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INVESTIGATION OF THE IMPACT OF DECISION PARAMETERS FOR A DUTCH AUCTION SIMULATION FOR IPO ISSUES

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ABSTRACT

Development of e-commerce has been proceeding at a furious pace over the past half a decade. Most companies now have a website and are conducting e-commerce. The move from bricks-and-mortar to clicks-and-mortar, if not pure play or virtual corporations is on in full swing. E-commerce applications span the gamut from basic buying/selling in the corporate world to e-government. Auction sites like e-bay have proved to be enormously successful. Auctions have been a part of traditional commerce ranging from the popular Christie's and Sotheby's to the government's auctions of bonds and T-bills. Companies that come out with their initial public offering are now conducting Internet road shows in their bid to maximize public subscription to their issues. This paper deals with one such application of doing online IPO exercises. This paper describes the design of a web-based Dutch auction simulation to teach the students the intricacies of pricing and stock evaluation for new initial public offerings as a part of the course in e-commerce Finance. A Monte-Carlo simulation was exercise is conducted to determine the impact of the game decision parameters on portfolio performance. Results are presented.

INTRODUCTION

There exist a variety of method for valuation of common stock for an existing company. Valuation of stock can refer to a security's intrinsic value or its actual market driven value. Even though intrinsic value of a stock is an important basis for investor's decisions to buy or sell a security, the issues are more complication for a new public offering. The market processes determine the value of a stock. For a company deciding to go public, there are a variety of factors that determine how to price an IPO. The part of an IPO that every company wants to know is how much money are they going to get. After all, that's what this is all about. However pricing an IPO is more of an art than a science.

The first part of the pricing analysis includes comparing the company with other companies, which are similar in the same industry. The impact of the added capital from the IPO also needs to be evaluated with respect to its impact on the financial condition of the company and operating results. The company's financial projections also need to be weighed against comparable companies with similar assets, earnings, and revenue. Other factors also need to be evaluated. These include the current trends in the investment community as to what is selling and what isn't selling right now.

The Dutch auction was developed in the 17th century in Amsterdam for the sale of fresh flowers and is different from conventional auctions in that the price of the goods on offer descends and all bids are immediately successful. In a Dutch auction the auctioneer begins at a high price, the price then descends by steps until a bidder indicates their intention to buy at the price level reached. The successful bidder then nominates all or part of the goods on offer. If any goods remain in the current lot, the auctioneer increases the offer price by a predetermined amount and then resumes the auction. The auction continues in this fashion until either the current lot is exhausted or its reserve price is reached. Central to the Dutch auction is a large electronic or mechanical clock, which shows the current offer price. During the auction this clock shows the offer price descending and then kicking up when a bid is made and then descending again. The Dutch auction originated in the Netherlands, and in essence, runs in reverse of a typical auction. Thus, prices go down as the auction is in progress. Thus the price of the item being auctioned is gradually reduced until it elicits a responsive bid. Dutch auctions are used to sell U.S. Treasury bills and to set rates on some remarketed floating rate debt instruments and preferred stocks. This project develops a simulation that mimics this process – in essence a modified Dutch auction - so that students can make hands-on decisions and figure out how to price their company's IPO price so as to maximize their company's value. The next section of the paper discusses auctions in general and Dutch auctions as applied to financial instruments such as T-bills, common stock, company auctions etc. We then proceed to describing the learning objectives for the simulation game. The design of the web-based interface for this game is then presented. We finally conclude the paper and suggest further avenues for exploration.

