Ofcom Review of Annual Licence Fees Consultation

Proposals for revised Annual Licence Fees for 900, 1800 and 2100 MHz spectrum

Virgin Media O2 response

7th March 2025

Non-Confidential Response

Executive Summary

1. Ofcom launched this review as it recognised that material misalignment had arisen between Annual Licence Fees (ALFs) and observed market values. Since the last review, market values have fallen in nominal terms whilst ALFs, as calculated by Ofcom, have risen due to inflation indexation. In addition to being the trigger for a review, these contradictory value and price trajectories should have informed Ofcom's approach to setting revised ALFs.

2. It is concerning that the current set of proposals do not account for this reality. Observed evidence confirms that the trend of falling market values has continued and is likely to continue. Failure to account for this trend within the approach to setting ALFs is also inconsistent with proposals for the future use of 6 GHz spectrum, where Ofcom's spectrum policy team implicitly relies on falling mobile spectrum values at the margin to, for the first time, propose that a prime candidate band for mobile spectrum be shared with another use (in this case WiFi). The implication that the marginal value of additional 6 GHz spectrum for mobile is insufficient to justify an exclusive allocation is inconsistent with an assumption baked into Ofcom's proposed lump sum values (LSVs) that the value of mobile spectrum has remained fixed in real terms since 2021.

3. Against the backdrop of declining values, adjusting auction prices and fees for inflation alone has the effect of materially increasing calculated fees, resulting in much higher fees than observed evidence on actual market values supports. The implication is that fees will exceed market values at the outset and increasingly so over time giving rise to the adverse impacts that Ofcom says it wants to prevent. The consequence is that Ofcom's current proposals do not meet the requirement of the 2010 Ministerial Direction for prices to reflect market value, nor its statutory duties, and will give to significant economic inefficiencies.

4. There are important parts of Ofcom's benchmarking proposals that we and other stakeholders agree with. We are aligned that the LSV for 900 MHz value should be determined based on the observed UK 700 MHz auction price in 2021 (accounting for the functional equivalence of all low band paired spectrum). We also agree with the aim (though not Ofcom's application) of putting greater weight on more recent auctions to benchmark 1800 and 2100 MHz values. Whilst we identify potential to refine benchmarking of the higher two frequency bands, we broadly agree with proposed and largely observed 2021 values for these bands. Consequently, we believe that Ofcom has acted appropriately *only* with respect to benchmarking for value as of 2021. This provides a *starting point* for setting ALFs that all stakeholders can likely align on. Unfortunately, for reasons we set out in this response, Ofcom's approach to subsequent steps is flawed, with the result that its proposals for ALFs in 2025 and beyond would exceed market value.

5. A significant error that touches on all aspects of Ofcom's methodology is its insistence on inflating benchmarks and fees to maintain 'fixed' prices in real terms, without any consideration to other factors that have been driving down nominal values for mobile spectrum. In the past, with low inflation and near zero interest rates, such adjustments were not a source of controversy. The compound impact of annual inflation did not

significantly increase values over time, and Ofcom's stated approach of acting conservatively and weighing benchmarks "in the round" allowed for adjustments that could offset any overstatement. Today, after a period of very high inflation and with prevailing high interest rates, the situation is different. Backwards inflation adjustment leads to grossly overstated historic benchmarks for LSVs, and without other adjustments (for example to account for the marked decline in expected mobile traffic growth since 2021), the baseline has become too distorted to be addressed by a simple conservative weighing of the benchmarking evidence alone.

6. There are three further steps in Ofcom's approach following the initial benchmarking: conversion of LSVs into today's prices; applying the annualisation rate to convert LSVs into annual fees; and adjusting fees for inflation going forward. Ofcom's proposals for these steps effectively guarantee a repeat of the current misalignment, with fees in excess of market values, that led to Ofcom launching its review. This goes way beyond any sentiment that Ofcom could have been more conservative. Proposals would systematically set fees that exceed market values going against the observed evidence of declining spectrum values.

7. Effectively, Ofcom has no story that explains observed market values for spectrum. Based on the prices that Ofcom has put forward, it apparently believes that the nominal value of each band fell significantly between 2018 and 2021, followed by a sudden and significant increase through 2025. At no point does Ofcom present evidence that explains this peculiar change in trajectory of spectrum values, and it has not presented a plausible discussion of the factors that affected spectrum values over this period. Virgin Media O2 believes that a coherent review of the factors that drive spectrum valuation can inform proposals for setting ALFs in 2025 based on the general consensus on 2021 values. Our response identifies four key factors that have driven value change from 2021-25: inflation (used by Ofcom; discount rates; the timing of future spectrum supply; and projections for mobile traffic. The impact of these factors, individually and jointly, must be considered to secure a full understanding of how spectrum values have evolved in recent years.

8. Adjusting auction prices by inflation alone is fundamentally wrong. What Ofcom proposes is to correct for the change in the "value of money" but not for the change in the "value of spectrum" as it is required to do. It means that Ofcom adjusts for inflation but not for the other factors that are known to affect spectrum values. We describe the other factors, their relation to spectrum values, and how they developed from 2021 to 2025. We conclude that each of the other factors will have exerted downward pressure on spectrum values and, using a simple cost-avoidance model, we estimate that their joint impact more than offsets the upward impact of inflation. This analysis confirms a continuation into 2021 to 2025 of the downward trend in nominal prices from 2018 to 2021 that Ofcom implicitly recognised in its decision to undertake this review. This is a story that is consistent with both the reason for undertaking the review and the observed evidence from awards post-2021.

9. We applied our understanding and modelling of spectrum value development over 2021-2025 to determine today's 900, 1800 and 2100 MHz LSVs. Ofcom's proposals for today's LSVs are essentially the observed 2021 values adjusted by inflation alone. Informed by

the analysis we conducted, we identify several methodologies that Ofcom can use to estimate 2025 market values from observed 2021 values:

a) extrapolating the pre-2021 downward value trends, assuming a constant compound annual growth rate (CAGR);

b) extrapolating pre-2021 value trends, assuming a diminishing depreciation trend;

c) keeping values constant in nominal terms;

d) estimating change in value using a multi-factor model that accounts for the impact of all factors on market value; and

e) (only for 1800 and 2100 MHz) a revised application of the distance method.

10. In Table 1, for each band, we compare the resulting 2025 LSV in in £m per MHz from applying each of these methodologies with the observed 2021 values and Ofcom's proposals for 2025 LSVs. We also show the differential between our 2025 estimates and 2021 values. The methodologies are presented in size order from highest to lowest. The highest estimate (to the left) involves keeping values constant in nominal terms, whereas the lowest estimate (to the right) is to extrapolate based on a constant CAGR. This ordering is instructive as these two methodologies provide the upper and lower bound for a reasonable estimate range for LSVs. The 2025 LSVs proposed by Ofcom fall well outside this range: they assume a steep increase in nominal values from 2021 onward whereas there is no evidence to suggest that even a small increase occurred.

Table 1: Estimates of LSV for relevant bands under different methodologies

	Observed 2021 value (£m per MHz)	Estimated 2025 value (£m per MHz)					
		Ofcom proposal	Constant	Diminishing depreciation	Revised distance method	Multi-factor model	Change by historical CAGR
900 MHz	14	17.4	14 (0%)	12.3 (-12%)	N/A	11.2 (-20%)	9.3 (-34%)
1800 MHz	11.1	12.8	11.1 (0%)	10.1 (-9%)	9.2 (-17%)	8.9 (-20%)	8.2 (-26%)
2100 MHz	10.5	12	10.5 (0%)	9.6 (-9%)	8.8 (-16%)	8.4 (-20%)	7.7 (-27%)

Source: VMO2 analysis using Ofcom's proposals from the Consultation and our analysis as presented in this response.

11. For 900 MHz, we prefer the methodology that uses diminishing depreciation to estimate the 2025 value. This is because our analysis of the factors that impact the value of spectrum from 2021-25 points to a continued reduction in the value of low-band spectrum but one that has slowed relative to the steep drop observed before 2021. This implies that keeping values constant would overstate today's 900 MHz value whereas maintaining a constant downward CAGR is likely to understate today's value. **We conclude that a reasonable estimate of the 2025 LSV for UK 900 MHz spectrum is £12.3m per MHz.**

12. For 1800 and 2100 MHz, our position is that values are similar across bands which broadly aligns with Ofcom's proposal for there to be a modest premium on 1800 MHz spectrum given its somewhat superior propagation. In our analysis, we used this premium to estimate LSVs in both bands. Simple interpolation (which includes constant, diminishing depreciation and change by observed CAGR) is not our preferred methodology as we have recent European benchmarks that merit analysis. This said, extrapolation identifies a reasonable range for 2025 LSV estimates which encompasses the estimates from other methodologies. A strong alternative methodology exists in the revised distance method. We apply Ofcom's distance method whilst making several corrections: no backwards inflation adjustment; pooling 1800 and 2100 MHz benchmarks; putting greater weight on the UK 3.6 GHz spectrum; and removing awards with unnatural price ratios. **Applying the revised distance method, we estimate 2025 LSV at £9.2m per MHz for 1800 MHz and at £8.8m per MHz for 2100 MHz.**

13. Application of our multi-factor model provides a cross check on all LSV estimates. Our preferred estimates are close to the estimates produced by this application. This provides

additional confidence that our preferred estimates are reasonable and consistent with the development in market values in recent years.

14. Our methodologies produce estimated LSVs that align with evidence that the downward trend in spectrum values observed from 2018-2021 has continued through 2025, contrary to Ofcom's unsubstantiated position that the downward trend was abruptly reversed after 2021. By accounting for the factors driving this trend, it is possible to develop an adjustment approach that accords with what is observable. Ofcom must use our analysis to revisit its approach to adjustment and then come up with an approach that produces 2025 LSV estimates that it can explain and that are in line with observed evidence.

