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The diminishing returns of SMRA: A data driven Analysis of India's Spectrum Sales (2010-2024)

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Abstract

This study evaluates the performance of India's spectrum auctions conducted under the Simultaneous Multiple Round Auction (SMRA) format during 2010–2024. Using the winning price to reserve price (WP/RP) ratio as the primary indicator, complemented by the sold/offered (S/O) ratio of spectrum blocks, the analysis investigates trends in price discovery, allocation efficiency, and market competition. The findings reveal a distinct shift in auction dynamics. Prior to 2016, scarcity of supply and strong demand drove premiums well above reserve prices. However, from 2016 onwards—and particularly after 2021—premiums disappeared, with most spectrum clearing at or near reserve prices. Regression analysis confirms that scarcity was the sole significant driver of premiums, while high reserve prices, industry consolidation, and heavy 5G-related capital expenditure weakened competitive bidding.

The results indicate that while SMRA remains effective for allocation, it has failed to deliver price discovery or revenue maximization under current market conditions. High reserve prices have acted as ceilings, leading to persistent unsold inventory and opportunity losses in both revenue and consumer welfare. The study concludes that reserve price calibration, rather than auction format alone, is the decisive factor in restoring auction efficiency.

Policy recommendations include recalibrating reserve price mechanisms to reflect market realities, adopting flexible or hybrid auction formats such as Combinatorial Clock Auctions (CCA) and publishing a long-term spectrum roadmap to provide investment certainty. Together, these reforms can ensure spectrum is allocated efficiently, stimulate healthy competition, and sustain sectoral growth in the 5G era.

Executive Summary:

This report presents a comprehensive analysis of India's spectrum auctions from 2010 to 2024, highlighting critical trends in valuation, demand, and auction performance. The findings reveal a clear transition in auction dynamics—from an intensely competitive seller's market in the early years to a mature, price-sensitive market in the later period.

The early auctions (2010–2015) were marked by aggressive bidding and substantial premiums, driven by intense competition and spectrum scarcity. In contrast, the more recent auctions (2016–2024) reflect a sharp shift: a significant portion of spectrum has either been sold at the base reserve price (RP) or left unsold. This shift underscores the impact of market consolidation, with fewer Telecom Service Providers (TSPs) bidding more selectively, guided by strategic considerations rather than scarcity pressures.

The decline in the **Winning Price to Reserve Price (WP/RP) ratio** to near 1.0, alongside a falling **Sold-to-Offered (S/O) spectrum ratio**, highlights a systemic issue—reserve prices are misaligned with market realities. This has weakened the price discovery function of the Simultaneous Multi-Round Ascending (SMRA) format, reducing its effectiveness in generating competitive premiums.

While auctions remain a more efficient mechanism than administrative allocation for distributing scarce, rivalrous, and excludable resources, their ability to maximize government revenue has diminished. The evidence suggests that post-2016 auctions have become largely supply-driven, with outcomes shaped predominantly by administratively set reserves rather than competitive bidding dynamics.

This report concludes with targeted recommendations to recalibrate the reserve price mechanism, modernize auction design, and better align policy with the realities of a consolidated, capital-intensive telecom sector. Such reforms are essential to restore balance between efficient spectrum allocation, fiscal objectives, and long-term industry sustainability.

1.0 Introduction

Spectrum is a finite natural resource critical for the expansion of the telecommunications industry. For over a decade, India has utilized the SMRA auction format as its primary method for allocating this resource, a mechanism intended to promote transparency, efficiency, and revenue discovery. The outcomes of these auctions reflect not only market health and operator strategy but also the effectiveness of the auction design itself.

This report analyses data from nine auction years to answer a critical question: **Why has the effectiveness of the SMRA format diminished over time?** Our central thesis is that while the SMRA mechanism was initially successful in a competitive, high-growth environment, its efficacy has been blunted by static pricing strategies that have failed to adapt to a dynamic, consolidating market. This analysis will identify emerging patterns, draw conclusions on the current auction strategy, and provide data-driven recommendations for the future. How SMRA works is illustrated in the Annexure-I.

2.0 Data & Methodology

The data for this analysis was compiled from public records on the Department of Telecommunications (DoT) website, covering all nine auctions from 2010 to 2024. The raw data—comprising spectrum blocks offered, reserve prices, blocks sold, winning prices, and winning TSPs—was cleaned, reshaped, and aggregated for analysis.

To measure auction performance, we developed two key metrics:

1. **Winning Price to Reserve Price (WP/RP) Ratio:** This ratio assesses the competitive premium paid by TSPs over the base price. A ratio greater than 1.0 signifies competitive bidding, while a ratio of 1.0 indicates a sale at the floor price.

