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GAMING AGENCY MARKETS

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ABSTRACT

Markets can be modeled or gamed. A taxonomy of markets, based on the extent to which traders delegate transaction-executing decisions to a principal of the market, is set forth that classifies markets into three types: bazaar, auction market, and agency market. A bazaar is a market wherein traders delegate nothing. An auction market is a market wherein traders on one side, which may be either the buying side or the selling side, delegate to auctioneers the task of fetching the best terms for the items the traders wish to trade. An agency market is a market wherein all traders entrust a single agent or group of collaborating agents with the task of executing trades whenever trading is possible. The agency market enables the greatest volume of transactions to be executed. Procedurally, the agency must choose which transaction to execute if several are possible but mutually exclusive, and at what price the transaction is to be executed if a range of prices is acceptable to both buyer and seller. These choices affect the collective welfare of market participants, market productivity, and computational efficiency. They also may depend on the items being traded, the question of balance, and the practical demands of the implementation. A proof-of-principle implementation in a computer-assisted, transaction-based business gaming simulation is discussed. Its incorporation of the agency market enable the gaming simulation to handle a much greater volume of transactions than would otherwise be practical, without increasing the number of decisions required of participants.

INTRODUCTION

Markets are central to business, and as such are indispensable to computer-supported business gaming simulations. They may be modeled or gamed (Thavikulwat, 1997, 1999). In a modeled market, the computer calculates the terms of trade for one side of the market. Thus, when participants take the role of company management with products to sell, the computer calculates the demand for the company's products. Generally, the calculation takes account of the company's product price, the simulated economic condition, and other factors, often including the product prices of competing companies. Much has written about models of this kind (Gold & Pray, 2001; Goosen, Jensen, & Wells, 2001).

In contrast, participants take on both seller and buyer roles in a gamed market, so no computer calculation of supply or demand is needed. The supply is what those with the goods have to sell, and the demand is what those in search of the goods are ready, willing, and able to buy. Thus, whereas some participants may be managers of companies that sell products, other participants may be either consumers of those products or managers of companies that require those products as resources for their own production. In this situation, the computer assists in the transactions by enforcing rules of trade.

Whereas the modeled market is a phenotypical representation of the marketing process, the gamed market is a genotypical representation of the process. As Crookall, Martin, Saunders, and Coote (1986) have pointed out, computer-assisted simulations, which are built on genotypical representations, "have greater scope and potential than other types when social and socially-mediated processes and skills are seen as important learning outcomes" (p. 370). This is because the genotypical representation is real, but the phenotypical representation can be no better than realistic. The genotypically represented process, however, is more difficult to develop and administer, but it is essential for capturing defining processes where anything less than the truth would be a fatal flaw (Thavikulwat, 1999).

Accordingly, the challenge in advancing the art of computer-supported business simulations is to develop workable mechanisms for gaming social and socially mediated processes, of which markets are an excellent example. But without well-built mechanisms that capture the basic structure of markets within the conditions that must be imposed to make them viable, however, the salient aspects of markets in their natural state may be lost.

Thus, the discussion that follows first sets forth a taxonomy of markets based on the extent of trader involvement. The discussion then focuses on one type of market, the agency market. Principles for designing the mechanisms of an agency market are discussed, followed by a discussion of a proof-of-principle implementation.

TAXONOMY OF MARKETS

Consider a taxonomy of markets based on the extent to which traders delegate transaction-executing decisions to a principal of the market. A *bazaar* is a market wherein traders delegate nothing. An *auction market* is a market wherein traders on one side, which may be either the buying side or the selling side, delegate to auctioneers the task of fetching the best terms for the items the traders wish to trade, in accordance with predefined procedures. An *agency market* is a market wherein all traders entrust a single agent or group of collaborating agents with the task of executing trades whenever trading is possible, also in accordance with predefined procedures. Figure 1 is a schematic diagram of the taxonomy. It shows the bazaar at the core, and the agency market at the peripheral, with the movement from core to peripheral dependent upon the extent of trader delegation.

