Studying Spectrum Allocation Methods: Applicability for Bangladesh

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Abstract

Allocation of public resources has always been a tricky issue for national government the world over. Primarily governments used beauty contests for selling coal blocks or for allocating oil drill licences. In some countries, lotteries and first-come-first serve methods were also employed. This paper studies the pros and cons of these methods with special reference to allocation through auctions. The Simultaneous Ascending Auction design, used by the FCC for allocation of spectrum licences in the US in 1993 and later on copied in different countries, is analyzed in detail. As a case study, the recent spectrum auctions held in Bangladesh in September 2013 were studied and it was found that the auction would have performed better if the government would have been able to attract one more bidder.

Key words: Spectrum allocation methods; Simultaneous Ascending Auctions (SAA); Bangladesh Spectrum Auction.

1. Introduction

Public resources are the property of any nations and governments have the reasonability to allocate them efficiently. Many of these resources are of genuine importance to society and therefore governments do not want to exploit them on their own. These resources include mobile telephony frequencies, radio frequencies, airport slots, public infrastructure, land for different uses, high voltage electricity cables, etc (Janssen, 2004).

There are many methods at the disposal of governments to allocate public resources to private companies. A government can use auctions, beauty contests, first-come-first-served, grandfather rights, and lotteries, to mention just a few common allocation mechanisms. In auctions, prospective buyer firms have to submit financial bids and the company with the highest bid wins the auction. In a beauty contest, firms are required to submit a business plan about how they are going to use the resource in future which is then evaluated by some government agency that determines who wins the contest. In the first-come-first-served mechanism, the firms which firs of all mention their intention to use an asset are given the right to do so. In grandfather rights, the government allocate

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the resource to that company which has used the asset in the past. This method is typically used to allocate airport slots. Lotteries assign the right to use the asset to one of the interested companies at random. Janssen (2004) reported that in Netherlands, the scarce places to study medicine in universities are allocated through lotteries.

Amongst these, traditionally the most popular method has been the beauty contest, where companies are invited to submit business plans, and a government agency is designated to select those companies whose business plans seems to be most credible (Börgers and Damme, 2003). The credibility depends on the understanding of the agency about the ability of a particular company to deliver valuable services. However, recently auctions have become more popular method due to certain advantages that auctions enjoy over other methods.

Auctions undertaken by government as a seller are different than those conducted by any private seller. This is because where government acts as a seller, the concept of efficiency takes two meanings. Here economic efficiency is not equivalent to 'the licences ending up in the hands of those who value them the most' (Börgers and Damme, 2003). This is mainly due to many externalities that exist in licence auctions. A benevolent government will the sell the licence having consumer welfare in mind. Here the consumers are not directly involved in auctioning of the resource but government will auction the resource in such a manner that consumer interests are not compromised. In fact, selling licence to the firm that values it the most may not be the one that consumers prefer.

Allocation of spectrum rights to telecom companies through auctions has become a preferred mode in all the major economies. The governments prefer auctions to obtain market determined price of spectrum through a transparent manner. Auctions ensure efficient use of spectrum and avoid hoarding. They are an effective means of stimulating competition in the telecom sector and results in maximization of revenue for the governments. From July 1994 to July 1996, the Federal Communications Commission (FCC) conducted nine spectrum auctions, raising about $20 billion for the US treasury (Cramton, 1998). These auctions were described as "*The Greatest Auction in History*" (William Safire, New York Times, March 16, 1995) and "*The Auction of the Century*" (Liberation, Paris, March 15, 1995) because of their efficiency and sheer volume of revenue they generated (McAfee).

Auctions were first used by the New Zealand government in 1990 to sell spectrum rights. This electromagnetic spectrum is in high demand the world over. It is termed as the next growth driver for telecom industry after saturation in voice-based revenues. By mid 2010, there were nearly 132 countries having access to 3G technology, India joining late in April 2010 by auctioning off the 3G spectrum licenses. According to a report in Times of India (Shalini Singh, April 12, 2010), there are 4.7 billion mobile users worldwide, of which

nearly 10% are 3G users. For Asia-Pacific region only, the projections are pegged at 564million users by the end of 2013.