DUTCH AUCTION FOR IPOs

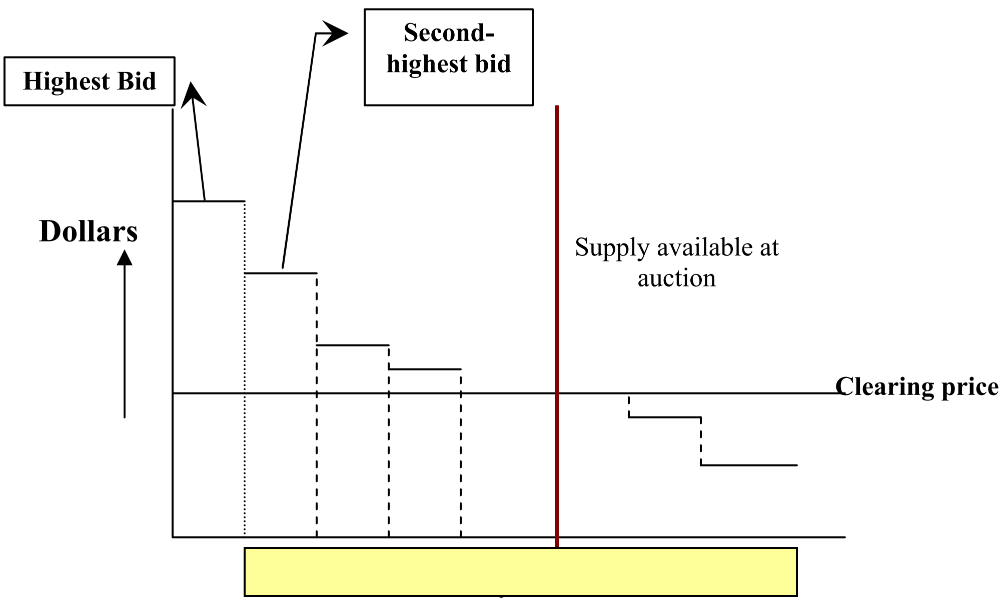
An auction is a bidding mechanism described by a set of auction rules that specify how the winner is determined and how much he has to pay [Wolfstetter, 10]. There are many different auction rules. Auctions can be oral or written, open or closed or they can be ascending price or descending price. Depending on these parameters the process of the auction is different. ***Table 1*** summarizes the different types of auctions

Table1: Different Types of Auctions

Open	Closed
Ascending-price (English)	Second-Price (Vickrey)
Descending-price (Dutch)	First-price

Source: Adapted from Wolfstetter, [10]

In an ascending-price or English auction, the auctioneer seeks increasing bids for a single item until all but the highest bidder(s) are eliminated. Instead of letting the price rise, the descending-price or Dutch auction follows a descending pattern. The auctioneer begins by asking a certain price, and gradually lowers it until some bidder(s) claims the item. In a written auction bidders are invited to submit a sealed bid, with the understanding that the item is awarded to the highest bidder. Under the first-price rule the winner actually pays as much as his own bid, whereas under the second-price rule the price is equal to the second highest bid. This terminology is not always used consistently. Thus in the financial community a multiple-unit, single price auction is termed a Dutch auction. It is really a sealed bid second-price auction. This is the auction that we will be employing in this paper.



Source: Adapted from Logue [4]

Many transactions in the financial world are accomplished via an auction process. These include U.S. Treasury auctions of securities, auctions of companies, secondary market auctions for equity, debt, and other financial instruments, Dutch auctions for share repurchases and dividend and interest rate resets. ***Figure 1*** shows the process of a financial Dutch auction. The company offering the shares has a limited quantity to sell. They also determine a reserve price below which they would not be willing to sell the shares. Various people then bid for the shares. This is a sealed bid in that the other bidders do not know any other bidder's price. The price at which all of the quantity is sold is the market-clearing price. All bidders who bid shares higher than this price will now receive the quantity of shares that they bid for at this market-clearing price. The firm offering its shares has to decide on the number of shares and the reserve price. The reserve price is effectively sends a message to the bidders as to the company's evaluation of its intrinsic net worth. If a company's reserve price is too large with respect to their inherent worth, then the offering may be under-subscribed and may thus result in lesser overall intake of funds. By the same token, if their reserve price is set too low, the offering will be oversubscribed which would indicate that the intake of funds is lesser than what they could have obtained. Thus, these are decision parameters that the company has to closely monitor.

