarized in Table 3. The top panel illustrates the results for the first case. These indicate that if agents are able to discern information about the costs of a less transparent player (STE), they can essentially defeat the advantage related to being non-transparent of the STEs. In the example there are four rivals: two less transparent STEs (Players 3 and 4), one transparent exporter (Player 2), and one exporter that is an agent (Player 1) of the STE. Results illustrate that this latter player is able to bid as if he were just as opaque as the STEs (optimal bid fractions, equilibrium bids, and players' assessment of probability of winning for players 1, 3, and 4 are the same). Of particularly interest is that Player 1's strategies and payoffs converge to be identical to those of Players 3 and 4, the less transparent STEs. Of interest is that he not only gains advantage relative to the STE for which he is an agent, but also relative to the other STE. This is due to the fact that in this example each opaque player and the agent perceive that they are bidding against two more transparent opponents and one opaque player. If the number/composition of STEs were altered, the ability of the agent to reduce (defeat) the informational advantage of other STEs (for which he is not an agent) would differ.

In the second case, the agent is only able to increase the transparency of a STE relative to more transparent players. In this case the agent reduces the advantage of the less transparent players (STEs) when they are in direct competition (lower panel of Table 3). In this case optimal bid fractions for the agent are higher than for either of the less transparent players representing STEs (Player 3 and Player 4), but are less than for the non-agent more transparent player (Player 2). Therefore, if a firm is able to increase knowledge of an STE's costs by acting as an agent, that firm would be able to reduce or in certain instances defeat informational advantages of the less transparent STEs including those for which the firm has not acted as an agent.

5. Summary and Implications

5.1. Summary of Problem

One of the gnawing issues identified by U.S. interests in recent trade negotiations is the price transparency problem. This emerged as a problem following the CUSTA and NAFTA and persisted throughout the last round of GATT negotiations. Transparency problems generally refer to the inability to observe rivals' terms of trade. This is normally associated with the effects of commercial exporters competing against STE rivals and the perception that by being less transparent, the latter would have an advantage.

Table 3. Results for One Player as Agent of STE Case

Asymmetric Information - One Player as Agent for STE Case

	Transparent Competitors		Hypothetical STEs	
	Player 1‡	Player 2	Player 3	Player 4
μ_i and μ_{ij}	150	150	150	150
$\sigma_{i,1}$ - $\sigma_{i,4}$	NA, 3, 10, 3	3, NA, 10, 10	3, 3, NA, 10	3, 3, 10, NA
Optimal s_i*	1.01161	1.014568	1.01161	1.01161
Equilibrium b_i*	151.74	152.19	151.74	151.74
PW(b_i*)	.139	.103	.139	.139
$E\pi_i$	.24	.23	.24	.24

Asymmetric Information - One Player as Agent for STE (Agent's Assessment of STE's Costs is Less Transparent) Case

	Player 1‡	Player 2	Player 3	Player 4
μ_i and μ_{ij}	150	150	150	150
$\sigma_{i,1}$ - $\sigma_{i,4}$	NA, 3, 10, 5	3, NA, 10, 10	3, 3, NA, 10	3, 3, 10, NA
Optimal s_i*	1.013586	1.015094	1.011992	1.011992
Equilibrium b_i*	152.04	152.26	151.80	151.80
PW(b_i*)	.125	.109	.149	.149
$E\pi_i$	.26	.25	.27	.27

* Equilibrium b_i*, PW(b_i*), and $E\pi_i$ are evaluated at player i's mean cost.
$\sigma_{i,1}$ - $\sigma_{i,4}$ represents player i's perception of the distribution of costs for opponent 1-4.
‡ Represents agent of STE.

It is important that issues related to the lack of transparency, though normally discussed in the context of price, are prevalent in other terms of trade. These include credit terms and allocations, quality specifications, and suspicion that excess quality is shipped to importers, as well as logistical terms. Transparency is also sometimes used interchangeably with another perplexing and controversial trade practice called price discrimination. However, these concepts and effects differ substantially. In addition, though issues of price transparency are discussed in this paper in the context of international grains competition and the effects of STEs, it is important that similar problems are emerging throughout the agribusiness sector.

This paper explores strategic implications associated with the transparency of prices for competition among sellers in the international grains sector. First, the concept is defined and characteristics of the market place that facilitate and detract from transparent prices are described. The important point is that generally, U.S. market mechanisms result in fairly transparent price information that is accessible to all rivals. This was heightened under the EEP program, which provided public disclosure of export demand and pricing of U.S. grains. However, similar mechanisms do not exist in countries dominated by STEs, notably Canada and Australia; their systems are alleged to be less transparent, or opaque, from an export pricing perspective.

5.2. Method

The effects of price transparency were analyzed using a game theory model of bidding competition among rival sellers. The presence of less transparent sellers has the effect of increasing information asymmetry amongst rivals. A model was developed to typify this situation and to simulate the effects of differences in information sets. A Bayes-Nash equilibrium was used to derive equilibrium solutions. Numerous stylized examples were used to illustrate aspects of competition and to analyze effects on bidding strategies.

In all cases it is expected that less transparent sellers would have an advantage relative to more transparent sellers. Indeed, this is an important analytic result of many previous game theory analysis of auctions. These results generally confirm this; however, in addition, it puts into perspective the prospective impacts of informational advantages and disadvantages.