This is a conceptual paper based on literature available on spectrum allocation through auctions. In section 2 of this paper various methods of spectrum allocation are analysed. Section 3 covers the review of literature on spectrum allocation by auctions. In section 4, the design of spectrum auctions is discussed along with the activity rules. Section 5 carries the analysis of allocation of 3G spectrum licences in Bangladesh. Finally, section 6 concludes the study.

The specific objectives of this study are:

- To compare the different methods of spectrum allocation employed in different countries;
- To discuss the activity rules of spectrum auction allocation;
- To analyze Bangladesh's experience of auctioning 3G spectrum.

2. Methods of 3G Spectrum Allocation

Electromagnetic spectrum is now in much demand, not only for traditional use of broadcasting but also for new forms of mobile communication. Spectrum is a national resource which has to be allocated by the government. For efficient allocation the government needs to know how highly the firms value the licences. There are different methods like – administrative process, lottery, first-come-first-served and auction-economic theory - by which spectrum rights can be allocated to various firms but auctions works best (McMillan, 1994). Out of these four methods of spectrum allocation, the 1990's has seen a shift of preference from administrative allocation process to auctions. As of now auctions are widely used in United States, Colombia, India, United Kingdom, Argentina, Australia and Hungary.

Auctions and beauty contests (administrative process) have been the preferred option for the allocation of 3G spectrum in most of the countries. But in few places in Europe licenses were offered free of charge to the incumbent mobile operators in the Isle of Man, Liechtenstein and Monaco (ITU, 2003). There are arguments and counterarguments in favour and against of different methods of spectrum allocation.

Auction theorist consider that auctions lead to efficient allocation of spectrum among the bidders while proponents of beauty contest argue that auctions increases the price of spectrum, which has to be ultimately born by the customers. The following table provides a comparative analysis of various methods of spectrum allocation in practice:

Table 2.1

Comparison between Methods of Spectrum Allocation

S. No.	Method	Time Consumption	Efficiency	Revenue Generation
1	**Administrative process**	Time consuming	Marked by red-tape	Not much
2	**Lottery**	Time efficient	Least efficient	Not much
3	**First-come-first-served**	Time efficient	Less efficient	Not much
4	**Auction**	Time efficient	Efficient	More revenue

Administrative Process (Beauty Contests)

The earliest method used for spectrum allocation has been the administrative process, widely practised in Canada and European Union. This method is also sometimes dubbed as "beauty contest". The criteria for allocation of spectrum is developed by the government and then an in-house committee of experts scan various proposals in light of the government laid criteria. Such a process gives a lot of flexibility to the government in determining the acceptance of a particular proposal. Although, the process is time consuming but the process adheres more to the government plans.

However, this method is not free from critics. According to McMillan (1994) it's widely perceived that technical aspects are clearly defined in the criteria set by government but there are subjective criteria like the ability of firm to implement the proposal, the telecom industry concentration and the feasibility of proposal that can't be specified in concrete terms. Some of the criteria are vague and some are not even stated. It provides a lot of room for lobbying and favouritism. This creates a very difficult situation for the applicant firm. They are not aware of the weights assigned to various subjective criteria and not any kind of explanation for rejection of their application. It's the lack of transparency and time consuming nature because of which administrative allocation method is hugely criticised.

Lottery

The second method of spectrum allocation is lottery. It is perceived to be more quick and economical as compared to administrative process. Lotteries too are not free from some serious short comings. They are rejected on the grounds that they lead to speculation and the technical competence of the firm to develop, maintain and operate the license can not be determined through them. After rejecting the administrative process United States experimented with lotteries in allocating cellular licenses during 1980s. Lotteries attracted many speculative applicants, many of whom were not technically competent. Such applicants after winning the licences sold them off to other firms at exorbitant prices leading to notional losses to government coffers.

