A SURVEY OF AUCTION THEORY AND AUCTION FORMATS

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Abstract

All around the world, auctions distribute enormous values between buyers and sellers on daily basis. Auctions exert such a major impact on global markets that the 2020 Nobel Prize for Economics went to Paul Milgrom and Robert Wilson for helping to shed light on the murky world of leveraging strategic game play and information asymmetry where fear of the winner's curse rules. In addition, the laureates invented new auction formats benefitting buyers, sellers and taxpayers around the world. This paper surveys auction theorems in the evolving auctions literature as well as their applications to corporate finance. Developing countries can reap enormous efficiency gains from the implementation of the innovative formats in government auctions.

Keywords: auction theorists, auction theorems, auction formats, game theory, hybrid auctions

1. Introduction

This paper reviews advances in auction theory with special attention to its finance applications. Auction refers to a mechanism for procuring and selling goods or services by presenting them for a bid. There is a long history to auctions. The Father of History, Herodotus, documented auctions' existence in Ancient Babylon for roughly 2500 years ago. In Ancient Rome, lenders utilized auctions to dispose confiscated assets of delinquent debtors. Stockholms *Auktionsverk* founded by Swedish Baron Claes Ralamb in 1674 is the oldest survivor in our present world. *Auktionsverk* was established for the purpose of disposing appropriated property. Auctions have been utilized in many parts of Europe. In 1744, Samuel Baker and George Leigh were reported to have sold a set of scarce books worth £826 at their then newly established London-based auction company which is the precursor to the modern-day Sotheby's. Sotheby's is currently one of the world's most prominent fine-arts auction house, currently headquartered in New York City. Sotheby's is the largest broker of fine and decorative art, jewellery and collectibles with annual revenue peaking at USD$1.035 billion in 2018 (Nobel 2020, Wikipedia). Some of the early prominent auction houses include Dorotheum, Uppsala auktionskammare, Mallams, and Bonhams to mention a few.

Today, virtually any item, license, or service can be traded or allocated through auctions. Even an item of property, plant and equipment (PPE) can be traded via auctions through a real estate agent. Other specific real world auction examples include allocation of waste or refuse collection rights, electricity distribution, spectrum auctions, sale of government securities, mineral rights, auction of emission allowances in the European Union (EU) and so on. Auction outcomes are very important to tax payers, citizens, policy makers and, by extension, accountants and financial advisors. More so, auctions are becoming increasingly popular and increasingly complicated. Thus, it is important for accountants and finance professionals to gain understanding of the auction mechanisms/designs in order to be equipped to play their professional roles effectively. The main objective of this research is to survey advances in auctions theory and applications to corporate finance.

The forward auction is the classic model which involves a single seller with many potential buyers, for example, the sale of government assets in a privatization process or broadcasting rights for World Cup football matches. The reverse auction involves a single buyer with many potential sellers – for example, the tendering process utilized to bring in contractors to build offices, shopping malls, houses and infrastructure projects. The participants in a double auction are many buyers and many sellers, for example, the Stock Exchange (Wilson 1985, Paseda 2021). Figure 1 below depicts the three classifications of auctions based on the number of participants, V represents number of sellers whereas C represents number of buyers.

