



# Spectrum Pricing

## GSMA Public Policy Position

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# Executive Summary

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To deliver affordable, high quality mobile broadband services, operators require fair access to sufficient radio spectrum. As a result, governments and regulators carefully manage mobile spectrum, which in turn supports a vibrant digital economy. Sometimes this includes charging a price for access to spectrum to encourage efficient use. However, evidence shows that when prices are too high, consumers can suffer from slower mobile data speeds, worse coverage and slower rollouts.

The issue of spectrum pricing has never been more vital. Awarding significant amounts of additional spectrum are central to expanding and upgrading mobile broadband services – and will be core to the success of 5G. However, instances of spectrum licences being sold for extremely high prices, or going unsold due to the cost, are becoming more common. These outcomes undermine consumer mobile services and the wider digital economy. The issue is especially problematic in developing countries where spectrum prices are on average three times higher than in developed markets once income is taken into account.

The cause of extremely high prices are typically policy factors that appear to prioritise other factors, such as maximising short-term state revenues, above long-term support for the digital economy through improved mobile services. Key concerns are when regulatory authorities fail to make sufficient amounts of mobile spectrum available, which creates scarcity thus inflating prices, or setting excessive auction reserve prices, final prices or annual spectrum fees.

Spectrum is a valuable state asset and governments have the option to use it to raise revenues to fund vital state activities. However, the primary goal in all awards should be to encourage the most efficient use of spectrum through investment in widespread, high quality networks.

Efficient spectrum awards maximise access to affordable mobile broadband services, which in turn have a major impact on the digital economy. Evidence shows that higher state revenues from excessive spectrum pricing are outweighed by losses incurred to the digital economy.

Many countries around the world successfully strike the right balance between raising revenues and delivering efficient spectrum awards. However, those countries that make maximising revenues a top priority are putting their national mobile services, and the overall digital economy, at risk.

This paper outlines the GSMA's key spectrum pricing positions:

- 1. High spectrum prices can harm consumers through lower quality mobile broadband services**
- 2. Governments should prioritise improved mobile broadband services – above revenue maximisation – when awarding spectrum**
- 3. Avoid limiting the supply of mobile spectrum (e.g. through set-asides), publish long-term spectrum award plans and hold open consultations**
- 4. Set modest reserve prices and annual fees, and rely on the market to determine spectrum prices**
- 5. Avoid creating unnecessary risks that put operators' current or future services in jeopardy**
- 6. Consult with industry on licence terms and conditions and take them into account when setting prices**
- 7. Auctions must be well designed and implemented to be an effective award mechanism**
- 8. There is no single best approach to estimating the value of spectrum and international benchmarks should be used with caution**
- 9. Spectrum pricing decisions should be made by an independent regulator in consultation with industry**
- 10. The rise in the total cost of spectrum is a threat to mobile broadband growth – especially 5G**

# Background

In most cases, an up-front price is paid for spectrum licences, normally at auction but occasionally through administrative awards such as beauty contests.<sup>1</sup> Licensees also normally pay an annual fee to cover the costs of managing spectrum. In some cases, the annual fee can be higher where licences have been renewed without an up-front cost, or where lower up-front charges were applied.

The primary goal of charging a fee for spectrum is to award spectrum to those who will use it most efficiently to deliver the maximum benefits for society. In this way, a well-designed auction will assign spectrum to those who value it most, thus incentivising them to use it efficiently through investment in widespread, high quality mobile networks. However, charging for spectrum can also provide substantial state revenues. This can lead governments to seek to prioritise maximising revenues by artificially inflating spectrum prices – at the expense of efficient spectrum use and the wider economy.

There are several ways governments and regulators inflate spectrum prices. They sometimes set excessive reserve prices (ie. the minimum amount paid for spectrum sold at auctions), final prices (e.g. in administrative awards) or annual spectrum fees. Another cause is restricting the supply of mobile spectrum to mobile operators by failing to clear a sufficient amount or setting aside spectrum for other users so it cannot be auctioned (e.g. set-asides for local users, verticals, new entrants etc). In other cases inflate prices can be due to inappropriate auction design or lot sizes.