15. Whilst our major concerns relate to Ofcom's proposals for LSV determination, we also reviewed calculation of the proposed annualisation rate. We have two concerns regarding the annualisation rate which are identified in the NERA report that we submit alongside our own response.[1]

    a) The change in capital market conditions from 2021 onward means that a disconnect has arisen between LSV determination and calculation of the annualisation rate. When adjusting for inflation alone, today's LSVs are based on the low discount rate that prevailed during the key 2021 UK auctions. Applying a higher discount rate reflecting today's capital market conditions against today's LSVs based on the low discount rate results in fees above market value. NERA explains that Ofcom must either: (1) adjust for the change in discount rate in setting today's LSVs (which our proposed methodologies do); or (2) use the discount rate from the 2100 MHz ALF Statement which reflects 2021 capital market conditions to convert its estimates of today's LSVs into annual fees. NERA shows that the second correction option is viable.

    b) Ofcom has made several errors that result in an overestimation of the discount rate (and, by extension, the annualisation rate). Notably, Ofcom uses an underestimated CPI projection in determining the lower and upper polar cases, and a too low inflation risk premium (primarily because it is not accounting for RPI's retirement in 2030). It has also overestimated its upper polar case by including for unsystematic risk which is in direct contradiction of its objective to set the WACC only accounting for systematic risk. NERA identifies correction to these errors and shows that correcting them brings **the annualisation rate down to 5.97%**.

16. We compared our proposals on 2025 LSVs, annualisation rate and 2025 ALF per MHz with those of Ofcom, as set out in **Table 2**. Our proposals involve 2025 LSVs per MHz that are more than 20% below the values proposed by Ofcom, and an annualisation rate of 5.97% compared to Ofcom's 6.38%. The combined impact of our proposals is for 2025 ALFs per MHz to be over 30% lower than the ALFs proposed by Ofcom. Our analysis

[1] NERA, 7 March 2025, *Deriving ALFs from LSVs – A Response to Ofcom's 2024/25 Consultation on the calculation of the annualisation rate for use in determining ALFs*, submitted to Ofcom by VMO2.

demonstrates that Ofcom, if it proceeded with its proposals, would set fees substantially above market values. Adjusting fees by inflation would only compound this misalignment.

Table 2: Comparison of Ofcom and VMO2 estimates for UK ALFs

	Ofcom 2025 LSV (£m per MHz)	VMO2 2025 LSV (£m per MHz)	Ofcom annualisation rate (%)	VMO2 annualisation rate (%)	Ofcom ALF (£m per MHz)	VMO2 ALF (£m per MHz)
900 MHz	17.2	12.3	6.38%	5.97%	1.097	0.734
1800 MHz	12.7	9.2	6.38%	5.97%	0.810	0.549
2100 MHz	12	8.8	6.38%	5.97%	0.766	0.525

Source: VMO2 analysis using Ofcom's proposals from the Consultation and our analysis as presented in this response. LSV and ALF figures all reported in £m per MHz.

17. VMO2 is due to pay £72m ALFs on its spectrum holdings in 2025. This is £10m more than we would pay if 2025 fees are based on Ofcom's proposals and £30m more than if 2025 fees are based on our proposals. At least from December 2024 when it published its Consultation, Ofcom has known that current fees materially exceed market values, contrary to its statutory duties. This means that operators are currently overpaying and must have done so for a considerable period. We expect that any Ofcom decision on new fees to be backdated to at least 1 January 2025, as from that point onward it is established that fees materially exceed market values. Not doing so means that operators pay too high fees, giving rise to the adverse impacts that Ofcom wants to avoid and a further breach of duties.

18. For the same reasons as set out above in the context of adjusting auction prices, the forward-looking adjustment of fees for inflation alone contributes to fees exceeding market values and means that Ofcom fails to implement the Direction and does not meet its statutory duties. Ofcom has not established that spectrum values will likely remain constant in real terms and has not accounted for observed evidence that spectrum values have fallen in nominal terms and will continue to do so. Again, the flawed proposal can be attributed to Ofcom not understanding how spectrum values evolve over time and which factors affect it. We note that in other regulatory contexts, Ofcom's economists adjust values going forwards to correct for factors other than just inflation. For example, when setting regulated prices, CPI-X formulae are regularly used to account for falling equipment costs or changes in data volumes affecting cost allocations over time. Ofcom can similarly estimate an X in this case, to take account of expected changes in the factors we have identified above.

Section 1: Introduction

19. Ofcom launched this review at an appropriate time as it had become increasingly clear that 900 MHz and 1800 MHz ALFs were misaligned from their underlying values, with misalignment increasing over time. This misalignment was driven by the fall in spectrum values since these ALFs had been set, whereas Ofcom's methodology only accounts for the changes in the value of money (rather than in the value of spectrum). This provided an early warning that adjusting by inflation alone is insufficient during a period in which spectrum values fall, and a key lesson that setting annual fees requires to account for a range of factors that affect spectrum values.

20. We are concerned that significant progress on initial benchmarking (i.e. determining 2021 LSVs) is undone by flaws in the three further steps: bringing LSVs into today's values, applying the annualisation rate and adjusting fees by inflation going forward. The implication of these flaws is that Ofcom – if it continues with its proposals – risks setting fees that exceed market values from the outset, with forward adjustment by inflation compounding the likely misalignment. To proceed with its proposals would be contrary to Ofcom's duties and the 2010 Ministerial Direction as Ofcom would be aware that its proposals go against observed evidence on values and prices. Simply put, Ofcom's current approach is insufficient to withstand profound and rigorous scrutiny.

21. Ofcom has determined the annualisation rate based on today's capital market conditions. The seismic shift in capital market conditions since the last review led Ofcom to revise several variables used to calculate the annualisation rate showing that it is possible to account for changes in variables. But it is disappointing that Ofcom has not been similarly interested in accounting for changes in the factors that affect market values to establish today's LSVs, does not achieve consistency across the parts of its approach and has not reflected on what its proposals mean for fees relative to market values over time.

22. Our response is structured in five further sections and an appendix.

    a) Section 2 reviews Ofcom's proposals against the relevant legal test, statutory duties and Ofcom's stated aim to be conservative – finding the current proposals to fall short on each count.

    b) Section 3 shows that Ofcom's approach lacks a coherent story that explains how UK spectrum values evolve and constructively builds up such a story by describing relevant factors and how they affect market values.

    c) Section 4 presents our review of Ofcom's determination of LSVs. We find that Ofcom has over-estimated LSVs in each band and then set out how alternative methodologies can be applied to more robustly estimate today's LSVs.

    d) Section 5 summarises our views on annualisation. We commissioned NERA to review Ofcom's approach to annualisation and how this approach is applied in this review. NERA identifies a disconnect that must be addressed and proposes corrections to several errors made by Ofcom in estimating variables used to calculate the discount rate.

e) Section 6 deals with forward adjustment of fees. For similar reasons as for backward adjustment, we explain that adjustment by inflation alone is not appropriate. We set out that other factors than inflation must be accounted for and we explain that Ofcom has the expertise to develop an adjustment approach which just does that.

f) The Appendix provides further information about the multi-factor model described in Section 3.4.

Section 2: Ofcom's proposals do not meet its statutory duties and are not conservative

Ofcom does not meet its statutory duties and its previously stated aim to be conservative

23. We first discuss the legal tests and statutory duties that Ofcom must meet in setting ALFs, identifying that Ofcom would fail on its aim to set ALFs conservatively and would not secure its duties when proceeding with its proposals.

24. The Government directed Ofcom in 2010 to set 900 MHz and 1800 MHz mobile spectrum fees to reflect the "full market value" of these frequencies as well as its statutory duties. Following EE's appeal of the 2015 ALF statement and the resulting Court of Appeal judgment, Ofcom has sought to set fees that are appropriate and address both the Direction and its statutory duties. In practice, it has done so by setting fees that reflect "full market value" and then validating that setting fees at this level meets its duties.[2] This aligns with its approach to pricing AIP spectrum: Ofcom considered that setting fees at market value contributes to spectrum efficiency by replicating the price signals in a well-functioning market.[3]

25. Ofcom retained its view that fees must be set to reflect market value in the current Consultation: "*As set out in Ofcom's Strategic Review of Spectrum Pricing ("SRSP") and our January 2024 review of our approach to mobile spectrum management, we continue to consider that setting fees to reflect the market value (opportunity cost) of the underlying spectrum is consistent with our statutory duties, including our duty to secure the optimal use of the spectrum.*"[4]

26. This starting point has now to be extended to also consider the extent to which the setting of ALFs address its new objective to promote economic growth. We come back to this once we have explained the shortcomings in how Ofcom meets its duties and aim of setting fees 'conservatively'.

27. Ofcom has long recognised that some uncertainty around what "market value" means that setting ALFs requires it to reflect on the risks of setting fees too high or too low. As part of its August 2014 Consultation[5], Ofcom explained that it wants to exercise its duties by adopting a conservative approach to interpreting evidence for two key reasons:

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[2] The 2018 ALF Statement illustrates this approach. Section 4 sets out Ofcom's determination of market values resulting in fees / MHz for the first year, and Section 5 then presents Ofcom's review of how fees set at this level are appropriate considering its regulatory duties.

[3] As set out by Ofcom in its "*SRSP: The Revised Framework for Spectrum Pricing*" published in 2010 which continues to apply to date.

[4] See paragraph 1.6 of Ofcom's ALF Review Consultation.

[5] See paragraph 1.34 of Ofcom's August 2014 ALF Consultation.

a) "*Asymmetry of risk as between the effects on spectrum efficiency from inadvertently setting ALFs either above or below market value, given the uncertainty about the correct estimates for market value*."

b) "*Possibility that forward-looking market values today could be lower than at the time of the auctions from which we derive our key evidence, due to greater certainty of future availability of mobile spectrum, compared to expectations at the time of the 4G auction*."

28. The combination of risk asymmetry and the possibility that market values may fall over time led Ofcom to favour adoption of a conservative approach. Ofcom reflected on this consideration in subsequent decisions. For instance, when setting 900 MHz and 1800 MHz ALFs in 2015[6] Ofcom said: "*We have generally preferred approaches which we consider are more likely to understate full market value than to overstate it, where such a choice arises."*

29. Ofcom maintains this approach in the current Consultation: "*In view of our statutory duties to secure the optimal use of spectrum, we propose to continue to adopt a conservative approach to the interpretation of the evidence*.", and it does so recognising "… *the asymmetry of risk as between the effects on spectrum efficiency from inadvertently setting ALFs either above or below market value, given the uncertainty about the correct estimates for market value*."