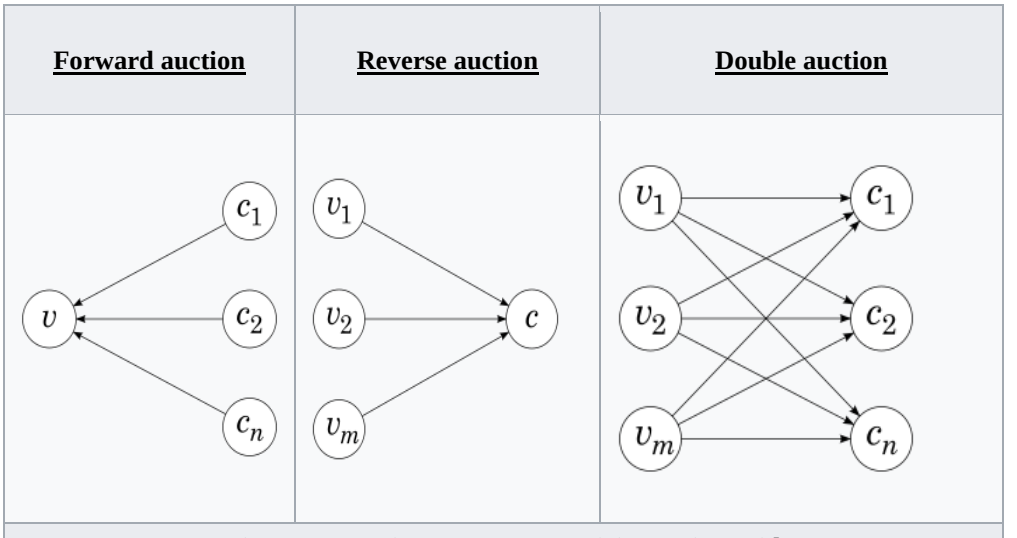

Figure 1: Auction Types By Participants in a Bid

Source: Wikipedia

Table 1 below summarizes the various arrangements based on the number of participants.

Table 1: Categorization of Auctions Based on Number of Participants

		Number of Sellers	
		One Seller	Numerous Sellers
Number of Buyers	One Buyer	Trade	Reverse auction
	Numerous Buyers	Forward auction	Double auction

Source: Author's review of literature

2 Theory

2.1 Overview

An auction's outcome is contingent on three factors: The *auction's rules or format*, the *auctioned object* and *uncertainty*. The rules or format borders on three attributes namely: the *openness* of the bids (open versus sealed bids), the *number of bid times* (single versus multiple rounds) and the *price the winner pays* (winner's bid versus second highest bid). The auctioned item may have a different value for each bidder or they may value it the same way. Also, the item may be a *single*- or an *inter-related object*. Finally, the uncertainty factor borders on the information differences about the object's value amongst the potential bidders. Indeed, one of the most significant and sparkling areas of economic research investigates circumstances where market participants have different information ("information asymmetries"). Incomplete and asymmetrically distributed information has fundamental effects, particularly in the sense that an informational advantage can often be exploited strategically – an important phenomenon that links auction to *game theory*. Game theory is the study of models of strategic interaction among rational decision-makers.

Based on the auction theory, the major influences consist of the bidders' strategic behaviour ("optimization") and the auction's outcome ("equilibrium"). Auctions come in four clusters: The *British* or *English auction* that begins with a low price and subsequently increase to higher prices (otherwise named "open ascending price auction"). Next, is the *Dutch auction* that starts with a very high price and progressively reduces the price until the item is sold. In other forms of auctions, the bids are **sealed**. *The first-price sealed auctions* (**F**) (or *blind auction*) and the *second-price sealed auctions* wherein the bids are closed but the winner pays the highest bid in the first-price sealed bid or the second-highest bid in the second-price sealed bid. The second-price sealed bid is also named the Vickrey auction (**V**). The difficulty in auction analysis also stems from the fact that a bidder's best strategy hinges on his beliefs about other participants' bids for the auctioned item – a factor that arises from bidders' information differences about the item's characteristics and value. Moreover, there is another possibility of cooperation

among bidders to manipulate the bid in order to lower the final price and thereby obviate the winner's curse phenomenon.

Theorists delineate auction items into three categories that reflect the values attached by bidders to the items namely: *private values*, *common values*, and *private and common values* ("hybrids"). The value attached to an auctioned object by one bidder is independent of the values that other potential bidders may place on it ("subjectivity element"). For instance, an opportunity for a dinner with a celebrity is an item with private values and the bidder should not bid more than its worth to him. Vickrey proved the "revenue equivalence theorem" of the existing auction formats. Mathematically,

$$B_R = D_R = F_R = V_R. \quad (1)$$

Where B_R, D_R, F_R and V_R represent revenues from British, Dutch, First-price sealed and Vickrey auctions respectively. Vickrey also established the strategic equivalence results for the four auction types, i.e., V=B and D=F. While analytically useful, the information setting in Vickrey's private-values model is rare in practice such that the independence axiom is especially inappropriate for an object whose resale value is important.

Robert Wilson, motivated by advances in game theoretic research especially the equilibrium notions of John Harsanyi, modelled equilibrium bidding strategies in common values auctions, namely, *ex-post and ex-ante.* Mineral rights and financial assets are common values examples.

