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Telecom Spectrum Auctions in India: The Theory and the Practice

by

Srobonti Chattopadhyay
Post Doctoral Research Fellow, IIM Calcutta, Diamond Harbour Road, Joka P.O.
Kolkata 700 104

&

Susmita Chatterjee
Assistant Professor, Serampore College P.O. Serampore Dist. Hooghly West Bengal
Pin 712 201

Telecom Spectrum Auctions in India: The Theory and the Practice

Srobonti Chattopadhyay

Post Doctoral Research Fellow, Indian Institute of Management, Calcutta

and

Susmita Chatterjee

Assistant Professor, Serampore College (Univ.)

Abstract

Telecom spectrum is a scarce natural resource whose misallocation is likely to have adverse impact on an economy. It is therefore crucial for a country to ensure efficient allocation of telecom spectrum. Although there are different methods of allocating spectrum, auction as a method of spectrum allocation is being adopted by increasing number of countries. This paper makes an attempt to provide an overview of auction as an allocation method for telecom spectrum in India, explaining the various possible auction formats along with their merits and demerits and also India's performance in telecom spectrum auctions in the light of the experiences of some other countries which have adopted this method for allocating their telecom spectrum.

1. Introduction

In recent times, our lives are becoming increasingly more digitalized. Starting from bank operations, official services, defense operations etc. to our personal works and requirements for maintaining social contacts, everything is largely dependent on digital technology. Telecom spectrum is the key component in this digitalization. How successful the impact of digitalization would be on the level of economic growth and development of a country depends substantially on the utilization of telecom and therefore on the prevailing state of telecom spectrum allocation in a country. The degree of digitalization and allocation of telecom spectrum in any country depend also on how the authorities perceive telecom spectrum. For example, as noted by Jhunjhunwala (2003), China and India, both had around 5 million telephone lines in 1990. But a decade later, there were only 30 million telephone lines in India, while that for China crossed 160 million. The reason for this, as suggested by Jhunjhunwala (2003), is primarily

because Chinese policymakers viewed telecommunications as a necessity while their Indian counterparts looked at it as a luxury at least till 1997.

Spectrum (also sometimes referred to as airwaves or frequencies) is a scarce natural resource. Prior to 1995, it was believed to be a property of the Government. But a Supreme Court verdict in 1995 ruled that "*The airwaves or frequencies are a public property. Their use has to be controlled and regulated by a public authority in the interests of the public and to prevent the invasion of their rights. Since, the electronic media involves the use of the airwaves, this factor creates an in-built restriction on its use as in the case of any other public property*."[1] Therefore, like any other scarce public resources, its allocation needs to be efficient in order to protect the interest of the public by minimizing wastage and maximizing public utility. With this background, it seems useful to have a broad overview of the issues relating to telecom spectrum allocation in India along with the regulatory aspects of such allocations. The rest of the paper tries to provide this. The focus, however, is mainly on auctions as a method of telecom spectrum allocation, since this method has been in use in some countries and more and more countries are adopting this method replacing their earlier practices for allocating telecom spectrum.

The paper is organized as follows: section 2 discusses the different ways in which telecom spectrum can be allocated, sections 3 identifies the different formats of auctions along with their pros and cons, section 4 explains the various concerns regarding designing of auctions, section 5 briefly discusses the experiences of some countries which have adopted auction as a method of allocating telecom spectrum, sections 6 and 7 are respectively about the telecom regulatory agencies and telecom spectrum auctions in India and finally section 8 outlines the policy directions and concludes the paper.

2. Different Methods of Telecom Spectrum Allocation

Telecom spectrum licenses can be allocated in various different ways e.g. *comparative hearings*, *beauty contests*, *lotteries*, *first-come-first-served* (*FCFS*) *basis* and *auctions*. The method of comparative hearings has been used by the Federal Communications Commission (FCC) for assigning spectrum rights in the US. Comparative hearings are "*quasi-judicial administrative process to select among competing applicants for spectrum licenses*"[2] in which the FCC "*evaluates applicants under comparative criteria*

[1] This Supreme Court judgment was delivered by Justice P.B. Sawant and Justice S. Mohan on 9.2.1995 in the case between the Union of India & Cricket Association of Bengal.
(Source: http://www.mib.nic.in/WriteReadData/documents/SUPREMECOURTJUDGEMENTONAIRWAVES.htm)

[2] Kwerel, E. (Office of Plans and Policy) and W. Strack (Wireless Telecommunications Bureau), (2001): "AUCTIONING SPECTRUM RIGHTS" (http://wireless.fcc.gov/auctions/data/papersAndStudies/aucspec.pdf)

established by rulemaking prior to the hearing."[3] The beauty contest method, which has been used in Bangladesh, judges the applicants "*on the basis of their proposed service offerings, e.g. roll out and coverage commitments*"[4] i.e. the applicants are judged based on their proposals on how they intend to use the spectrum and selected accordingly. Lotteries as means of allocating spectrum licenses were in use in the US during the early 1980s. The FCFS method, where the earlier applicants are allocated the spectrum licenses, was in use in Bangladesh and in still in use in Bhutan. Auctioning as a method of allocating telecom spectrum is now commonly used by many countries like the USA, the UK, Germany, New Zealand, Canada, Pakistan etc.