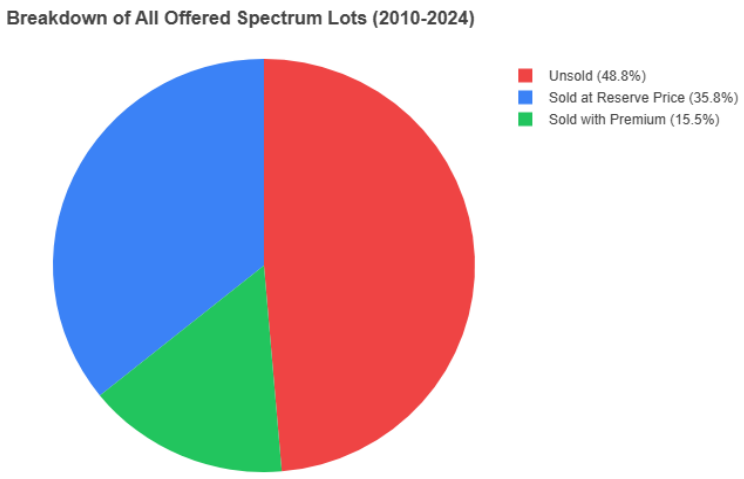
2. **Sold to Offered (S/O) Ratio:** Calculated as the number of spectrum blocks sold divided by the number offered, this metric serves as a direct proxy for market demand at the prevailing reserve price.

3.0 Analysis: A Tale of Two Eras

The data highlights a clear shift in market dynamics, best understood as two distinct phases: the High-Growth Era marked by intense competition, and the Maturity Era characterized by strategic acquisitions.

3.1 Overall Auction Performance (2010-2024)

An examination of 818 spectrum instances—across nine auctions, multiple frequency bands, and 22 service areas since 2010—offers a clear quantitative picture. Nearly half (48.8%) of the instances attracted no buyers. Of the remainder, 15.5% sold at a premium above the reserve price, while 35.8% cleared at the base price. These figures suggest that for almost half the offerings, reserve prices were set too high to attract demand, and for another third, they were high enough to suppress competition.



Plot-1: Pie chart showing the breakdown of all offered spectrum lots (2010-2024) into Unsold, Sold at Reserve Price, and Sold with Premium

This shortfall created a substantial revenue gap. Of the ₹17.23 lakh crores worth of spectrum offered at reserve prices, only ₹5.64 lakh crores was sold, leaving nearly ₹11.6 lakh crores unsold—an overall revenue efficiency of just 32.7%. The strong proceeds from the high-value 3G auction in 2010 may have inflated expectations, leading to overly optimistic revenue projections in subsequent auctions. After the 2016 auctions, with the sharp decline in the number of operators, spectrum sales at reserve price became the norm rather than the exception.

3.2 The High-Growth Era (2010-2016): Scarcity and Competition

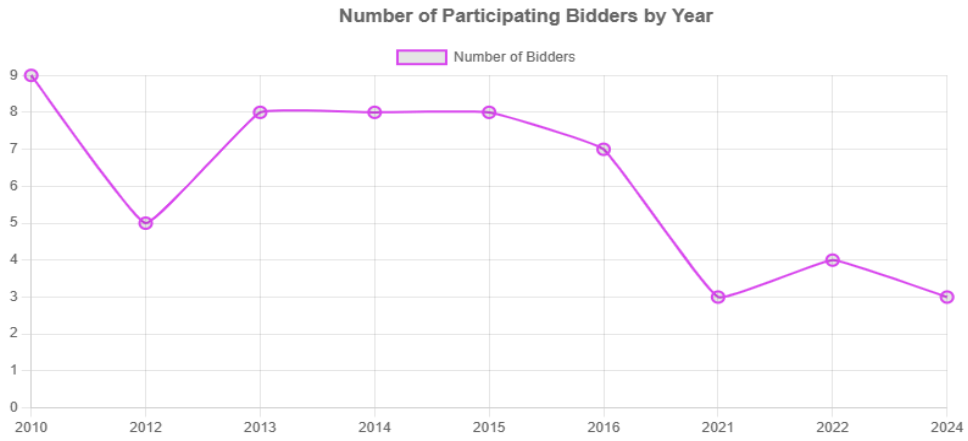
The initial auction years were defined by a land-rush mentality. With numerous operators competing for limited 3G and 4G spectrum, the market was intensely competitive.

- **High Premiums:** The 2010 auction was a landmark success, with the WP/RP ratio reaching **5.34**, indicating bidders paid over five times the reserve price. This fierce competition, driven by a market with 9-10 active bidders, ensured high revenue and efficient price discovery.
- **Strong Demand:** The S/O ratio was consistently high, peaking at nearly 90% in 2015. This shows that almost all spectrum offered was considered valuable enough to be purchased, even with escalating prices.

3.3 The Maturity Era (2016-2024): Consolidation and Price Sensitivity

The market dynamics shifted dramatically after 2016, driven by two key factors:

1. **Market Consolidation:** A wave of mergers and exits reduced the number of bidders from a high of nine to just three or four in recent auctions. With fewer players, the competitive pressure to outbid rivals evaporated.

