UNIVERSITY OF MARYLAND

DEPARTMENT OF ECONOMICS

3105 Tydings Hall
College Park, Maryland 20742–7211
301.405.3495 TEL 202.318.0863 FAX
ausubel@econ.umd.edu

Comments on Internet Auctions

by
Lawrence M. Ausubel
Professor of Economics
University of Maryland

Before the Federal Trade Commission's Public Workshop on
"Possible Anticompetitive Efforts to Restrict Competition on the Internet"
October 10, 2002

Introduction

There has recently been a vast increase in the volume of Internet auctions. While public attention has focused largely on the growth of Internet bazaars such as eBay, there has equally been a tremendous rise of less-visible auctions involving such areas as telecommunications spectrum, energy, the environment, and business-to-business procurement. Electronic bidding gives the auction designer greater flexibility and control in designing an efficient auction process; electronic bidding vastly reduces the participation costs of bidders; and electronic bidding greatly reduces the tangible expenses associated with running an auction. Consequently, the preferred medium for implementing new auctions today is on the Internet, and it is easy to envision a day when online auctions will all but supercede traditional auctions in which buyers bid in person.

I am providing my professional opinions at this workshop in two capacities. First, I am an economist and game theorist who has written extensively on the theory and practice of auctions, and I hold three patents related to auction technology. Second, as vice president and treasurer of Market Design Inc., I have advised sellers in designing and implementing some of the Internet auctions to which I will refer in these comments, and I have advised bidders in numerous high-stakes telecommunications auctions.[1]

Less-Visible Internet Auctions

I will not in any way attempt to provide a comprehensive survey of Internet auctions. Rather, I will briefly mention three specific high-stakes, real-world Internet auctions with which I have first-hand familiarity.

[1] Further information about auction theory and practice is available at http://www.ausubel.com (the author's website), as well as at http://www.market-design.com and http://www.efficientauctions.com.

Beginning in July 1994 and through the present, the Federal Communications Commission (FCC) has allocated scarce telecommunications spectrum using auctions with electronic bidding. In a typical FCC auction, the U.S. is divided into anywhere from 6 to 734 regions, and licenses covering the respective regions are auctioned simultaneously in a single auction process. Unlike a traditional auction process, in which the auctioneer might first sell the New York license by open outcry, then the Los Angeles license, and then the Washington license, the FCC solicits bids on *all* of the licenses in a series of rounds. Bids continue to be accepted on every license until a round elapses in which no further bids are submitted on any licenses. This has allowed bidders to realize synergies among related licenses, since they can condition their bidding strategies on the prices of the likely combinations that they may win, as the auction progresses. This advanced auction process has been wildly successful: variations on the FCC auction have been used for spectrum auctions on six continents generating more than $100 billion in revenues. The FCC will soon enhance its bidding procedure to accept package bids: e.g., an all-or-nothing bid to purchase the package consisting of the New York license and the Washington license, at a given price.

Electricité de France (EDF), the dominant power producer in France and the world's largest electricity group, began the divestment of 6,000 megawatts of generation capacity, representing approximately 10% of France's electricity supply, in 2001. This divestment is being accomplished not by selling the physical power plants, but by selling "virtual power plants" (VPP's), option contracts replicating the outputs of the power plants. A quarterly, Internet auction is used for selling the French generation capacity. The seller begins the auction by announcing a price vector for each of the products. The participating bidders respond with electronic bids representing the quantity demanded of each of the products. The seller announces the aggregate demand for each product, compares the aggregate demand for each product with the available supply, and adjusts the price vector accordingly. The process is repeated for approximately 5 to 10 rounds (taking no more than a day), until all of the products clear. Again, this advanced auction process has been quite successful, and has so far been used for five quarterly auctions, selling approximately one billion euro of electricity.

Earlier this year, the United Kingdom government initiated a Greenhouse Gas Emissions Trading Scheme (ETS) intended to facilitate an efficient reduction in greenhouse gas emissions. As part of the introduction of this arrangement, the government offered incentive payments to UK companies committing to greenhouse gas emission reductions. The UK government allocated the incentive payments by an Internet auction. In the world's first auction for greenhouse gas reduction, in March 2002, the UK government offered incentive payments of £215 million. The auction was conducted with a descending price clock, on account that it was a procurement auction (or "reverse auction"): the government sought to purchase emission reductions at minimum cost. The government posted a price per unit of emissions reductions, and firms bid the quantity of emission reductions that they were prepared to make at that price. In each new round, the government announced a successively lower price and bidders indicated the quantity of emission reductions that they were prepared to make at the lower price, until the market cleared. Again, this Internet auction was quite successful, and yielded 4 million metric tons of emission reductions at apparently a lower cost than if incentives had been allocated by non-market means.

Implications for Regulation

(1) As regulators consider new requirements on Internet auctions, they should be cognizant that there are many less-visible Internet auctions besides Internet bazaars such as eBay. The less-visible auctions have been operating largely without any complaints, yet they would be extremely adversely impacted by intrusive regulations.

(2) Even in regulations limited to Internet bazaars, regulators should be cognizant that fraud is only one side of the story relevant to consumers. Fee structures are another factor of equal relevance. Typically, buyer commissions and seller commissions are significantly lower at Internet auctioneers than at traditional auction houses, and Internet auctioneers apply competitive pressure on the commission levels of traditional auction houses.

(3) Thus, regulations requiring licensing of Internet auctioneers (or otherwise limiting them) should be viewed as quite possibly anticompetitive. The beneficiaries of such regulations are likely to be not consumers, but incumbent traditional auctioneers.

(4) To the extent that fraud is a problem on Internet bazaars, attention would be better directed toward enhancing escrow and related services that enable consumers to better protect themselves.

Auctions for IPO's

Lawrence M. Ausubel*

University of Maryland

October 4, 2002

Send comments to:

Professor Lawrence M. Ausubel
Department of Economics
University of Maryland
Tydings Hall, Room 3105
College Park, MD 20742−7211

ausubel@econ.umd.edu
(301) 405−3495

*This paper, still in progress, is an expanded version of "Implications of Auction Theory for New Issues Markets," *Brookings-Wharton Papers on Financial Services*, 2002, pp. 313–343. I am grateful to collaborators and co-authors on the various projects and publications described in this paper, including Kathleen Ausubel, Peter Cramton, Ulrich Gall, Eric Maskin, Paul Milgrom and Jesse Schwartz, and to Peter Grajzl for excellent research assistance. The generous support of National Science Foundation Grant SES–01–12906 is gratefully acknowledged.

1 Introduction

Imagine attempting to explain to a visitor, from another era or another planet, the economic rationale behind various institutions in the American economy at the start of the 21st century. Few practices seem more difficult to justify to the outsider than the current procedure for the issuance of equity securities. The share price in initial public offerings (IPO's) often bears little connection to the equating of supply and demand, so that IPO's are sometimes massively oversubscribed and the share price increases by as much as a factor of five from the offering price to the close of the first day of trading. Shares in these oversubscribed offerings are rationed, not according to willingness to pay, but to favored clients of the underwriting investment banks. Often there is at least the appearance that clients receive their allotments in exchange for returning value to the investment banks in other transactions; and recently there have been allegations that some allotments have been made in exchange for agreements to buy additional shares on the open market after the IPO. While the associated returns foregone by the sellers (i.e., the companies going public) would be easier to justify if the explicit fees for the service were commensurately discounted, the explicit fees charged for IPO's actually seem quite high, generally a 7% commission on proceeds from the new shares.[1]

The main objective of this paper is not to hammer away at the inefficiencies present in the current system of new equity issuance; nor to attempt to explain what prevents the current system from being swept aside. Rather, this paper seeks to draw from new developments in market design—both theoretical results and new practices in other sectors—and to highlight alternative procedures that may be best suited to supplement or replace the current flawed system.