India is also among the early adopters of auction as a mechanism for telecom spectrum allocation. Among the various methods of spectrum allocation, e.g. first come first serve (FCFS), lotteries, beauty contest etc., auctions have gained ground as a more acceptable allocation mechanism due to greater transparency and less administrative discretion involved in the process. It is also likely to ensure better efficiency in the sense that it allocates licenses to those providers who can ensure services in the best possible way (i.e. the most efficient types), whereas the allocations under all the other mechanisms specified above are more random and therefore more likely to allocate licenses to less efficient providers .

3. Different Auction Formats

Depending on the associated payment rules, there can be different auction formats. These auction formats can be classified into open-bid and sealed-bid categories. Among the sealed-bid single unit auctions, the most commonly used formats are *first price* and *second price sealed-bid* auctions. In both these auctions the highest bidder wins, but in first price auction, the winner has to pay his/her own bid, while in the second price auction, the winner pays the second highest bid or highest losing bid. Among the open auction formats, the most familiar ones are the *English* and *Dutch* auctions. In the English auction, either the bidders call out their bids which they keep revising upward, until only one bidder remains, or the auctioneer starts calling out bids and revises them upwards, while for higher prices the bidders drop out one by one and the auction terminates when only one bidder survives. Thus English auction is an open ascending auction. In the Dutch auction, the seller calls out a very high price and asks the bidders whether they are interested to purchase at that price. If no one is interested then the price is revised downward and

[3] ibid.

[4] SATRC Report on SPECTRUM PRICING (2012)

the process continues until at least one bidder expresses his/her willingness to purchase. Then that bidder obtains the object at that price. Thus this is an open descending auction.

For multiple objects we have analogous auction formats, again associated with different payment rules. Among the sealed-bid formats, the common ones are the *discriminatory* or *pay-your-bid* auction, the *uniform price* auction and the *Vickrey* auction. In the discriminatory auction, the highest among the submitted bids are chosen as the winning bids and the corresponding bidders have to pay those bids. In case of uniform price auction again the highest bids are chosen as the winning bids, but all the winning bidders have to pay one common price, which by convention is the highest losing bid. In case of the Vickrey auction, each winning bidder has to pay as many highest losing bids as the number of objects he/she wins. Among the open auctions, the English and Dutch auctions may also be conducted following the same principles as for any single indivisible object. In the English auction the prices increase and in the Dutch auction the prices decline until the market clears.

With multiple unit auctions, often the concern regarding efficient allocation arises, since in case of discriminatory or uniform price auction, where bidders have demand for more than one unit, the issue of "bid-shading" (i.e. suppressing bids) beyond the first object comes into play. This problem, however, is not prevalent when bidders have single-unit demand. For Vickrey auction with independent private values usually efficiency in allocation is ensured.

The auction formats which have been mostly used so far for allocating telecom spectrum, include the second price sealed bid/Vickrey formats, *Simultaneous Ascending Auction* (SAA) also known as *Simultaneous Multiple-Round Ascending Auction* (SMRA), *Simultaneous Clock Auction* (SCA), *Combinatorial Auctions*, *Anglo-Dutch auction* etc. The bidding strategies for these types of auctions are simpler to calculate and therefore easier to implement in practice and also they are always allocatively efficient. Among these, the second price sealed bid and the Vickrey auction formats are static formats (since these involve submission of bids only once and the selection of winner on the basis of those bids). For second price auction, the probability of collusion among the bidders leading to low final prices for the object always remains[5]. Also, as pointed out by Compte and Jehiel (2007), revenues in ascending auctions are larger than those in second price auctions under certain conditions. They suggest that in most cases values of assets are not known beforehand and at times costly investments are required to discover these values. Certain dynamic formats allow bidders to observe the number of competitors left throughout the selling procedure. The reduction in the number of potential contenders in later rounds makes the reduction

[5] Example has been provided subsequently in the section on country experience.

in competition visible to the bidders. This induces them on one hand to stay in the auction for a long time as well as to gather information on the actual value of the asset. Both these effects contribute to higher revenue generation.

In the SAA, the bidders simultaneously quote bids, mostly posting their bids through internet. The highest bid in every round is disclosed after the completion of the concerned round without naming the bidder in order to avoid possibilities of tacit collusion among the bidders. Setting the highest bid of a particular round as the reserve price for the immediately following round, the auction continues till the number of licenses demanded by surviving bidders matches the number of licenses up for sale.

In case of SCA, there is a clock which marks the continuous increase in price of the objects up for sale. The bidders observe the prices on the clock and decide when to step out. The auction is concluded when the demand from the remaining bidders equal the available number of licenses. In clock auctions, the bidders have less scope to manipulate the final prices as the sellers quote bids in the form of prices and the bidders have to just indicate their willingness to buy the concerned object(s) at those bids. Hence the probability of revenue loss resulting from collusions among bidders is quite low for such auctions.