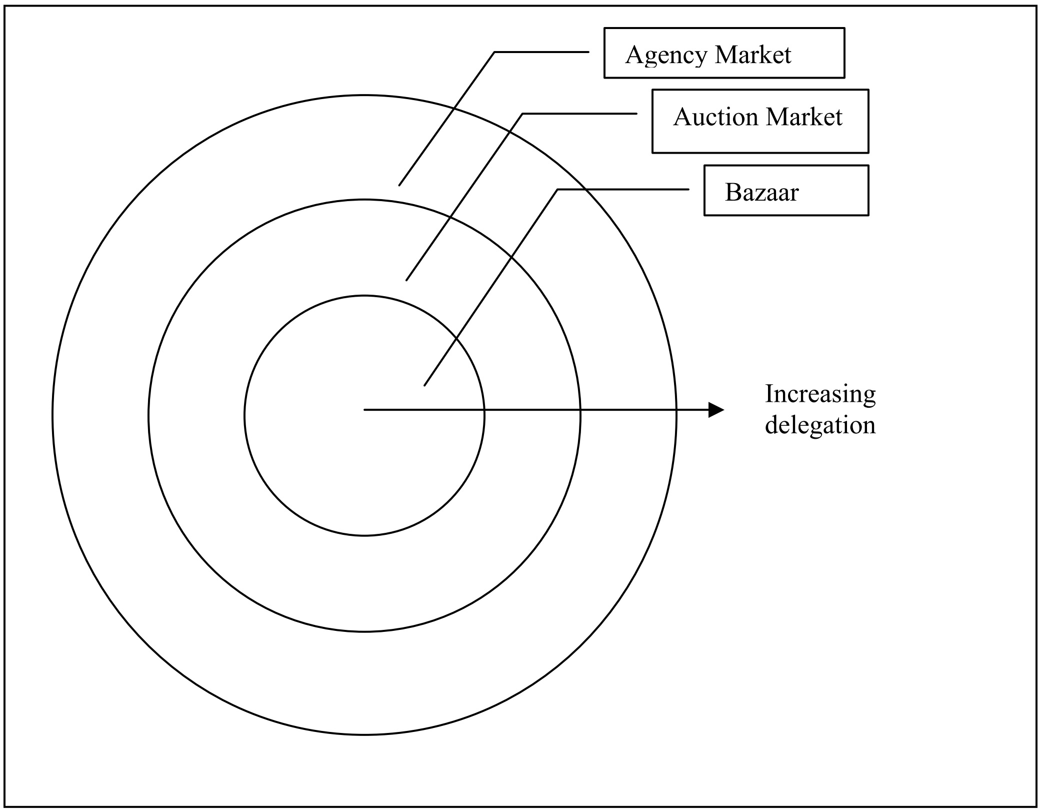

Figure 1: Taxonomy of Markets Based on Degree of Trader Delegation

In a bazaar, each trader personally examines the offers available, and personally decides on the offers to accept or reject. As a result, trading is limited to the time each trader can spend in the marketplace. Whenever a trader is away from the market for any reason, that trader's trading activity is suspended.

In an auction market, the traders on one side set terms for their auctioneers. Respecting those terms, the auctioneers conduct the auctions in one of two ways. In an English auction, prices start low and move upward; in a Dutch auction, prices start high and move downward. The execution price is not necessarily the best price offered. If it is the best price, the procedure is called a first-price auction. If it is the second-best price, the procedure is called a second-price auction. The price also can be the worst price of all offers accepted, which applies to U.S. Treasury auctions. In this case, it is a market-clearing price auction. These and other procedural differences are discussed by Pillutla (2002), who studied their dynamics under Monte-Carlo simulated conditions. Inasmuch as the delegating traders need not be there to execute each trade, the volume of transactions can be greater in an auction market than in a bazaar.

An agency market differs from an auction market in that both parties rely on the same single agent or collaborating group of agents. In this case, the agency must choose among the trades to execute when several are possible but mutually exclusive. Moreover, when the price the buyer will pay in a trade exceeds the price the seller will accept, the agency must decide the price on which to execute the trade, assuming that it does not function as a brokerage, which would make its profit from the difference. Inasmuch as neither the buyers nor the sellers need to be present to execute trades, the volume of transactions can be greatest in agency markets.