30. Our assessment of this Consultation shows that Ofcom has not consistently adopted a conservative approach. Apart from the introductory references above, Ofcom has had regard to the 'conservative' aim solely in its benchmarking. It is entirely missing from its discussion of inflation adjustment, annualisation and overall approach.

31. The choice now arises (to use Ofcom's words) to adopt an approach that either:

a) Uses a conservative benchmark, but then adjust prices upwards into real prices notwithstanding that the observed trend is one of falling market values in nominal terms; or

b) Adapt to the new circumstances since the last ALF review, taking account of all observable factors that have impacted UK market value in recent years, including higher inflation but also higher discount rates, reduced expectation for future mobile traffic demand growth and more imminent future spectrum supply.

32. Whilst the first approach might have been acceptable in a low interest rate, low inflation environment with benchmarks taken from auctions in similar circumstances, to choose that approach today does not satisfy either the Direction to set prices at "market value" or meets Ofcom's duties or policy aim of setting prices conservatively to avoid the downside

[6] See paragraph 1.42 of Ofcom's September 2015 ALF Statement.

of over regulation. The second approach is the only way to arrive at an evidence-based decision that is sufficiently robust to withstand profound and rigorous scrutiny.

33. Put simply, Ofcom's approach leads to ALFs rising over time, when observable market values are still declining; whereas the alternative approach that we introduce in this response can take account of observable variables and thus can align with observable market values.

The value of money is not synonymous with the value of spectrum

34. The lesson from the past years is that determining market value on a forward-looking basis is complex and involves a degree of uncertainty. Ofcom set 900 MHz and 1800 MHz ALFs in 2018 based on its (then) best assessment of forward-looking market values. The reality is that market values have declined from the 2018 benchmarks in nominal terms, yet in the current Consultation the only adjustment Ofcom makes is to restate benchmarked prices in real terms – i.e. adjust for changes in the "value of money", rather than changes in the "market value of spectrum" since the benchmarks were taken. The latter, of course, being the statutory requirement contained in the Direction. We expand on this below, but the implication for how to secure its duties is that Ofcom must be truly conservative in how it sets fees – across its assessment, not just the benchmarking.

35. To truly set the market value of spectrum Ofcom must account for the impact of, and changes in, factors that are known to affect market values of spectrum over time. Specifically:

    a) *inflation*, to account for the current value of money relative to its value when benchmarks were taken;

    b) *changes in the discount rate*, which is driven by the Bank of England's response to observed inflation, that fundamentally affects today's value of future cashflows from fixed asset investment, like spectrum purchases[7];

    c) *changes in demand*, especially where in other areas of spectrum policy, Ofcom accounts differently for traffic growth and what this means for the value of mobile spectrum relative to other uses; and

    d) *changes in supply*, given that with the passage of time, operators gain better information about future supply conditions, something that will affect the current market value of spectrum they own.

[7] Spectrum is typically valued based on the future cashflows accrued by that investment, whether that be avoided costs, increases in revenues, or a combination of the two. Ex post changes in the discount rate will affect how the expected future cashflows from a historic investment are valued at a given point in time. This is analogous to corporate bonds or gilts, where values rise if interest rates decline and fall when interest rates rise. To take account of just inflation, without taking account of consequent changes in interest rates would likely be seen as unreasonable.

36. Ofcom has consistently qualified that its approach is conservative where it concerns *interpreting evidence*. In this response we provide substantial evidence about how observable factors affect the development of market values from historic observed values onward. Ofcom appears entirely comfortable to adjust for inflation yet does not adjust for changes in discount rates or mobile traffic, which are equally as observable. When acting conservatively based on evidence, Ofcom must be even handed in adjusting for factors that move prices down and up.

37. Earlier we mentioned the introduction since the last ALF review of the new growth duty.[8] The duty to have regard to the growth must mean that Ofcom should take even greater account of the risks and adverse impact of setting fees above market value. This particularly concerns any negative impact of higher fees on investment incentives. Lower fees, especially where fees are set below market values, improves investment incentives and thus supports greater investment. This has, at least, two positive effects.

38. Firstly, the direct effect is increased investment spend on the economy in general. The CMA's approval of the Vodafone/Three merger subject to remedies is materially based on its recognition that competition based on investment in infrastructure, between mobile operators, plays an instrumental role in the market delivering better long-term outcomes for UK mobile users. For instance, the CMA considered that "…*the changes resulting from the Network Commitment would likely elicit a competitive response from BTEE and VMO2 compared to the counterfactual, for example by way of further network investment, lower pricing or improved customer service*".[9] In other words, the CMA expects that remedies combined with market forces will encourage operators to invest in their networks to remain competitive or to gain a competitive edge. Lower fees, in such circumstances, means that operators have more funds available to invest and as recognised by the CMA directing funds to investment is one of things that operators will look at.

39. Secondly, the indirect effect is that improved mobile networks allows for delivery of higher quality connectivity and supports new use cases. Enhanced mobile connectivity is known as a catalyst of economic activity and growth as it enables consumers and businesses to improve their productivity and to innovate.[10]

40. Ofcom may be cautious where it concerns the positive impacts of lower fees encouraging investment and promoting growth but it is an additional relevant consideration in favour of adopting a conservative approach. Even if Ofcom deems that fees below market value have a limited effect on investment and growth, it must acknowledge that the opposite is not true. Fees that exceed market value deter efficient

[8] See Growth duty - GOV.UK and Open letter How Ofcom contributes to UK growth.
[9] See paragraph 84 of the CMA's Summary of final report.
[10] The McKinsey Global Institute identified and estimated the wide-ranging benefits of mobile connectivity for consumers, businesses and economics as a whole. See mgi_connected-world_discussion-paper_february-2020.pdf. This concerns benefits accruing from existing infrastructure but also from new use cases supported by enhancements in infrastructure and delivery of services.

spectrum use and investment with adverse impact on the development of mobile networks and economic growth.

It should have been clear that backward inflation adjustment alone is not appropriate

41. Ofcom proposes to retain its historic approach of adjusting auction prices for inflation. This approach keeps historically observed values in real prices, and given the high inflation in recent years increases LSVs in today's prices by more than 20% compared to when prices are kept in nominal terms.[11] It is important to understand that this adjustment is a technical one. It adjusts for the changes to "the value of money", not changes in the value of the underlying asset.[12] This means that Ofcom does not account for changes to factors other than inflation in determining the "market value" as required by the Direction.

42. Adjusting by inflation alone increases spectrum values from observed historical values which contradicts consecutive Ofcom findings that are consistent with a fall in spectrum values:

    a) the 900 MHz LSV was set well below the 800 MHz auction price in 2018;

    b) 2100 ALFs were set much lower in 2021 than 1800 ALFs determined three years previously (involving functionally equivalent spectrum), and;

    c) proposed 900 and 1800 MHz LSVs are nearly 30% below the equivalent LSVs for current ALFs determined in the 2018 Statement.

43. In the above decisions, the low prevailing inflation meant that adjusting for real prices did not lead to a substantial deviation and a conservative outcome was maintained, at least on a backward-looking basis. This held as long as the benchmarking approach was sufficiently conservative – if the starting number is low, indexing by low inflation has limited risk of increasing prices above current market values.

44. Recent Ofcom policy decisions or proposals have been consistent with an ongoing decline in spectrum values. This includes the proposed downward revision of 2100 MHz LSV from the level at which it was set in 2021, and Ofcom is – for the first time proposing to not allocate spectrum solely to mobile services but envisaging sharing between WiFi and mobile (the lower 6 GHz band). The rationale of this proposal is that mobile may no

[11] Ofcom acknowledges the material impact that its proposal would have on fees in paragraph 3.48 of its Consultation.

[12] The net present value is defined as the sum of the present values of all cash flows associated with the investment, which are being discounted at the appropriate cost of capital. See Damodaran (2017), Measuring Investment Returns I: The Mechanics of Investment Analysis, page 238."

longer be the most valuable spectrum user – something that historically has never been in doubt.[13]

45. Regulators must make consistent decisions. If Ofcom now believes that spectrum at the margin is of sufficiently low value that it no longer needs to secure it solely for mobile use, it follows that nominal spectrum values today are lower than they were in 2021, rather than higher (which is the case in the current proposals).

46. It is concerning that Ofcom has not reflected on what caused the misalignment that prompted this review and that its proposals do nothing to prevent the same outcome happening again. Unless the development in spectrum values changes drastically from its ongoing trajectory, Ofcom's proposals lead to fees that exceed market values. Ofcom must revise its proposals to prevent this outcome *or* it must explain why the factors that caused misalignment in recent years will not have the same effect going forward.

47. We presented Ofcom with direct evidence of falling spectrum values. The NERA report that we submitted as part of our pre-Consultation submission presents a chart which shows that average spectrum prices for low and lower-mid bands fell consistently and materially over the period 2015-2023 for a set of European countries.[14] This provides direct evidence consistent with a fall in UK spectrum values in nominal terms.

48. Ofcom has not had regard to this evidence in the Consultation though the fall of international spectrum prices is clear from both our earlier submission and the data points it reviewed as part of its benchmarking. Given the availability of this evidence, it is incumbent on Ofcom to use this evidence to inform its backward adjustment approach or to articulate why, uniquely, UK spectrum prices have risen materially in nominal terms from 2021, whereas prices in other countries are falling.

Justification for backward inflation adjustment alone does not suffice

49. Ofcom, on pages 17-19 of its Consultation, set out the considerations that led it to reach the provisional view that it remains appropriate to determine today's LSVs by adjusting the prices of UK and international auctions for inflation. Ofcom's starting point, consistent with its previous ALF decisions, is that spectrum values likely remain constant in real terms over time. Based on a short review, it considered there is no compelling reason to depart from this approach.

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[13] On page 4 of its 6 GHz Consultation, Ofcom said "*We believe shared use will maximise the use of this 700 MHz of spectrum, bringing the greatest overall benefits to citizens and consumers, rather than the alternative of allocating the spectrum exclusively for either mobile or for Wi-Fi.*" This suggests that mobile would no longer be the single, most valuable use of this spectrum. In contrast, when Ofcom decided in 2014 to allocate this band to mobile use there was never a question about mobile being the most valuable use. It considered that there would be significant demand for and value in mobile use of this spectrum and that demand for spectrum by other use cases could be fulfilled elsewhere. See page 25 of Maximising the benefits of 700 MHz clearance - Statement.