5.3. Summary of Results

The base case model was constructed to characterize competition in international grain trading. Four rivals were assumed, expected mean costs were at $150/mt, and in the base case each player’s standard deviation about his rivals’ cost was $3/mt.

In the base case model with symmetric information, i.e., in which all rivals were similarly transparent, equilibrium bids were $151.26 and expected payoffs for all firms were identical. An increase in uncertainty about all rivals’ cost to $10 results in an increase in equilibrium bids to $154.30, or by $3.04/mt. In addition, expected payoffs for all rivals increase. Finally, if any firm were able to lower their costs relative to rivals, this would yield advantages, as expected.

An asymmetric model was also solved to assess the prospective impacts of opaque rivals. In the base case there were four rivals, two of whom were assumed to be less transparent, as typical of STEs (i.e., STEs have better information about commercial rivals, than the latter have about STEs). Results were particularly interesting. Relative to the equilibrium results with symmetric rivals, the results indicate that 1) all rivals increase their bids; and 2) the more transparent rivals increase their bids more than the less transparent STEs. As a result of these the less transparent STEs gain a competitive advantage, increasing their probabilities of winning and their expected payoffs. In our stylized case this amounts to an advantage of about $0.49/mt.

The effect of EEP was to increase transparency about U.S. sellers relative to STE rivals. The simulation results indicate that increasing the transparency of the more transparent players increases the advantage of the more opaque players. As expected, eliminating EEP which had the effect of reducing the transparency of U.S. sellers, enhances the advantage of U.S. firms and reduces that of STEs.

The number of bidders has important effects on the structure of competition among sellers. However, this is also affected by the composition of sellers. Results illustrate that as the number of rivals increases, competing against two STEs, the optimal bids diminish and the advantage of the opaque players declines. However, as the composition of sellers that are less transparent increases, the equilibrium bids increase. Finally, the model was used to simulate the informational implications of STEs selling through agents or accredited exporters. In this case, the agent is able to reduce the informational advantage of the STE.

5.4. Implications

These results have numerous implications for participants in the international grain trading industry. First, buyers of grain are particularly influenced by the form of competition because it affects the prices (or bids) they pay for grains bought through bidding competition. These results indicated that 1) anything that can be used to reduce cost uncertainties among rivals would reduce equilibrium bids and prices; 2) bidding situations in which there is less transparency have the effect of increasing bids and prices to buyers, and payoffs to sellers; and finally, 3) increases in the number of rivals have the effect of reducing bids and mitigating the informational advantages of STEs.

Competition among sellers has always been intense and firms have pursued different strategies. These results illustrate and confirm that being low-cost relative to rivals is an immense advantage. In addition, as the number of rivals increases, the equilibrium bids and expected payoffs diminish. However, this conclusion depends on the composition of competitors. As the number of rivals increases, the advantage of STEs diminishes. Information has always had an important role in competition among sellers in international grain trading. Commercial sellers seek to develop comprehensive and efficient information systems about demand, competition, prices, etc. Similarly, an important source of alleged disadvantage in the past for STEs has been their less developed/comprehensive information systems. In both cases information is critical.

These results illustrate that more uncertainty about costs among rivals results in increases in equilibrium bids (for selling) and expected payoffs for sellers. However, an increase in less transparent competitors has the effect of reducing the advantage of the transparent sellers, though the overall price level is increased.

The effect of less transparent sellers in international transactions on sales prices is clear. Specifically, the incidence of less transparency among sellers has the effect of raising prices to buyers. However, at least from this analysis, we are unable to discern the impact on producer prices.

One of the motivations for this study was to understand the impacts of lack of transparency in international grains on producers. Allegedly, producers in countries with highly transparent market systems (e.g., United States) view that they are disadvantaged in bidding competition relative to rivals that are less transparent--typically STEs. Though there are lots of potential competitors, it is frequent in international wheat tenders that the actual number of rivals is substantially less. This is due to tenders being normally wheat class/grade and origin specific, and/or being for an individual country's needs. As a result, it is common in many import tenders in which U.S. firms compete with Canada and/or Australia, for the number of bidders to be in the range of three to six. Therefore, these results confirm this allegation. In all cases less transparent sellers have an advantage in bidding competition relative to more transparent sellers. That advantage in our stylized case is in the area of 1-2$/mt. However, that advantage is mitigated with an increase in the number of transparent rivals and in the case where more transparent players have acted as agents for an STE and have more information about costs of an STE. Further, cessation of exports under U.S. EEP programs should have decreased the transparency of U.S. firms, increasing their competitiveness in the international grain trade.

5.5. Limitations

The results drawn in this study were from a highly specific game theory analysis of bidding competition. Any game has to be highly stylized, which limits the analysis. The model used in this study is of bidding competition that is static, single shot, single-market (not allowing price discrimination) and in which price is the only strategic variable. In addition, not being able to empirically confirm the information structure of players, it was necessary to make assumptions about these. However, the chosen values are thought to be fairly representative of the stylized cases presented here.

Because this is an equilibrium solution, a number of things should be cautioned. First, if trades occur infrequently, it may be difficult for players to determine the "type" of player for competitors (in essence, how opponents would respond to changes in player i's bid fraction). This means that if trading is more infrequent, it might be difficult for bidding competition to converge to an equilibrium. Second, this methodology assumes a constant information set for players. In the context of international grain trading, information sets may change continually. Further, the number of players bidding in games and the composition (individual traders) may change repeatedly, altering the information sets of players and type of game represented in bidding competition.

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