In the combinatorial auctions the objects (licenses in case of telecom spectrum auctions) are sold as a complete package or as a combination of different packages (i.e. no single license is sold in isolation, a number of licenses combined constitute a package). These auctions can induce bidders to bid higher in presence of *positive synergy* or *superadditive values* (i.e. having the objects together generates higher value to the bidder than the sum of the values derived from having the objects individually). This is because when there is superadditive value for every bidder, each of them always faces the possibility of not being able to have all the objects together unless they are sold in a package. This means that each bidder is always uncertain about the materialization of the positive synergy which might result in underbidding. To understand this aspect more clearly we consider an example involving just two identical objects and two bidders, following Brusco and Lopomo (2009). The bidders are assumed to be budget constrained (i.e. have limited resources so that they might not be able to pay up to the total value for the two objects together). A clock auction is conducted to allocate the objects. Once the clock price exceeds the stand alone value for one object, the concerned bidder is very likely to drop out soon. This happens because, given limited resources, the concerned bidder faces the uncertainty of not being able to get both the objects (since very high prices might not permit the bidder to purchase both the objects), but ending up purchasing a single object at a price higher than the stand alone value for it and thus earning a negative

surplus. This analysis can help us to understand situations involving heterogeneous objects analogously[6]. This prompts the bidders to bid less for the second object. However, when there is a combinatorial auction, the winner always obtains all the objects together as a package and therefore, the bidders do not face the type of uncertainty discussed above. So, the underbidding does not occur.

The Anglo-Dutch auction first proposed by Klemperer (1998) involves an English auction to begin with, where the prices rise continuously until exactly one more bidder than the number of objects survives. After that in the Dutch auction stage, the surviving bidders submit sealed-bids. The bids are required to be no lower than the current price level. The highest bids are the winning bids and highest bidders have to pay the lowest winning bid.

4. Concerns Regarding Auction Designing

In this context we must also note that how successfully any auction can serve the intended purposes depends crucially on the designing of the auction. For example, in case of telecom spectrum license allocation in India, an important objective is to ensure competition in the market. Therefore the auction should be so designed that there is enough participation by the potential bidders. For allocation of public resources, social welfare always remains a concern. This is true for telecom spectrum allocation as well. At the same time the government also will have some revenue target. As long as efficiency in auction is ensured, i.e. the highest types[7] are rewarded, there is no contradiction between maximizing revenue and ensuring efficient allocation[8]. The winning type always bids higher than the losing types and therefore their payments are also the maximum that can be earned. However, if the government solely concentrates on revenue maximization putting the welfare concern aside, efficiency in allocation and therefore social welfare is highly likely to be compromised. Thus maximizing efficiency subject to a target level of

[6] Only difference will be in terms of the bids on individual objects and therefore on the final outcome. In the case considered by Brusco and Lopomo (2009), the bidders are indifferent between the two objects when they win just one of them. This is simply because the objects are homogeneous. Heterogeneity among the objects might make one object more preferable than the others for any bidder.

[7] Auctions are one form of Bayesian games, i.e. games involving incomplete information, where bids are functions of the types of the bidders. In case of private value auctions, the bids are simply the valuations of individual bidders, while for interdependent values the types are the private signals regarding the actual value(s) of the object(s) for sale are the types of the bidders. In case of telecom spectrum auctions, the values or types can be interpreted as the private signals regarding the expected turnovers from being service providers (through the usage of the spectrum).

[8] Auctions are essentially allocation mechanisms and different auction formats involve different allocation rules. An allocation rule suggests the probability of any bidder being awarded the object depending on their reported types or bids and an allocation rule is considered efficient if it maximizes social welfare (Krishna, V. (2010): *Auction Theory*, Academic Press, USA), where social welfare is defined as the sum of individual expected valuations for all the agents in the concerned system. For any auction an efficient allocation is attained when the highest types are awarded, since no transfer can make any agent in the system better off without making anyone else worse off. Thus an efficient auction also ensures a Pareto efficient outcome. It is also social welfare maximizing since the bidders with higher valuations have higher expected valuations as well form the allocation in their favour and thus the sum of the individual expected valuations are maximized when the highest types are awarded the objects.

revenue is likely to somewhat address both the objectives, for which setting an appropriate reserve price becomes very important.

The issue of setting an appropriate reserve price needs to be understood clearly. Standard auction theory suggests that in the presence of possibilities of collusion among the potential bidders reserve price mitigates the problem to a large extent. When there is no reserve price the bidders might collude to keep the final prices in the auction low, and thus also lowering the level of revenue generated by underbidding. In this context the auction of telecom spectrum licenses in New Zealand in 1994 is worth mentioning. It was a second price sealed-bid auction. In this auction the winning bid was NZ$ 7 million while the auction ended with the runner-up's bid of only NZ$5,000[9]. This drastic difference strongly suggests the possibilities of collusion. However, choosing an appropriate reserve price is important, since a very high reserve price might leave the bidders with negative surplus thus discouraging them from participating in the auctions. Thus a very high reserve price might lead to no participation at all thus leaving the intended objects unsold. Even though there is participation by a few bidders, in cases like auction telecom spectrum this would lead to very low level of competition in the post auction telecom market.