Globally, spectrum prices reached all-time highs with the 3G auctions at the start of the millennium, before falling gradually until 2007. From 2008-2016, when 4G auctions became common, the average final price paid for spectrum sold at auction increased significantly – by 3.5 fold.<sup>2</sup> This average rise was largely due to the increase in awards of sub-1GHz bands, which tend to be more valuable, higher reserve prices<sup>3</sup>, as well as a number of outlier auctions where final prices were extremely high. A recent study showed high prices are especially problematic in developing countries where on average prices are three times higher than in developed countries when income is taken into account.<sup>4</sup> African countries, specifically, account for half of all extremely high spectrum prices globally.<sup>5</sup>

Extremely high price auctions are typically the result of national policy decisions, including setting excessive reserve prices, making an insufficient amount of spectrum available for auction, and a lack of clarity on future releases or the process of renewing expiring licences. Such factors can create uncertainty, artificial scarcity of spectrum and encourage excessive bidding above operators' true valuations of the licences on offer.<sup>6</sup> For example, African countries have assigned approximately half the amount of mobile spectrum<sup>7</sup>, compared with the global average, which creates scarcity and risks higher prices. More widely, reserve prices at spectrum auctions in developing countries are on average more than five times those in developed countries once income differences are considered.<sup>8</sup>

A particular concern in the 5G era is the issue of governments and regulators failing to make enough spectrum available for 5G. There is already a significant variation in the amount of 5G spectrum that is assigned around the world, and the prices paid at auctions, which means the potential of 5G services will vary notably between countries.

Another risk from very high prices can be unsold spectrum. In-demand digital dividend spectrum - which has propagation characteristics that make it ideal for connecting billions of unconnected people to the Internet - has gone unsold in several developing markets<sup>9</sup> due to excessively high reserve prices. Failure to assign this spectrum stalls the development of broadband services, especially in rural areas, impacting citizens and the economy.<sup>10</sup>

High spectrum prices also have other serious consequences for consumers. A recent study found significant evidence to suggest a causal link between high spectrum prices and slower mobile data speeds, worse coverage and slower rollouts.<sup>11</sup> It found that in the countries studied with the highest spectrum prices, the average mobile operator's 4G network would cover 7.5% more of the population if they had acquired spectrum at the median spectrum price. Numerous other recent studies also highlight similar harms to consumers from high spectrum prices.<sup>12</sup>

These studies contradict earlier research that used classical economic theory to conclude that spectrum costs are 'sunk' and are therefore unable to impact consumer prices and network investment.<sup>13</sup> One recent study used behavioural economics, financial theory and economic theory to show how high spectrum prices could affect consumer pricing and network investment.<sup>14</sup> This means high spectrum prices may be regarded a 'deadweight loss' tax given they cost more to the wider economy than they raise in additional state revenues.

Policy makers' approaches to spectrum pricing range from those who focus on maximising revenues to those for whom revenue raising is of lesser or no importance. In general, most countries seek to generate some revenue from spectrum but their statements as well as their policies show that revenue is secondary to an efficient award. This is especially the case in more developed mobile markets, such as Sweden and Finland, where encouraging efficient assignments and investment in high quality networks are the top priorities.

1. In beauty contests, governments or regulators directly award licences based on various criteria. But determining and applying the criteria is complex and outcomes can be subject to bias, so auctions are now more prevalent.

2. See report: 'Effective Spectrum Pricing: Supporting better quality and more affordable mobile services' by NERA Economic Consulting (2017)

3. Reserve prices increased over five-fold in this period

4. See report: 'Spectrum pricing in developing countries' by GSMA Intelligence (2018)

5. Once income differences are taken into account. See report 'Effective Spectrum Pricing in Africa' by GSMA Intelligence (2020)

6. Ibid – NERA (2017)

7. See report 'Effective Spectrum Pricing in Africa' by GSMA Intelligence (2020)

8. See report: 'Spectrum pricing in developing countries' by GSMA Intelligence (2018)

9. In 2016 alone, part or all digital dividend mobile spectrum went unsold in Ghana, Senegal and India. In 2021, India failed to award the digital dividend at auction again due to high reserve prices.

10. The economist Jerry Hausman valued the consumer welfare loss from a 7-10 year regulatory delay impacting mobile services in the US at up to \$24.3bn a year (in 1983 dollars).