[14] See Figure 3 of NERA report prepared on behalf of Virgin Media O2.

50. Maintaining consistency with previous decisions must not be a goal in and of itself. In previous decisions, inflation had cumulatively increased by 5.9% (2018) and 7.9% (2021) over the preceding four years compared to 23.2% at this review.[15] The impact of adjusting auction prices for inflation alone on fees is far greater at this review, hence the renewed focus on whether it is either appropriate or in our view, not the only factor that Ofcom must account for. Adjusting for inflation alone does not produce conservative estimates of market value, as is obvious from the rise in nominal values when keeping values constant in real terms being in sharp contrast with the observed fall in spectrum values. Ofcom, at best, gives a cursory assessment of other factors in its Consultation[16], something that will not wash, given the observed evidence on market values and factors affecting spectrum values that we present in this response.

51. We agree that the value of incremental spectrum to an operator likely depends on the additional profits it can generate through increased coverage, capacity and higher quality, and the avoided network costs to achieve similar network and user outcomes without the additional spectrum.[17] This brings Ofcom to consider that, in general, operators' profits (and revenue) and network costs are likely broadly to increase in line with inflation. But Ofcom has not proven this consideration. It reviewed neither operators' network costs nor revenue (or prices as main revenue driver) over recent years, and its profit review is superficial in its application and interpretation.

52. We analysed the development of mobile revenue and prices finding that these variables did not increase in line with out-turn inflation in recent years.

    a) Mobile service revenue fell marginally in nominal terms over the period 2019-24 whilst inflation rose by 25% cumulatively.[18] The underlying development is that the material revenue increases in 2022/23 (though below inflation) were not sufficient to offset revenue reductions from earlier years.

    b) As part of its 2024 mobile monitoring report, Ofcom reported that average monthly spend for pay-monthly mobile contracts increased moderately between Q1 2019 and Q2 2023: from £26/month in 2019 to £28/month in 2023 (which amounts to a 7.7% increase over four years).[19] In explaining its results, Ofcom reflected that "*the analysis presented in this report offers a more comprehensive picture of how much consumers are paying for mobile services*."

    c) In its 2024 Pricing Trends report, Ofcom reported that the price of a basket of mobile services was 5% lower in 2024 in nominal terms compared to 2019

[15] Ofcom observed that the 2021 auction price of 700 MHz was £14m per MHz in nominal terms and that this would have risen to £17.2m per MHz by September 2024. This amounts to a 22.9% increase which is very similar to the 23.2% we determined for a nearly identical period.
[16] See discussion of "Adjusting past auction results for inflation" in Section 3 of Ofcom's Consultation
[17] See paragraph 3.49 of Ofcom's Consultation.
[18] As reported by Enders Analysis in its multi-annual reports on UK mobile markets.
[19] See page 22 of Monitoring Consumer Outcomes in the Mobile Sector.

despite average data use having trebled over this period.[20] Consistent with the revenue development described above, recent basket price rises have not fully offset price reductions in earlier years.

53. In response to BT's suggestion to have regard to quality-adjusted prices of telecoms services, Ofcom said that: "*To the extent that the evolution in the price of mobile services is an indicator of the value of spectrum, we consider that this would be best observed directly. We note that in 2023 and 2024 all four MNOs increased their in-contract prices by more than CPI…".* So, Ofcom refers to in-contract price rises to create the impression that operators increased their prices above inflation, failing to take account that competition moderates operators' ability to use price rises to increase revenue. Its own pricing analysis proves this impression is not validated.

54. There are at least two problems with how Ofcom reviewed profits as an indicator of spectrum values.

    a) Ofcom reviewed a measure of total profits that does not align with the additional profits that operators can generate by having additional spectrum to use. Ofcom rightly identified the latter as a potentially relevant indicator of spectrum values but did not apply this in its own analysis.

    b) Ofcom misinterpreted how its chosen measure, EBITDA, developed in recent years and what that suggests for spectrum values. It presented aggregate real EBITDA across the four mobile network operators, observing it increased by 8% over the 2018-2023 period but 15% down from its 2020 peak. Inspection reveals the reported increase is greatly driven by Vodafone's EBITDA increase in 2018. Real EBITDA fell by 13% over 2019-2023 when excluding 2018 and by 6% over 2018-2023 when excluding Vodafone. These cases show how sensitive the +8% is that Ofcom reported to suggest that nominal EBITDA increased by more than inflation over 2018-2023.

55. If EBITDA reflecting total profits is an indicator of spectrum values, the appropriate conclusion is that spectrum values likely remained constant in nominal terms. If Ofcom had properly interpreted this evidence, it would have looked to account for factors other than inflation in adjusting past auction prices as it would have been clear that adjustment for inflation alone is not appropriate. To not undertake such an analysis is unacceptable, given that in the weeks allowed for this Consultation process (rather than the months available to Ofcom), VMO2 has analysed three other, observable factors that have a clear relation with spectrum values and that must be part of an evidence-based adjustment approach.

Ofcom has not tried to understand or to model spectrum values

56. What contributed to the shortcomings described above and Ofcom not realising that its proposals are undermined by evidence, is that Ofcom has not sought to improve its

[20] See page 5 of Ofcom's Pricing trends for communications services in the UK 2024.

understanding of and to model how market values evolve as a function of observable factors, including but not limited to inflation.

57. The implication is that Ofcom's proposal accounts for the impact of inflation but not for other factors that affect spectrum values: discount rate, mobile traffic growth and spectrum supply. By not accounting for these factors as *determinants* of spectrum values, Ofcom denies itself the opportunity to use observable evidence on these factors to improve its understanding of how spectrum values evolve over time. This is particularly problematic as inflation increases spectrum values whereas other factors exerted downward impact on spectrum values in recent years.

58. Ofcom is right to use observed market values to determine historical LSVs. But where market values cannot be observed (from UK 2021 auction onward), Ofcom can use observed values of the factors to further its understanding of and to model how spectrum values evolved. At a minimum, this allows it to conclude on the directional move in spectrum values and to understand how it was driven by the factors. But, as we show later, it allows Ofcom to model and then estimate how spectrum values evolved by using observed changes in the factors and the known relation between factors and spectrum values. As such, it is possible to develop an evidence-driven approach that adjusts values for a range of relevant factors, not just inflation.

Section 3: Ofcom lacks a coherent story explaining how UK spectrum values have evolved

59. A fundamental flaw in Ofcom's analysis presented in the Consultation is that it lacks a coherent story that explains changes in the market value of mobile spectrum over time. There is a consensus amongst stakeholders, including Ofcom, that the UK market value of 900 MHz and 1800 MHz spectrum has fallen in nominal terms over the last decade (until 2021 at a minimum). However, Ofcom has no explanation for why values have fallen, and it clings to a contradictory methodology that assumes that historic benchmarks have maintained constant value in real terms from 2021 to the present day.

60. Ofcom's position lacks consistency. If the market value of UK mobile spectrum has declined, and if – as we all agree – European prices provide useful benchmarks for inferring UK value, then it must be that European market values have been subject to the same downward pressure on prices as in the UK. And, indeed, there is both evidence and broad consensus that prices paid for spectrum in Europe and worldwide have been falling since around 2015. For example, the data demonstrating this was clearly laid out in Section 1 of the NERA report submitted to Ofcom in September.[21] Ofcom must develop a coherent story that explains this global decline in spectrum value and incorporates it into its analysis of UK market value.

61. As Ofcom says at paragraph 3.49, "*Spectrum is an input into the production of mobile services*". When modelling the value of any input, the starting point for an economist is to consider the interaction of supply and demand for that input. This requires an analysis of the factors that determine the supply of spectrum and operators' demand for spectrum. In addition, because Ofcom is seeking to understand how spectrum values have changed over time, it is appropriate to consider how relevant exogonous factors associated with the market environment have evolved. Ofcom identifies changes in inflation as a relevant factor. It also needs to consider changes in the discount rate (which changes in response to changes in the value of money) applicable to operator valuation models, and develop a model that considers how supply and demand for mobile spectrum has evolved over the last decade in the context of broader economic shifts, and will evolve going forward.

62. In the absence of such a model, Ofcom makes two serious errors:

    a) Ofcom is hyper-focusing on inflation adjustments with the objective of keeping historic benchmarks and UK values constant in real terms. We do not dispute that inflation needs to be accounted for when expressing a price in current terms. However, inflation is just one of multiple factors driving change in spectrum prices, and (as we will show) throughout the 5G era it has been more than offset by other factors that have brought down market value. Focusing on inflation alone leads Ofcom to inflate nominal prices, despite overwhelming evidence that

[21] NERA, 30 September 2024, UK 900 MHz, 1800 MHz & 2100 MHz Annual Licence Fees, submitted to Ofcom by VMO2.

market value in nominal terms has fallen. Currently, it is just a technical adjustment for changes in the value of money, not a contributor to the value of spectrum.

b) Ofcom's industry analysis in Section 3 of the Consultation is broadly focused on the overall performance of mobile operators, including factors such as retail pricing, revenues and industry profitability. These factors are not particularly informative regarding the magnitude of changes in the value of spectrum because they are too general and overly influenced by non-spectrum factors. Ofcom should instead focus on industry trends that directly relate to the value of spectrum, such as its spectrum pipeline, the level of mobile traffic, expectations for future growth in traffic, and the impact of new technology on network capacity.

63. To determine the market value of spectrum, Ofcom should account for the development of major, observable factors of spectrum values. Ofcom has not done so. It has analysed neither conceptually nor empirically how such factors developed and what their likely impact on spectrum values has been in the years since its benchmarks were taken.

64. In this section, we identify and discuss six factors, under the headings of supply, demand and exogenous factors, that have influenced the market value of mobile spectrum over the last decade:

65. **SUPPLY-SIDE FACTORS**

a) **The supply of mobile spectrum**. This has nearly doubled in the 5G era. We see spectrum supply as a key factor bringing down global spectrum prices over the last decade. Within the UK, increasing supply was a major factor bringing down prices in successive UK spectrum auctions through to 2021. We also identify supply as a relevant but less significant source of downward pressure on UK market values between 2021 and 2025, yet that will become increasingly important again as we head towards major new spectrum releases in the 2030s.