The issue of spectrum trading also becomes crucial in this context. Allowing for spectrum trading post auction can act in two opposing directions. First, the very possibility of trading is more likely to lead to a socially efficient allocation of spectrum. However, this possibility might also create more scope for tacit collusions among the bidders resulting in substantial revenue loss for the government in some cases.

While designing an auction, the designing authorities have to be very careful in order to reconcile the apparently opposing objectives. For example, promoting competition might very well come to contradict the realization of synergy in auctions. If there are positive synergy or superadditive values, restricting the number of circles might adversely affect the bidding incentives of some bidders. But at the same time, it might encourage participation by some other bidders. In general, the positive synergy encourages the richer bidders to bid more aggressively whereas the restriction on the number of circles for individual bidders encourages the less resourceful bidders to participate.

5. Telecom Spectrum Auction: Experiences of Different Countries

In this section we briefly discuss the experiences of a few countries who have adopted auction as the method of telecom spectrum allocation.

[9] Klemperer (2004)

United States

The US Congress authorized the spectrum auctions in 1993. The auction format adopted here was the simultaneous multiple round ascending auctions (SMRA). Only 6 per cent of the US population had been using a mobile phone at that point of time. The Federal Communications Commission (FCC) initially had allowed no more than two providers in most markets. According one FCC report, in 2013, the penetration rate of wireless technology is more than 100 per cent since most of the US citizens have more than one mobile connection. Today, 97.2 per cent of the US consumers have the option to choose between three or more service providers and 80.4 per cent can choose among five or more providers[10]. This shows that the FCC has been successful in attaining its objective of ensuring competition in the telecom market. Overall, the US telecom auction is rated as a success story.

United Kingdom

The auction of 3G licenses in the UK which commenced in March 2000 was designed for two larger (2x15MHz paired), three smaller (2x10MHz paired) and four blocks of unpaired (5MHz) licenses, all non-tradable in secondary market. The wireless market incumbents were Vodafone, BT Cellnet, One2One and Orange. Competition was ensured through rules of bidding (no one could acquire more than one license); moreover one of the large licenses was restricted to new entrants. All five licenses were sold, raising $35.4 billion. "3UK" (TIW, the company backed by Hutchison) won the new entrant set aside licenses. Efficiency of the auction was questioned on the ground that discounted set-aside licenses generated less revenue due to less valuation by bidders (strongest new entrant and small existing telecom operators). Though ensuring competition was the primary objective of set-aside licensing in 2000 auction, in recent date UK telecom market is consolidated and is ruled by four players, the three major players are –Vodafone, Everything Everywhere, O2 and a small market share is catered by 3UK[11].

Germany

The German government auctioned national licenses for 120 MHz spectrum of paired spectrum and 25 MHz of unpaired spectrum in two consecutive phases in July and August 2000. Prior to auction four major players were in the market[12].The regulatory authority imposed spectrum cap to limit the number of successful participants between four to six. While setting the eligibility condition, financial strength was the only criterion. Two new entrants were MobilCom (owned by France Telecom) and Group 3G (trade

[10] Earle and Sosa (2013)
[11] European Commission, Case No COMP/M.5650 --- T---MOBILE/ ORANGE, pp.9,13,14,15,16
[12] T---Mobile, Mannesmann Mobilfunk (now Vodafone),E---Plus, and Viag Interkom.

name Quam, a consortium between Spain's Telefonica and Finland's Sonera), won the 3G spectrum; however they failed to deploy the service. In 2002 Group 3G exited from the market and Mobile Com returned the license to the regulator in 2003 keeping the market serviced by four network operators. The unused paired spectrum was reassigned for 4G technology in 2010 spectrum auction. The auction rule of capping was unable to increase the competition and caused distortions in the market affecting the access of improved technology.

Austria

The Austrian auction of 3G spectrum of late 2000 tried to enhance competition by increasing the number of service providers from existing four[13] . German spectrum auction method of the same year closely followed to structure the auction with capping to facilitate the stated intention but the auction failed to increase carriers; only two new entrants Telefonica and Hutchinson 3G entered the market but Telefonica exited the market in 2003. After twelve years of Universal Mobile Telecommunications System (UMTS) technology auction, only three operators are there[14] in the Austrian network market.

New Zealand

The first spectrum auction in New Zealand took place in 1990. The New Zealand government adopted the simultaneous second price sealed bid auction format for each license. Four providers had taken part in this auction: Sky Network TV, BCL, Totalisator Agency Board, and United Christian Broadcast. However, the bid data clearly reflected that there was little connection between the demands expressed by the bidders, the licenses they obtained and the prices they ended up paying and therefore evidently the allocation was inefficient[15]. Another serious problem, as noted by McMillan (1994), was that in two separate cases, there had been a surprisingly large gap between the highest and the second highest bids: in one case the highest bid was NZ $ 1,00,000 and while the second highest bid was NZ$ 6; in the other the highest and the second highest bids were respectively NZ$ 7 million and NZ$ 5,000. So the NZ government ended up earning a revenue of NZ$ 36 million, while the projected figures were NZ$ 250 million. After that the NZ government switched to the more standard first price sealed bid auction formats for allocation of telecom spectrum.