Paul Milgrom extended the auction theory to real-world auctions that encompass both private and common-values constituents and made decisive detections. Milgrom's in-depth analysis generated surprising theorems that generalized many earlier insights, particularly, the issue of expert. Capability relates to the expert's competence to exercise his or her skills in the circumstances of engagement, for instance, the availability of time and resources to perform a task. Objectivity relates to the possible effects that bias, conflicts of interest or the influence of others may have on the judgment of the expert. If an expert has a vested interest in expressing anything other than objective opinion with respect to the subject matter, then the opinion will be of no value to the accountant.

2.2. Review of Major Auction Theorems

2.2.1 The Milgrom-Weber (1982) Model

The Milgrom and Weber (1982) study develops a general model of competitive bidding where payoffs may depend on three factors namely: personal preferences of bidders, others' preferences and the intrinsic worth of the auctioned object. In addition, the model includes independent private

values and common values auctions as special cases. Also, the model suggests optimal ranking of the different auction types (British, Vickrey or Second-price sealed bid, Dutch and First-price) under basic conditions.

Specifically, in the Milgrom-Weber model, the Nash equilibrium expected price is highest from a British ascending auction, next from a Vickrey second-price auction, and lowest from blind (or sealed) tender. Symbolically,

$$B_\rho > V_\rho > D_\rho > F_\rho \quad (2)$$

Where $B_\rho, V_\rho, D_\rho, F_\rho$ *represent prices from the respective auction types*

Further, the Nash equilibrium expected price is higher when the seller shares relevant information amongst bidders.

2.2.2 The No-trade Theorem of Milgrom and Stokey (1982)

The Milgrom and Stokey (1982) demonstrate that concordant beliefs are sufficient to rule out common knowledge trade when, in two-sided bids, both buyers and sellers are seeking to protect themselves from the winner's curse.

The *no-trade theorem* hinges on the efficient market hypothesis (EMH) and rational market participants assumptions (Fama 1970, 1991; Silva 2020). In other words, if markets are operating in efficient equilibrium and investor behaviour is based on purely rational considerations rather than sentiments, then even though some traders may possess some private information, none of them would be able to profit from it. In simple terms, the no-trade theorem states that any bid or offer would embody the bidder's private information into the market price so that no side of the bargain can profit from a trade. Alternatively, an attempt to profit from inside information through an offer in the market place will lead to no party accepting the offer, thus the condition is sometimes referred to as the *zero-trade* theorem.

2.2.3 The Glosten-Milgrom (1985) Theorem

The Glosten-Milgrom study borders on price information in financial markets. The regression mode of the early microstructure is of the form:

$$s_i = \alpha_0 + \alpha_1 \ln(M_i) + \alpha_2(1/\rho i) + \alpha_3 \sigma_i + \alpha_4 \ln(\vartheta_i) + \mu_i \quad (3)$$

Where:

s_i: *average (percentage) bid − ask spread for firm i.*

M_i: *market capitalization* $(-)$

ρi: *stock price level* $(-)$

σ_i: *volatility of stock price measured by standard deviation* $(+)$

ϑ_i: *trading volume* $(-)$

μ_i: *error term*

According to the market microstructure literature, there are three broad rationales, namely-: *order processing costs, inventory control* and *asymmetric information*.

The Glosten-Milgrom model is an asymmetric information-based model of sequential trading. The market structure has the following features: quote-driven market, unit trade size, one trade per period, no explicit transaction costs, anonymous trading, random arrival of both informed and uninformed traders, presence of specialist market maker who sets buy (*ask*) and sell (*bid*) quotes. The specialist faces an adverse selection problem – loses on trading with informationally advantaged traders. The strategic behaviour of the market maker is then to quote higher prices for buyer-initiated transactions (ask) and lower for seller-initiated (bid) transactions.

The vital thoughts of the Glosten-Milgrom model comprise: that informed traders are more probable to buy when there is good news; trade direction (buy or sell) conveys information about true value; adverse selection difficulty for the market maker. A notable addition to the Glosten-Milgrom model is the Easley and O'Hara (1987) study, which integrates the likelihood that there is no information (event uncertainty) and choice of trade size (small or large). The two possible equilibrium consequences emerge namely: a *separating equilibrium*, in which case informed traders will continuously trade large quantity if the scale influence is substantial, and a *pooling equilibrium* where informed traders randomize between small and large trades, conceals some of his information to increase prices for large trades. Other theoretical and empirical studies along these lines include Baur and Dimpfl (2020) for cryptocurrencies, Baig, Butt, Haroon and Rizvi (2021) and Haroon and Rizvi (2020) for gauging the impact of pandemic on stock market liquidity, Gao, Lee and Murphy (2020) and Blankespoor, deHaan and Marinovic (2020) that document the importance of local newspapers' monitoring of public finance to reduce information asymmetry.