The bidders, on the other hand, have to determine the quantity of shares that they would like to buy and the price that they would like to bid for it. Higher is the price that they bid better is the chance of getting the shares, but they risk buying over-valued shares. Lower is the bid price; lower is the probability of winning the bid.

The simulation game is designed to simulate a real market of this sort and thereby inculcate in the students an awareness of the factors coming into play in the auction process. Below we examine the impact of game parameters on the auction performance.

DECISION PARAMETERS IN THE GAME

Let

- M = # of sellers
- N = # of bidders
- Q_i = Quantity of shares offered for sale by seller *i*
- q_{ij} = Quantity of shares of Seller *i* bid for by bidder *j*
- p_{ij} = Price per share bid by bidder *j* for shares of seller *i*.
- M_i = Market price per share for shares of seller *i*.
- r_i = Reserve price per share of Seller *i*.

Let the price p_{ij} be uniformly distributed with a probability density function U[10,1] modified to reflect the reality on the ground. In general there may exist a bias/tendency for most bidders to bid high or low. This is captured through what is termed a *bid price bias*. Similarly the quantity of shares bid for is uniformly distributed with a probability density function of U[0,1]. The numbers of shares bid are normally a fraction of the total shares offered by a company to reflect the multiplicity of numerous buyers vying for shares of a particular company.

The seller's motivation is to raise the greatest amount of equity for the shares offered. Thus the seller's objective can now be stated as:

$$Max\ p_{in}\sum_{j=1}^{n} q_{ij} \quad if \quad \sum_{j=1}^{n} q_{ij} \geq Q_i \ \ \& \ \ p_{ij} \geq r_i \ \forall j \leq n < N$$

$$Or \ \ p_{iN}\sum_{j=1}^{N} q_{ij} \quad if \quad \sum_{j=1}^{N} q_{ij} \geq Q_i \ \ \& \ \ p_{ij} \geq r_i \ \forall j \leq N$$

This can be stated as

$$Max \quad \Pr\left[\left(\sum_{j=1}^{n} q_{ij} \geq Q_i\right) \cap \left(\underset{j=n}{\forall}\, p_{ij} > r_i\right)\right].p_{in}\sum_{j=1}^{n} q_{ij} +$$

$$\Pr\left[\left(\sum_{j=1}^{N} q_{ij} \geq Q_i\right) \cap \left(\underset{j=N}{\forall}\, p_{ij} > r_i\right)\right].p_{iN}\sum_{j=1}^{n} q_{ij}$$

On the other hand, the buyer's primary objective is buy shares so as to maximize the value of his portfolio. Thus the buyer's objective can now be stated as:

$$Max \quad \sum_{i=1}^{M} (M_i - p_{in})\, q_{ij} \qquad if \quad p_{ij} \geq p_{in} \quad \forall i$$

This can be stated as:

$$Max \ \ \Pr(\bigcap \sum_{i=1}^{M} (M_i - p_{in})\, q_{ij} \qquad if \quad p_{ij} \geq p_{in} \quad \forall i$$

M_i, the *market price*, for the purposes of this investigation, is calculated as the weighted average of the price of all *successful* bids. Also p_{in} is the *market-clearing price, i.e.,* the price at which all shares of the company have been bid for and thus the price that each successful bidder pays per share.