THE AGENCY MARKET

The agency market is especially interesting because of the choices it presents and because of the volume of transactions it enables. Choices have consequences for the viability of the market, and a market that can handle a high volume of transactions is essential for continuously running business gaming simulations that execute policies set by participants who cannot always be present. Transaction-based simulations are rare, a shortage that has been decried by Teach (1990). Continuously running transaction-based simulations may not be workable without agency markets.

Rational choice, however, requires a criterion. In this case of a choice of market procedures, the criterion of maximizing the collective welfare of both buyers and sellers would seem to be sensible, because an agency that performs poorly in this respect may not be competitive with one that performs better. Even so, this criterion is of no help in selecting a transaction-execution price, when the seller's minimum selling price is below the buyer's maximum buying price. If the trade is executed at the seller's minimum price, the benefit of the difference in prices goes entirely to the buyer; if executed at the buyer's maximum price, the benefit goes entirely to the seller; and if executed at a price in between, the benefit is split between the two parties. To the extent that money has the same value to both, it follows that the collective welfare is the same for every price within the range acceptable to both.

For a second criterion, consider the productivity of the market, a criterion of special interest to agents with compensation based on productivity. Thus, the procedure that processes a higher volume of items for any given set of offers is more productive than the procedure that processes a lower volume. For example, take the case of an agency market with two offers, each to sell a unit of a product; two offers, each to buy a unit of the same product; and matching maximum and minimum prices as shown in Table 1. If *S1* is matched with *B1* and *S2* is matched with *B2*, then two transactions will be executed, but if *S2* is matched with *B1*, only one transaction will be executed. The buyer's maximum price on offer *B2* is below the seller's minimum price on offer *S1*, so the remaining offer cannot be executed. Accordingly, the productivity criterion favors the first procedure.

Table 1: Example of Matching Offers

Seller's Offer	Seller's Minimum Price	Buyer's Offer	Buyer's Maximum Price
S1	$2	B1	$2
S2	$1	B2	$1

In principle, the first procedure matches worst offers on one side with best offers on the other. Thus, the worst seller's offer, *S1*, is matched with the best buyer's offer, *B1*. After executing that transaction, the procedure is reapplied to the remaining offers. If a pair of offers cannot be executed because the worst offer is not good enough, that offer is set aside in favor of the next worst offer, with the process continuing until all offers that can be executed have been executed.

The second procedure matches best offers on one side with best offers on the other. Execution stops immediately when a selected pair cannot be executed, because if the best offer of either is unsatisfactory, the next best offer cannot be more satisfactory. This second procedure is the most computationally efficient, in the sense that it finishes soonest and therefore will take the least time when performed by a computer.

Besides the worst-to-best and best-to-best procedures, one may consider other procedures, such as random pairing, first-in-first-out, and last-in-first-out. With respect of productivity, however, no procedure can exceed the productivity of worst-to-best. With respect to computational efficiency, none can exceed the efficiency of best-to-best. These conclusions, evident by inspection, should require no formal proof.

The worst-to-best procedure presents a problem beyond its relative inefficiency. This procedure minimizes the collective welfare of parties with the best offers by making them trade with parties with the worst acceptable offers. Best-offer parties would therefore do better by defecting from the agency using the worst-to-best procedure to an agency using the best-to-best procedure, where the increase in collective welfare would permit the trading parties to have more for themselves after compensating the agency for arranging the trade. Thus, with competition among agencies, the best-to-best procedure will prevail.

There remains the question of how to select among identically priced offers. A first-in-first-out (FIFO) rule takes the oldest offer first; a last-in-first-out (LIFO) rule does the opposite, taking the newest offer first. FIFO may seem fairer, but it minimizes the collective welfare of parties with new offers. These would do better by defecting to an agency using LIFO. Thus, with competition among agencies, LIFO will prevail. Even so, LIFO minimizes the collective welfare of parties with old offers, but these parties can get to the head of the line simply by withdrawing their old offers and submitting new ones. This refreshing of offers just to get to the head of the line is wasteful work, and therefore an unfortunate consequence of the rule.