McMillan (1994) has reported that lotteries were rejected by Canadian government as they would attract more frivolous applicants and speculators. In addition to this, in case of lotteries there was no way the government could ensure that the successful applicant has the technical competence to develop, maintain, and operate a public telecommunication service. The United States allocated cellular licences by lottery system in 1980s. Although, this system succeeded in giving assigning licences quickly, but the possibility of windfall gain attracted nearly 400,000 applicants. Many of these applicants were not technically capable of providing cellular-telephone services and as a result many successful applicants resold the licences in secondary market. This resale resulted in delays in launch of services and considerable revenue loss for the government.

First-Come-First-Served

Under first-come-first-serve mechanism, the firms that first mention their interest in using the asset get the right to do so (Janssen, 2004). Some of the European Union members resorted to first-come-first-serve basis of allocation of mobile radio licences. This process has the time advantage but has the same disadvantage as the lottery.

Auctions

Economists have been campaigning for auctioning of radio spectrum since the times of Ronald Coase (1959). Auctions are considered to be more efficient in allocating the licence to that firm which can best make use of them. This is so because the firm which has the ability to start the services quickly, which can introduce new services and which believes it can utilize the spectrum more efficiently will value the spectrum more. This valuation will lead to higher bidding and more revenue generation for the government. Thus the auction designs which award the licences to those bidders who have the highest willingness to pay promote the efficient use of spectrum.

The advantages of auctions over other methods of spectrum allocation are:

1. Auctions help in revealing the value of a license as perceived by the bidders;
2. Auctions are quicker and more efficient as compared with administrative procedures;
3. Auctions are more transparent;
4. Auctions are flexible, i.e. can be moulded in such a fashion so as to suit the government policies.

In the year 1993, United States decided to switch to auctions for granting new mobile communication licences. The Federal Communication Commission (FCC) was asked by the US government to design and operate the auction process for granting licences. The commission came up with a novel method of auction termed as *the electronic simultaneous multiple round bidding auction*. This method has been copied round the world to sell over US$100 billion in radio spectrum (McAfee et al.).

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nine spectrum auctions, raising about $20 billion for the US treasury (Cramton, 1998). These auctions were described as "*The Greatest Auction in History*" (William Safire, New York Times, March 16, 1995) and "*The Auction of the Century*" (Liberation, Paris, March 15, 1995) because of their efficiency and sheer volume of revenue they generated (McAfee).

Binmore and Klemperer (2002) while advocating for auctions over beauty contests argued that the 'second generation' licenses fetched the UK government only 40,000 pounds as compared to 3G spectrum auctions which yielded about of GNP. Spectrum auctions proved that they can play a vital role in nation building by reducing the government debts and lowering the income taxes on public. They extract and provide information to governments which can't be accessed through beauty contests.

Allocation of spectrum through auction is not just about raising money but it also reveals the information how value the bidders believe the license to be. The Federal Communications Commission (FCC) of United States puts that "since the bidder's ability to introduce valuable new services and to deploy them quickly, an auction design that awards licenses to those bidders with highest willingness to pay" results in most efficient use of spectrum (McMillan, 1994).

3. Literature Review

Simultaneous Ascending Auction (SAA) was considered by Klemperer (1999) as the most important new auction design. According to him the germs of SAA can be traced to Vickrey, 1976 but the onus of practically designing such auctions for the first time goes to Milgrom, Wilson and McAfee who proposed the rules that were necessary to make the SAA effective in the context of US radio spectrum auctions. Cramton (1997) has analysed the six spectrum auctions conducted by FCC from July 1994 to May 1996. Cramton argues that this auction format had theoretical virtues which were never proven. FCC chose to innovate. The auctions went on smoothly with some minor hitches and were termed as very successful. Cramton adds a note of caution also that the success of these auctions doesn't imply that alternative methods were less successful and that the success is assured in future also. Although allocation of spectrum by auctions is a huge improvement over allocation by lottery or comparative hearings.