2 Comments on Current Practice for New Equity Issuance

The years 2000 and 2001 have seen Securities and Exchange Commission (SEC) investigations into two alleged abuses in the current practice for new equity issuance, a $100 million tentative settlement of charges by Credit Suisse First Boston, and a plethora of private lawsuits filed. In May 2001, *The Economist* provided an early, well written, and somewhat skeptical synopsis:

> Were investment banks crooked when they made billions of dollars from the Internet bubble?
>
> It enjoyed the dotcom party as much as anyone. But now that the whole thing has ended messily, Wall Street has become everybody's favourite scapegoat. Its analysts are accused of abandoning objectivity to tout shares that their investment banks underwrote. Underwriters are said to have set the share price too low in initial public offerings (IPOs), so as to ensure a huge jump in the price when trading began. That jump in turn enabled investment banks to reward favoured clients who were allocated shares in the IPO, which clients could instantly sell at a fat profit. To compound the rascality, the banks shared in those profits by demanding return favours from the clients.[2]

[1] The underwriting commission was exactly 7% for more than 90% of U.S. IPO's raising $20-80 million in recent years (Chen and Ritter, 2000).

[2] "Wall Street under scrutiny: A penny in whose pocket?" *The Economist*, May 26, 2001, pp. 71-72.

No matter how farfetched or corrupt this scenario seemed, by early 2002 substantial evidence had accumulated supporting some of these claims. Credit Suisse First Boston had reached final agreement on a $100 million settlement of government charges. According to published accounts, “The regulators singled out First Boston, accusing it of demanding that customers pay back some of the profit they made from trading new stocks in the form of inflated commissions on other stock trades. Investigators gathered evidence, including e-mail messages, that indicated that the firm's sale representatives had told some customers to pay the firm at least $1 in commissions for every $3 of new-stock trading profits.”[3] Furthermore, “Plaintiffs’ lawyers have filed more than 1,000 lawsuits against First Boston and about four dozen other securities firms, asserting that they manipulated the prices of new stocks in various ways. Those suits contend that sales representatives at First Boston gave relatively big allocations of new stocks to professional investors in exchange for a share of the profits those buyers made by reselling the stocks. They also contend that other investment banks, including Goldman, Sachs and Morgan Stanley Dean Witter, solicited promises from investors that they would buy more shares of a new stock at higher prices after it started trading. Such arrangements, expressly prohibited by securities laws, could have driven new stocks to artificially high prices. Spokeswomen for Goldman, Sachs and Morgan Stanley declined to comment. Federal regulators are continuing to investigate the second practice, known on Wall Street as ‘laddering’ a stock, and they may still bring charges against one or more investment banks.”[4]

There has been some speculation that the SEC and the National Association of Securities Dealers might issue rules forbidding kickbacks or inflated commissions in IPO allocations. But, according to published accounts, regulators correctly recognize that an incremental change in rules may do little to prevent recurrent abuses. “It's very difficult to draw up rules to regulate allocation of shares that are underpriced,” one official is quoted as saying.[5]

Rather, it has become increasingly clear during 2002 that the current system of new security issuance is fundamentally corrupt. Over the years, a myriad of explanations have been put forth in the finance literature to explain the empirical regularity of IPO underpricing. However, it is recently beginning to appear that one of the best explanations for the stability of the current system may be a principal-agent problem in the selection and pricing of investment banking services. Typically, a limited set of executives and/or owners of the firm (the *agents*) select the investment bank(s) with which the firm does business and negotiate the terms of payment for the investment banking services. Meanwhile, the payments for the investment banking services are borne by all of the owners of the firm (the *principal*). Consequently, there is a very strong incentive for collusion between the agent and the investment bank, at the expense of the principal. In short, the principal pays more than is necessary for investment banking services, and the agent receives implicit rebates. [*The next version of this paper will include a model of this principal-agent explanation.*]

---

[3] “First Boston Seen Settling Kickback Case,” *The New York Times*, December 12, 2001, p. C1.

[4] “First Boston Seen Settling Kickback Case,” *The New York Times*, December 12, 2001, p. C1.

[5] “US may drop IPO rule changes: Doubts are increasing as to whether changing share allocation practice would end abuses,” *The Financial Times*, December 12, 2001, p. 23.

Underpriced IPO shares appear to have become the preferred currency for implicit rebates, as documented in recent investigations by lawmakers and regulators. Former WorldCom chief executive Bernard J. Ebbers made more than $11 million in four years on shares of 21 hot offerings that he received from Salomon Smith Barney, according to documents released by the House Financial Services Committee.[6] A March 1999 Salomon memo details allocations of shares in Rhythms NetConnections, Inc. to 26 Salomon clients, half of whom were executives of other telecommunications companies with which Salomon did business. Rhythms NetConnections went public on April 7, 1999 at $21 per share and reached $93 per share within a week (and, at this writing, is in bankruptcy).[7] Meanwhile, a 1999 email by a Credit Suisse First Boston analyst asserts that some IPO shares were routinely reserved for "friends of the investment bank" and amount to "something of an 'if you scratch my back I will scratch yours'" arrangement.[8]

The New York State Attorney General recently filed suit against Ebbers and four other former telecom executives, under essentially this theory. Ebbers made more than $11 million on Salomon IPO's, while WorldCom paid Salomon $107 million in investment banking fees, the suit contends. Clark E. McLeod made more than $9 million from the shares he received from Salomon, while his company, McLeod USA, paid $50 million in fees to Salomon, the suit said. Philip F. Anschutz made about $5 million and Joseph P. Nacchio made more than $1 million, while the company they led, Qwest Communications, paid $37 million in fees to Salomon, the suit said. Stephen A. Garofalo made $1.5 million for himself, while Metromedia Fiber, the company of which he was chairman, paid $47 million in fees to Salomon, the suit said.[9]

Thus, the perspective of the current paper is that a more radical overhaul of current IPO practice is necessary: a change to a modern auction system that provides an open transparent mechanism for price discovery. This is the clearest way that the persistent underpricing—and the accompanying incentives for abuse—can be eliminated.

3 Auction Theory Preliminaries

This section will provide some background information on auction formats that might be contemplated for new issues markets and some associated results in the literature.

3.1 Sealed-Bid, Multi-Unit Auction Formats

Sealed-bid, multi-unit auction formats are best known in the financial sector for their longtime and widespread use in the sale of central government securities. For example, ten years ago, the *Joint Report on the Government Securities Market* surveyed OECD countries and found that the U.S., Australia, Canada, Denmark, France, Germany, Italy, Japan, New Zealand and the United

[6] "Ebbers Made $11 Million on 21 Stock Offerings," *The New York Times*, August 31, 2002, p. C1.

[7] "Salomon Memo Hints at Favor on New Stock Issues," *The New York Times*, August 29, 2002, p. C1.

[8] "Analyst's '99 E-Mail Details IPO Rewards," *The Washington Post*, September 7, 2002, p. E01.

[9] "Spitzer Sues Executives of Telecom Companies," *The New York Times*, October 1, 2002, p. C1.

Kingdom then used sealed-bid auctions for selling at least some of their government securities.[10] For many years, sealed-bid auctions have also been used rather extensively for share repurchases by publicly traded companies[11] and, in relatively rare instances, for IPO's.[12]

Pay-As-Bid Auctions.[13] Bidders submit sealed bids that effectively comprise demand curves. The auctioneer aggregates the bids and determines the clearing price at which demand equals supply. Each bidder wins the quantity demanded at the clearing price, and pays the amount that he bid for each unit won.

Uniform-Price Auctions.[14] Bidders submit sealed bids that effectively comprise demand curves. The auctioneer aggregates the bids and determines the clearing price at which demand equals supply. Each bidder wins the quantity demanded at the clearing price, and pays the clearing price for each unit won.

3.2 Ascending-Bid, Multi-Unit Auction Formats

Ascending-bid, multi-unit auction formats have become dominant in recent years for government sales of telecommunications spectrum. As described in Section 4 below, they are also coming into significant use in the energy and environmental sectors.