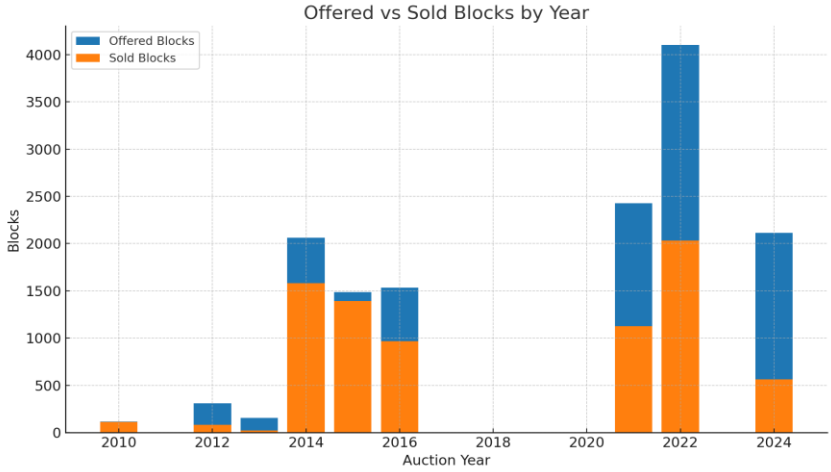


Plot 2- Line chart showing the Number of Participating Bidders by Year, illustrating the market consolidation

2. **Shift from Scarcity to Sufficiency:** By the 2020s, the remaining TSPs had amassed substantial spectrum holdings. Acquisitions became more strategic—focused on renewing licenses, filling coverage gaps, or acquiring specific 5G bands—rather than being driven by a desperate need for any available spectrum.

This new reality is reflected starkly in the data:

- **Vanishing Premiums:** Since 2016, the WP/RP ratio has flatlined at **1.0**. The reserve price is no longer a floor for bidding but has become the fixed sale price. This precipitous drop is the clearest indicator that the SMRA's price discovery mechanism is no longer functioning as intended.



Plot 3: Stacked bar chart showing Offered vs. Sold Blocks (S/O) showing the growing gap of unsold spectrum

- **Declining Demand:** The S/O ratio has become volatile and trended downwards, indicating that TSPs are unwilling to purchase a large portion of the offered spectrum at the high reserve prices.
- **The 5G Anomaly:** The high revenue in the 2022 auction was not due to a return of competition, but the introduction of new, high-value 5G bands. Crucially, even this

essential spectrum was sold almost entirely at the base reserve price, reinforcing the argument that the reserve prices were set at the market's maximum tolerance level, leaving no room for competitive bidding.

4.0 Analytical Deep Dive into Spectrum Auctions

The auction history data is analysed in detail on the basis of Auction Years, the Spectrum Bands and the Service Areas in the following sections.

4.1 Small canvas: Average price and revenue per block

Yearly Average				Bandwise Average		
Year	**RP_AVG**	**WP_AVG**		**Band**	**RP_AVG**	**WP_AVG**
2010	119.32	672.69		1800	27.89	29.38
2012	96.18	96.4		2100	379.74	558.26
2013	26.37	26.37		2300	231.1	370.03
2014	26.5	44.38		2500	113.05	113.06
2015	174.85	218.56		26	15.89	15.89
2016	275.71	280.4		3300	144.09	144.09
2021	187.8	187.8		700	892.5	892.5
2022	271.92	272.06		800	189.89	227.4
2024	16.99	16.99		900	19.89	33.01

Table -1: Avg. RP/block vs Avg. WP/block

The table reports the average reserve price (RP_AVG) and average winning price (WP_AVG) per block, aggregated by auction year and by frequency band. A clear divergence is observed in 2010, when intense bidding activity drove winning prices to more than five times the reserve price. Smaller but notable premiums also appeared in 2014 and 2015, suggesting residual competition in selected bands. In contrast, auctions held after 2016 reflect a structural shift: blocks were consistently sold at reserve price, with no evidence of competitive bidding.

This pattern is particularly evident in the higher-frequency bands (2500 MHz, 700 MHz, 3300 MHz, and 26 GHz), which were introduced during the maturity era. For these bands, RP_AVG and WP_AVG converge, underscoring weak demand relative to supply and the absence of scarcity-driven price discovery. Collectively, the data suggests that post-2016 auctions became supply-driven exercises, where pricing outcomes were determined almost entirely by administrative reserve settings rather than market competition.

4.2 Year-based analysis of auction performance metrics

The WP/RP ratio serves as a measure of auction competitiveness: values above 1 indicate active bidding above the reserve price, while values below 1 reflect weak demand. The per-block averages discussed in the previous section provide only a limited view, as they do not capture overall trends across auctions. To obtain a comprehensive perspective, it is necessary to compare the aggregate reserve price (RP) of all blocks offered with the aggregate winning

price (WP) of blocks actually sold. Table 2 presents this broader picture for each auction year, along with the total number of blocks offered and sold.

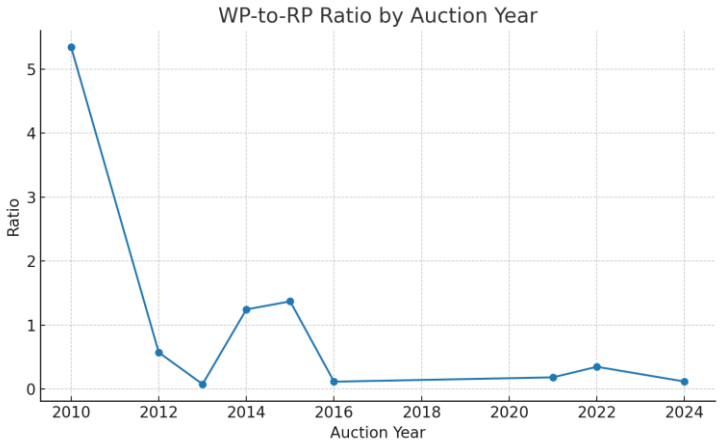
Year	Offered Blocks	Sold Blocks	Total RP (Rs.Crores)	Total Revenue (Rs Crores)	Sold/Offered ratio	WP/RP ratio
2010	115	113	14330.00	76580.13	0.98	5.34
2012	312	83	14657.77	8393.48	0.27	0.57
2013	156	24	44950.00	3430.02	0.15	0.08
2014	2062	1581	49143.00	61162.22	0.77	1.24
2015	1485	1392	80180.00	109874.91	0.94	1.37
2016	1532	967	567387.25	65439.12	0.63	0.12
2021	2427	1126	424643.00	77814.80	0.46	0.18
2022	4100	2031	431604.95	150173.29	0.50	0.35
2024	2115	563	96317.65	11340.53	0.27	0.12