Klemperer (2002) while commenting on Börgers and Dustmann (2002) result's reports that the UK 3G telecom auction of 2000 is considered as the most successful of the Western European 3G auctions in terms of revenue raised per capita and efficiency. The aspect of revenue was most obvious. But the efficiency aspect was probed by different researchers and was found to be efficient or close to be efficient, in the sense of maximizing the sum of the valuations of the license holders. The pre-auction and post-auction data suggest that the four-incumbent firms in UK auction were having the highest valuations, so were the efficient winners. Moreover, Vodafone was having the highest incremental value for a large license and so the allocation of spectrum among the winner's was also efficient.

Lueck (1998) describes the opinion of S. Moreton and Pablo T. Spiller deduced from their

empirical study of the Personal Communications Service (PCS) auctions of 1995 and 1996 in USA, in which they have shown that the bidder behaviour is consistent with most economists' conceptions of competitive markets. They have also shown that firms competing in these auctions were able to aggregate licenses, thus offering vindication for simultaneous multiple-round auctions.

A detailed description of why auctions were used in spectrum allocations and which format of auction best suited such an allocation is given by Börgers and Damme (2003). They have argued that a seller wants to get the best price for the item which he/she is selling. This objective gets slightly modified if the seller happens to the government instead of a private-sector seller. Compared to revenue generation, the government will be more interested in achieving an efficient outcome – placing the license into the hands of those who value them the most. Although more revenues are also desired as they help the government to reduce the fiscal deficits and taxes. An ascending auction provides an attractive alternative, which itself can be modified to suit the particular need.

By empirically analysing the data from the 1995 US Broadband PCS auctions Klemperer and Pagnozzi (2002) have concluded that when the number of objects available exactly equals the number of "advantaged" bidders, revenues will be lower in an ascending auction. A fall in revenues is because of the reluctance of the weaker bidders to participate in the auction, and those that are present bid extremely cautiously because of the enhanced 'winner's curse' they face. In US, revenues were lower when there were exactly two "advantaged" bidders among the bidders for the two licences in an area, than when there were either few or more than two advantaged bidders. They have estimated a revenue loss of around 15% to the government in such cases.

Hafalir and Krishna (2006) have pondered over the idea of restriction on the resale of spectrum once sold in the secondary market. They believe that with asymmetric bidders, the resulting inefficiencies create a motive for post-auction trade. Even a ban on such a resale can be easily circumvented, as happened in 3G spectrum licences of UK. The government banned the resale of license and TIW, a Canadian company, bid successfully for the most valuable license "A". However, Hutchison, a rival company, then acquired the license by buying TIW itself.

4. Spectrum Auction Design

Thus, in literature auctions are considered as best mechanism, they appears to be efficient, clear, and fast, and in addition, if designed properly, they raise fair amount of revenue also. At the core of any successful auction is its design mechanism. In case of FCC auction for spectrum allocation the auction design was known as Simultaneous Ascending Auction (SAA). Under the method used - all licenses were open for bidding simultaneously and remained open until bidding on all ceases. This means that instead of selling licenses, one by one, they were open for bidding at the same time and all the licenses would remain open until bidding ceased on all of them. Bidding occurred in rounds and bids were announced after each round. This helped in containing the winner's curse and thus boosted the

confidence of bidders. They started bidding more aggressively.

Since the licenses are interdependent – there aggregate value may exceed the sum of their individual values - by simultaneous bidding, bidders were able to build efficient license aggregations. The FCC auctions are considered as the best example where synergies play a critical role by Katok and Roth (2004). Synergies often arise from owning licences in adjacent geographical locations or adjacent frequencies.

Bidders were having an initial eligibility based on their deposits and were supposed to remain active to maintain their eligibility. Activity was defined as the sum of standing high bids and new bids.

Activity = Standing high bids + New bids

Insufficient activity reduces the eligibility to win. The auction proceeded in three stages:

Stage 1: bid at least 50% of eligibility

Stage 2: bid at least 80% of eligibility

Stage 3: bid at least 100% of eligibility

Bidders were not supposed to bid more than their eligibility. If the activity of a bidder reduces than his/her eligibility to win the auction also get reduced. A withdrawal penalty was also imposed. If a winner wants to withdraw then he/she was to surrender the license. The process of auction will start again and the withdrawer would have to pay the difference between current highest bid and his final price in case the present bid is lower than the previous final price.