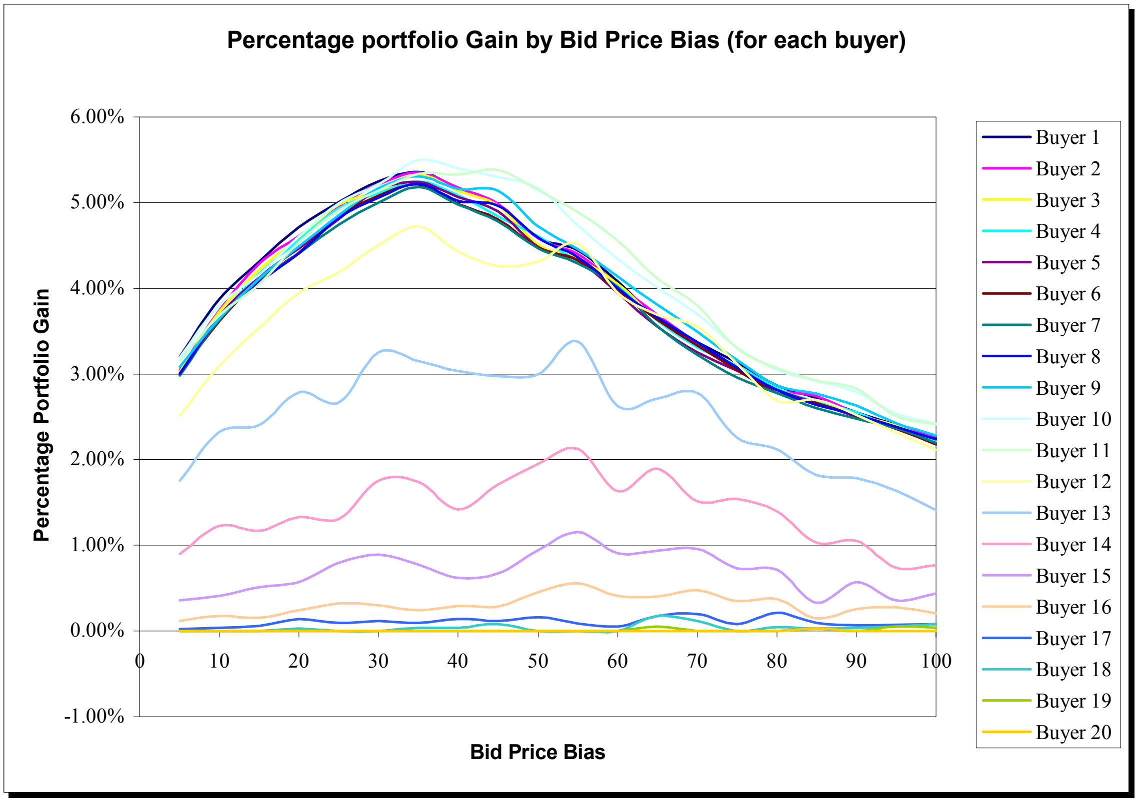
A Monte Carlo simulation exercise was conducted to investigate the impact of decision parameters on the twin factors of the amount of equity raised and the buyer's portfolio. The simulation was constructed to reflect a typical class scenario with four companies (sellers) offering shares for sale and 20 investors (buyers) participating in the IPO bid. Two primary variables that the buyers determine include the number of shares they would be bidding for and the price that they would bid. Since a Dutch auction of this sort is not a common value auction but based on perceptions of investors as to the company's one could conceivably have widely gyrating bid prices. In reality, an investor would consider a company's pro forma balance sheets, income statements and cash flow statements while determining their bid price.