Simultaneous Ascending Auctions.[15] The items are auctioned simultaneously in multiple rounds of bidding. In each round, bidders may submit new bids. A bid is a pair comprising an item and an associated price (higher than the standing high bid). Bids can continue to be submitted for any item until the auction ends for all items; the auction ends only when a round elapses with no new bids submitted for any of the items.

Ascending Clock Auctions.[16] In each round, the auctioneer announces a price (or price vector) for the items being auctioned, and bidders respond with bids. A bid comprises a quantity of items demanded at the announced price. If the aggregate demand exceeds the supply, the auctioneer raises the price and the process repeats. The auction ends at the first price at which aggregate demand is less than or equal to supply.

---

[10] U.S. Department of the Treasury, U.S. Securities and Exchange Commission, and Board of Governors of the Federal Reserve System (1992), *Joint Report on the Government Securities Market*, pp. B–25 - B–26.

[11] *See* Bagwell, Laurie S. (1992) and Gay, Kale and Noe (1991).

[12] *See* Kandel, Sarig, and Wohl (1999) and Sherman (2001).

[13] Pay-as-bid auctions are often referred to as "pay-your-bid auctions," or less descriptively, as "discriminatory auctions" or "multiple-price auctions." They generalize the sealed-bid, first-price auction for single items.

[14] Uniform-price auctions are often referred to, less descriptively, in the financial press as "Dutch auctions," or variously as "nondiscriminatory auctions," "competitive auctions," or "single-price auctions." It is sometimes asserted (incorrectly) that they generalize the sealed-bid, second-price auction for single items. However, the correct multi-unit generalization of the second-price auction is due to Vickrey (1961).

[15] *See* Cramton (1995) and Milgrom (2000).

[16] *See* Ausubel (1997, 1999, 2000, 2002).

Variations on the simultaneous ascending auction have been used during 1994-2001 for spectrum auctions on six continents generating more than $100 billion in revenues. Among the best-known examples of these auctions were the U.S. PCS auctions of 1994-96 and 2001, the UK 3G auction in 2000, and the German 3G auction in 2000. When large numbers of identical items are to be auctioned—as is the case in the issuance of equity or debt securities—it is often advantageous to instead formulate the procedure as an ascending clock auction. Since the auctioneer, rather than bidders, names the prices in a clock auction, the auctioneer has greater control over the speed of the clock auction and can assure that it runs at a deliberate pace. The EDF Generation Capacity Auction and the UK Emissions Trading Scheme Auction, described in the next section, are two examples of high-stakes ascending clock auctions.

3.3 Standard Results of Auction Theory

Auction formats are generally evaluated according to two criteria: efficiency, the extent to which the auction assigns items to the bidders who value them the most; and revenue maximization, the extent to which the auction maximizes the seller's expected revenues. Most of the early results of auction theory concern sales of single items. If bidders are symmetric and have pure private values, the sealed-bid first-price, the sealed-bid second-price, and the ascending (English) auction all achieve equal efficiency and seller revenues. However, to the extent that bidders' valuations are affiliated (approximately meaning positively correlated) with one another, ascending auctions outperform sealed-bid auctions with respect to revenues (Milgrom and Weber, 1982). The intuition often provided for this result is that sealed-bid auctions are particularly susceptible to the "Winner's Curse": a bidder is more likely to win an auction when opposing bidders possess unfavorable information and so, in this sense, winning may be bad news. However, since an ascending auction provides bidders with continuous feedback about the opposing bidders' valuations, providing opportunities to draw inferences and to respond accordingly, it ameliorates the Winner's Curse and leads on average to more aggressive bidding, to the seller's ultimate benefit.[17]

More recent work in the auction literature has examined multi-unit auctions. Much of the empirical emphasis has been on the comparison between the pay-as-bid auction and uniform-price auction. Indeed, the U.S. Treasury conducted an "experiment" from 1992 to 1998 of using the uniform-price auction for selling 2-year and 5-year notes and using the pay-as-bid auction for selling other Treasury durations (Malvey and Archibald, 1998), and then switched entirely to the uniform-price auction in November 1998. However, the theoretical literature makes clear that, except in very special circumstances, the revenue rankings of the pay-as-bid and uniform-price auctions are inherently ambiguous, and both formats inevitably yield inefficient outcomes (Ausubel and Cramton, 1996). Moreover, any focus on the pay-as-bid and uniform-price formats ignores other auction approaches that are likely to outperform both.

In particular, ascending-bid multi-unit auction formats offer several decisive advantages over sealed-bid multi-unit auction formats. First, the insight from single-item auctions that the continuous feedback about other bidders' valuations would ameliorate the Winner's Curse and lead to more aggressive bidding should be expected to carry over to many multi-unit

[17] *See* McAfee and McMillan (1987) for an excellent survey of the early results of auction theory.

environments. This intuition led the *Joint Report on the Government Securities Market* to conclude: "Irrespective of whether the single-price, sealed-bid auction would prove superior to the current practice, the Agencies believe that there is an auction technique that may be superior to both types of sealed-bid auction techniques discussed above. This is an ascending-price, open auction system, which will be feasible for the first time once the auctions are automated." [18] Second, ascending-clock auctions, better than sealed-bid auctions, allow bidders to maintain the privacy of their valuations for the items being sold. Bidders never need to submit any indications of interest at any prices above the auction's clearing price. Third, an efficient ascending-bid auction format, improving upon the basic clock auction design, has been developed in recent years. This paper will continue by, first, in Section 4 describing two practical implementations of clock auctions, and then in Section 5 explaining the efficient ascending-bid auction.

4 Case Studies: High-Stakes Auctions in Other Sectors of the Economy

This section of the paper does not in any way attempt to provide a comprehensive survey of modern auction techniques as applied to other sectors of the economy. Rather, it focuses on two specific high-stakes, real-world auctions utilizing designs that are also well suited for financial services applications, including the issuance of securities. They are both projects that the author has helped to run during the time since he agreed to write this paper.

4.1 The Electricité de France (EDF) Generation Capacity Auctions

Electricité de France (EDF), the dominant power producer in France and the world's largest electricity group, committed in an agreement with the European Commission (in connection with EDF's acquisition of a substantial interest in German utility Energie Baden-Württemberg AG) to begin the divestment of 6,000 megawatts of generation capacity in 2001. The 6,000 megawatts to be sold represented approximately 10% of France's electricity supply. This divestment would be accomplished not by selling the physical power plants, but by selling "virtual power plants" (VPP's), option contracts replicating the outputs of the power plants. Two basic types of virtual power plants would be sold: (a) base-load VPP's, whose strike prices would equal the variable cost of a nuclear power plant (and so the options would be exercised essentially around the clock, 365 days per year); and (b) peak-load VPP's, whose strike prices would equal the variable cost of a peak load plant (and so the options would be exercised only at peak times). Base-load and peak-load VPP's in a variety of durations would be offered. In addition, a third type of product, "Power Purchase Agreements" (PPA's), would be sold. PPA's represent a block of power based on the output from co-generation plants under power purchase contracts.

The French generation capacity is being sold by way of a dynamic, ascending-clock auction. To date, EDF has conducted three capacity auctions, in September 2001, December 2001 and March 2002, advised by PricewaterhouseCoopers and Market Design Inc. The following description will largely focus on the first auction, in which VPP's representing some 300 million Euros worth of electricity were sold.[19]

[18] U.S. Department of the Treasury, U.S. Securities and Exchange Commission, and Board of Governors of the Federal Reserve System (1992), *Joint Report on the Government Securities Market*, pp. 14-15.