Table – 2: Year based summary

The inclusion of total blocks offered and sold further contextualizes auction efficiency, showing whether low WP/RP ratios were driven by limited demand, inflated reserve prices, or a combination of both.

4.2.1 WP/RP Ratio trends by year

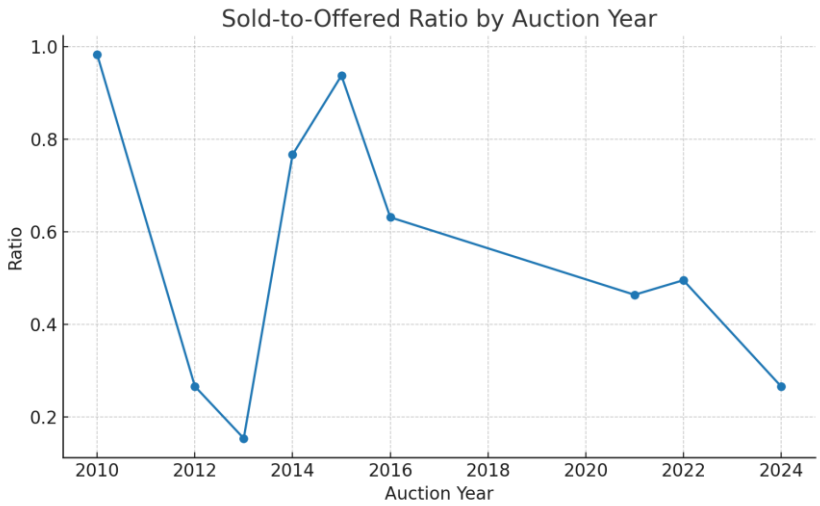
The 2010 auctions demonstrated the potential for highly competitive spectrum pricing, recording a WP/RP ratio of 5.34—indicating that bidders paid more than five times the reserve price. In contrast, subsequent auctions reflected declining competitiveness, with recent events producing ratios below 0.12.



Plot-4: Line chart showing the WP-to-RP Ratio by Auction Year, highlighting the peak in 2010 and subsequent decline.

4.2.2 S/O Ratio trends by Year

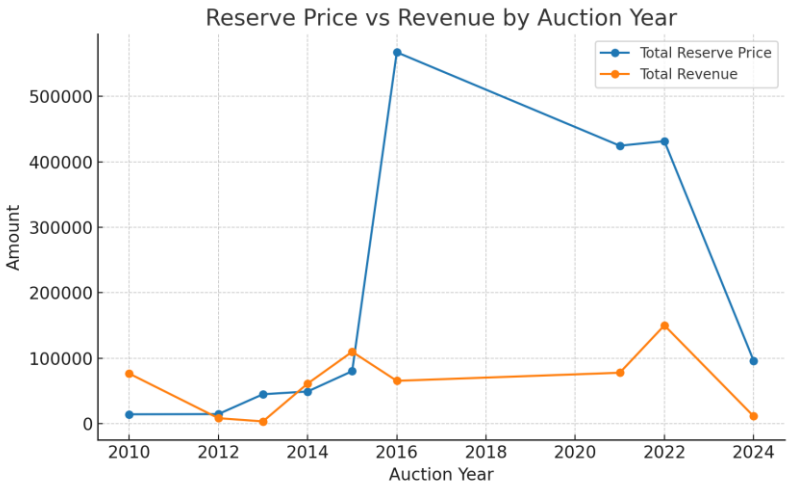
The Sold-to-Offered (S/O) ratio reflects the proportion of spectrum blocks purchased relative to those offered in each auction year. A value of 1 indicates full sale of all available blocks. The ratio was nearly 100% in 2010 but declined steadily, reaching just 27% in 2024. This trend underscores a fundamental weakening in auction efficiency, where large portions of spectrum remain unsold despite expanding bandwidth availability.



Plot-5: Line chart showing the Sold-to-Offered Ratio by Auction Year, highlighting the peak happening in 2010, then ascending in 2014 to year 2015 and further declining trend.

4.2.3 Reserve Price vs. Revenue by auction year

A comparison of aggregate reserve prices with total revenues generated reveals the extent to which auctions met, or fell short of, revenue expectations. As shown in the table above, this measure also captures the revenue gap relative to estimated values. The years 2016–2022 recorded peak revenues; however, these were achieved against very high reserve prices, resulting in low overall efficiency.



