

The Analysis and Discussion of Spectrum Auctions Based on Case Study

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Abstract. With the prevalence of technology, there is a growing demand for telecommunications, which has led to a scarcity of spectrum. In order to allocate the usage of the spectrum more rationally, many countries have started to use spectrum auctions that can maximize the utilization of limited spectrum resources. However, some potential risks, such as insecurity, might be caused during the process of auctioning the spectrum. This article analyzes the spectrum auctions based on a series of case studies, obtaining the advantages and disadvantages of the discussion. Besides, there is a need for more research to be carried out to investigate the fraudulent conduct of some auctioneers and the manipulative actions of bidders.

Keywords: Spectrum Auction, 3g spectrum auction, optional modes, spectrum.

1. Introduction

A spectrum is a set of sound waves applied for telecommunications needs. FM and AM radio transmissions, as well as Wi-Fi or Bluetooth, are included in this.

Frequency is associated with the spectrum. The frequency of a wave is the number of times it can be seen in a certain period. A spectrum auction is a system whereby the government sells the rights to broadcast communications over specified electromagnetic spectrum bands and distributes finite spectrum resources.

The spectrum auction is dependent on several factors, including the action type. From its initial opening up to the time a bid is declared to have won, a spectrum auction can last between a single day to even several months depending on the type and nature of the auction. A well-designed auction makes it possible to effectively assign resources to the individuals who value them the most, resulting in more income for the government. There are some researches related to spectrum auctions conducted by several specialists. In 2003, Womack & Zhang found that spectrum auctions are a means to move into market-based spectrum management and are also a means to privatize state-owned airwaves [1-2]. Spectrum auctions are also a mechanism for authorities to redistribute finite resources.

The origin of spectrum auctions in the United States is dated to when the Federal Communications Commission (FCC) ventured into the business of auctioning spectrum for 5G services for the first time in 2018. After the FCC had introduced the auctioning process, according to Vernon et al., the bidding for spectrum in the 28 GHz band was then initiated, with more than 3,000 country-based licenses made available for purchase. A 24 GHz spectrum auction will precede the 28 GHz spectrum auction [3].

Telecommunications has turned into a very competitive business over the recent past, with businesses battling for a prized spectrum. Technological advancements, privatization, and liberalism have sparked this competitiveness. For over two decades now, Teneja pointed out that the mobile industry has advanced from second to third to fourth and 5 g network, with the transition to fifth-generation presently underway [4].

Because there are more suppliers in the mobile business, competitiveness throughout spectrum auctions has intensified due to rising customer needs [5-6]. Tanega stated that when the United States

switched from the traditional analog to the new digital broadcast television transmissions in June 2009, the lucrative 700 MHz spectrum became accessible since analog TV signals were no longer broadcast.

Google announced in 2007 that it would join the mobile market with its highly successful Android operating system and aspirations for a mobile broadband system. The spectrum auction's "C" block corresponds to lower 700 MHz channels 54, 55, and 59, as well as higher 700 MHz channels 60, 61, 65, and 66, which are routinely utilized to supply countrywide telecommunications services, according to Google found by Vernon et al.. AT&T and Verizon announced plans to compete in the spectrum auction to purchase "C" block frequencies simultaneously as Google.

The three private telecom providers, Reliance Jio Infocomm, Bharti Airtel, and Vi, are allowed to purchase more spectrum to sustain their network's growing user base [7]. The pre-bid conference for the spectrum auctions was attended by a number of telecom providers, including Reliance Jio, Bharti Airtel, and Vodafone Idea. All telecommunication companies, or telcos, were required to submit pre-written questions concerning the rules and practices to the telecom department.

The term "spectrum" became widespread in 2010-11 after India announced the world's largest swindle, the 2G Spectrum Scam. This case involved a number of legislators, and many of them were convicted. From that time, the spectrum and its auctions have attracted many people's attention.

The Union state seized all available public assets within the country's geographical boundaries, particularly airwaves. Signals are needed to configure gadgets like cellphones and landline telephones from one end to the other. These messages are transmitted over the airways and sent at higher wavelengths to minimize collisions. The need to offer more room for signals emerges periodically as the number of mobile, landline telephone, and internet users grow.

2. Case study

2.1 The modes to allocate spectrums

Due to the large-scale application of spectrum in modern society, it becomes scarce at an increasing rate. The management departments about the spectrum are looking for new technology or allocational methods to use the spectrum resources more efficiently [8-9]. There are some differentiated methods to allocate the spectrum in "Introduction to the world pattern of spectrum auction". Application and drawing lots are common modes to distribute that.

It shows that the application is according to applied priority. In this mode, it will have unfairness when the demand of applicators is larger than the amount of spectrum although it has rapid processing when spectrum is enough. Drawing lots is also a kind of method to allocate spectrum because of its transparency and high speed but there is no assurance for efficiency of use within the pure luck situation. In addition to those methods, the model named "administrative examination and approval" also was used in spectrum allocation. The mode has a lack of transparency with high uncertainty in the decision-making process although it is simple and worldwide. Owing to the deficiency of traditional modes, spectrum auction was appearing.

The paper "Study about the mechanism of Spectrum Auction", illustrates the practice of spectrum auction in the countries around the world such as America and England. The first spectrum auction was put up in New Zealand. Americans put up for spectrum auctions 33 times generally from July 1994 to February 2001. Lots of countries took spectrum auction and improved it with the passage of time. There were some auction modes that are shown in the paper.

(1) First price auction: The bidder with the highest price wins the goods and pays his bid. It follows the principle of Success of the highest-price-offer.