Janssen (2004) has argued that many aspects of auction design can have a considerable impact on the final outcome of an auction. The different auction forms will have different outcomes as they get affected by collusion, winner's curse, and entry deterrence differently. Collusion in an auction will lower the bids of individuals bidders and, hence, the revenues. Collusion is more probable in auctions that occur one after the other between same bidders. In a common value auction, where bidders' valuations are strongly correlated and uncertain, possibility of winner's curse will lower the revenue generation. Finally, when incumbent shave advantage over potential entrants; entrants are confronted with the question of whether they should take part in the auction at all as preparing for an auction will require considerable investment of time and money.

Apart from defining the auction design rules, an auctioneer is required to pay attention to some externalities also. These externalities include evolving market structure, political problems, loopholes in design, and credibility of auction rules.

Market Structure

While deciding on the rules and format of some auctions, like spectrum auctions, the auctioneer must also anticipate the type of market that will evolve after the auction is over. This approach of 'looking ahead and reasoning back' helps in avoiding collusion or predation efforts by the bidders. Cramton (2001) was also of the view that the allocation of

licences and auction design plays a critical role in determining the market structure or the future competition in the market.

From the social efficiency perspective, a market having strong competitors is preferred because competition will lead to better services, greater innovations and lower prices. Auctions are not usually designed for achieving social efficiency. The outcome of an auction is generally driven by the profits of the bidders. In some type of markets, like telecom markets, the joint profits of firms are more than their individual profits. So, it might be possible that some strong firms collude together in an auction to prevent the entry of new firms. Also a firm which is unable to meet its demand can make it easier for others to enter, by not going in the auction wholeheartedly. Both these outcomes are inefficient. Hence, it may be imperative for the auctioneer to predetermine the market structure, in order to prevent such kind of behaviour of the bidders.

Political Problems

Politics can put a number of constraints in policy implementation. It can act as major hindrance in economic growth, as in issues related to privatization, or its role could be limited, as in some spectrum auctions. Political interference in the US spectrum auction is reported by McMillan (2003), who states that in one such auction, only small firms were allowed. Easy repayment option of paying in instalments resulted in speculative overbidding by the firms and most of the top winner later on defaulted in payments.

Klemperer (2002) explores a few more possible arenas where politics can play spoilsport. Sometimes government officials may find it difficult to set some serious reserve prices, because they fear that the auction might result in failure if the high reserve prices will deter firms in participating in the auction. In sealed bid first price auctions, the winner would find it difficult to explain if after the end of auction he finds that he has bid too much for the object. Similarly, a loser who has lost by a narrow margin will also find himself in the same position. A second price auction can be much embarrassing for the auctioneer, if the difference between the highest and the second highest bid is too large. Such an outcome can be easily avoided by setting a minimum reserve price that the winner will have to pay.

Loopholes

Loopholes in auction design could prove to be very costly if the item to be auctioned is a high ticket one. The bidders can exploit the loopholes to take home unfair advantage. McMillan (1994) cited the example of Australian auction of satellite television licenses. Two bidders competed with each other fiercely, raising the prices but later on defaulted in payments because the government had forgotten to impose fines for defaults. Possibilities of default also arise when small underfinanced firms are allowed to participate in the auctions, as they can default on commitments by filing for bankruptcies.

Credibility of Rules

Plugging the loopholes by formulating rules is one aspect and credibility of such rules is

another aspect. Despite having best laid rules, it is possible that the auctioneer may face the problem that there are many numbers of bidders as are required for the auction to continue, and one of the bidders is violating the rules. In such a situation, the auctioneer must consider that if the auction is repetitive in nature than any relaxation in rules now may jeopardise the credibility of such rules in all the future auctions. Moreover, imposing some astronomically high penalties for defaults can also become a hindrance in the entry of some bidders. Whatever may be the rules for the conduct of auction process, they must be viewed as credible and enforceable by the bidders.