6. Telecom Regulatory Agencies in India

[13] Mobilkom Austria, Connect Austria, Max.mobil (T Mobile) and Tele.ring.
[14] T mobile,Mobilkom and Hutchinson 3G.
[15] Milgrom (2004)

Prior to 1991, India was an economy under state command. It became a pro-market and a more open economy only with the reforms that unfolded during 1991. According to the Indian Telegraphs Act, 1885, the Government of India was to be the sole authority for operating or licensing others to operate in the telecommunications sector. Following this Act, till 1991, the Department of Posts and Telegraphs, along with its successor the Department of Telecommunications (DoT) under the Ministry of Communications had a monopoly in the telecom sector. Although certain liberalising measures were introduced in the telecom sector in 1991 followed by a second phase of reform through the introduction of the National Telecommunications Policy (NTP) in 1994, the issue of a regulatory authority still remained unaddressed. But it was soon realized that "*merging of institutions of regulation, licensing, and adjudication, all in one body, which was also an operator, was bound to lead to perverse decisions*"[16] and the actual turn of events confirmed this. Thus the "*need for different competent institutions, each with its own role, competence and powers to discharge its functions*"[17] was urgently felt. Therefore, in January, 1997, the Telecom Regulatory Authority of India (TRAI) came into being solely for the purpose of regulation through an act of the Parliament.

The TRAI Act, 1997, had specified certain functions for the TRAI without clearly stating how this body was to fulfill these functions. For example, it could ask for any information from any service provider including the DoT. But TRAI did not have any enforcement power in case of a refusal by any provider to disclose such information. It could only make recommendations. Likewise, licensing was not in TRAI's jurisdiction, it was only entitled to set terms and conditions of license of a service provider. But DoT challenged even this power of setting terms and conditions that TRAI was initially assigned in the Delhi High Court and won the case. The New Telecommunications Policy (NTP), 1999 suggested that TRAI would have complete power of issuing directives to all service providers including the Government ones like DoT, MTNL, and VSNL and to adjudicate disputes among service providers and between the service providers and the Government. But the issuing and disbursement of licenses including the selection of providers were completely in the Government's jurisdiction. The TRAI could however give its recommendations regarding these issues only when sought by the DoT.

Thus, although TRAI was created as a regulatory body, the DoT can easily defy its suggestions. This implies that TRAI is essentially a regulatory authority only with the power to suggest policies and having no control over the implementation of its suggestions. Conducting of auctions and setting auction rules in the telecom sector is completely under the control of DoT. Therefore, despite being two departments

[16] Dossani and Manikutty (2003)
[17] ibid.

under the same government, there always remain differences among these two bodies. The strange thing to observe here is that, as noted above, one major objective behind creating TRAI was to reduce the number of functions that the DoT used to perform and distribute the responsibilities; but if DoT still continues to take decisions on its own, without any consideration about what TRAI suggests, then the whole idea of creating a separate regulatory body becomes meaningless. Moreover, the perpetual differences in opinion between these two government departments is detrimental to a consistent policy making which is likely to have severe adverse consequences for the economy as a whole.

7. Telecom Spectrum Auction in India

India started allocating spectrum licenses through auctions in 1991. In India, the Department of Telecommunications (DoT) is the authority that conducts the auctions of spectrum licenses. The entire country was divided into 20 circles categorized as A, B, C depending on their revenue potential, for service provision. The larger states were divided into two circles whereas smaller sates were clubbed together to ensure administrative convenience. DoT decided to have two providers per area for cellular services and one other operator along with the DoT per area for regular services. In the 1991 auction, the rules dictated the potential service providers to seek foreign partnership, since it was felt that no Indian provider had adequate financial resources and technical knowledge. The adopted auction format was first price sealed-bid. The DoT designated Global System for Mobile Communications (GSM) as India's accepted cellular technology. No specification was provided prior to the auction about the maximum number of that could be awarded to a single entity. After the submission of all bids, it was discovered that one single company had won nine circles and submitted very high bids. The prospects of payment of license fees by this company was quite uncertain, since its annual turnover at that point was just $0.06 billion while the payment requirements were $15 billion over 15 years[18]. Also, ensuring competition in the telecom sector was one of GoI's major objectives. Awarding nine circles to a single company would have contradicted this. Therefore, this company was asked to choose any three circles, and 15 circles were put up for re-bidding with the government specifying reserve prices. There was very poor participation as the bidders perceived the reserve prices to be too high and nine of the circles remained unallocated to any provider.