2.2.4 Arnosti, Beck and Milgrom (2016) Theorem

Arnosti, Beck and Milgrom (2016, hereinafter referred to as ABM) introduced a novel context with respect to internet display advertising and the taming of the winner's curse. Poorly informed "display advertisers" bid against well-informed "performance advertisers".

Model:

$$Value_j = Common\ Value\ X\ Match\ Value_j \quad (4)$$

The framework proceeds as follows:

Let A be the set of auction designs that satisfy these five properties:

1) Deterministic winner selection rule
2) Strategy-proof
3) Efficient assignment among performance advertisers
4) Free of adverse selection for display advertisers
5) False-name bidder proof

Then A is a one-parameter family in which a performance advertiser wins when the ratio of the two highest performance bids exceeds a parameter $\alpha \geq 1$.

2.2.5. Milgrom Convergence Theorem (Milgrom, 2000)

Following the invention of the novel Simultaneous Multiple Round Auction (SMRA) for inter-related radio spectrum licenses in the 1990s, certain questions arise in strategic bidding behaviour such as: how can bidders avoid procuring multiple substitute items?, how can they know prices to find the best ones? The concept of silent auction in charity events partially addresses the problem. Milgrom, Wilson and McAfee invented the SMRA solution with activity rule to overcome the problem of bid snipping.

With straightforward bidding, Milgrom (2000) demonstrates that prices and allocations converge to an appropriate competitive equilibrium and the allocations that emerge would be efficient.

2.2.6. Hatfield and Milgrom Matching Theorem (Hatfield and Milgrom, 2005)

A central puzzle in the matching mechanism literature - pioneered by Gale and Shapley – with no role for prices is if the mechanism is mathematically connected to Vickrey's price-based auction mechanism. In both mechanisms, it is a dominant strategy for the "bidders" to make truthful offers. In both mechanisms, if offers are substitutes, the outcome is the core allocation most preferred by the offerors. Hatfield and Milgrom (2005) advocated a framework of matching with contract which integrates some special cases, for instance, the college admissions difficulty, labour market equivalent framework, and soaring package auctions. Truthful reporting is a dominant strategy for workers in a worker-offering auction matching algorithm.

Essentially, the Hatfield-Milgrom theorem is that the two mechanisms (Gale-Shapley non-price based and Vickrey price-based auction) are both special cases of "matching with contracts" that share these properties - *truthful offers* and *optimal offeror outcomes*.

2.2.7. Day and Milgrom Truthful Bidding Equilibrium (Day and Milgrom, 2008)

In combinatorial spectrum auctions, the problem is the situation where bidders wish to buy a collection of licenses sufficient for a business plan without the risk of winning a non-viable subset of a high price. In such a scenario, the relevant questions are:

1. How can bidders identify and bid on relevant packages?
2. What pricing rule creates best truthful incentives subject to ensuring competitive revenue for the seller?

The result is the Day-Milgrom theorem which states "*that an auction minimizes bidder incentives to bid untruthfully and provides competitive*

revenue from truthful bidding if and only if it is a maximum revenue-core selecting auction."

2.2.8. Kagel, Lien and Milgrom Theorem (Kagel, Lien and Milgrom, 2010)

With many possible packages (say, in a spectrum auction), some packages will receive no bids. Are good outcomes still possible?
If bidders bid to their limits on efficiency-relevant (respectively, core-relevant) packages in an ascending auction, then the final allocation will be efficient (respectively, in the core). This powerful result is demonstrable through experiments. Auto-bidders who select tentatively most profitable packages can simulate and predict the outcomes of student bidders in a laboratory.

2.2.9. Milgrom and Segal Theorem (Milgrom and Segal, 2020)

The Milgrom and Segal (2020) study addresses the challenge with incentive auction involving inter-related objects such as sale of broadcasting rights. Some rights are allocated while others are "re-packed" into a smaller set of channels. Freed TV channels redeveloped for mobile broadband licenses sell mobile broadband licenses to mobile telephone companies.