[19] The author managed Market Design Inc.'s participation in the project, which included designing the auction, developing the auction software, and advising EDF in the conduct of the auction. University of Maryland professor Peter Cramton also contributed to all aspects of Market Design's participation in the project.
More detailed information about the EDF Generation Capacity Auctions is available at

In the first auction, an initial tranche of 1,190 megawatts (MW) of electricity was offered. This generation capacity was sold in fifteen products, ordered as five product "groups":

- Product Group A: VPP Base-Load Product
  - Six durations, all beginning 1/1/2002
  - Supply = 800 MW
- Product Group B: VPP Peak-Load Product
  - Six durations, all beginning 1/1/2002
  - Supply = 200 MW
- Product Group C: VPP Base-Load Product
  - One duration: 11/1/2001 – 12/31/2001
  - Supply = 800 MW, limited by Group A
- Product Group D: VPP Peak-Load Product
  - One duration: 11/1/2001 – 12/31/2001
  - Supply = 200 MW, limited by Group B
- Product Group E: PPA Product
  - One duration: 1/1/2002 – 12/31/2002
  - Supply = 190 MW

In broad perspective, the auction is conducted as a practical implementation of the fictitious "Walrasian auctioneer" of microeconomics theory. The auctioneer (seller) begins the auction by announcing a price vector for each of the 15 products. The participating bidders (buyers) each respond with a quantity demanded of each of the 15 products (limited by a constraint that no single bidder can demand more than 45% of the available supply). The auctioneer announces the aggregate demand for each product, compares the aggregate demand for each product group with the available supply, and adjusts the price vector accordingly. The process is repeated until all of the product groups clear.

The EDF Generation Capacity Auctions are implemented on proprietary, commercial-grade software designed for clock auctions. The auction software operates on a web server located in Europe, with a backup server located in the United States. Bidders submit bids in the auction and follow the auction's progress using standard web browsers (Internet Explorer or Netscape Navigator). The auction software utilizes a variety of security features, including: 128-bit SSL (the same encryption standard used by financial institutions on the Internet); a digital certificate for establishing authentification; a web server protected by a firewall; and login ID's and passwords distributed to bidders by non-electronic means. In the event that an individual bidder suffers failure of his own computer system or Internet connection, the bidder contacts the auction administrator and submits his bid by fax. The software then permits the auction administrator to enter a bid on behalf of a bidder. All transactions on the auction system are recorded in an audit file. The audit file notes the time and amount of all bid submissions. It also records such other events as a bid placed by the auction administrator on behalf of a bidder.

---

www.efficientauctions.com/electricity.htm and www.edf.fr/htm/en/enchere/enchere/. Further information about the auction software and its availability for applications in the financial services sector is available from the author. Further materials on auction theory and practice are available on the author's website, www.ausubel.com, and on www.market-design.com and www.efficientauctions.com.

The three EDF Generation Capacity Auctions to date appear to have been entirely successful. They have attracted the participation of some 45 energy traders and suppliers, with more than 20 bidders emerging as successful purchasers. The first two auctions concluded in ten rounds each, and the third auction concluded in nine rounds. Due to the fact that it was the first auction, the September auction was conducted on a relatively relaxed schedule and took two days. Beginning with the second auction, the bidding has concluded in a single day: the bidders were experienced, and after the second round, the auction could be conducted on a schedule of 30-minute bidding rounds followed by 30-minute breaks between rounds.

The parties involved consider the auction process to have achieved an extremely good result. The electricity generally traded at a premium relative to secondary-market prices in nearby countries. The auction software performed flawlessly. The simultaneous ascending-clock auction format seems to have been successful in persuading bidders to bid up to their full valuations. This format also enabled bidders to base their demands for each product on the prices of all the products, and the various product groups closed in a quick and orderly succession.

4.2 The United Kingdom Greenhouse Gas Emissions Trading Scheme Auction

In 2002, the United Kingdom government is initiating a Greenhouse Gas Emissions Trading Scheme (ETS) intended to facilitate an efficient reduction in greenhouse gas emissions. As part of the introduction of this arrangement, the government has offered incentive payments to UK companies committing to greenhouse gas emission reductions. Emission reductions that are paid for from the incentives fund form company emission reduction targets. Companies will have the option of meeting their emission reduction targets by either reducing their emissions or by purchasing emission permits from other participants in the ETS. Companies will also be able to sell or bank emission permits if they reduce their emissions further than their targets require.

The UK government allocated the incentive payments among UK companies by auction. In the world's first auction for greenhouse gas reduction, March 11 and 12, 2002, the UK government offered incentive payments of £215 million. The government was advised by Environmental Resources Management, Natsource Tullett Europe, and Market Design Inc.[20]

The auction was conducted with a descending price clock, on account that it was a procurement auction (or "reverse auction"): the government sought to purchase emission reductions at minimum cost. The auctioneer (buyer) posted a price in £ per metric ton of CO_2 (or the equivalent) and bidders (firms) bid the quantity in metric tons of emission reductions that they were prepared to make at that price. In each new round, the government announced a successively lower price and bidders indicated the quantity of emission reductions that they were prepared to make at the lower price.

---

[20] The author, together with University of Maryland professor Peter Cramton, managed Market Design Inc.'s participation in the project, which included contributing to the design of the auction, developing the auction software, and advising the UK government in the conduct of the auction. Institute for Advanced Studies professor Eric Maskin, Oxford University professor Paul Klemperer, and Stanford University professor Jeremy Bulow also made major contributions to the auction design. More detailed information about the UK ETS Auction is available at www.efficientauctions.com/co2.htm and www.defra.gov.uk/environment/climatechange/trading/auction.htm.

38 UK firms logged onto a website, www.etsauction.com, and participated in the auction. In the first round of bidding, the auctioneer named a price of £100 per metric ton, and the bidders collectively indicated a willingness to reduce their emissions by 4.9 million metric tons. The price was then allowed to descend until a point was reached where the budgeted £215 million in incentive monies was exactly spent. This occurred in Round 9, at a price of £53.37 per metric ton. The 34 winning bidders collectively took on the obligation to reduce their annual greenhouse gas emissions below their 1998-2000 levels by 4 million metric tons over five years.

While the design of the UK ETS auction is quite a bit simpler than that of the EDF auction, three aspects of the design may be especially instructive to the issuance of new equity securities. First, as is typically the case with equity issuance, there was just a single product being auctioned—but in enormous quantities. A clock auction design, where the auctioneer names prices and bidders respond with quantities, is particularly well suited for such circumstances. Indeed, essentially the identical rules and software system from the ETS auction could be used for IPO's, only with the price clock adjusted to ascend rather than descend.

Second, the role of price discovery was particularly important in the UK ETS auction; nobody appeared to have a clear idea as to the true economy-wide cost of reducing CO_2 and equivalent emissions. In this respect, the ETS auction was very close in spirit to a speculative IPO, where again it is often difficult to predict with any accuracy the closing price after the first day of trading. It is precisely in such a situation of substantial value uncertainty where dynamic auction processes offer the strongest advantages as compared to sealed-bid auctions.

Third, as illustrated by the UK ETS auction, dynamic clock auctions may easily accommodate situations where the quantity being auctioned may depend on the market-clearing price. The ETS auction was an extreme case of this: the total quantity of emission reductions transacted equaled a predetermined budget divided by the market-clearing price. Just as easily, an IPO auction may be implemented in which a smaller number of shares are offered at a lower price and a larger number of shares are offered at a higher price (or the reverse).

5 Auction Theory, Continued: The Efficient Ascending Auction

The auction format described in depth in the previous section, for the EDF and ETS auctions, is a dynamic version of the uniform-price auction. The price is allowed to adjust iteratively until demand equals supply, bidders are allotted the quantities that they bid at the final clearing price, and each bidder's payment equals the final clearing price multiplied by his final quantity. This section of the paper describes an alternative dynamic auction design, sometimes referred to as the "Ausubel auction." It utilizes the same general structure, but a different payment rule. Theoretically and experimentally, this alternative design yields more efficient allocations than a uniform-price auction, and it may be especially well suited for security issuance. A more detailed description and results can be found in Ausubel (1997, 2000).