GoI announced the National Telecom Policy in 1994 and invited private companies to bid for Basic and Cellular licenses separately for each circle. DoT specified GSM for cellular services and foreign

[18] Jain (2001)

Partnership was also mandated in 1995. During that period Code Division Multiple Access or CDMA[19] mobile network started to be deployed in various parts of the world.

In the first bidding round the government invited bids for each circle for basic wireless services but when the bids were opened in August 1995, Himachal Futuristics Communications Limited (HFCL) had the highest bid in 9 circles. In many cases its bid was more than double the second highest bid. At this point the government announced a cap of three circles for a single bidder in Category A and B circles excluding Category C circles and extending the cap to cellular bids. Also, the GoI rejected the highest bids in ten telecom circles on the grounds that they were below the reserve price. The reserve price however, had not been announced prior to the auction. An obvious consequence of such policies was multiple rounds of bidding. The Government's decision to use the valuation of the bidders in each round of auction as an input for fixing the reserve price for the next round might have contributed to collusion among the bidders leading to lower bids in order to force the Government to reduce the reserve price[20]. Even though in 1995, the Indian Government reduced reserve prices in order to attract bidders, the licenses in eight of the 21 circles still remained unallocated.

The bidders selected for each circle were asked to match the license fee quoted by the highest bidder. As a result of this process 34 licenses were issued in 18 circles. The second bidding round also faced major problems. As more lucrative circles had been awarded in the first round there was lack of enthusiasm and only six bids were received. Naturally initial service rollout was slow, as a result of narrow licensing conditions and the high cost of license fees.

The payment rules in the auctions conducted in 1994 and 1995 required the second highest bidders to match the winning bids. In many cases the second highest bidders failed to do so as the difference between the highest and the second highest bids were very high.[21]

In 2008, 122 new second generation (2G) Unified Access Service (UAS) licenses were distributed on FCFS basis to telecom companies at 2001 prices. The Central Bureau of Investigation (CBI) filed a charge sheet indicating corruption in the distribution process. It was alleged that the distribution of licenses had been in favour of certain companies subject to payment of bribes by them and some of these companies did not have prior experiences in telecom operations.

[19] CDMA uses a single spectrum of bandwidth (not slices of bandwidth) for all users in the cell. Each conversation is assigned a unique code. The coded signal is extractable at the receiver, by the use of a complementary code.
[20] Babu, P.G. and Nibedita Das (1999): "Privatization and Auctions", India Development Report, 1999.
[21] ibid

Among the recent auctions, the 3G and 4G telecom spectrum were auctioned in a highly competitive bidding in 2010. Tata Docomo was the first private operator to launch 3G services in India[22]. The Government earned a total revenue of over ₹106219 crores (US$19 billion) from the 3G and the Broadband Wireless auctions[23].

In 2012, the DoT auctioned 2G spectrum in both GSM and CDMA bands. The government received bids worth a total of ₹9,407 crores, far lower than its target of ₹28000 crores from the sale of 2G spectrum in the GSM band. None of the bidders bid for a pan-India spectrum for which the reserve price was set at Rs140 billion for 5 MHz of airwaves[24].

In March, 2013, the DoT auctioned 2G spectrum in GSM (1800 MHz) and CDMA (800 MHz) bands. Response to the 2013 spectrum auction was poor. While there were no bidders for spectrum in 1800 MHz and 900 MHz bands, Sistema Shyam Teleservices Ltd. (SSTL), which is also known as MTS India[25] (since it is the Indian subdivision of the Russia based Mobile Tele-Systems or MTS telecommunications company) was the only bidder for airwaves in 800 MHz band. Some companies complained about the very high reserve prices that, according to them, have deterred entry of many potential bidders[26].

Thus, despite being an early adopter of spectrum auctions, it has not quite been a success story for India. Due to problems with the design and rules of the auction the rolling out of services has been very slow[27]. For example, as noted earlier, in case of 1991 auction, many rules came up once the auction was over, e.g. that of restricting the number of licenses that a single operator can possess. Also the decision for the second highest bidder to match the highest bid is something not supported by auction theory. From the perspective of auction theory, this decision is bound to create disincentive for the bidders and prevent them from bidding truthfully. Also disclosing policies, which can affect the operators' profits, after the auction (*ex post*), creates a bad precedent. In such cases bidders become skeptical about what policies would prevail afterwards, unnecessary speculative activities crop up leading to untruthful bidding and the net outcome is an inefficient allocation.

[22] "3G spectrum auction begins smoothly, top telecom operators in fray". The Times of India. 9 April 2010
[23] Official results for 3G Spectrum Auctions: Department of Telecomm – Government of India
[24] "2G auctions flop as 57% of spectrum remains unsold; govt gets less than a quarter of its revenue target – Economic Times". Economictimes.indiatimes.com. Retrieved 2013-03-06
[25] http://www.mtsindia.in/
[26] PTI 26 Feb 2013, 08.40 pm IST (26 February 2013). "Spectrum auction base price too high in India: Vodafone CEO – Economic Times". Economictimes.indiatimes.com. Retrieved 2013-03-0
[27] Jain, R.S. (2001). "Spectrum auctions in India: Lessons from experience". *Telecommunications Policy* **25** (10–11): 671–688.