Buying TV broadcast rights/licenses and reassigning stations optimally is a large-scale problem for which optimization is difficult.

The Milgrom-Segal theorem is that "this new class of descending clock auctions is obviously strategy-proof budget compliant uniquely privacy-preserving and accommodates limits on computational power."

2.3 Auction Formats

A key challenge in the auction of inter-related or multi-objects is the dilemma of the auctioneer to maximize efficiency and revenue in allocation of the auctioned items. Common auctioned items in this category include radio frequency bands, electricity and lots of "troubled debt". The desire to achieve wide coverage for the auction of these objects is integral to efficiency. Reaping those gains was elusive under prior allocation methods (administrative licensing and beauty contests) and still so in many developing countries where administrative licensing is rife in mineral rights, electricity and spectrum auctions. Standard auction formats had ignored cogent issues such as technical and geographical complementarities (for example, in the auction of radio spectrum frequencies), issues such as economies of scale and scope, complementarities between objects, externalities across participants and connected issues may tempt bidders to lessen their bid or conspire with the effect that the items may not end up with the bidders that value them the

most. These challenges necessitated invention of new auction formats. The "new" auction formats include:

a) Share auctions (Wilson's 1979 common values model)
b) Multiple round auctions – such as the Simultaneous Multiple Round Auction (SMRA) invented by Milgrom, Wilson and McAfee for the U.S. Federal Communications Commission's radio spectrum auctions; Combinatorial Clock Auctions (CCA) invented by Ausubel, Cramton and Milgrom (2006); Incentive Auctions (Milgrom, et al 2012).
c) Other auction formats: Product-mix auctions, Position auctions.

Share Auctions as distinct from unit-auction formats involve the allocation of fractional shares of the item for sale to bidders at a sale price that equates the demand and supply of shares. The main effect is that the share auction can result in a significantly lower sale price relative to the final sale price in a unit-auction format (Wilson 1979, 2020).

Simultaneous Multiple Round Auction (SMRA) involves numerous items for sale with multiple bidders and conducted in two or more rounds with opportunity for bidders to bid on a set of items individually within a given round.

SMRA is done in sequences, with definite stages in which all bidders can submit bids and when the round is ended, the auctioneer unveils the winning and the price of each item. The *activity guidelines* adopted in the SMRA compel bidders to be active. Also, the *monotonicity rules* safeguards that bidders cannot bid on more items in later rounds.

The SMRA was first used in 1994 by the U.S. for allocation of radio spectrum auctions. Since then, several countries such as Canada (in 1999), United Kingdom (2000), Germany (2000), Ireland (2012), Pakistan (2014), Slovakia (2013), Sweden (2008) and others have used the SMRA to raise billions of dollars from the sale of public assets – sums of money which hitherto, had ended up in private pockets and companies through speculation aided by beauty contests and administrative licensing of spectrum auctions.

Combinatorial Clock Auction (*CCA*) involves a combination of clock auction during which bidders may disclose their authorizations in reaction to the escalating prices, with a chronological scaled bid auction, in which bidders submit sealed bids.. Generally, CCAs are relevant when bidders have non-additive assessments on bundles of items, that is, they view combinations of items more or less than the sum of their valuations of individual elements of the combination ((Ausubel, Cramton and Milgrom (2006); Ausubel and Baranov (2014)).

Incentive Auctions (IAs) are a voluntary, market-based means of repurposing spectrum by encouraging licensees to freely surrender spectrum usage rights in exchange for a share of the proceeds from an auction of new licenses to use

the repurposed spectrum. In other words, an IA comprises two discrete but mutually dependent auctions – a *reverse auction* that regulate the price at which licensees (i.e., broadcasters) will renounce their rights and the *forward auction* that regulate the price bidder-companies are enthusiastic to pay. *Product-mix auction* was introduced by Paul Klemperer in response to the 2007 Northern Rock bank run (Klemperer 2010, 2019), it is a single-round auction scheme adopted in circumstances where the auctioneer wants to sell (or buy) numerous differentiated stuffs. Central banks have utilized it to dispose batches of delinquent debt.

Position auctions are utilized by search engines to sell keyword advertising. This class of auctions comprises the generalized second-price auctions of Edelman and others. Google has relied on this auction format in the sale of keywords for internet searches.