66. **DEMAND-SIDE FACTORS**

a) **Increasing traffic growth** and **expected future traffic growth**. Massive increases in the data traffic carried by mobile networks was a driver of rising spectrum prices in the 4G era. Absolute growth in traffic continues to drive demand from operators for more spectrum and underpins value creation through spectrum acquisition. However, throughout the 5G era, growth rates for mobile traffic have lagged industry projections, meaning that historic valuations have overstated future capacity requirements and therefore inflated spectrum values. Notably, since 2021, there has been a marked downward correction in expected traffic growth, which significantly reduces spectrum values. Ofcom has made proposals to release spectrum into the primary market, taking account of this change in demand – it needs to similarly take account of demand when setting prices for spectrum already in the market.

b) **New mobile technology**. Modern network infrastructure uses spectrum more efficiently, providing greater capacity per MHz deployed. Notably, massive

MIMO antennas have extended the downlink range of mid-band frequencies, thereby both inceasing network efficiency and eroding the value premium for lower frequencies. Alongside supply expansion, we see this as a primary driver of the fall in a spectrum values over the 5G era, and largely explains the convergence in value across all sub-6 GHz mobile bands. This dynamic was particularly important between 2018 and 2021.

c) **Industry consolidation.** Many countries worldwide have seen consolidation in the number of mobile operators, usually from four to three. To the extent that consolidation reduces duplication in spectrum deployment, this can be expected to exert a downward pressure on spectrum values.

67. **MARKET ENVIRONMENT**

a) **Inflation**, which has significantly increased in recent years, has pushed up the cost of many inputs into mobile services, such as equipment and labour, relevant to the avoided cost of deploying spectrum. This puts upward pressure on spectrum value.

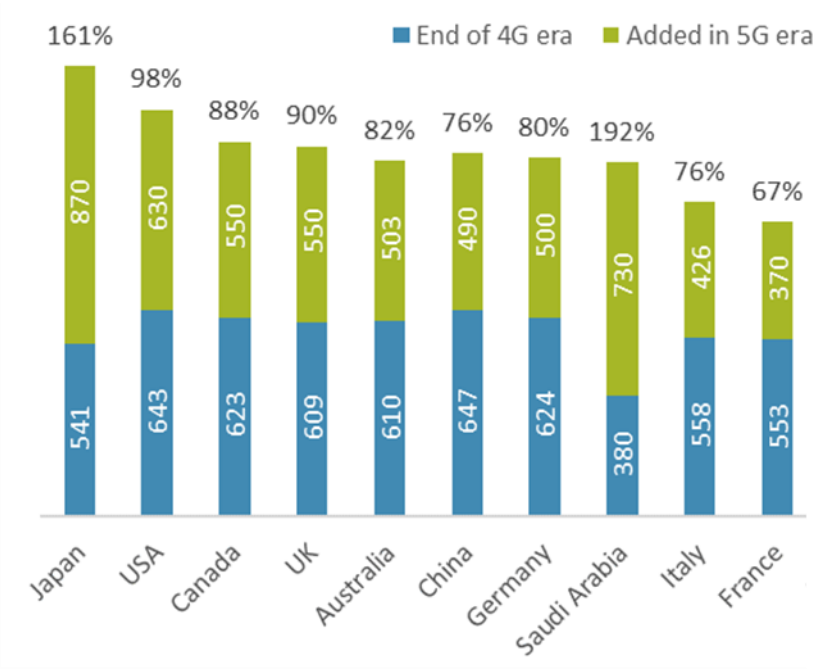
b) Driven by a large increase in the interest rate environment since 2021, the **discount rate** increased. This raises the cost of investing in long-term spectrum licences, thereby reducing spectrum valuations.

68. After discussing each factor in more detail, we conclude this section by setting out how Ofcom can bring them together to build a model of how UK spectrum values developed between 2021 and 2025.

Section 3.1: Supply-side factors

69. A critical factor explaining the decline in market value for spectrum across the entire 5G era is the increase in spectrum supply. In the UK, spectrum supply for mobile increased by 90% between the 2013 4G auction and 2021 second 5G auction. Other major economies in Europe and beyond have seen a similar transformation, as illustrated in Figure 1. Other things being equal, if the supply of an input increases significantly, the price falls. Therefore, it is reasonable to assume that increased spectrum supply has played a key role in the reduction in unit prices paid for spectrum observed in the UK and worldwide since 2015.

Figure 1: Change in supply of mobile spectrum for major economies, 2015-2023

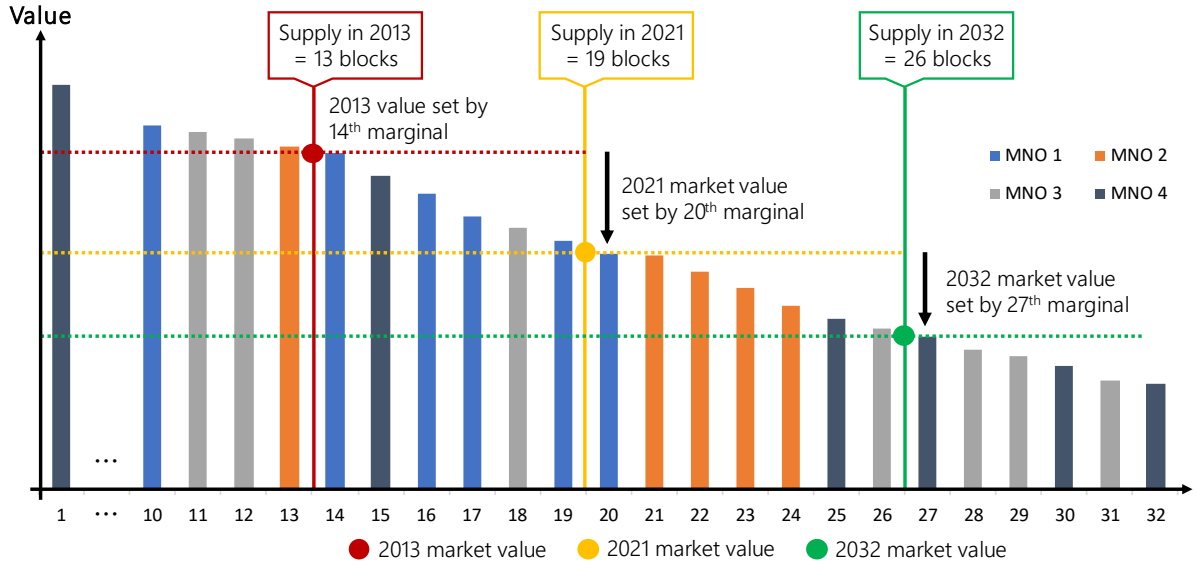


Source: Marsden, R., Round-by-Round, Learnings from the First 35 Years of Spectrum Auctions, Figure 34, page 113.

70. Market values are set by the interaction of demand and supply. Operators exhibit broadly conventional demand curves for spectrum, with diminishing returns for incremental spectrum. In contrast, supply curves are far from conventional, as the supply of spectrum at any given time is fixed. Consequently, in the short-to-medium term, operators face horizontal supply lines. Periodically, this supply line is moved to the right, as regulators release more spectrum for mobile.

71. This relationship is illustrated in Figure 1, where we plot demand and supply for low-band spectrum in a four-player market. The demand curve is made up of a set of hypothetical values for incremental 2x5 MHz blocks of sub-1 GHz spectrum from all operators arranged in descending order. We have overlayed this with three horizontal supply lines corresponding to the supply of low-band spectrum in three eras, which we have aligned with past, current and future UK supply: 2013 (800 MHz + 900 MHz = 13 blocks); 2021 (existing + 700 MHz = 19 blocks); and 2032 (existing + 600 MHz = 26 blocks). In each case, the market value is set by the highest incremental demand that cannot be satisfied within the fixed supply of 2x5 MHz blocks. Other things being equal, an upward shift in the supply curve (i.e. to the right in Figure 2) significantly reduces market value.

Figure 2: Impact of increasing supply on market value of spectrum



Notes: Horizontal bars show hypothetical values for incremental 2x5 MHz blocks of low-band spectrum, arranged in descending order. The market value is set by highest losing value at each level of supply.

72. The evidence that increasing supply of spectrum has driven down the price of spectrum over time seems incontrovertible. For example, Marsden (2024) reveals that average prices paid per MHz for low-band spectrum worldwide more than halved in the period from 2016 to 2023, and identifies increased spectrum supply as the "*major factor*" explaining this.[22] And the Canadian Regulator, ISED, in its 2024 consultation on setting prices for spectrum renewals, said that "*Overall, international spectrum licence fees have shown a downward trend over time* ***as additional spectrum is made available*** *and peer regulators seek to promote service deployment conditions"* [emphasis added].[23] The downward movement in UK spectrum prices across auctions and ALF reviews over the last 15 years is also consistent with this trend.