Plot-6: Line chart showing the gap between the revenue estimated and revenue collection.

The resulting revenue gap—defined as the difference between aggregate reserve values and actual proceeds—illustrates how auctions during this period failed to translate supply into effective demand. In other words, high nominal revenues masked underlying inefficiency: spectrum cleared at or near reserve price, and large volumes remained unsold.

4.3 Band based analysis of auction performance metrics

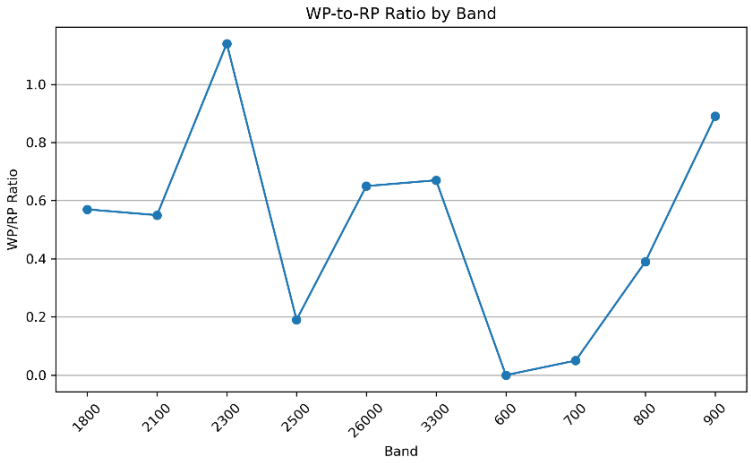
The table below compares two key ratios—WP/RP and S/O—across frequency bands, aggregated over all auction years. Lower ratios in particular bands may indicate persistent demand gaps or reserve prices set above market-clearing levels. The plots based on this table are presented in the following pages.

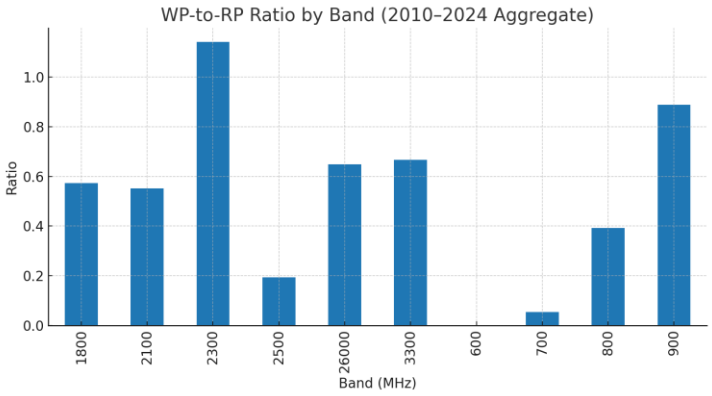
Band	Offered Bloacks	Sold Blocks	Total RP (Rs Crores)	Total Revenue (Rs Crores)	Sold/Offered ratio	WP/RP ratio
1800	7913	4417	186797.28	107048.48	0.56	0.57
2100	252	113	146710.00	81030.00	0.45	0.55
2300	144	124	47900.00	54645.66	0.86	1.14
2500	113	39	64280.00	12461.60	0.35	0.19
26000	1428	907	22655.50	14708.50	0.64	0.65
3300	837	549	120861.20	80590.00	0.66	0.67
600	132	0	117810.00	0.00	0.00	0.00
700	418	44	730485.00	39270.00	0.11	0.05
800	682	241	159955.56	62762.30	0.35	0.39
900	2385	1446	125759.08	111691.96	0.61	0.89

Table-3:Band-wise data

4.3.1 WP/RP Ratio trends by Band

A band-level comparison of WP/RP ratios highlights variations in competitive intensity across spectrum bands. Higher ratios signal strong bidding activity, while lower ratios indicate weak demand. For example, the 600 MHz band recorded a low WP/RP ratio, suggesting limited market interest in that frequency range.