The huge success of simultaneous many-unit multiple round auctions has opened new arenas for efficient allocation and good revenue generation from similar natural resources. Auctions are now increasingly used in electric power generation rights, airport landing rights, off-shore drilling rights, and privatization of micro-wave spectrum.

5. Spectrum Auction: Bangladesh's Experience

Bangladesh is one of the largest and fastest growing mobile markets in the world. The country is home to 154 million people, out of which around 70% lives in rural areas on less than US$2 per day. It is one of the few countries in Asia which are still lacking behind in the nationwide deployment of high-speed mobile networks. Owing to low penetration level of mobile telephony (just around 40%), there is tremendous room for growth and expansion. Till 2013, the top four mobile operators, namely, Grameenphone, Banglalink, Robi and Airtel, were offering data services solely on 2G-GSM networks. These operators control nearly 97% of the country's mobile connection market (GSMA Intelligence, 2013).

Bangladesh started its journey of 3G internet services in October 2012, when Teletalk - a government owned telecom operator, was awarded the license to operate 3G services. Next year, on 8th September, 2013, the Bangladesh Telecommunication Regulatory Commission (BTRC) conducted the auction of 3G spectrum in 2.1 GHz band (BTRC, 2013). The top four cell phone companies in Bangladesh participated in the auction which finished in three rounds of bidding. The reserve price set by BTRC for one MHz spectrum was fixed at $20 million. The auction raised US$ 525 million from four bidders from the top four private operators. The Grameenphone bagged 3G license for 10 MHz spectrum at the price of US$210 million in the first round. In the second round, other three players: Banglalink, Robi and Airtel, each acquired 5 MHz spectrum at the price of US$105 million. There were no new bids received in the third round leading to ending of auction (Karim, 2013). The license was to be issued upon payment of the first instalment of 60%, payable within 30 working days, and the remaining 40% to be made within 180 working days.

It was expected that the launch of 3G services in the country would bridge the 'digital divide'. The companies would be able to tap more revenues from fast growing data services while reducing their regulatory costs under a new licensing regime (Karim, 2013). However, along with these high expectations, BTRC chairman S K Bose expressed doubt over the capability of operators, who got 5 MHz, in ensuring proper service quality in 3G services (New Age, 2013).

The final outcome of the auction would have been largely different if the auction had one more bidder. In the auction, four bidders competed with each other for just four licences. Several right groups have also protested against the behaviour of bidders in the auction process. They argue that bidding companies exhibited behaviour that is typical of oligopolistic firms which operate through tactic collusion (New Nation, 2014). Bangladesh's 3G spectrum auction failed in attracting new players, thereby, lasting for less than one hour. The entire exercise was apparently a predetermined game, in which bidders acted in collusive manner. As a result, the government sold licenses for 15 year period, for just $525 million as against initial estimates of $800 million.

6. Conclusions

Allocation of public resources such as spectrum rights, coal blocks, and oil leases have contributed enormously to government coffers in many cases. As a result the methods for their allocation have become a highly debatable topic in corporate, government and academic circles. The traditional method for such allocations had been the beauty contests where allocations were made on the basis of some pre-specified criteria. But this method was mainly criticized for being time consuming along with being more bureaucratic in nature. Other methods like lottery systems and first-come-first-serve also have their limitations of being low on efficient allocation and less profitable for the government. Auctioning of public resources came into limelight with the historic spectrum licences auction conducted by the FCC in the US in 1993. The remarkable success of this auction led other countries also to allocate natural resources through auctions. The auction design used by the FCC was simultaneous ascending auction where all licences were open for bidding simultaneously until bidding on all ceases.

Although, auctions have been successful in many cases but there utter failure in some countries have called for cautious approach. The success of the auction depends on the mechanism design. One size fit all approach would not be a good option for allocation of public assets. The allocation of spectrum licence through auctions is an example of this. The auction raised revenue marginally above the reserve price set by the government. A closer look reveals that if the government would have taken measures to combat collusion amongst bidders by encouraging other players, the final outcome would have been different.

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