8. Policy Directions

Indian mobile telecom industry has grown to an estimated ₹1,60,000 crores during the April-June quarter of 2013. But the nation's performance in terms of revenue generation is not at par with the global standard. A meager 2.3 percent of the estimated global telecom revenue of ₹ 79,80,800 crores (US$ 1.16 trillion), has been earned reflecting that the Indian operators are offering the lowest global tariffs.

The upcoming 2G bandwidth auction following the cancellation of 122 mobile licenses by the Supreme Court in February 2012 has thrown up several issues which have to be tackled by the regulatory authority. The Telecom Regulatory Authority of India (TRAI) is now trying to be transparent about the allocation procedure. Several companies have demanded the auction base price similar to 2001 reserve price, Rs.1658 crore for 6.2 MHz of airwaves, for a period of 20 years on a pan-India basis for their economically viable and bankable participation purpose. In this regard TRAI has contended that the previous base price is no longer relevant and has calculated a new reserve price of Rs. 3847 crore for 6.2 MHz of airwaves by indexing the old one, taking into account the inflation and cost of money against a prime lending rate of 12% (say).

TRAI has recommended a 60 per cent reduction in the base price for 900-MHz spectrum in the Delhi, Mumbai and Kolkata circles and announced a 37 per cent slash in 1,800-MHz spectrum for the forthcoming spectrum auction by end of 2013[28]. It had also suggested introduction of a uniform spectrum usage charge (SUC) rate of three per cent on all operators and auctioning the extended GSM (EGSM) band along with 800-MHz spectrum (rather than keeping it for CDMA operators)[29].

But Department of Telecom has rejected the proposal of auctioning the extended GSM band. Besides, the regulator had recommended that digital dividend giving 900-MHz spectrum to be put up for all the license bidders, incumbent operators as well as new entrants, and this will ensure competition in the sector.

The slash in reserve price has not been welcomed by DoT. The reason forwarded by it for this is that expecting the reserve prices to be slashed further, the potential bidders might postpone their participation in the present auction. Also, as pointed out by Klemperer (2004) low reserve price may lead to tacit collusion among the bidders thus lowering the potential revenue amounts for the government. High reserve price had been blamed by most of the potential bidders as the main reason for abysmally low

[28] See appendix.

[29] Across the bands there are certain frequency ranges in which the communication is the most suitable. Example: 400 MHz for public utility service (e.g. community TV services). 800 MHz is also suitable for the same purpose.

participation of bidders in the March, 2013 auction. As observed by Klemperer (2004), high and binding reserve prices often deter participation thus making the auction a "failure".

In Indian spectrum auction, in order to choose the most appropriate auction format, it is essential to understand first, whether the bidders' values are *private values* or *common values*[30]. If we proceed with the private value assumption, then the first and second price sealed bid auction formats are equivalent in terms of expected revenue. But when there is common value, under certain conditions, the second price sealed bid auctions generate higher expected revenue as compared to their first price counterparts. In case of telecom spectrum auction, when some operator enters a market for the first time, the operator might not have definite information about the market demand for its services. But for a given market whichever operator acquires the right to serve that market will face the same market demand. Thus there is some sort of common value element involved in such a situation. However, once some operator has started serving a market and some other operator makes an entry in that market, the new entrant is likely to have a more or less appropriate estimate of the market demand if it is able to observe the performance of the incumbent. Thus, for the new entrant, there is mostly no common value element.

Also bidders' attitude towards risk is of crucial importance in deciding the prospects for revenue generation. If the bidders are risk averse rather than risk neutral, then the first price sealed-bid auction fetches higher expected revenue than does the second price sealed-bid auction. So when the telecom spectrum licenses are sold through auction for the first time, it is likely that the bidders will be risk averse, since they do not have enough information about the prospects of roll out of their services. Thus using the first price sealed-bid format in such cases is likely to ensure the best possible outcome. However, when the service providers are operating in the telecom spectrum market for a long time, they are likely to be more well-informed about the market and thus they are likely to be less risk averse or even risk-neutral.

Therefore, while designing auctions, the nature of bidders (i.e. risk-neutral or risk-averse) and their valuations (private or common values) always need to be taken into consideration in order to earn the maximum revenue possible, without compromising on the efficiency in allocation.

Also, *substitutability* and *complementarities* among telecom spectrum licenses for different circles should be kept in mind while designing auctions. In India, the format followed in the last few auctions have been SMRA. It takes care of the substitutability aspect since if some bidder wins a license in a particular round,

[30] In case of private values the valuation(s) of each bidder for the object(s) is (are) known only to the concerned bidder while all other bidders and the seller have a probabilistic notion about it. In case of common value, the value that will accrue to whosoever possesses it is same across bidders but is not known to anyone prior to the auction. Each bidder receives a signal regarding what can be the possible materialized value after winning it through the auction and the signal is private information to each bidder. So in case of common values the private signals constitute the types of the bidders.

that same bidder is unlikely to bid for another license which is a close substitute for the license already obtained in any subsequent round. However, this format does not address the issue of complementarities among licenses (for which there is positive synergy), since there is always the possibility that a bidder might not get the set of licenses that are complementary to each other from the bidder's perspective. To deal with this issue, a combinatorial auction might supplant the other alternative formats, since it involves the sale of licenses in one or many packages. For this reason, the 800 MHz and 2.6 GHz frequencies had been allocated through combinatorial auction format in UK in February, 2013[31]. For this same reason, TRAI also recommends combinatorial auction format for the upcoming telecom spectrum auction in 2013[32].