5.1 Illustrative Example

This efficient ascending-clock procedure is easiest illustrated with an example where five units of identical items are available for auction, although the procedure will work just as easily with five million units (e.g., shares of stock in an IPO). For simplicity, let us suppose that there are four bidders. Suppose that the auction begins with the auctioneer announcing a price of 10, and suppose that the bidders respond with the following quantities:

Price	Bidder A	Bidder B	Bidder C	Bidder D
10	3	2	2	2

Then, at the initial price of 10, the aggregate demand of $3 + 2 + 2 + 2 = 9$ exceeds the available supply of 5. The price needs to adjust upward, and assume that it increases continuously. Now suppose that the bidders continue to bid the same quantities until the price reaches 25, at which point Bidder D drops out of the auction, yielding:

Price	Bidder A	Bidder B	Bidder C	Bidder D
25	3	2	2	0

At the price of 25, the aggregate demand of $3 + 2 + 2 + 0 = 7$ continues to exceed the available supply of 5. However, examine this situation carefully from Bidder A's perspective. Bidder A's opponents collectively demand only $2 + 2 + 0 = 4$ units, whereas 5 units are available. It may now be said that Bidder A has *clinched* winning 1 unit: whatever happens now (provided that Bidders B – D bid monotonically), Bidder A is certain to win at least 1 unit. The auction rules take the fact of clinching literally, and award a unit to Bidder A at the clinching price of 25.

Since there is still excess demand, the auctioneer continues to adjust the price upward. Suppose that the next change in bidders' demands occurs at a price of 30, at which point bidder B reduces her demand from 2 to 1, yielding:

Price	Bidder A	Bidder B	Bidder C	Bidder D
30	3	1	2	0

At the price of 30, the aggregate demand of $3 + 1 + 2 + 0 = 6$ continues to exceed the available supply of 5. However, again, examine this situation carefully from Bidder A's perspective. Bidder A's opponents collectively demand only $1 + 2 + 0 = 3$ units, whereas 5 units are available. It may now be said that Bidder A has *clinched* winning 2 units: whatever happens now (provided that Bidders B – D bid monotonically), Bidder A is certain to win at least 2 units. The auction rules continue to take the fact of clinching literally, and award a second unit to Bidder A at the new clinching price of 30. By the same token, let us examine this situation carefully from Bidder C's perspective. Bidder C's opponents collectively demand only $3 + 1 + 0 = 4$ units, whereas 5 units are available. It may therefore be said that Bidder C has *clinched* winning 1 unit: whatever happens now (provided that Bidders A, B and D bid monotonically), Bidder C is certain to win at least 1 unit. The auction rules take the fact of clinching literally, and award a unit to Bidder C at the clinching price of 30.

Since there is still excess demand, the auctioneer continues to adjust the price upward. Suppose that the final change in bidders' demands occurs at a price of 35, at which point bidder B reduces her demand from 1 to 0, yielding:

Price	Bidder A	Bidder B	Bidder C	Bidder D
35	3	0	2	0

At the price of 35, the aggregate demand of 3 + 0 + 2 + 0 = 5 is brought equal to the supply of 5. Thus, the market-clearing price is 35. Bidder A, who had already received a first unit at 25 and a second unit at 30, wins a third unit at 35. Bidder C, who had already received a first unit at 30, wins a second unit at 35. In summary, we have the following auction outcome:

	Bidder A	Bidder B	Bidder C	Bidder D
Units Won	3	0	2	0
Payments	$25+30+35$	0	30 + 35	0

Thus, bidders are awarded the quantities that they bid at the final price, but bidders pay according to the prices at which they *clinch* the various units.

5.2 Mathematical Description

Let p be the price that is posted by the auctioneer and is increased continuously.[21] Let n be the number of bidders, let S be the supply of items being auctioned, let $x_i(p)$ denote the quantity bid by bidder i at price p, and let $x_{-i}(p) = \sum_{j \neq i} x_j(p)$ denote the aggregate quantity bid by bidder i's opponents at price p. Then the cumulative amount clinched by bidder i at price p is defined by the following equation:

$$c_i(p) = \max\{0\,, S - x_{-i}(p)\}. \tag{1}$$

Let p^* denote the clearing price, i.e., $p^* = \min\left\{p : \sum_{j=1}^{n} x_j(p) \leq S\right\}$, and let p_0 denote the initial price in the auction. Bidder i wins the quantity, $x_i(p^*)$, of units bid at the clearing price. The payment of bidder i for these units is given by the following equation:

$$y_i = \int_{p_0}^{p^*} p\, dc_i(p)\,, \tag{2}$$

where Eq. (2) is calculated as a Stieltjes integral. This means that, at every point where the value $c_i(p)$ increases by one unit, an amount equal to the current value of p is added to the payment (i.e., exactly the clinching calculation described informally above).

[21] An analogous description would apply to a descending-clock procurement auction (or "reverse auction"), only now the auctioneer would pay the winning bidders.

5.3 Results on the Efficient Ascending Auction

Many conventional auction formats for multiple items have theoretical properties that are less than ideal. In particular, in the sealed-bid uniform-price auction (described in Section 3) that is now used for the U.S. Treasury auction, optimizing bidders engage in "demand reduction" (Ausubel and Cramton, 1996). Bidders have an incentive to bid less than their true valuations, and the incentive for demand reduction increases in the quantity bid. As a result, the sealed-bid uniform-price auction tends to inefficiently allocate the items being sold. With a well-functioning secondary market, this inefficient allocation is likely to come at the seller's expense (Ausubel and Cramton, 1999). Furthermore, this theoretical property of inefficiency is likely to be the same or even worse in dynamic uniform-price auctions (see, for example, Ausubel and Schwartz, 1999).

By contrast, the efficient ascending auction has highly desirable properties. In theory, bidders have every incentive to bid sincerely: that is, to bid exactly their true valuations on every unit for which they bid. With all bidders bidding their true valuations—and with the winners being determined by the high bids—the auction has the attractive property of allotting all items to the bidders who value them the most. The following theorem holds:

THEOREM. If bidders have (weakly) diminishing pure private values, then under complete or incomplete information, sincere bidding by every bidder is an equilibrium of the Ausubel auction. In this equilibrium outcome, the allocation of items is fully efficient. Moreover, in a suitable discrete specification of the game: under complete information, sincere bidding survives iterated elimination of weakly-dominated strategies; and under incomplete information, sincere bidding is (generically) the unique equilibrium and it is (generically) the unique outcome of iterated elimination of strictly-dominated strategies.

6 Underpricing of New Issues, Current IPO Practice, and Auctions

One of the best-established facts of the finance literature on IPO's is the persistent existence of underpricing in the offering price. For example, Ritter (2002) reports that among a sample of 6,249 IPO's in the United States from 1980–2001, the mean percentage increase from the offering price to the end-of-first-day price equaled 18.8%. Most spectacularly, the mean first-day return in 1999 was 71.7%, and the mean first-day return in 2000 was 56.1%.

By way of comparison, an IPO auction offers the promise of all but eliminating the underpricing. In theory, the clearing price in a well-designed auction is virtually equal to the market price, so the first-day return should be essentially zero. And in practice, IPO auctions have tended to yield much smaller underpricing than current practice.

Nevertheless, one observes that the usage of auctions for IPO's may have actually declined, worldwide, over the past two decades. Even in countries where the IPO tender was previously well established, auctions have been abandoned in favor of other IPO methods (Sherman, 2001). For example, in the United Kingdom, 15 of 24 offerings in 1983 were done by tender, whereas no private sector IPO's by tender have occurred there since 1986 (Jenkinson and Ljungqvist, 1996, p. 13). In the United States, W.R. Hambrecht & Co. began to conduct IPO's by auction, but was only able to find seven clients that were willing to go public in this way.