In summary, three general criteria, *collective welfare*, *market productivity*, and *computational efficiency*, for choosing procedures for agency markets have been discussed, but the essential decisions on pricing and matching of offers are not entirely resolved by reference to the criteria. Every price within the range acceptable to buyer and seller maximizes the collective welfare of the parties to the trade. The best-to-best offer-matching procedure maximizes the collective welfare of parties with the best offers and is computationally most efficient, but it gives rise to the lowest market productivity. For identically priced offers, LIFO maximizes the collective welfare of parties with the newest offers, but it encourages the wasteful refreshing of offers. The choice of price and matching procedure may therefore turn on the particulars of the items being traded and the practical demands of the implementation.

PRODUCTS VERSUS STOCKS

Products are characteristically different from stocks, for whereas products cannot be produced without effort, in principle, stock can be issued on a whim. Accordingly, it follows that a company selling its stock has an advantage over the buyer of its stock that it does not have over the buyer of its products. The company can issue more stock at will, thereby diluting the value of stocks previous sold. It cannot do the same as easily with respect to its products.

Inasmuch as the company is more advantaged in the selling of shares than in the selling of products, an agency market counters the advantage if it favors the buyer of shares more than it favors the buyer of products. The balancing of advantage can be accomplished by executing stock sales at the seller's minimum price while executing product sales at the buyer's maximum price. The short-term effect is to attract participants to the stock market, where they have better price protection, and to restrain them from the product market, where they may more easily end up paying too high a price on products they wish to buy.

The long-term effect, however, is to move stock prices up and product prices down when offers are matched best-to-best. As the best buying prices are the highest prices, investors offering to pay the highest prices have every advantage: They are most likely to get the stock they want, but they will pay no more than the selling company's minimum price. Each investor's rational behavior in this situation is to bid the highest price allowed, even if that price exceeds the price that the investor is truly willing to pay. The companies' rational response, however, is to raise their minimum selling prices to match the investors' higher bidding prices. In effect, investors are caught in a Prisoners' Dilemma (McCarty, 2001) wherein the action that is best for them individually (bid high prices for stocks) is bad for them collectively (companies raise prices). The situation is reversed in the case of products.

In summary, both product and stocks should be matched best-to-best. Although this procedure engenders the lowest market productivity, it gives rise to the highest computational efficiency and maximizes the collective welfare of parties with the best offers. To balance the advantage of the parties to the trade, stocks should be sold at the company's asking price, but products should be sold at the customer's bidding price. For identically prices offers, last-in offers should be executed first, despite its seeming unfairness and encouragement of wasteful work, for it facilitates survival in competition among agencies.

IMPLEMENTATION

As proof of these principles, markets for products and stocks have been gamed in GEO, an international business gaming simulation that is transaction based (Teach, 1990) and computer assisted, in the precise sense explicated by Crookall, Martin, Saunders, and Coote (1986). Time in the gaming simulation is most often activity driven, but occasionally clock- and administrator-driven (Chiesl, 1990; Thavikulwat, 1996). The effect is to give participants the sense that the gaming simulation runs continuously, although in reality it is only active when participants are active.

The gaming simulation games all three markets: the bazaar, the auction market, and the agency market. All transactions are executed through a computer program that directly accesses centralized files located on a file server. This arrangement enables transactions to be executed immediately, without the waiting unavoidable in batch processed computer-controlled gaming simulations. Despite the underlying complexity of gaming three market mechanisms simultaneously, the participant is presented with only a handful of common decisions on price and quantity, as will be shown.

In the gaming simulation, products can be bought by participants acting as consumers, or by companies purchasing resources necessary for their own production. The consumer is presented with a dialog box, an example of which appears in Figure 2. In this implementation, only one entry box is needed for the bazaar, and two entry boxes served both the auction and agency markets. The three entry boxes have white backgrounds, as shown in the figure.

The consumer chooses the bazaar by entering the quantity of the tab-selected product the consumer wants to buy, in the *Quantity to Buy* box. A nonzero entry in this box lights up the *Execute Purchase* button, which the consumer depresses to execute the purchase. In response, the program checks that the offer remains valid under the *Asking Price* given. If it is, the transaction is executed immediately; otherwise, the consumer is informed that the offer shown is no longer valid.