2.4. Revenue Recognition of Auctioned Items

The core principle for revenue recognition is in tandem with the established five-step model framework of International Financial Reporting Standards (IFRS) 15 *Revenue from Contracts with Customers* namely:

- Contract identification with a customer
- Performance responsibilities' documentation in the contract
- Contract price assessment
- Sharing of the transaction price in the contract
- Revenue acknowledgement

3.0 Auction Applications to Organizations and Society (Examples)

The academic research on auctions has benefited from a host of factors including advances in *game-theoretic tools and models*; the worldwide impulse towards *privatization* (caused by collapse of communism in the east as well as disenchantment with public ownership in the west); its appeal to *financial economists' social engineering instincts* – that is, the urge to change the world; its connection to *fundamental economic principles* such as demand and supply; and the *elegant propositions and theorems* such as those reviewed in section 2 that deliver remarkably powerful conclusions from apparently modest hypotheses. Its applications include:

1) Human commodity auctions – as seen in historical and modern slave markets, wife selling and virginity auctions
2) Real estate auctions – especially in Australia during the 1990s and 2000s until the percolation of media and public outcry for improved transparency.
3) Government auctions – for example, debt auctions involving sale of treasury securities, and spectrum auctions.
4) Commodity auctions - fish, wool, wine, livestock, timber allocation, electricity generation and distribution, and agricultural produce.

5) Online auctions: Websites like eBay and Amazon are veritable platforms for numerous sellers around the world.
6) Unique item auctions – such as antiques, collectibles, on-site auctions, second-hand goods, thoroughbred horses, travel tickets, holidays, mystery auction, blockchain auctions involving some rare Cryptokitties.
7) Other contexts – include *charity auctions* adopted by non-profits, tertiary educational institutions and religious bodies to fund a mission or policy advocacy.

3.1 Spill-overs to Other Fields

Auction theory has exerted considerable impact on at least four fields of economic research namely: *information in securities markets*, *matching theory*, *utility pricing*, and *game theory*. Because of space constraints, only a sketchy discussion of the impact of auction theory on these fields is done.

It suffices to mention that the analysis of Milgrom and co-authors produced landmark theorems for financial markets operating under asymmetric information as earlier mentioned. Their analysis justifies how adversative selection in financial markets lessens liquidity complications (Milgrom 2004, 2020).

In terms of *matching theory*, Milgrom is a leading explorer of the linkages between auction theory, matching theory and general-equilibrium theory. His works sparked new applications of market design, including regionally capped matching of resident doctors to hospitals, and cadets to military specialties.

With respect to *utility pricing*, Wilson's (1993) *Nonlinear Pricing* provides an all-inclusive analysis of tariff plans in businesses like electricity, telecommunications, and transportation. Indeed, a rigorous analysis of auctions by Vickrey began with his application of non-cooperative game theory pioneered by John F. Nash. The impact between the two sub-fields of auction and games has been mutually reinforcing with the ground-breaking influences of notable scholars in the game-theoretic literature such as Reinhard Selten (perfect equilibrium games) and John C. Harsanyi (games of incomplete information). Terms and applications such as Bayesian equilibrium, trembling hand perfect equilibrium, sequential equilibrium, chainstore game, and chain-store paradox have infiltrated the auction literature (Nobel Foundation, 2020).

4.0 Specific Applications to Corporate Finance

Here, an attempt is made to survey auction applications to corporate finance. The market for corporate control and bankruptcy are arguably the most fertile grounds for auctions application. Other areas include means-of-payment in mergers and acquisitions (M&As), initial public offerings (IPOs), share repurchases, and capital market finance.

4.1 The Market for Corporate Control

This framework has proven productive for numerous auction-based models to be created that elucidate diverse features of auction market. A facet of the auction-based prototypes enlightens the wealth gains to bidders and targets, as well as the shared wealth gains. Similarly, all-stock offers largely produce lower returns to bidders than do all-cash offers (Dasgupta and Hansen, 2007).

Roll (1986) used the winner's curse clue to elucidate that acquiring companies appear to over-bid for targets in acquiring firms' stock prices fall (or remain at best constant) upon declaration of acquisitions. For instance, in a sample of 326 acquisitions between 1975 and 1987 in the United States, Morck, Shleifer and Vishny (1990) reported that three forms of acquisitions have methodically lower and negative declaration period returns to bidders: diversifying acquisitions, acquisitions of progressively growing targets and acquisitions by companies with poor-performing executives before acquisition. The writers further contend that these results are consistent with the opinion that managerial goals propel acquisitions that lessen the market value of bidder companies, this position is corroborated by Lang, Stulz and Walking (1991). Jensen (2004) offers a novel outline by conjecturing that high market evaluations upsurge managerial decision, making it likely for executives to engage in bad acquisition deals.