The puzzle is thus why auctions—inexpensive to run and destined to reduce underpricing—have not gained in the securities area as they have in other sectors of the economy. This paper will not, in any sense, answer this puzzle. However, this section will explore the various explanations that have been put forth in the literature for underpricing. It will then indicate how modern auction techniques can be used to accomplish the same goals that are allegedly served by underpricing. So part of the explanation for the trend away from auctions in the securities area may simply be that nobody has tailored modern auction techniques to serve the needs of firms going public.

6.1 Explanations in the Literature for IPO Underpricing

A myriad of explanations have been put forth in the literature to explain the empirical regularity of IPO underpricing. My treatment here borrows heavily from that of Jenkinson and Ljungqvist (1996, Chapters 3–5). Some of the explanations argued for underpricing include:

- **The Winner's Curse**: Suppose that some investors are asymmetrically informed about the value of the new stock. Then uninformed investors stand a greater chance of being allocated shares in the IPO when the informed investors' information is unfavorable. Without underpricing, the uninformed investors face a "lemons" problem, and they would not participate in the IPO. With underpricing, the uninformed investors can still earn nonnegative returns in the IPO despite the fact that they receive disproportionate allocations of shares when the informed investors' information is unfavorable.
- **Underpricing as a Signal**: Suppose that the firm has superior information about the value of the new stock, and that it is less costly for a high-value firm than a low-value firm to underprice its shares. Then, as in a classic signaling model, the firm may use underpricing to credibly convince investors that the value of the new stock is high.
- **Issuer or Underwriter Liability**: Suppose that issuers, underwriters, accountants and other parties associated with securities issuance in the U.S. are preoccupied by potential shareholder lawsuits following an IPO that goes bust. Since the potential liability may be limited to the amount that the share price drops below the offering price, the various parties may have an interest in depressing the offering price (i.e., in underpricing).
- **Price Support**: Suppose that underwriters of IPO's effectively take on the obligation of intervening in the aftermarket to help prevent the stock price from falling below the offering price for some number of days after the issue. To the extent that this is the case, the *ex post* initial-days returns may be a truncated distribution, and so the apparent underpricing may not be a real phenomenon.
- **Dispersion of Ownership to Retain Control**: Suppose that the managers of a firm have an incentive to disperse the post-IPO ownership among many small investors, in order to exacerbate the separation of ownership and control for the managers' benefit. Then, the managers may welcome an arrangement under which the issue is underpriced—and, therefore, radically oversubscribed—so that purchases may be rationed to very small blocks of shares.
- **Concentration of Ownership to Enhance Monitoring**: Conversely, suppose that the owners of a firm recognize that a large outside investor provides a public good to other investors by monitoring the firm's management. Then, the owners may underprice the issue in order to provide extra incentive for an outside investor to acquire a large stake.

- **Guaranteed Return**: Suppose that the owners of a firm are primarily concerned with realizing a given price or amount of money from the IPO, and are relatively indifferent about the extent to which this price or amount of money is exceeded. Then, the owners may be happy with an arrangement that guarantees them the given price or amount of money, even at the cost of significant underpricing in some states of the world.
- **Underpricing as a Marketing Event**: Suppose that the owners (and buyers) of dot-com firms going public in 1997–2000 equated IPO success with a very high first-day return. Then firms may have agreed to vastly underprice their issues in order to obtain the resulting marketing "pop" on capital markets.

6.2 Explanations for Underpricing and the Relationship with Auctions

Some of the pre-Internet-bubble explanations put forth for IPO underpricing make little sense within the context of the 71.7% and 56.1% mean first-day returns in 1999 and 2000. For example, the price support explanation may argue that apparent 5% underpricing is spurious, but cannot possibly suggest that 50% underpricing is anything but a real phenomenon. Other explanations (such as underpricing as a marketing event) appear to lean heavily on issuer or capital market stupidity, and so are difficult to disprove on rational grounds. However, the purpose of this subsection is to explain how many of the effects put forth to justify underpricing can be handled in a superior fashion by a securities auction. In some cases, the instrument being auctioned must be widened beyond simply a share of stock, or the service being provided by the auctioning intermediary must be widened beyond the simple sale of shares of stock.

- **The Winner's Curse**: To the extent that it is present, this structure of asymmetric information may create problems for any method of IPO. However, it is worth reemphasizing that some mechanisms outperform others in the face of the Winner's Curse. In particular, as we have seen in Section 3, the accepted wisdom in the auction literature is that dynamic ascending-bid auctions are superior to static sealed-bid auctions with respect to the Winner's Curse. The intuition for this result is that uninformed bidders in an ascending-bid auction receive continuous feedback about the level of participation of informed bidders, so that when the informed bidders' information is unfavorable, uninformed bidders have greater opportunities to infer this and to respond accordingly.
- **Underpricing as a Signal**: Many commentators have questioned the empirical relevance of the signaling explanation. As noted by Jenkinson and Ljungqvist (1996, p. 55), would firms signal through underpricing if they had a wider menu of signals to choose from? Apart from the more obvious signals, such as a choice of a particularly reputable underwriter or venture capitalist, the offering of longer-term price guarantees can serve as quite effective signals. For example, bundled together with the issued share can be a derivative security that returns x% of any decline in the share's market price during a one-year period following the IPO. Similar to a warranty of quality, this serves as a classic credible signal, since a longer-term price guarantee is relatively less costly for a high-value firm than for a low-value firm. The new shares and the associated derivative securities can be auctioned simultaneously, eliminating much of the cost of underpricing.
- **Issuer or Underwriter Liability**: Again, many commentators have questioned the empirical relevance of the liability explanation. Drake and Vetsuypens (1993) find that litigation appears to be driven by large aftermarket price declines long after the IPO, not by the offering price of the IPO. Alexander (1993) notes that, while damages under the

Securities Act of 1933 are limited to declines below the offering price, damages under the Securities Exchange Act of 1934 are not so limited.[22] In any case, she argues, underpricing would be an inefficient and ineffective means for avoiding issuer or underwriter liability. Jenkinson and Ljungqvist (1996) conclude that this explanation is a good example of a U.S.-centric model that fails in the international context: severe liability is a U.S. phenomenon, while IPO underpricing is a global phenomenon.

- **Price Support**: It is not necessarily the case that price supports following the IPO should be viewed as value-enhancing or desirable, but if they are, there appear to be much more efficient ways to accomplish this as part of an auction process. One possibility is for the underwriter and/or auctioneer to explicitly take on the obligation of providing price support as part of the services rendered for its fees—as in current practice, this could be provided for, in part, through use of an over-allotment (or "green shoe") provision. A second possibility is to bundle together, with the issued share, a derivative security that returns x% of any decline in the share's market price during a short period following the IPO—in principal, this percentage could be as much as 100%.
- **Dispersion of Ownership to Retain Control**: If the issuer wishes to disperse the post-IPO ownership among many small investors, this can be easily built into auction rules. For example, it is quite standard to restrict bidders to no more than y% of the total supply offered: if the issuer wishes to disperse ownership, y% can be set at 1 or 2%, or some other very small level. Obviously, this dispersion will come at the expense of auction revenues, but the cost should still be much lower than the current cost of underpricing. Furthermore, the dispersion can be locked in for some time, for example by providing a one-for-ten bonus share for investors who retain their shares for more than one year; or a one-for-ten bonus share, capped at a limited number of bonus shares per investor.
- **Concentration of Ownership to Enhance Monitoring**: Again, if the issuer wishes to concentrate the post-IPO ownership among large investors, this can be easily built into auction rules. For example, some of the shares can be offered in a very large lot size (with bidders not permitted to bid on only a fraction of the lot for these shares). It should also be noted that the efficient ascending auction (described in Section 5) automatically provides some benefits to a bidder who chooses to acquire a large number of shares.
- **Guaranteed Return**: A guaranteed price or amount of money from the IPO is another feature that is easily built into the auction procedure. One simple approach is to utilize a reserve price in the auction. A more complicated approach is for the issuer and the underwriter (or auctioneer) to establish an arrangement in which the underwriter guarantees the issuer a given price or amount of money. In return, the underwriter receives a negotiated percentage of the extent to which the price or proceeds exceeds the guaranteed level. In all likelihood, such an arrangement is more beneficial to the issuer than the current underpricing, since the issuer receives the guaranteed amount plus typically a positive share of the proceeds above the guaranteed amount.
- **Underpricing as a Marketing Event**: In the post-Internet-bubble, post-Credit Suisse First Boston environment, it seems relatively easy to educate issuers that an oversubscribed auction which rations bidders via a very high market-clearing price

[22] She further opines that "it is difficult to imagine circumstances in which a 1933 Act claim could be brought but a 1934 Act claim could not be alleged."

provides just as good marketing "pop" in the capital markets as an oversubscribed process which rations bidders via under-the-table commissions paid to the underwriter.