(2) Second price auction: The bidder with the highest price wins the goods and pays the second-highest price. Sometimes the highest price is quite different from the second price, especially when the number of participants is small. It is unreasonable that win goods with a very high bid but pay an evidently low price.

(3) Open auction: It adopts open bidding which leads to mutual competition. In this auction, Collusion is caused easily because each participant is allowed to deliver information.

(4) Simultaneous auction: Bidders offer a price for some goods from a specific spectrum. It is meaningful only in the public auction because bidders must adjust their bid strategy according to others.

(5) English auction: In this auction, the price starts off low, and the buyers' bid-up price is until. No one is willing to bid higher. The winner gets the goods and pays the bid.

(6) Dutch auction: It starts off high and the price decreases until someone bids. The winner gets the goods and pays the bid.

2.2 The merits and drawbacks of auction modes

Auction is the optional method to allocate spectrum and different auctions own respective characteristics. Their features are shown by analyzing those modes. In the First-Price Auction, it operates easily and maximizes the profits of governments. But it can not reflect the real valuation of bidders and it will lead to a winner curse.

The second price can reflect the real valuation of buyers. For bidders, there is no strategic complexity without the necessity to think about the strategies of opponents. It also avoids the winner curse to some extent. For the government, it is unreasonable when there is a big difference between the first price and the second price.

Open auctions which can spur the competition have a simplicity to operate. However, it can not reflect the real valuation and is easy to lead to collude meanwhile the new bidders will be prevented from entry.

In an English auction, the bidder who has a lower valuation has less probability to win a bidder who owns a higher bid. The bids can not reflect the real valuation and the bidder who wins the bid has a high possibility to bear the winner curse.

A Dutch auction is very fast though it can not spur competition. Moreover, it does not suit for spectrum.

The majority of those auctions have a common deficiency which is the collusion between the bidders. A part of the bidders makes up a consortium in some ways to coordinate their individual strategies. They can reduce the transaction price and get a higher profit by collusion.

2.3 3g spectrum auction in different countries

Spectrum is a necessary resource in the information age. It shows its importance in some aspects of the economy and social development for example the 3G spectrum. Lots of countries try to use spectrum auction to auction 3G which is a kind of communication spectrum.

A 3g spectrum auction was held in the UK on March 6, 2000. It attracts 13 telecom operators to participate in the bidding. This auction continues for more than 1 month and the government gets about 22.5 billion pounds.

Germany holds the first spectrum auction on 31 July 2000. That continues for 19 days and collects about 50.8 billion pounds. Finally, the operators that won the spectrum license were E-Plus Hutchison, Group 3G, Mannesmann Mobilfunk, MobileCom Multimedia, T-Mobile, and VIAG intercom. However, The first spectrum auctions of the two countries are not successful. For the UK, those operators who won the spectrum license bear the heavy financial burden due to the higher bids. After the first 3G spectrum auction of Germany, there are some operators which went bankrupt and withdrew capital.

3 Discussion

3.1 Preference for spectrum allocation

In recent years, the auction has become the best way to allocate spectrum. Compared with other methods, it is evidently more efficient.

3.2 The optional auction modes

According to the confirmation of Myerson, the optimal auction has two basic conditions: Firstly, the bidders can get a positive payoff in the auction. Secondly, it attains “incentive compatibility”, this auction mechanism ensures every bidder is willing to give a realistic valuation. Under these two conditions, Myerson illustrates that the optimal auction is an auction that has a reserve price.

3.3 For the cases about 3g

From those cases, the higher transaction price is not the only factor that needs to consider for the spectrum. The transaction price of the spectrum has a rational range and that should not be too low or too high. The excessively low transaction price is disadvantageous for assisting efficient spectrum utilization. Excessively high costs make the operators bear the heavy financial burden which is disadvantageous for market stability.

4 Conclusion

Spectrum resources are becoming extensively limited as 5G communication networks and technology evolve. Due to the paucity of spectrum resources, market-driven spectrum auctions have become a significant way of spectrum allocation, and the safety of spectrum auctions cannot be overlooked owing to the difficulty of the distributed environment. In 2021, Wang et al. [4] claimed that a semi-honest agent is used in most existing safe spectrum auction technologies. However, in a real-world application scenario, the purely theoretical quasi model does not guarantee spectrum auction security, which could lead to serious security issues such as the agent uncovering the privacy of the bidder, the agency or auctioneer secretly cooperating with the bidder with the aim of manipulating the spectrum auction, among other things.

The study uses advanced contract technology to recommend a protected spectrum auction mechanism. In this approach, the traditional moderately honest agent who is in charge of the auction with the auctioneer server is replaced by a smart contract written into the blockchain. Wang et al. stated that a secure spectrum auction technique is developed to ensure the scheme's security, leveraging the Software Guard Extensions (SGX) technology and the Parlier cryptosystem to preserve the confidentiality of the bidder.

To facilitate public validation, the research system employs a significant Pedersen commitment, which plays the role of ensuring that the auctioneer server and the bidder do not collaborate and therefore, result in invalidation of the total amounts of the group bid. Due to this, the safety mechanism helps in offering different types of dangers that can be addressed. In addition, Wang et al. also found that the researchers examined a theoretical analysis as well as modeled trials for the method used [10]. The emergence of 5G and other vital technologies associated with it will lead to the development of different wireless networks.

The study has a limitation that there is a potential risk in the proposed scheme. There are also security threats in the process used in the study. The untrusted component may behave dishonestly during the spectrum auction. There is a need for more research to be carried out to investigate the fraudulent conduct of some auctioneers and the manipulative actions of bidders. This is crucial in ensuring security threats ensure in spectrum auctions are eliminated.

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