Although, the reasons for takeover bids could be varied, the takeover background is significantly more complex. The takeover models, such as Grossman and Hart (1980), presumed that the takeover benefits arise from enhancements in operational effectiveness of the target firm. According to these scholars, the resulting "free-rider" difficulty could weaken the success of any takeover drive.

4.2 Means of Payment in Business Combinations

Some scholars have reflected on the role of non-cash approaches of payment in the market for corporate control purposes. In one model, academics theorize that ex post means of payment can upsurge the seller's earnings beyond cash payments (Rhodes-Kropf and Viswanathan, 2004). The R-KV model is one of an open auction with bidders offering shares of the combined company and rationalizes the use of stock as means-of-payment. Shleifer and Vishny (2003) advocated a theory of mergers and acquisitions using similar ideology of R-KV. They contend that merger activity is propel by the relative assessments of bidders and targets and observations of collaborations from merger activity.

4.3 Auctions in Corporate Bankruptcy

The theoretical competence of auctions in assigning assets to their most highly-valued use has led numerous academics to suggest auctions as panacea

to antagonistic concerns in corporate bankruptcy. Nonetheless, the informational questions in bankruptcy are quite stark so that any complete auction-based framework of the process which will yield forecasts on total cost which must incorporate information cost acquired by bidders (Eckbo and Thorburn, 2005; Hart, *et al*., 1997).

4.4 Share Repurchases

Businesses regularly buy back their shares through either fixed-price tender offers or Dutch auction mechanisms. In a Dutch auction share repurchase, a company regulates a quantity of shares to buy back and asks shareholders to submit bids stipulating a price and quantity of shares that they are enthusiastic to sell. Differences in bids recognized for Dutch auction repurchases are characteristically due to dissimilarities in evaluation, asymmetric information (Milgrom and Weber, 1982), and differences in opinion (Miller, 1977). According to Persons (1994), a condition in which shareholders demand a premium (possibly due to capital gains tax frictions) to tender their shares, but this premium varies across shareholders, leading to an upward sloping supply curve. If the executive aims to indicate the accurate value by maximizing a weighted average of the inherent value and the market value of the shares as in the dividend signalling framework of Miller and Rock (1985), adoption of fixed-price offers are more superior. On the other hand, if the manager desires to buy-back a precise number of shares to preclude a takeover, a Dutch auction is superior.

4.5 Initial Public Offerings (IPOs)

A variant of the Wall Street Dutch auction was utilized during the historic IPO of Google which sold 19.6 million shares at an offer price of $85 each. IPOs of equities seem to be fanciful approach for an auction procedure. In the use of auction theory to IPOs, a collective starting point is the notions of uniform price, multiple unit auctions whose foremost contributors include Wilson (1979), Back and Zender (1993) and Kremer and Nyborg (2004).

5.0 Conclusion

For about six decades, the auction theorists have produced a body of work that have shed light on how auction markets function and incentivise predictable outcomes in the presence of private information. Auction theory has been an enormous success. Even after decades of intensive research, the burgeoning literature continues on a phenomenal, even accelerating ride. It has produced much empirical and experimental research. Its influence has spread to other disciplines. Auction theorists have been influential in mechanisms design in the privatization of public assets and for the allocation of electricity and other goods. The theorists have also served as consultants to bidders in such mechanisms. In terms of theoretical elegance, the intersection of auction theory and information-based corporate finance has enriched the analysis of

corporate control market, IPO under-pricing, share repurchases and corporate bankruptcy.

The advancement of the theory and practice of auctions has benefitted buyers, sellers and taxpayers around the world through *efficient allocations* of scarce resources, promotion of *economic opportunity and competition*, avoidance of excessive concentration of licenses/rights, reducing the unjust enrichment of a few and *recovering* for the State a portion of the value of a scarce public asset (Paseda 2021). Many of these innovations can benefit developing countries such as Nigeria if there is concerted effort to implement the auctions formats in areas such as utility pricing, electricity auctions, spectrum auctions and sale of oil blocks and mineral rights.

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