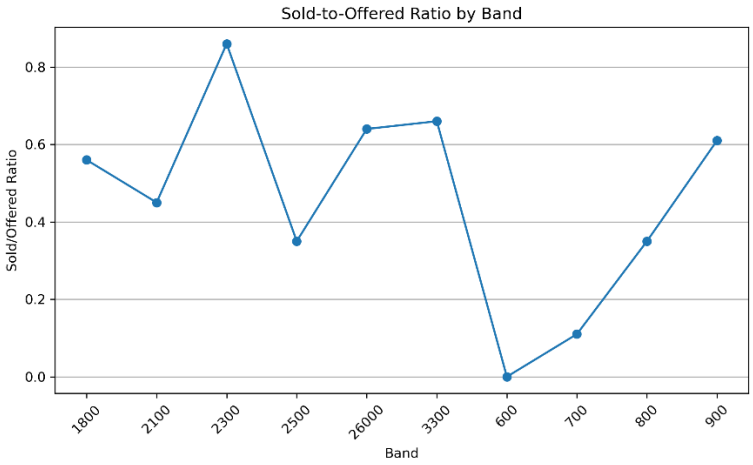


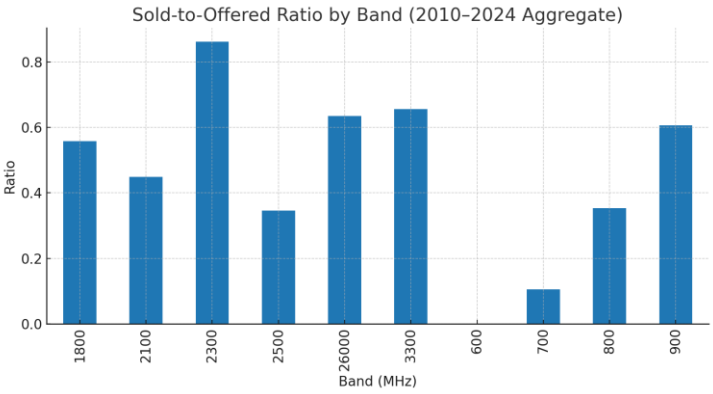


Plot-7: Line chart showing the WP-to-RP Ratio by Band-wise, highlighting that the bands auctioned in the earlier years fetching good margin over RP.

4.3.2 S/O Ratio trends by Band

Bands with strong ratios signal scarcity value and strategic importance to operators. The plots illustrate these contrasts, underscoring how spectrum characteristics—coverage, capacity, and ecosystem readiness—interact with pricing policy to shape auction outcomes.

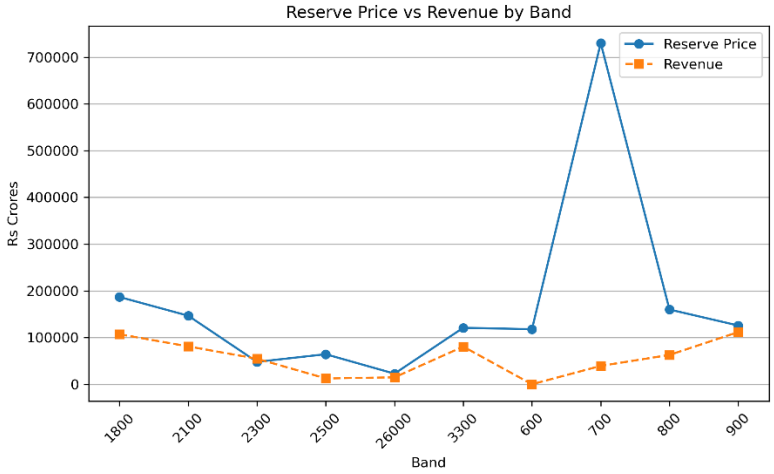




Plot-8: Line chart showing the Sold-to-Offered Ratio by Band-wise, following a similar patter as W/R ratio

4.3.3 Reserve Price vs. Revenue by Band

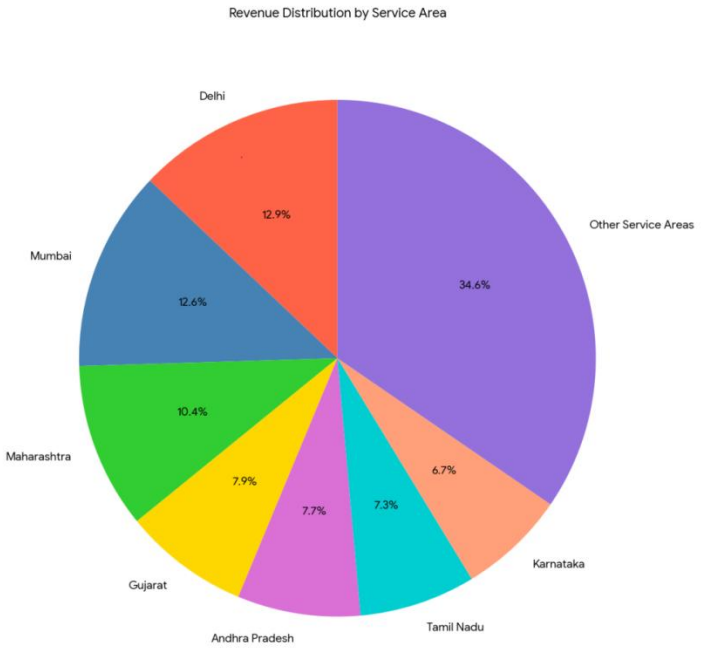
A comparison of reserve prices and realized revenues across bands highlights clear performance patterns. Mid-band spectrum—specifically 1800 MHz, 2100 MHz, and 2300 MHz—emerges as the most commercially attractive, consistently generating strong demand due to its favourable trade-off between wide-area coverage and network capacity. By contrast, the 900 MHz band functions as a premium resource: while more limited in availability, it commands higher prices in urban markets, where superior indoor penetration offers significant competitive advantage. Together, these patterns underline how physical propagation characteristics directly shape revenue outcomes and reinforce the strategic centrality of sub-1 GHz and mid-band frequencies in auction performance.



Plot-9: Line chart showing the gap between the revenue estimated and revenue collection relating to the different spectrum bands auctioned.