Not declaring the auction rules a priori can lead to even more long term problems other than the one stated above. For example, in future auctions, the bidders might be skeptical about some new policy restriction being introduced ex-post and that might prevent them from bidding truthfully. As mentioned earlier, no explicit prior specification of the auction rules in terms of payments or levels of reserve prices during the 1995 telecom spectrum auction in India led to certain unnecessary complications.

Ensuring competition in the telecom sector has always remained a priority of the Indian Government. As we have noted earlier, the possibility of tacit collusion among bidders and asymmetry among the bidders in terms of resource levels resulting in one or very few firms buying up all the licenses are detrimental to a competitive market structure. Thus restricting the maximum number of licenses that each operator can acquire and setting appropriate reserve price are two important policy instruments for the Indian Government which can solve the above mentioned problems. In fact Vodafone is in early phases of discussion with the Tata Group for purchasing its controlling stakes in Tata Teleservices[33]. Thus, despite putting a ceiling on the number of licenses to be awarded to a single company in order to promote competition in telecom sector, post auction resale of licenses by certain operators can very well result in greater market concentration. This needs to be countered by some anti-trust laws. On the other hand, rather than selecting the operators solely on the basis of how much they offer to pay, some pre-specified quality control can be exercised to judge the competence of the bidders, so that the possibilities of post auction resale of licenses are reduced. For this some scoring auction formats can be considered. The exact designing of the scoring auction, however, will need a careful evaluation of the context and compatibility with other social objectives.

[31] http://media.ofcom.org.uk/2013/02/20/ofcom-announces-winners-of-the-4g-mobile-auction/

[32] Details presented in Appendix C.

[33] http://articles.economictimes.indiatimes.com/2014-01-03/news/45837313_1_vodafone-india-tata-sons-ntt-docomo

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Appendix

A. Results of 3G Auction in India, 2010

Winner	No. of Circles	Bid Amount (Rs. Crore)	Bid Amount (US$ mn)
Idea	11	5765	1153
Bharti Airtel	13	12290	2458
Vodafone	09	11617	2323
Reliance Communcations	13	8583	1717
BSNL/MTNL	22	16761	3352

Circle	3G Reserve price (for 2x5 MHz) (INR crore)	3G Reserve price (for 2x5 MHz) (US$ mn)	3G Price (2x5MHz) (INR crore)	3G Price (2x5MHz) US$ mn)
Metros	760	152	7108	1422
Cat ' A' Circles	1600	320	6752	1350
Cat 'B' Circles	960	192	2439	488
Cat 'C' Circles	180	36	452	90
Total	3500	700	16751	3350

Source: Telecom Regulatory Authority of India (TRAI)

B. Spectrum to Be Allocated in the Forthcoming Auction in India, 2013

	1800	800
Block Size	1.25 MHz	1.25 MHz
Cap for Existing Players	1 Block	2 Blocks
Cap for New Entrants	Min. 4 Blocks; Max 5 Blocks	Min. 2 Blocks; Max 3 Blocks
Total Spectrum put to auction	8 to 11 Blocks (10 MHz to 13.75 MHz) in each Circle	3 to 4 Blocks (3.75 to 5 MHz) in each Circle

Source: Telecom Regulatory Authority of India (TRAI)

C. Recommended Rules for the Forthcoming Telecom Spectrum Auction in India

Combinatorial clock auction (CCA) has been recommended for upcoming spectrum auction. In case of clock action auctioneer announces prices and bidders respond with quantities. Here activity rule is based on eligibility points and/or the Weak Axiom of Revealed Preference (WARP)[34]. In the supplementary rounds bidders supplement their bids from the clock rounds with additional package bids but this bidding activity is based on WARP activity rule.

The "eligibility points" for any bidder are assessed on the basis of bidder's initial deposit. According to bidder's current eligibility the bidder has to bid on a sufficiently large quantity of spectrum (this is between 80 per cent and 100 per cent of the bidder's current eligibility). In UK, Ofcom (telecom regulatory and competition authority for the communications industries in UK), recommended the *eligibility points rule*, according to which no bidder can increase the package size during the clock stage.

[34] According to WARP, bids should only involve switches to packages those become relatively less expensive.

For any choice of eligibility points there exists bidder valuations and price histories such that the bidder is prevented from bidding its true valuation by an activity rule requiring monotonicity in eligibility points (this approach is also adopted in SMRA) and if bidders attempt to bid straightforwardly, the outcome will necessarily be inefficient.