Table I: A portion of the spreadsheet showing bid prices and award quantities

Bid For	Seller 1					Seller 2				
	Quantity	100000		Up	Down	Quantity	100000		Up	Down
	EMP	$ 10	Devn.	$1	$ 1	EMP	$ 10	Devn.	$1	$ 1
	Reserve	$ 9				Reserve	$ 9			
Buyer #	Quantity Bid	Qty. Award	Sorted Price	Total $	Price/ Share	Quantity Bid	Qty. Award	Sorted Price	Total $	Price/ Share
1	18181	18181	$10.95	$199,082	$10.93	13135	13135	$10.97	$144,091	$10.71
2	17853	17853	$10.93	$195,133	$10.73	538	538	$10.92	$5,875	$10.04
3	2284	2284	$10.91	$24,918	$10.13	4856	4856	$10.85	$52,688	$10.85
4	12919	12919	$10.86	$140,300	$10.37	13380	13380	$10.85	$145,173	$10.02
5	19557	19557	$10.77	$210,629	$10.50	13256	13256	$10.74	$142,369	$10.85
6	10323	10323	$10.73	$110,766	$10.58	13311	13311	$10.71	$142,561	$10.68
7	3284	3284	$10.69	$35,106	$10.77	15197	15197	$10.69	$162,456	$10.58
8	16063	15599	**$10.66**	$166,285	$10.95	17933	17933	$10.68	$191,524	$10.74
9	15404	0	$10.65	$0	$10.62	2494	2494	$10.58	$26,387	$10.41
10	2990	0	$10.65	$0	$10.65	15965	5900	**$10.57**	$62,363	$10.97
11	12062	0	$10.62	$0	$10.02	17515	0	$10.54	$0	$10.24
12	5079	0	$10.58	$0	$10.86	16272	0	$10.41	$0	$10.54
13	6382	0	$10.53	$0	$10.69	12037	0	$10.35	$0	$10.07
14	6150	0	$10.52	$0	$10.52	1123	0	$10.29	$0	$10.57
15	3834	0	$10.50	$0	$10.65	8701	0	$10.29	$0	$10.29
16	1766	0	$10.37	$0	$10.53	17268	0	$10.24	$0	$10.92
17	3311	0	$10.26	$0	$10.22	12180	0	$10.11	$0	$10.29
18	19621	0	$10.22	$0	$10.91	6510	0	$10.07	$0	$10.11
19	19454	0	$10.13	$0	$10.66	15994	0	$10.04	$0	$10.35
20	19610	0	$10.02	$0	$10.26	4476	0	$10.02	$0	$10.69
	216127	**100000**		**$1,082,220**		**222141**	**100000**		**$1,075,487**	