4.4 Service Area- based regional disparities

Examining auction performance by service area reveals significant regional concentration. Over the 2010–2024 period, just seven LSAs—Delhi, Mumbai, Maharashtra, Gujarat, Andhra Pradesh, Tamil Nadu, and Karnataka—generated nearly two-thirds (65%) of total revenues. This disproportionate contribution reflects both higher market potential in urban and industrialized regions and the limited commercial viability of spectrum in less developed circles. The data underscores how structural asymmetries in telecom demand—driven by population density, income levels, and data consumption patterns—shape revenue outcomes more strongly than uniform national auction design.



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Plot-10: Share of Revenue

5. Statistical significance

An Ordinary Least Squares (OLS) regression was conducted using the WP/RP ratio dataset, with the number of spectrum blocks available each year as the independent variable. The results indicate a distinct shift in auction dynamics:

- **Before 2021:** Auctions were competitive and demand-driven. Scarcity of supply led to significant premiums above reserve price.
- **After 2021:** Premiums disappeared entirely. Reserve prices were effectively the clearing price, with no evidence of bidding competition.

The disappearance of premiums can be attributed to several factors: (i) high reserve prices, (ii) consolidation of the telecom industry reducing the number of bidders, and (iii) heavy 5G-related capital expenditure limiting willingness to bid aggressively.

Key takeaway: Scarcity was the only consistent driver of premiums in Indian spectrum auctions. Once supply expanded and demand weakened after 2021, winning prices converged with reserve prices, establishing WP ≈ RP as the new normal. The dataset is provided in Annexure II.

6.0 Discussions and Inferences:

The WP/RP ratio serves as a key indicator of market competitiveness, while the Sold/Offered (S/O) ratio captures allocation efficiency. Together, these metrics reflect the interaction of

demand (driven by subscriber growth, data usage, and technology adoption), supply (spectrum availability), reserve price settings, and auction design.

- **Reserve Prices**: The reserve prices are fixed by the telecom regulator, TRAI. High benchmarks have functioned as ceilings rather than floors, deterring competition and leaving large volumes unsold, creating an "opportunity loss" of spectrum resources and revenue.
- **Band Characteristics**: Higher-frequency bands face weaker demand due to limited coverage and higher deployment costs.
- **Revenue Trends**: Early auctions (2010, 2015) delivered exceptional revenues. Since 2016, however, unsold spectrum has risen sharply, with most sales occurring at or near reserve price.
- **Efficiency Concerns**: Elevated reserve prices created chronic under-demand, leaving valuable spectrum unsold and idle, resulting in both lost revenue and lost social welfare.
- **Market Maturity**: Demand has shifted from aggressive, scarcity-driven bidding to selective, value-based acquisition, reflecting industry consolidation, high debt levels, and cautious 5G investment strategies.
- **Macroeconomic and Regulatory Factors**: Sectoral health, ARPU levels, GDP growth, and rollout obligations also shaped demand and sell-through outcomes.
- **Weakening of Premium Drivers**: Bands that historically commanded premiums (900, 1800, 2100, 2300 MHz) and high-revenue circles (Delhi, Mumbai, Karnataka) now clear at reserve price, signalling systemic mispricing.
- **Auction Design**: The SMRA format is functionally adequate but has limitations, particularly in handling complementarities. Nonetheless, recent auction failures stem more from reserve price miscalibration than from the mechanism itself.

6.1 Key inference

Spectrum auctions in India now perform adequately in allocation but poorly in price discovery and revenue maximization. Persistent oversupply, combined with aggressive reserve pricing, has weakened both government revenue realization and operator incentives, ultimately slowing network expansion. The structural shift from competitive bidding to reserve price clearance reflects deep misalignment between policy objectives and market realities.

6.2 Limitations of the Study

This study's findings emphasize reserve price calibration as the decisive variable. While alternative auction formats may modestly improve outcomes, no mechanism can overcome demand–supply imbalance created by overpricing.

However, the analysis does not account for broader confounding factors, such as sectoral indebtedness, low ARPU, high spectrum charges, and regulatory obligations, all of which

constrain operators' willingness to bid. Without addressing these structural financial burdens, reforms in auction design alone cannot restore the competitive intensity seen before 2016.

7. Recommendations – Way Forward

7.1 Revisit Auction Format

- Transition from the current SMRA model to Combinatorial Clock Auctions (CCA) or hybrid formats that enable package bidding and minimize demand fragmentation.
- Incorporate innovations such as iterative clock rounds, multi-band packages, **and** incentive auctions (particularly when repurposing spectrum from incumbents).
- Caveat: Format innovations cannot by themselves correct mispriced reserves; reserve price calibration remains critical.

7.2 Recalibrate Reserve Price Mechanism

- Move away from rigid indexation and historical benchmarks toward a market-aligned approach that reflects:

  • Operator financial capacity,
  • sectoral demand trends, and
  • macroeconomic conditions.

- Lower, market-driven reserve prices can stimulate competition, improve sell-through**,** and paradoxically generate higher total revenue than inflated benchmarks with limited buyer interest.

7.3 Enhance Flexibility in Spectrum Management

- Allow re-auctioning of unsold spectrum at recalibrated reserve prices instead of repeatedly carrying forward unsold inventory.

7.4 Publish a Long-Term Spectrum Roadmap

- Provide operators with a **5**–10 year forward-looking plan for spectrum release schedules.
- Greater visibility helps operators align investment cycles, reduces uncertainty, and smoothens demand fluctuations.