11. See report: 'The impact of spectrum pricing on consumers' by GSMA Intelligence (2019)

12. The effects of spectrum allocation mechanisms on market outcomes' by T. Kuroda and M. Forero (2016) found that 'auctions, when used to raise public revenues, not only transfer profits to government but also sacrifice consumer surplus'. A Policy Tracker study for the European Commission (2017) concluded that countries with low spectrum auction prices, long licence lengths and less onerous coverage obligations tend to have better network coverage, a wider choice of services, better take-up and healthy competition. Spectrum 5.0: Improving assignment procedures to meet economic and social policy goals by Gerard Pogorel and Erik Bohlin recommended governments prioritise mobile network investment rather than maximising spectrum fees

13. Evan Kweref, Federal Communications Commission, 2000, Spectrum Auctions Do Not Raise the Price of Wireless Services: Theory and Evidence

14. Ibid NERA (2017)

# Positions

## 1. High spectrum prices can harm consumers through lower quality mobile broadband services

High spectrum prices are associated with slower mobile data speeds, worse coverage and slower rollouts.<sup>15</sup> Research shows that when prices are too high, operators are likely to invest less in their networks – which impacts the quality and reach of services as well as the pace of rollouts. This is not helped by the fact that spectrum costs are rising at the same time that many mobile markets are saturated and ARPUs are flat.<sup>16</sup>

Naturally, some spectrum auctions may produce unusually high prices due to normal competition between bidders. However, most cases of very high spectrum prices are due to policy factors.<sup>17</sup> These include high reserve prices, limited spectrum availability, no spectrum roadmap and auction rules that serve to artificially inflate prices.

## 2. Governments should prioritise improved mobile broadband services – above revenue maximisation – when awarding spectrum

Spectrum is a scarce resource that enables wireless services that deliver profound socioeconomic benefits. Governments typically price spectrum to recover the costs of spectrum management, but many go beyond this by actively trying to raise state revenues. Both aims are perfectly acceptable, as long as revenue-raising is not so excessive that consumers of mobile services, and the wider digital economy, suffer. The primary goal in all spectrum awards should be to encourage efficient spectrum use and the significant investment necessary to provide high quality mobile services.

Policy measures that inflate the price of spectrum can result in spectrum going unsold, or sold at such a high price that the quality of services are adversely affected – both have a negative impact on the mobile economy. The mobile economy – which relies on spectrum – is extremely valuable. In 2020 alone, mobile services contributed US\$4.1tn to the global economy<sup>18</sup> – and provided vital social benefits including improved healthcare and education.

It is widely accepted that all forms of taxation are an overall economic burden (ie. a 'deadweight' loss) as greater economic benefits would have accrued had taxpayers spent this money themselves. As such, governments try to develop tax policy that minimises this deadweight loss. Such is the positive knock-on effect of the mobile industry on the overall economy<sup>19</sup>, a well-respected study has shown that spectrum costs (which are essentially a tax) create a more significant deadweight loss than general taxation.<sup>20</sup> Therefore, decisions to prioritise maximising spectrum revenues may create a short-term windfall for the treasury, but will have a negative impact on the overall economy in the longer run.

## 3. Avoid limiting the supply of mobile spectrum (e.g. through set-asides), publish long-term spectrum award plans and hold open consultations

It is essential that regulators proactively work towards releasing additional spectrum for mobile services. A sufficient amount of spectrum, in the right frequency bands, is essential to deliver affordable, high quality mobile broadband services. Rapidly growing consumer demand for mobile data services and new technologies (e.g. 4G and 5G) - which require significant spectrum to operate most effectively - is only making demand for spectrum more intense. When insufficient spectrum is available to meet that demand, operators can be forced to pay excessively in auctions due to artificial scarcity. The result is that consumers are more likely to suffer from lower quality mobile services, as mobile operators struggle to invest in networks, especially outside of urban areas.

A key cause of mobile spectrum scarcity is the failure to clear incumbent users out of new mobile bands effectively so an insufficient amount is available for mobile use. Others include setting aside mobile spectrum for local use, verticals or for spectrum sharing when it leaves an insufficient amount that can be awarded at auction. This issue has grown with the use of more modern mobile broadband technologies as they require increasingly large amounts of spectrum to deliver expected improvements in user experience. In the case of 5G, the GSMA recommends awards of at least 80-100 MHz of contiguous spectrum per operator in initial 5G mid-bands (e.g. 3.5 GHz) and 800 MHz per operator in initial millimetre wave (mmWave) bands (e.g. 26/28 GHz). Regulators should also plan timely significant further awards in both ranges to help 5G scale as needed. This should include more spectrum in the 3.5 GHz range (3.3-4.2 GHz), as well as 6 GHz and 40 GHz.