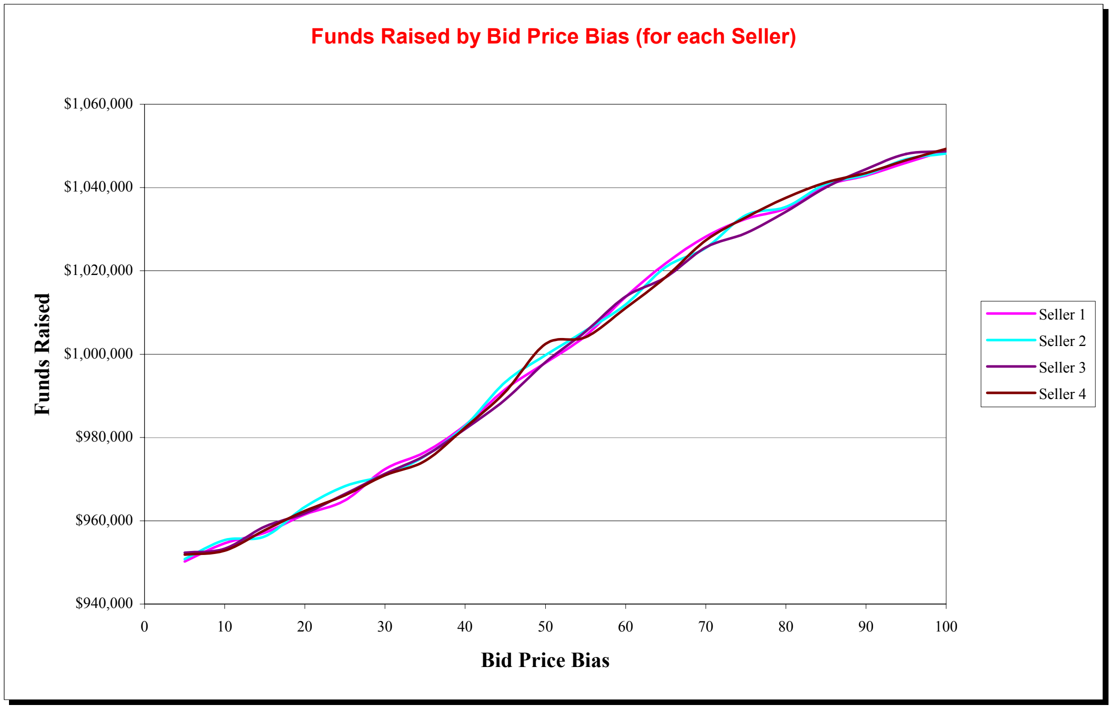
Market-clearing price

For the purposes of this Monte Carlo simulation, an *estimated market price (EMP)* was used as a base around which bid prices were generated using a uniform probability density function. Thus an EMP of $ 10 was chosen and a variation of $ 1 was used in terms of generating the bid prices. Since the key in this auction is the bid price, it would be interesting to see how the probability of having a successful bid is affected by a specific investor's bid price in relation to other competitive investors. As mentioned earlier, we use a factor termed the *bid price bias* to generate bids that are either lower or higher than the *EMP*. Thus if a bias of 5 % is used, that would imply that the bid price by various buyers is higher than the EMP only 5% of the time. A sample size of 200 was chosen for this simulation. This simulation was implemented in MS-Excel. A *portion* of the spreadsheet depicting the various factors for two of the companies (sellers of shares) is shown above. The simulation was accomplished through the use of Excel macros.



As seen in the **Table I**, a reserve price of $ 9 was selected for this simulation. Each company is offering 100,000 shares for sale. The price column figures were generated using the (a) EMP, (b) the up and down deviation and (c) the bid price bias. The sorted price column is simply the price column sorted in descending order. It is assumed that this is the price that was bid by each of the buyer. What this accomplishes is that it highlights buyer 1 as the person that perennially bids high (and similarly buyer 20 as the consistently low bidder) and thus allows us to make conclusions about high bidder performance versus low bidder performance. The clearing price is highlighted in **Table I.** It is seen that for seller 1, the clearing price ($ 10.66) occurs at Buyer 8 while it occurs at Buyer 10 for seller 2 ($ 10.57).

Shown above is a graph of how buyers' portfolio gains vary with the bid price bias. Portfolio gains are calculated as the increase in portfolio value as opposed to the amount of funds spent in building that portfolio. It is seen from this figure that for most of the successful buyers, the percentage gain in portfolio value is between approximately 3 % to about 5.5 %. The highest gain occurs when approximately 35% of the bidders bid below the EMP. The percentage gain then drops off if most of the buyers are at the higher end of the bidding spectrum. This insight tells us that, while intuitively it would make sense to bid higher to increase ones chance of a success, this would have *not* have as positive a return on an investor's portfolio. It is also seen that if one is at the low end of the bid price then the returns drop off since one is not as successful in terms of receiving any allocation. It is also seen, in general, that regardless of the bid price, as long as one is successful in being awarded shares, the percentage returns are fairly closely clustered.



On the other hand, what's the impact on the seller's ability to raise funds? The graph above shows the behavior of the total funds raised by a company. It is seen that as most of the bidders keep bidding higher (a higher bid price bias percentage), the company takes in more funds for the same amount of shares.

CONCLUSION

Curricula in business schools are changing in keeping with the dynamic environment that we operate in today. Also, pedagogical approaches are changing, as we better understand the teaching and learning environment. In addition, technological advances are resulting in a slew of tools being available to better accomplish what was difficult, if not impossible, in the academic teaching-learning environment. The convergence of these three elements - new content, new pedagogical approaches and new technological delivery tools - is revolutionizing the academic environment. One can view this situation as an undesirable challenge which makes obsolete our current knowledge base and skill set. Alternatively one can view this in a positive light as offering exciting new opportunities for transforming the current academic landscape. This paper has delineated one such effort to take advantage of the confluence of new knowledge, technologies and pedagogies in designing a simulation game. The impact of gaming decision parameters on the performance of a Dutch auction simulation was examined in this paper.

Further work needs to be done to evaluate and assess the impact of other factors such as the reserve price that a company sets for its shares. Also would the number of shares that a company offers at an IPO make a difference? More detailed work about further environmental scenarios needs to be investigated in terms of other buying behavioral patterns.

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