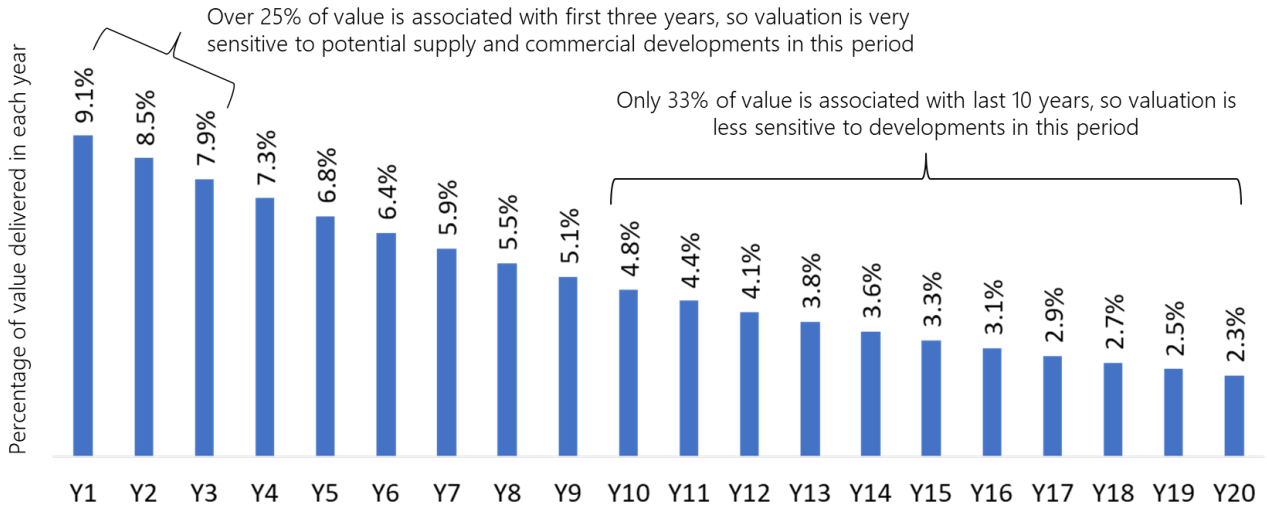
73. Ofcom's failure to properly analyse the impact of increasing spectrum supply on market value over time is a serious flaw. At paragraph 3.56, Ofcom claims that it can ignore the "*supply of spectrum*" on the basis that operators factor this into their forward valuations. This assumption is wrong, as it fails to consider how future supply is factored into valuations. Operators do, of course, factor future supply into valuations. However, access to scarce spectrum in a period prior to the release of future supply may command a significant value premium, especially of the timing of future supply increases is uncertain

[22] Marsden (2024), page 110. See also Figure 2 in "The NERA report" (September 2024) that VMO2 submitted to Ofcom as part of the pre-consultation process.
[23] ISED, December 2024, Consultation on a Fee Framework and Amendments to Conditions of Licence for Certain Spectrum Licences Used to Provide Commercial Mobile Services Below 10 GHz.

and may be delayed. Operators may be willing to pay a premium for spectrum now over spectrum later if this confers a competitive advantage or reduces strategic risk.

74. To understand why even short periods of differences in supply can have a big impact on spectrum values, consider the following example. Suppose that an operator is valuing an incremental block of spectrum over 20 years. For illustrative purposes, let us start with a simplifying assumption that the spectrum will deliver equal value in nominal terms in each year of the licence. Applying a WACC of 7.5%, this gives a profile for the real annual returns from the spectrum block as illustrated in Figure 3. With this profile, in today's money, 25% of the value is generated in the first 3 years and only 33% of the value in the final 10 years. Consequently, valuations and thus market prices observed in auctions are highly sensitive to potential near-term supply and commercial developments and less sensitive to long-term changes.

Figure 3: Percentage of value delivered each year for a 20-year asset generating equal annual cash flows



Notes: Each column reports the proportion of value associated with that year if value is expressed in Year 0 prices and the buyer uses a weighted average cost of capital (WACC) of 7.5%.

75. An obvious implication of this profile is that the expected timing of supply shifts can have a big impact on value. With more supply, the amount of demand that can be accommodated is increased, so the price should fall. Operators should anticipate this in their valuation model, so a near term supply expansion should have a big impact on value and a distant one a much lower impact. However, even a modest time interval between awards of substitutable spectrum can result in marked value differences between awards, as a disproportionate share of the value may be associated with how the earlier available spectrum is used in the first few years of the licence term.

76. A complication is that the actual value profile that a spectrum block may deliver over time may vary depending on technology ecosystems and market circumstances. For example, the value of an incremental block earmarked primarily to meet future capacity

requirements may be disproportionately weighted towards the later years of the licence term, i.e. a flatter profile for Figure 2. In contrast, if an incremental block delivers an immediate market advantage – such as a higher 5G speed shout, or an enhanced strategic position in a future auction – the value may be disproportionately associated with the early years of the term, i.e. a steep downward value curve in Figure 2.

77. Applying this logic to UK auctions and considering our own experience as a bidder, we observe that the supply of spectrum has played a leading role in determining relative price outcomes within and across UK spectrum auctions:

    a) **700 MHz vs 800 MHz.** The release of 700 MHz in 2021 delivered a 46% increase in supply of low-band paired spectrum, moving the market from the first to second supply curve in Figure 2. Predictably, this was associated with a significant reduction in the price paid per MHz for 700 MHz in 2021 compared to 800 MHz in 2013.

    b) **2.3 GHz vs 3.4 GHz.** In the 2018 auction, the 2.3 GHz spectrum sold at a discount to 3.4 GHz, even though 2.3 GHz offered an established 4G ecosystem and better propagation. This outcome may seem perverse but it can readily be explained through a supply lens. 2.3 GHz offered more mid-band capacity for 4G, but most UK operators (O2 excepted) already had a lot of this type of spectrum. In contrast, the 3.4 GHz band was a first opportunity for UK operators (Three excepted) to acquire 5G capacity spectrum, so was identified by all as a strategic imperative.

    c) **3.4 GHz vs 3.6 GHz.** At paragraph 3.41, Ofcom struggles to explain why the price of "*functionally equivalent*" spectrum dropped significantly between the 2018 and 2021 auctions. However, there is a simple explanation: shifting supply. In 2018, 3.4 GHz spectrum commanded a significant premium because it was the only immediately available 5G capacity band. As a bidder in that auction, our view was that an operator that failed to secure at least 40 MHz of 3.4 GHz (Three excepted owing to its pre-existing holdings) risked being handicapped in its ability to launch 5G. This made for a high stakes and highly strategic auction, in which winning bidders paid a premium price. In contrast, in 2021, with spectrum supply nearly doubled and all operators already having a critical mass of 3.4 GHz, the stakes were lower and there was less incentive for strategic play raising prices above long-run market value. Accordingly, we strongly disagree with Ofcom's conclusion at paragraph 3.42 that it should put equal weight on prices observed in both auctions. It should focus on the 3.6 GHz price when supply was fully available.

78. Looking forward, we expect supply dynamics to continue to play a significant role in determining the market value of UK spectrum, exerting further downward pressure on the value of 900, 1800 and 2100 MHz:

    a) **900 MHz.** It is increasingly likely that an additional 2x35 MHz of low-band spectrum at 600 MHz will come available in the early 2030s. UK broadcasters have signaled their desire to turn off DTT and vacate the broader UHF band.

Mobile is the obvious use case for 600 MHz, as there is already an ecosystem established at 617-698 MHz (this spectrum is used in North America for 5G). This positive supply shock, equivalent to moving from the second to third supply line in Figure 2, will reduce the market value of other sub-1 GHz spectrum. As the release date for this spectrum approaches and certainty over timing of availability increases, the expected extra supply will increasingly weigh on the market value of 900 MHz.

b) **1800 and 2100 MHz.** We anticipate that the general increase in the supply of new mobile spectrum will continue to weigh on the market value of these bands. New supply at 1500 MHz (25 MHz) and 600 MHz (70 MHz) will offer better propagation for 5G. And operators now have plenty of alternative frequencies at 2300, 2600 and 3500 MHz to meet their capacity requirements, and may benefit from 6 GHz in the future. Indeed, Ofcom has proposed that mobile share the 6 GHz band with WiFi on the basis that the value of the spectrum to mobile may no longer be sufficient to justify allocating the entire band to mobile, an unprecedented development. This approach appears to be grounded in an expectation that marginal spectrum value will fall as spectrum supply increases.

79. With the passage of time, operators gain better information on future supply and this affects the value of spectrum they purchased in the past. The ongoing direction is for more spectrum in relevant bands to have become available for mobile use, and this will continue in coming years. More spectrum supply means that the marginal value of spectrum reduces even when the value of all spectrum held by operators increases. For Governments, who may be concerned about revenue impact, it is relevant to consider that lower unit prices for spectrum do not necessarily mean less revenues, as operators pay for a greater volume of spectrum.

80. In summary, we consider that increasing spectrum supply is a critical factor explaining the observed decline in UK market value for low-band (including 900 MHz) and lower mid-band (including 1800 and 2100 MHz) spectrum between 2013 and 2021. We think it remains relevant but is less important as an explanatory factor for the further decline in UK market values between 2021 and 2025, as the next wave of UK supply increases are modest in size (L-band), not close substitutes (mmWave) or years away (e.g. 600 MHz, 6 GHz). Expanding supply is also a massive factor in explaining why European and global benchmark spectrum prices have been falling. Ofcom's failure to account for spectrum supply as a critical factor affecting market values leads it to overweight prices from legacy awards, such as the 2015 German 5G auction that took place under constrained supply.

Section 3.2: Demand-side factors

81. In well-run spectrum markets, the prices in 5G-era spectrum auctions are primarily determined by competition for incremental spectrum between established operators. The most important element in a valuation model is therefore the expected traffic load over the licence term, as this determines how the spectrum will be utilised and the extent to which other network investment to deliver capacity will be required. Any model of market value must consider the role of data traffic in driving demand for spectrum.

82. Ofcom's analysis omits any meaningful discussion of how data traffic has and is expected to evolve, and how this might impact spectrum value. Yet understanding traffic is key to understanding what has happened and may happen to spectrum values.

83. There are two key trends:

    a) **Mobile traffic volumes have been rising every year but growth is slowing.** Rising traffic underpins the industry's need for more spectrum and sustains willingness to pay for spectrum, despite increased supply. Traffic growth is slowing, with projected growth rates much lower than previously forecast. With the benefit of hindsight, we now know that historic valuation models overstated future traffic growth (as based on market expectation at the time), and therefore overstated spectrum values. This overstatement is particularly pronounced when comparing 2021 to today.

    b) **Technology change has increased the amount of traffic that can be carried over a given amount of spectrum.** This trend, associated with late-4G era and 5G era technologies such as massive MIMO antennas and beamforming, has partially mitigated the need for more spectrum to meet rising traffic.

Mobile traffic

84. Operators need spectrum to provide network capacity to support rising data traffic and meet customer demand. They want enough spectrum to be able to increase capacity when needed to avoid congestion or to deliver increases in quality. They want to avoid owning spectrum that remains largely unused and where alternative delivery is more cost effective than the cost of acquiring and deploying the spectrum. A challenge for operators is that they purchase spectrum with licence duration of at least twenty years, so valuation models must project demand for a long period. The compound effect means that limited demand changes in initial years can have a great impact on demand later in the valuation period when incremental spectrum will be most needed.