7 Additional Aspects of Security Issuance by Auction

7.1 Who are the Bidders?

One can easily imagine two alternative, basic structures for an IPO auction.

7.1.1 Investors as bidders

Instead of fixing an offering price and then rationing shares to investors at the offering price, the underwriter conducts an auction in which investors act as bidders. The offering price is determined so as to set demand equal to supply, that is, price is itself the rationing device. Investors submit bids according to the same considerations as which they apply in making buy and sell decisions in the aftermarket and—in principle—the auction clearing price should be approximately equal to the aftermarket price.

As in current IPO practice, the underwriter and accounting firm would perform a due diligence review of the issuer and prepare a prospectus before the auction. The auction itself would be conducted as an ascending clock: the auctioneer names a price, bidders respond with quantities; the auctioneer raises the price, bidders respond with revised quantities; and the process iterates until demand is brought equal to supply. Bidders win, respectively, the quantities of shares that they demand at the final price.

One approach is for participation in the ascending-clock auction to be limited to institutional investors. Optionally (and similar to U.S. Treasury auction practice), small investors could be given the opportunity to submit "noncompetitive" bids, which would be honored at the clearing price of the auction. Another approach is for participation in the ascending-clock auction to be open to all bidders—small investors as well as institutional investors. Obviously, investors would need to provide financial guarantees for their bids: for example, bids could effectively be placed through bidders' brokerage accounts; and the same limits could be applied as for ordinary secondary-market purchases of shares.

As discussed in Section 6.2, above, some of the desirable characteristics of current IPO practice could be preserved in an auction process by bundling related derivative securities with the offered shares of stock or by modifying the auction rules to restrict purchases in various ways. Moreover, derivative securities could be bundled with the stock shares in new ways to further create value. Here are some examples:

- Each share of stock could be bundled with a call option to purchase 0.15 additional shares of the stock at the clearing price of the auction for a short period of time after the auction, thus replicating standard "green shoe" provisions of IPO's which tend to provide price stabilization (but now effectively requiring bidders to pay for the call option).
- Each share of stock could be bundled with a put option to sell 0.50 shares of the stock at the clearing price of the auction for a one-year period after the auction, thus providing a

price guarantee that small investors might consider to be valuable (and which would encourage participation by small investors).[23]

- The quantity demanded by each bidder could be limited to 1% of the issuer's total shares, in order to encourage a wide dispersion of ownership among investors.

However, there is no particular reason why such derivative securities need to be bundled with shares of stocks in any fixed proportion. Indeed, in all likelihood, some bidders will value price protection more than others, and will desire different mixtures of stocks and derivatives. As a result, a superior IPO design is to conduct a multiple-clock auction for two goods: the shares of stocks; and the derivative securities. (In practical terms, the EDF auction design described in Section 4, which involved multiple products, could be exploited.) For example, a quantity of 10 million shares of stock, together with a quantity of 5 million put options at the clearing price, are offered simultaneously. Let (p_{share}, p_{put}) denote prices for the two securities, and let (q_{share}, q_{put}) denote associated quantities. The auction is conducted with two ascending clocks: the auctioneer names a price vector (p^1_{share}, p^1_{put}), bidders respond with quantity vectors (q^1_{share}, q^1_{put}); the auctioneer raises the prices to (p^2_{share}, p^2_{put}), bidders respond with revised quantities (q^2_{share}, q^2_{put}); and the process iterates until demand for both securities are brought equal to supply. Bidders win, respectively, the quantities of shares and put options that they demand at the final prices.

7.1.2 Intermediaries as bidders

As an alternative structure, instead of contracting with a single investment bank to act as lead underwriter, an issuer conducts an auction in which investment banks (or other intermediaries) themselves act as bidders. The investment banks submit bids for shares in the auction knowing that they must earn their profits from the difference between the prices that they pay the issuer in the auction and the prices at which they can resell the shares to investors. Competition within the auction process determines—and, in principle, should limit—the level of profits that investment banks can earn in the IPO.

Under such a structure, in advance of the auction, each investment bank would be given an opportunity to examine the issuer's operations and books in detail, to form its own assessment of the value of shares in the aftermarket. Quite possibly, each investment bank bidding would be responsible for providing its own due diligence services. The auction itself is conducted as an ascending clock: the issuer names a price, bidders respond with quantities; the issue raises the price, bidders respond with revised quantities; and the process iterates until demand is brought equal to supply. The investment bank bidders win, respectively, the quantities of shares that they demand at the final price, and they can dispose of their shares in whatever way they see fit.

Some of the embellishments to the auction described in the previous Section 7.1.1 could also be used here. For example, each share of stock could be bundled with a call option to purchase 0.15 additional shares at the clearing price for a short period of time after the auction, to replicate standard "green shoe" provisions. At the same time, it is less likely that longer-term price

[23] Such a put option might need to be guaranteed by an escrow account or might be purchased from a well-capitalized third party, in order to give credibility to the price guarantee.

guarantees or other arrangements would be offered: these are more likely arrangements that individual investment banks would make with the investors to whom they distribute their shares.

7.2 Regulatory Inhibitions

There appear to be a number of regulatory inhibitions to introducing IPO auctions in the U.S.—but none of these inhibitions seem insurmountable.

First, the U.S. Securities and Exchange Commission (SEC) heavily regulates the entire IPO process, and so SEC approval would be necessary for any novel IPO procedure. Beginning in the late 1990's, the SEC began to receive inquiries concerning proposed online auction procedures. The SEC staff has responded by issuing letters indicating that the SEC would not take action against particular proposed procedures. In July 1999, SEC staff issued a "no-action letter" that allowed Wit Capital to offer securities subject to certain conditions, including that: a current preliminary prospectus is made available on the website; investors provide conditional electronic offers to buy securities prior to effectiveness and these offers to buy are reconfirmed within 48 hours of the date of effectiveness; and the offer to buy is not binding and the investor may withdraw the offer for a specified period following effectiveness. Since then, the SEC has also issued no-action letters to WR Hambrecht and to Bear Stearns. [24]

A requirement that bids must be nonbinding is detrimental to the introduction of auctions. For an auction to work most effectively, bids need to be made to have real consequences. A regulatory requirement making bids nonbinding can be significantly sidestepped: the investment bank appears to be free to bar an investor who backs out of his bids from receiving allocations in future auctions. In addition, to the extent that derivative securities are utilized to provide short-time price support, the incentive for a bidder to back out of his bids can be minimized. Nevertheless, regulatory rules that effectively reduce the usual binding nature of bids will inhibit the use of auctions—and it is difficult to see any positive benefit from such rules—so it is hoped that the SEC will change its position over time.

Second, some commentators interpret the National Association of Securities Dealers (NASD) rules as requiring uniform pricing. However, this interpretation is not unambiguous. While an attempt to charge one price to one class of investors but a higher price to another class of investors is likely precluded, it is less clear whether auction rules that may result in non-uniform pricing should be viewed as "discriminatory". For example, in the pay-as-bid auction described in Section 3 or in the Ausubel auction described in Section 5, above, there is no discrimination among different bidders in the bids that they are allowed to submit or in how the winning bids are selected. It is simply in the nature of things that different bidders are likely to submit different bids—and under the auction rules, these different bids may translate to different prices.