To realise the full potential of mobile services, regulators should aim to license spectrum as soon as operators have a business case to use it. This will ensure the amount of available mobile spectrum keeps pace with demand and ensures network investment is optimised leading to higher quality services. Regulators should hold open consultations and publish long-term spectrum roadmaps detailing exactly what bands will be made available, and when, to meet future demand. This will give operators confidence that policy makers support future mobile broadband growth, and encourage sustainable, long-term investment. Spectrum roadmaps also allow operators to improve their valuations and bidding strategy at auctions as they know when future spectrum will be made available.

## 4. Set modest reserve prices and annual fees, and rely on the market to determine prices

The most efficient way to assign spectrum is by allowing the market to set the price. This is the fundamental purpose of an auction, but is only possible if the reserve price is set well below any prediction of market value, to allow price discovery. High reserve prices discourage participation and at worst leave vital, in-demand spectrum unsold, or at best artificially increase the final price paid which risks reduced network investment and higher consumer prices.

Annual fees should be set at modest levels with a view to recovering the regulator's spectrum management costs. If higher annual fees must be levied then they should still be moderate and predictable to ensure they do not negatively impact consumers. These higher annual fees should also be treated as an important component of total spectrum cost - so expectations for potential auction prices should be reduced accordingly.

## 5. Avoid creating unnecessary risks that put operators' current or future services in jeopardy

Governments and regulators can create an environment that incentivises heavy investment in networks. Conversely, they can also introduce uncertainties and risks that artificially inflate prices and jeopardise widespread network rollouts. These include auction and assignment decisions that encourage excessive bidding, thereby putting current or future mobile services in jeopardy:

- Auction formats that limit price discovery can mean operators are forced to bid blindly and risk overpaying or not getting spectrum
- When the size or number of spectrum lots is not carefully planned, operators can risk failing to win enough spectrum to support their customers
- When spectrum packaging or bidding rules are not sufficiently flexible, operators may be forced to buy, as part of a package, some frequencies that others may value more
- Payment terms that force operators to make large payments before the spectrum is available introduce an additional risk outside their control

15. Ibid NERA (2017)

16. The Telegeography Global Comms Database shows 67 out of 83 mobile operators in OECD countries reported declining ARPUs between 2010 and 2015. This excludes 9 operators where 2015 data is not yet available

17. Ibid NERA (2017)

18. GSMA Mobile Economy Report 2020

19. A US study found that every \$1 spent on mobile services resulted in \$2.32 of total economic spending (Source: 'Mobile Broadband Spectrum: A Vital Resource for the American Economy')

20. What really matters in spectrum allocation design by Hazlett, Munioz and Avanzini (2012)

## 6. Consult with industry on licence terms and conditions and take them into account when setting prices

The terms and conditions associated with a spectrum licence have a major impact on its value. Where regulators set coverage or other obligations, they must be factored into the reserve price and annual fee. Expensive spectrum licences coupled with onerous obligations can cause a variety of problems: the licences may go unsold, the obligations may prove impossible to meet<sup>21</sup>, or they could lead to reduced investment in networks or higher retail prices.

An increasing number of regulators are adopting more innovative approaches to using spectrum prices to improve mobile coverage.<sup>22</sup> For example, French and Portuguese operators have been granted very low-cost spectrum licence renewals in return for covering defined rural and remote areas. In Sweden, operators have been able to claim back part of the amount they bid at spectrum auctions in order to pay for base stations in rural areas defined by the regulator.

## 7. Auctions must be well designed and implemented to be an effective award mechanism

The majority of spectrum auctions allow the market to determine final prices, which encourages a fair and efficient outcome. However, there remain examples of auctions that are poorly designed where spectrum goes unsold; or sells for very high prices that ultimately pose risks for consumers of mobile services; or where the prices paid by bidders for similar spectrum varies significantly. It is essential that policy makers study best, and worst, practices when designing an award mechanism, and consult with potential licensees.<sup>23</sup>

Auctions should be designed to allow operators to secure the optimum spectrum to meet their needs (e.g. amount, type, location etc) and thus ensure it is used as efficiently as possible. Policy makers can support this by ensuring enough spectrum is made available in the award; it is offered in small generic block sizes to support varying demand from all bidders; and activity rules allow bidders to aggregate complementary licences and/or move to substitutes during the auction

It is also important to note that spectrum auctions are not always the most appropriate method for assigning spectrum. Auctions can be complicated to design and operate and can therefore be avoided when there is evidence of lack of excess demand, or when all qualified operators and the government or regulator are able to find a mutually agreeable split of the spectrum on offer at a fair price. This can be attractive given auctions can be time consuming, especially if a framework of rules and procedures doesn't exist, and expensive for the regulator to run and bidders to participate in. However, where there is not enough spectrum to satisfy operators' spectrum requirements, or where the requirements are incompatible, auctions are typically the fairest means of determining the assignment.