85. Other things being equal, rising absolute levels of mobile traffic should increase the value of spectrum. This is because, each year, marginal spectrum should be more highly utilised within a network. However, other factors can and do offset this upward pressure. As discussed above, spectrum supply increases may address incremental traffic, allowing operators to shift down their demand curve. And, as we discuss here, traffic forecasts may change. A modest decrease in expected annual traffic growth can lead to very large decreases in projected capacity requirements over the lifetime of a spectrum licence.

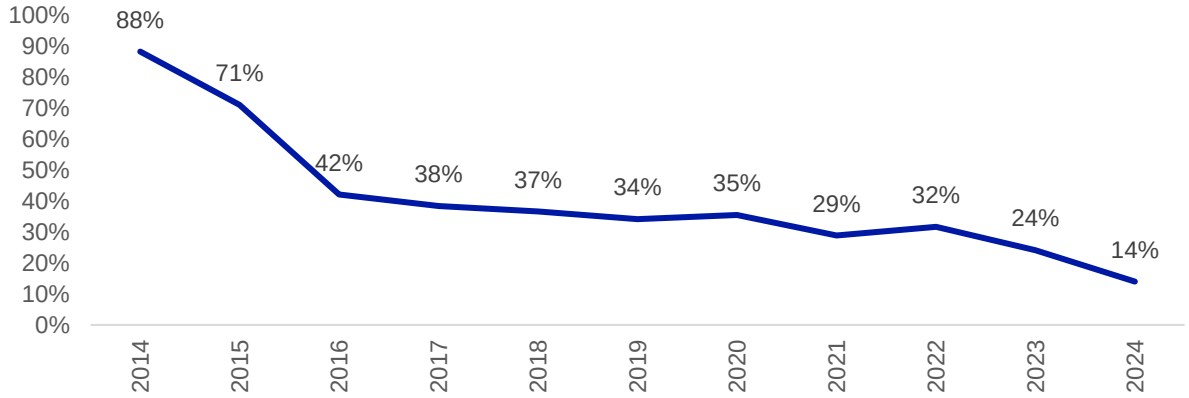
86. Figure 4 shows actual year-on-year UK mobile data growth rates, as reported by Ofcom, between 2014 and 2024. This period can roughly be divided into three parts:

    a) 2014 – 2016: Data growth rates were very high but falling, as data use expanded from what we would now consider a modest base;

    b) 2016 – 2022: data growth was relatively stable, with a modest decline from around 40% to 30%; and

c) 2022 onwards: data growth rates declined sharply from around 32% in 2022 to 24% in 2023 and 14% in 2024.

Figure 4: UK mobile data growth, year-on-year



Source: Ofcom Telecommunications Market Data Update Q3 2024
Note: 2024 year-on-year growth rate extrapolated from data up to Q3 2024 using quarterly seasonal adjustments derived from 2014 to 2023

87. Ofcom's last two ALF reviews, in 2018 and 2021, and the last two UK spectrum auctions, in the same years, occurred in the period of relative stability in growth rates. At the time, Ofcom was of the view that traffic levels would would either stay close to this level or might increase. Notably, in 2022, Ofcom forecast a 10-year compound annual growth rate (CAGR) for UK mobile data traffic of between 25% and 55%, with a medium case of 40%.[24] Many other forecasters were bullish. For example, in 2021, Ericsson forecasted a 5-year CAGR of 28% for Western Europe.[25]

88. In hindsight, these data projections look far too optimistic. Ofcom's own data shows UK data growth falling to 14% in 2024.[26] Similarly, Ericsson's latest mobility report is projecting a 5-year CAGR of 14% for Western Europe.[27] Some commentators, notably former Ofcom CTO William Webb, have projected that traffic levels could level off by around 2027.[28]

89. In our opinion, an operator building a conservative business case for a UK or western European spectrum auction in 2021 might plausibly have used a 5-year CAGR of 25%-28%, declining thereafter. In contrast, even an operator with an optimistic business case in 2025 would be unlikely to use a CAGR greater than 14% for the next 5 years. This

[24] Ofcom, 9 February 2022, Mobile networks and spectrum: Meeting future demand for mobile data, Discussion paper.
[25] Ericsson Mobility Report, June 2021.
[26] Ofcom, Telecommunications Market Data Update Q3 2024.
[27] Ericsson Mobility Report, November 2024.
[28] See, for example: https://www.lightreading.com/5g/data-traffic-growth-or-decline-there-s-no-upside-for-telecom.

change has a big impact on valuation models. For example, owing to compound effects, if traffic grew 14% per annum for 10 years, the traffic level at the end of year 10 would be just two-fifths of the total if traffic had grown at 25% per annum. Over 20 years, other things being equal and with no efficiency gains from technology improvements, this would result in a 80% decline in valuation.[29] A change of this magnitude can obviously swamp other factors, such as annual inflation of 1-4%.

90. Ofcom is aware of these shifts in data growth. For example, it presents a similar description of trends in mobile traffic growth in its February 2025 consultation access to the 6 GHz band:

> "*Data published through our Connected Nations reports suggests that, in absolute terms, fixed traffic volume is roughly ten times that of mobile. While both have reliably grown year-on-year, the growth rate for mobile traffic has been consistently higher than fixed traffic. However, the annual growth rate in traffic over both fixed and mobile networks has slowed in the last five years, with the current annual growth rate for mobile down to less than 20% and for fixed networks less than 10%. This is in line with Ericsson's November 2024 Mobility Report which shows slowing global mobile traffic growth rates, including forecasted annual mobile traffic growth rates for Western Europe (2024–2030) dropping from 17% to 14%*."[30]

91. In its proposals for the 6 GHz band, Ofcom relies on on a downward revision in mobile traffic projections to justify its novel proposals for mobile to share the band with WiFi. Yet, Ofcom has failed to act consistently and take account of lower demand forecasts when adjusting benchmarked spectrum prices for the purposes of determining ALFs. This is a serious error that Ofcom must address when updating its proposals.

Technology change

92. Improvements in antenna technology (specifically massive MIMO with beamforming) have increased spectral efficiency as well as the coverage of mid-band spectrum from 1800 MHz through 3.8 GHz. It is widely recognised that this has extended the universe of usable mobile spectrum, making it economic to deploy large bandwidths above 3.4 GHz, and diminishing the premium value associated with lower frequencies.

93. Ofcom has acknowledged that technology impacts the utility of spectrum. For example, in its 2018 ALF decision, Ofcom recognized that MIMO and beamforming might erode the value of 1800 MHz over time.[31] And in the current consultation, it says that "*EBITDA margins are more informative of spectrum values over time than unit margins, especially* ***when technological developments can enable an increase in the amount of traffic that can be carried over a given amount of spectrum***" [emphasis added].[32] However,

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[29] Calculated using the multi-factor model presented in Section 3.4.
[30] Ofcom, 13 Feb 2025, Expanding access to the 6 GHz band for mobile and Wi-Fi services, Consultation, para 2.27.
[31] Ofcom (2018), Section A3.
[32] See paragraph 3.54 of Ofcom's ALF Review Consultation.

oddly, its latest discussion of this trend links technology change to industry profit margins, a relationship that is indirect and opaque, when it should think about its direct impact on spectrum benchmarks and LSVs.

94. At the time of 2018 ALF decision, the economic benefits of massive MIMO were not yet fully understood. The topic was a relatively late input into the process. However, over the next few years, the technology rapidly transitioned from innovation to an integral part of network planning for European operators. From about 2021, we think it reasonable to suppose that the benefits of this technology change were substantially accounted for in valuations, and no equivalent efficiency gains of similar magnitude have yet materialised. For benchmarks before 2021, the older they are, the greater the risk of overstatement because improvements in spectral efficiency were likely underestimated. A problem with Ofcom's approach is that it gives equal weight to all benchmarks from 2015 onwards, when technology evidence suggests it should put decreasing weight on benchmarks as you move back in time from around 2021.

Industry consolidation

95. Many countries worldwide have seen consolidation in the number of mobile operators, usually from four to three. When operators merge, the combined entity has a larger traffic base so it is to be expected that it will require more spectrum than either of its predecessors. However, there is normally some duplication in spectrum holdings. Often, this is reflected in merger remedies, voluntary or otherwise, involving the sale or return of spectrum. As a result of this reblancing, more marginal demand for spectrum may be accomodated, equivalent to a downward shift in the industry demand curve. Other things being equal, this will reduce market value.

96. This is a topical issue for the UK given the approved merger of Vodafone and Three, and spectrum transfer to VMO2. In the 700 MHz auction, Vodafone's losing demand set the price of what is now the key benchmark for 900 MHz ALF. While there is no equivalent UK benchmark for 1800 and 2100 MHz, we think it reasonable to suppose that VMO2 would set the marginal value in a hypothetical auction, given our relatively weak lower mid-band holdings. The merger has the potential to reduce market value for all three bands as the MergeCo will likely have a lower marginal value for low-band, now that it has more low-band than VMO2 or EE. And our own marginal value for more 1800 MHz or 2100 MHz will be reduced as a result of the new spectrum we are acquiring.

97. We have not attempted to factor consolidation into our quantitative estimates of UK value, in part because the transactions are not yet complete. However, we think that the impact of consolidation should at least be considered by Ofcom as a qualitative overlay to its results, in support of a conservative approach.

Section 3.3: Market environment

98. When considering the value of spectrum over time, it is also relevant to consider exogonous economic factors that may impact the market value of spectrum. In the same way that we consider both supply and demand, we focus here on inflation and discount rates as the two are linked. These two exogenous factors have seen significant changes

in recent years, and are known to affect spectrum valuations. Other relevant exogonous factors include population growth and economic growth, given that these impact the size of the addressable market and ability to spend of the customer base. However, in both the UK and much of Europe, population and economic growth have tracked projections, so we might reasonably assume that traffic projections account for these factors. Hence we focus on the capital market environment.

Inflation

99. Ofcom's view is that, other things being equal, the market value of spectrum should increase with inflation. As we have shown here, other things are not equal: there are other factors at play – such as new spectrum supply and changes in data growth – that can and do offset the impact of inflation on spectrum value. Nevertheless, it is relevant to consider rising general prices as a factor when assessing how spectrum values change over time.