One generally expects that a bazaar will have offers from many parties from which a consumer can choose. In this implementation, however, all products that fall in each of the five product categories, namely Service, Material, Chemical, Energy, and Food, are of identical quality. Accordingly, the rational consumer will always choose the lowest-priced offer. That being so, the program simplifies the consumer's task by presenting only the lowest-priced offer, choosing among ties by applying the LIFO rule.

The consumer chooses the auction market by entering a *Bidding Price* that equals or exceeds the *Asking Price*, and a non-zero *Period Quantity to Buy* figure. Nonzero entries in both of these boxes light up the *Submit Offer to Buy* button.

Upon depressing that button, the program executes a first-price English auction that results in the consumer purchasing up to the period quantity specified at or below the consumer's bidding price. If the consumer's bid cannot be completely satisfied by the available offers, the balance of the bid is left for the agency market.

The consumer's bid also is sent to the agency if the consumer enters a bidding price lower than the lowest asking price. Offers left with the agency are executed immediately after the gaming simulation advances into the next period. All capable companies produce products during the advance, and therefore all have products that can be sold at the end of the advance. The agency's offer-matching rule is best-to-best, with LIFO used to select among identically priced offers and the pricing advantage going to the seller. That is, the agency executes transactions by matching best offers to sell with best offers to buy, choosing the latest offer whenever more than one best offer is found, and selecting the buyer's bidding price as the price of the sale.

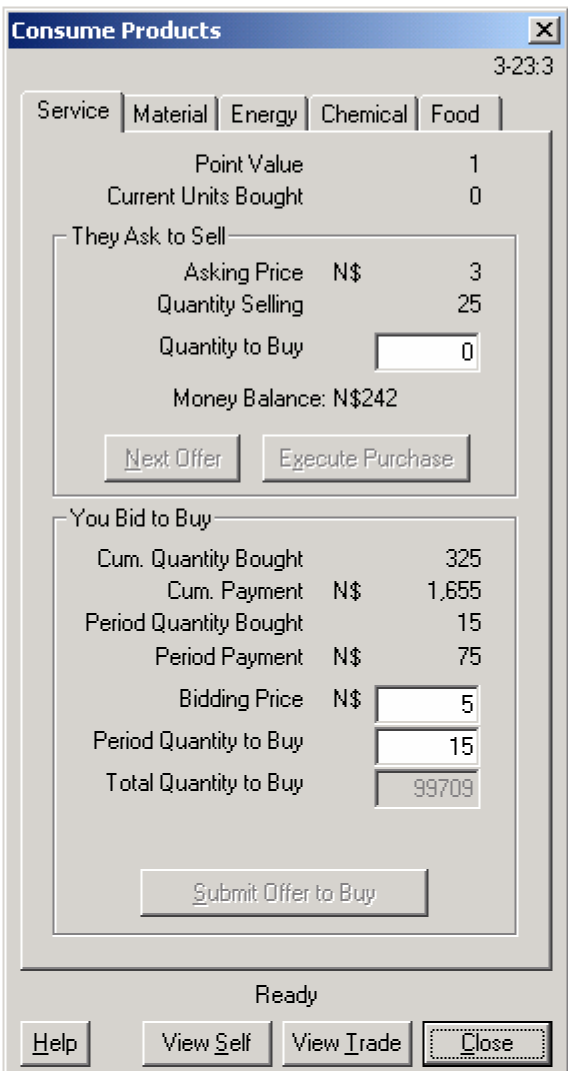

Figure 2: Consumer's Dialog Box

As for the companies that sell the products, they are presented with a complementing dialog box, an example of which is shown in Figure 3. Companies require only two entry boxes, one for the bazaar and one for both the auction and agency markets. These have white backgrounds, as shown in the figure.

The company chooses the bazaar by entering the quantity the company wants to sell in the *Quantity to Sell* box. A nonzero entry in this box lights up the *Execute Sale* button, which the company depresses to execute the sale. In response, the program checks that the bid remains valid under the *Bidding Price* given. If it is, the transaction is executed immediately; otherwise, the company is informed that the bid shown is no longer valid. As with the consumer, the program simplifies the company's task by presenting only the best bid, which in this case is the highest-priced bid, choosing among ties by also applying the LIFO rule.