A requirement that prices must be uniform is also detrimental to the introduction of auctions. Various formats that yield non-uniform pricing offer advantages, in efficiency or in revenues, over auction formats with uniform pricing. At the same time, the impediment posed by a

[24] "Technology, Capital Markets and the Digital Divide," speech by SEC Commissioner Paul R. Carey, December 6, 2000.

requirement for uniform pricing should not be overstated. Both the EDF auction design and the Emissions Trading Scheme auction design described in Section 4 would fully comply with any requirement for uniform pricing. And, while in theory they are not the absolutely ideal auction designs, they still offer potentially very large advantages over current IPO practice.

7.3 Recent Attempts to Introduce Auctions to U.S. Issues Markets

The most conspicuous attempts to introduce IPO auctions into the United States were undertaken by WR Hambrecht & Co. beginning in 1999. Through Hambrecht's "OpenIPO" process, bids are typically accepted during a 3- to 5-week period prior to the effective date of the IPO. With the exception that these bids are not formally binding pursuant to the SEC's "no-action letter," the auction is conducted as a sealed-bid, uniform-price auction, as described above in Section 3. Bidders submit bids that effectively comprise demand curves for the stock being offered. After the close of the auction, the auctioneer aggregates the bids and determines the clearing price at which demand equals supply. Each bidder wins the quantity demanded at the clearing price, and pays the clearing price for each share won.

Unfortunately, Hambrecht's efforts have not met with overwhelming success. Only seven IPO's have been auctioned by Hambrecht, the most recent one in May 2002.[25] Hambrecht's efforts appear to have been hampered by three factors: (1) Hambrecht is in the second tier of investment banks and appears to be largely unable to attract issuers that top-tier investment banks are interested in representing; (2) Hambrecht has used a rather protracted, sealed-bid auction process in which bids are not binding, rather than a short and more effective ascending-bid process; and (3) entry by any auction process would have been difficult in an Internet-bubble environment where success of an IPO was gauged by the first-day "pop".

8 Conclusion: The Political Economy of Innovations in Market Design

One question on which to conclude is: Why is it the case that sectors such as telecommunications spectrum, energy and environmental markets have adopted innovative auction techniques for high-stakes sales, whereas new security issuance has stuck with old, severely-flawed designs? One candidate answer is that equity issues are badly suited for dynamic auction procedures. However, such an explanation seems implausible to this author. In particular, telecom spectrum appears to present valuation uncertainties as great as those of any high-tech IPO; yet an open, transparent, formal auction procedure has been shown to perform well for telecom spectrum.

A better explanation should take notice of whether a market process already exists, with incumbents earning substantial rents from the existing process, or whether a market is starting from scratch. In the case of communications spectrum, governments had previously given away spectrum licenses, and they introduced auctions in 1994 with no prior history of existing spectrum markets of any significance. In the case of the energy sector, the market moved from heavy regulation to substantial deregulation, again with little history of existing markets. In the

---

[25] At this writing in October 2002, Hambrecht's completed IPO's by auction are: Ravenswood, $11,550,000, April 9, 1999; Salon.com, $27,300,000, June 22, 1999; Andover.net, $82,800,000, December 8, 1999; Nogatech, Inc., $42,000,000, May 17, 2000; Peet's Coffee & Tea, $26,400,000, January 25, 2001; Briazz, Inc., $16,000,000, May 2, 2001; and Overstock.com, Inc., $39,000,000, May 29, 2002.

case of CO_2 reductions, at the time that a decision was made to conduct an auction, no more than one or two inter-firm trades had ever taken place.

In each case where an innovative market design was introduced, there were relatively few self-interested market participants with a stake in preserving the status quo market structure. By contrast, in the arena of new security issuance, there exists a legion of powerful investment banks with an enormous stake in maintaining the profits of the current IPO system. So, despite well-established defects in the current system, the incumbents have staved off alternative mechanisms and have, in fact, consolidated the use of the current process.

Will the combination of general interest in reforming the recent IPO abuses and recent successes of new market designs in other sectors finally lead to change in the process for new securities issuance? Only time will tell.

References

Alexander, Janet C. (1993), "The Lawsuit Avoidance Theory of Why Initial Public Offerings are Underpriced," *UCLA Law Review*, 41, 17-73.

Ausubel, Lawrence M. (1997), "An Efficient Ascending-Bid Auction for Multiple Objects," University of Maryland Working Paper 97–06.

Ausubel, Lawrence M. (1999), "Computer Implemented Methods and Apparatus for Auction," U.S. Patent No. 5,905,975, issued 18 May 1999.

Ausubel, Lawrence M. (2000), "System and Method for an Efficient Dynamic Auction for Multiple Objects," U.S. Patent Number 6,026,383, issued 15 Feb 2000.

Ausubel, Lawrence M. (2002), "An Efficient Dynamic Auction for Heterogeneous Commodities," mimeo, University of Maryland.

Ausubel, Lawrence M. and Peter Cramton (1996), "Demand Reduction and Inefficiency in Multi-Unit Auctions," University of Maryland Working Paper 96–07.

Ausubel, Lawrence M. and Peter Cramton (1999), "The Optimality of Being Efficient," mimeo, University of Maryland.

Ausubel, Lawrence M. and Jesse Schwartz (1999), "The Ascending Auction Paradox," mimeo, University of Maryland.

Bagwell, Laurie S. (1992), "Dutch Auction Repurchases: An Analysis of Shareholder Heterogeneity," *Journal of Finance*, 47, 71-106.

Chen, Hsuan-Chi and Jay R. Ritter (2000), "The Seven Percent Solution," *Journal of Finance*, 55, 1105-1131.

Cramton, Peter (1995), "Money Out of Thin Air: The Nationwide Narrowband PCS Auction," *Journal of Economics and Management Strategy*, 4, 267-343.

Drake, Philip D. and Michael R. Vetsuypens (1993), "IPO Underpricing and Insurance Against Legal Liability," *Financial Management*, 22, 64-73.

Gay, Gerald D., Jayant R. Kale, and Thomas H. Noe (1991), "Share Repurchase Mechanisms: A Comparative Analysis of Efficacy, Shareholder Wealth and Corporate Control Effects," *Financial Management*, 20, 44-59.

Jenkinson, Tim and Alexander Ljungqvist (1996), *Going Public*. Oxford: Oxford Univ. Press.

Kandel, Shmuel, Oded Sarig, and Avi Wohl (1999), "The Demand for Stocks: An Analysis of IPO Auctions," *Review of Financial Studies*, 12, 227-247.

Malvey, Paul F. and Christine M. Archibald (1998), "Uniform-Price Auctions: Update of the Treasury Experience," mimeo, Department of the Treasury.

McAfee, R. Preston and John McMillan (1987), "Auctions and Bidding," *Journal of Economic Literature*, 25, 699-738.

Milgrom, Paul (2000). "Putting Auction Theory to Work: The Simultaneous Ascending Auction," *Journal of Political Economy*, 108, 245-272.

Milgrom, Paul and Robert Weber (1982), "A Theory of Auctions and Competitive Bidding," *Econometrica*, 50, 1089-1122.

Ritter, Jay R. (2002), "The Future of the New Issues Market," *Brookings-Wharton Papers on Financial Services*, forthcoming.

Sherman, Ann E. (2001), "Global Trends in IPO Auctions: Book Building vs. Auctions," mimeo, University of Notre Dame.

U.S. Department of the Treasury, U.S. Securities and Exchange Commission, and Board of Governors of the Federal Reserve System (1992), *Joint Report on the Government Securities Market*. Washington, D.C.: U.S.G.P.O., January.

Vickrey, William (1961), "Counterspeculation, Auctions and Competitive Sealed Tenders," *Journal of Finance*, 16, 8-37.