7.5 Balance Efficiency and Revenue Objectives

- Treat auctions not just as revenue-raising tools, but as mechanisms for efficient allocation and sectoral growth.
- Align reserve pricing and auction design with the realities of a mature telecom market**,** ensuring spectrum is acquired by those best positioned to deploy it effectively.

8.0 Bottom Line

India's spectrum auctions have shifted from a seller's market (scarcity-driven, high premiums) to a buyer's market (abundant supply, demand-constrained at high reserve prices). The way forward requires a three-pronged reform agenda:

- **Smart pricing reforms** that realign reserve prices with market fundamentals,
- **Modernized auction formats** that enhance efficiency and flexibility, and
- **Transparent long-term roadmaps** that support stable investment cycles.

Together, these steps can restore efficiency, ensure productive use of spectrum, and sustain healthy telecom sector investment—critical for the rollout of 5G and future technologies.

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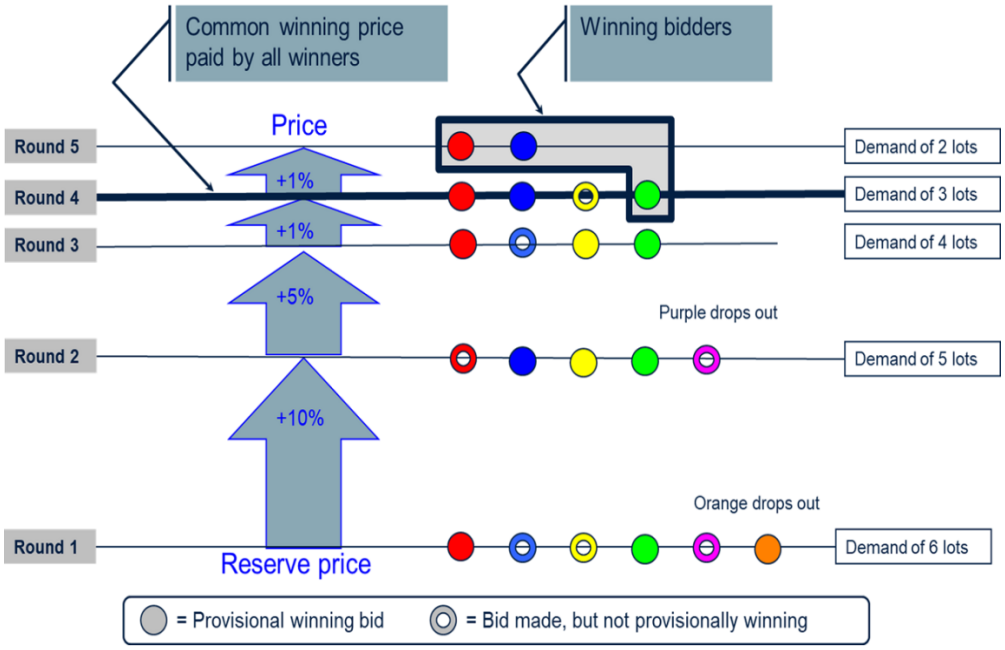
The SMRA Auction Model Explained

The Department of Telecommunications (DoT) used the **Simultaneous Multi-Round Auction (SMRA)** format for spectrum sales between 2010 and 2024. Under this system, multiple blocks of spectrum are offered in each Licensed Service Area (LSA), with prices determined through iterative bidding rounds.



How it works:

- **Starting point:** Each block is assigned a **Reserve Price (RP)**, the minimum acceptable bid. Bidders submit initial bids at RP, backed by upfront payments that define their eligibility.
- **Price progression:** If demand exceeds supply, prices rise in subsequent rounds. The increment is linked to the level of excess demand—larger when demand is strong, smaller as it tapers off. Bidders may drop out as prices increase. *(Excess Demand is defined as the total number of bids received in a service area at a Clock Round price equal to the Clock Round price set in the last completed Clock Round minus the number of blocks available in that service area.)*
- **Auction close:** The process continues until demand equals supply. At that point, the standing bidders become provisional winners and pay the **winning price**, which is the final clearing price of the last accepted bid (*The Winning Price to be paid by a Winning Bidder may be less than or equal to but never greater than the Winning Bid of a Winning Bidder in that service area*.)

Illustration: In a case with 3 lots and 6 bidders, prices rise over successive rounds as bidders drop out, until only 3 bidders remain. They secure the spectrum at the final clearing price.

Drawback: When **supply exceeds demand**, the mechanism fails to generate competition. For example, if 6 lots are offered but only 3 bidders participate, each wins at RP in the very first round, leaving the remaining lots unsold.

Year	No of Instances				No of Bidders
	Sold above RP (WP>RP)	**Sold at RP (WP=RP)**	**Not Sold (RP≠0, WP=0)**	**Not Available (RP=0)***	
2010	44	0	0	0	11
2012	1	17	26	0	6
2013	0	8	20	38	1
2014	14	11	0	19	8
2015	48	13	8	19	8
2016	17	53	56	28	7
2021	0	74	65	15	3
2022	1	90	119	10	4
2024	2	27	104	43	3
Total	**127**	**293**	**398**	**172**	
*** No spectrum available for some LSA/Band combination**					

The number of instances of spectrum auction from 2010 to 2024.