The company chooses the auction market by entering an *Asking Price* that is less than or equal to the *Bidding Price*. The program sets the *Quantity to Sell* equal to the

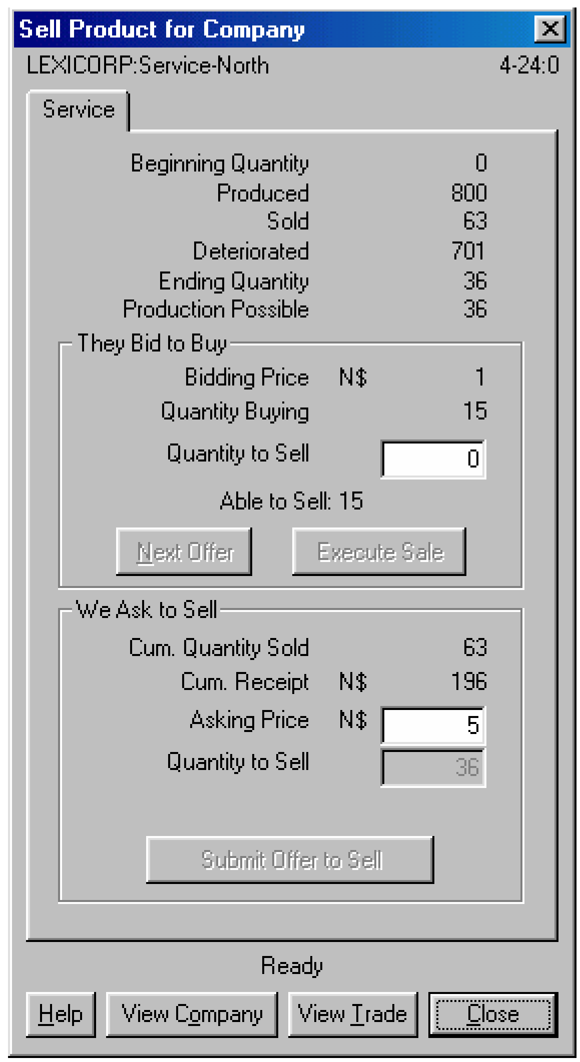

Figure 3: Company's Dialog Box

total that the company has in its inventory. Then when the company selects the *Submit Offer to Buy* button, the program executes a first-price Dutch auction that results in the company selling its inventory at or above the company's asking price. If the company's offer cannot be completely satisfied by the available bids, the balance of the offer is left for the agency.

The company's offer also is sent to the agency if the company enters an asking price higher than the highest bidding price. Offers left with the agency are executed immediately after the gaming simulation advances into the next period. Inasmuch as consumers' period quantity requirements are reset during the advance, they have renewed demands that may be satisfied after the advance.

Similar dialog boxes are presented to companies that must buy resources, and to investors and companies for the trading of shares. As these dialog boxes operate in similar fashion, they will not be discussed further.

CONCLUSION

The bazaar, the auction market, and the agency market are three different market processes that can be gamed in a computer-supported business gaming simulation. The agency markets enables the greatest volume of transactions. Choices for an agency include which sales offer to match with which purchase offer, and at what price to execute a transaction when a range of prices is acceptable to both parties. The choices made have consequences for the collective welfare of market participants, for the productivity of the market, and for computational efficiency. They also may depend upon the items being traded, on the question of balance, and on the practical demands of the implementation.

The addition of an agency market does not mean that participants will have to make a greater number of decisions, a measure of gaming-simulation complexity (Wolfe, 1978, 1990). In the implementation discussed, the decisions required for the agency were identical to those required for the auction, so a single set of decisions served both purposes.

An agency market is but one kind of gamed market. Accordingly, gaming simulation designers who wish to include an agency market in their gaming simulations must first consider whether some or all of the markets that they have heretofore been modeling should be gamed. If only a small number of transactions are to be gamed, the market can be a simple face-to-face bazaar that requires minimal computer support. Thorelli (2001), for example, has incorporated negotiated contract sales between companies into INTOPIA in this simple way. An agency market is most useful where the required volume of transactions is high.

A substantial body of literature already exists on the modeling of markets. With continued research into the requirements of business gaming simulations, an equivalent body of literature may yet be developed on the gaming of markets.

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