While auctions can work well for initial spectrum assignments, they are almost always inappropriate in the case of renewing mobile spectrum licences that are expiring. The key focus for renewals should be to provide the predictability licence holders need to invest heavily in their networks throughout the term of the licence. If expired licences may be re-auctioned – and thus operators may lose access – then it becomes rational to limit investment in the network in the years preceding expiry. This can in turn negatively impact mobile coverage and broadband speeds and if the operator ultimately loses the spectrum can lead to sudden drops in network quality.

Auctions are suitable for expired licences if the licensee does not want to renew the spectrum or if they have breached the terms of the licence. In cases where spectrum assignments are deemed to be unbalanced or inefficient then the market should be allowed to correct itself by facilitating spectrum trading. Laws which prevent expiring licences from being automatically renewed should be revised to better protect network investment and quality of service.

## 8. There is no single best approach to estimating the value of spectrum and international benchmarks should be used with caution

Governments and regulators that try to maximise the revenues from auctions often rely on ambitious predictions of the market value of spectrum when setting reserve prices. Factors impacting spectrum value vary significantly between markets and there is significant scope for error. These factors include the general economy, the mobile market, competition, national topography and the broader state of spectrum availability. The risks associated with over-estimating spectrum value – and thus spectrum going unsold or sold at too high a price – are much more damaging than underestimating the value.

Spectrum valuations should be based on long-term business cases, involving assumptions about network deployment, and technical and commercial trends. Many of these assumptions are uncertain and subject to a variety of external risks, so valuations are typically subject to a wide margin of error. As such, reserve prices must be set sufficiently below any prediction of market value, in order to allow the auction to function through multiple ascending rounds and fulfil its purpose of determining the market price through competitive bidding.

Some policy makers look to international benchmarks (e.g. final prices in comparable markets) when assessing the value of spectrum. However, in practice, even small differences in local conditions between countries can make these comparisons wildly inaccurate. There can also be a temptation to choose the highest benchmarks, which are often caused by policy mistakes, and can then lead to negative outcomes for consumers and the digital economy. As such, it is prudent to base valuations on local market conditions at the time of the award, and err on the side of caution.

## 9. Spectrum pricing decisions should be made by an independent regulator in consultation with industry

The key aim when awarding spectrum should be to encourage its most efficient use through high quality and affordable mobile services. This is undermined when governments prioritise maximising revenues from spectrum above improving the affordability and quality of mobile services. Mobile users and the wider digital economy are best protected when all spectrum management decisions, including pricing, are assigned to an independent regulator that is tasked with protecting their interests. Awards will also be most efficient when regulators consult with potential bidders on the viability of the auction format.

## 10. The rise in the total cost of spectrum is a threat to mobile broadband growth – especially 5G

The rising cost of spectrum is unsustainable and poses a major threat to the future development of mobile services. Both the cost of spectrum and the amount that operators require to meet user demand are rising, while at the same time, operator revenues per MHz of spectrum used is falling. Unless this changes it will become increasingly difficult, and ultimately impossible, to fund sufficient investment in future mobile spectrum and networks.

The problem is worsening as mobile users put ever greater demands on networks that in turn requires operators to use more spectrum. With the total amount of spectrum used and unit spectrum prices (ie. \$/MHz/pop) both rising, operators will struggle to make the significant investments required to support dense 4G and 5G networks. This is especially the case given that in many countries the mobile market is saturated and ARPUs are flat. A reduction in unit spectrum prices is vital in order to avoid total spectrum costs spiralling – especially as extremely wide millimetre frequency bands look set to play a key role in 5G. High spectrum costs also make it difficult to extend services more widely, especially in rural areas where the cost of delivering services is 25% higher than in cities.<sup>24</sup> Regulators can respond by avoiding measures that artificially increase the cost of spectrum, and planning spectrum awards in a manner that enables a fall in spectrum prices in line with the increase in spectrum supply.

21. High reserves and onerous coverage obligations led Argentinian new entrant, Airlink, to default on its first 700 MHz licence payment. Its licence was subsequently revoked and has since failed to be put to use

22. See the GSMA public policy position paper: 'Driving the digital revolution with improved mobile coverage' (2020)

23. See GSMA public policy position paper.

24. Opex per cell site is 25% higher in rural areas than cities – and 100% higher in remote areas (source: GSMA: 'Unlocking rural coverage' report)



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