100. There are at least two ways that inflation may impact spectrum values. Firstly, a significant component of any spectrum value model is the avoided cost of network deployment that might otherwise be required to deliver greater capacity. To the extent that the costs associated with network deployment, such as incremental network equipment costs and labour rates, track inflation, then one would expect this to push up market values. In practice, we doubt whether inflation in mobile equipment is as high as general inflation, in particular, because increased scale in the supply of electronic equipment leads to falling unit prices over time.[33] Secondly, to the extent that operators are able to pass through inflation to customers, higher prices increase the absolute size of the market, so should increase the commercial value associated with spectrum. And, as noted above, operators' ability to increase prices with inflation has been limited by downstream competition. Accordingly, we think that Ofcom's proposal to adjust by inflation overstates the impact of rising input prices on spectrum values.

101. In previous reviews, Ofcom's application of inflation to historic benchmarks was not contentious. There were two reasons for this. Firstly, inflation rates were low (well below 2% on average) and stable, so applying inflation would not significantly distort comparisons of benchmarks across years. Secondly, Ofcom has always taken an "in the round" approach to assessing benchmarks, rather than applying simple averages. Any noise associated with modest inflation adjustments was therefore second-order relative to the position Ofcom adopted on weighing benchmarks.

102. In this Consultation, two things have changed, causing inflation adjustments to become a highly contentious issue. Firstly, inflation between 2021 and 2025 was much higher and unstable. Worldwide supply distortions led to a surge in UK inflation which was exceptionally high in 2022 and 2023 and remains well above the Bank of England's 2% target. Market and public expectations are for average UK inflation to be in the range of

[33] For instance, [REDACTED].

2.45%-2.80 over the next 10 years with potential for significant volatility.[34] Secondly, as we discuss further in Section 4, Ofcom has good benchmark evidence for the value of UK spectrum in 2021, but lacks benchmark evidence for how prices have changed since then. The LSVs that Ofcom proposes for 2025 are essentially its 2021 valuations plus inflation, so inflation adjustment has become a critical part of its metholodology.

103. In summary, we accept that when considering the value of spectrum in 2025, it is appropriate to account for changes in the general price level. However, we have two concerns with Ofcom's approach. Firstly, we expect that the impact of operator-specific inflation has been less than general inflation which means that mechanistic application of CPI to UK and European benchmarks is not conservative. Secondly, inflation is only one and not the most important factor driving spectrum values. Application of inflation to spectrum values without considering the impact of changes in other factors leads to the erroneous conclusion that nominal market values are going up, instead of down.

Discount rate

104. The increase in inflation after 2021 prompted the Bank of England to increase its interest rates with a knock-on impact on market-wide interest rates. This has led to increases in the discount rates that UK operators use to value their spectrum. The mobile industry requires high capital investment, so the business case is sensitive to higher discount rates, with increased financing costs offsetting any value gains from higher inflation.

105. Operators value spectrum in the same way you would value a financial instrument, such as a bond. There are costs: they invest to acquire spectrum, to deploy it and to sustain deployment. There are benefits: when deploying more spectrum, they expect greater commercial returns and/or savings on network spend. Costs involve major initial investment whereas benefits accrue more gradually over time. When dealing with cashflows over time, investors project incoming and outgoing initial and future cashflows and discount them using a discount rate to determine the net present value of the asset.

106. A higher discount rate means that operators more heavily discount their future cash flows (which are more benefit heavy), which absent changes in future cash flows, reduces their valuation of spectrum. Although this may be partially offset by higher nominal revenues, owing to inflation, a reasonable expectation is that the industry will lose more value than it gains.

107. Ofcom estimated the real post-tax discount rate used in calculating the annualisation rate has increased by 1.6% point between 2021 (at its 2100 MHz ALF Statement) and its current Consultation. This percentage point increase is broadly in line with our own observed increase in discount rates of 1.4% from the 2021 auction until today (the

[34] See pages 12-13 of NERA, 7 March 2025, *Deriving ALFs from LSVs – A Response to Ofcom's 2024/25 Consultation on the calculation of the annualisation rate for use in determining ALFs*, submitted to Ofcom by VMO2. This is the range that NERA predicts assuming that Ofcom does not change its assumption on the inflation risk premium.

difference may reflect factors specific to VMO2, such as the joint venture between Telefonica UK and Virgin Media, and changes in funding structure).

108. In summary, a side-effect of higher inflation has been increases in mobile industry discount rates. This exerts downward pressure on forward-looking spectrum valuations. If Ofcom adjusts for inflation, it should also adjust for the impact of higher discount rates on market value. Considering how changes in industry discount rates impact valuations is consistent with Ofcom's approach to other regulatory decisions, e.g., MCT.

Section 3.4: Modelling spectrum value over time

109. As we discuss in our analysis of LSVs, our primary objection to Ofcom's proposals is the way it has derived values for 2025 from historic LSVs. It de facto adjusts 2021 values for UK inflation while ignoring other factors that have impacted spectrum value. Above, we identified a range of factors that have impacted spectrum values over the last decade, including but not limited to inflation.

110. The following factors stand out as being significant in the period 2021-25:

    a) **Supply:** Future increases in spectrum supply are more certain and closer in time now than they were in 2021 (*Downward pressure*).

    b) **Data growth**: Traffic has increased from 2021 to 2025, but expectations for data growth have fallen significantly, with projected CAGR over 20 years falling from upwards of 19% to less than 14%. (*Significant downward pressure*). This impact will be partially mitigated though by reduced expectations regarding future efficiency savings from new technology. (*Combined, downward pressure*)

    c) **Inflation**: There has been significant inflation, so price levels in 2025 are higher than in 2021, and inflation is expected to average well above the level expected in 2021 (*Upward pressure*).

    d) **Discount rates**: According to Ofcom, the real, post-tax discount rate increased by 1.6% point between 2021 and 2025 (*Downward pressure*).

111. To illustrate the impact of these changes on spectrum valuation, we developed a simplified 20-year cost-avoidance model. In our model, additional spectrum is valued based on the difference in cash flows between a scenario with and without additional spectrum. Without additional spectrum, increases in yearly traffic require a network expansion driven by the investment in additional sites. With additional spectrum, the number of sites required to satisfy the traffic is reduced owing to the increased capacity per site provided by the additional spectrum. The spectrum value is the net present value of the difference in cash flows between these two scenarios. Our model is described in detail in the appendix.

112. We used the model to determine the spectrum value in 2025 based on the observed spectrum value in 2021, information about how the factors noted above have developed between 2021 and 2025, and assumptions about how the factors will develop going

forward. As we only use the model to determine *the change in value* over the reference period, not absolute values, we can ignore much of the detail that is required in a full valuation model.

113. The key information and assumptions that we rely on are as follows:

a) **Supply**: We consider that there will be a 35% increase in the relevant supply of spectrum in around 2032.[35] This expansion was 11 years away in 2021 and is only 7 years away in 2025.

b) **Data growth**: We consider the change in levels of data traffic and forecast CAGR between 2021 and 2025. Data consumption increased by 86.5% between 2021 and 2025, but forecast growth rates have decreased. In 2021, an operator would have observed the declining year-on-year growth rates from 88% in 2014 to 29% in 2021. Accordingly, we model a conservative operator building a valuation in 2021 with a 5-year CAGR of 25%, decreasing thereafter.[36] This is equivalent to a 19% CAGR over a 20-year licence starting 2021.[37] Similarly, having observed the 14% year-on-year growth rate in 2024, an operator today would likely start its projection around 14% while decreasing the rate over time. This equates to a CAGR from 2025-2045 of 13%.[38]

   We also consider the effects of the evolution of spectral efficiency which has increased with the adoption of technologies such as massive MIMO. Expectations of further progress have slowed in recent years, implying that valuations in 2021 may have been overly bullish relative to a valuation in 2025. Thus, this factor may mitigate somewhat the downward pressure on valuations from lower expected data growth.

c) **Inflation**: We consider the change in levels and forecasted inflation between 2021 and 2025. The level of prices has increased 23.8% between 2021 and 2025. In addition, forecasted inflation has also increased. We assume that spectrum valuations in 2021 would have used a 20-year inflation forecast of around 2%, while valuations in 2025 would forecast inflation at around 2.5%.

d) **Discount rates:** Based on Ofcom's 2024/2025 Consulation, we assume that the real, post-tax discount rate has increased by 1.6 percentage point in our model. This is the change identified by Ofcom between its 2021 ALF Statement and the current Consultation in relation to the discount rate used to calculate the

[35] Specifically, we assume that an operator expects to expand its total spectrum holdings (excluding mmWave) by one-third from 300 MHz to 400 MHz.
[36] 25% is equal to Ofcom's low case in Ofcom's 2022 Mobile Market Forecast. See footnote 24.
[37] 19% is the CAGR of a series growing at 25% for five years, 22% for another five years, and 15% for five years, and 14.5% for an additional five years
[38] 13% is the CAGR of a series growing at 14% for five years, 13% for another 10 years, and 12% for five additional years.

annualisation rate. Increases in discount rates can also be observed in financial reports released by VMO2 and BT.

114. Table 3 provides a summary of key assumptions and results of our model. Based on our model, we estimate that the changes in supply, data growth, inflation, and discount rates between 2021 and 2025 have decreased spectrum values by ~20% between 2021 and 2025. Amongst these factors, the most significant ones are the downward revision in data traffic forecasts and inflation.

Table 3: Impact of the major factors affecting spectrum value between 2021 and 2025

	Assumptions used in valuation in different years		
Factor	**2021**	**2025**	**Impact on spectrum value***
Supply	Additional 100 MHz in 11 years (2032)	Additional 100 MHz in 7 years (2032)	-9.9%
Data growth (demand)	19% data CAGR 2021 – 2041 14% efficiency CAGR 2021 – 2041	86.5% data base increase 2021 – 2025 13% data CAGR 2025 – 2045 46% efficiency base increase 2021-2025 10% efficiency CAGR 2025 – 2045	-22.9%
Inflation	2.0% CAGR 2021 – 2041	23.8% base increase 2021 – 2025 2.5% CAGR 2025 – 2045	+22.1%
Discount rate	7%	8.6%	-10.1%
TOTAL			**-20.81%**

*Notes: * See the appendix for our methodology to calculate the impact of each component.*

115. As a cross-check on this model, we reviewed our actual valuation model used to value 700 MHz spectrum ahead of participating in the 2021 auction. This model considered a variety of factors that impact spectrum value, including but not limited to scenarios for mobile traffic growth, separate inflation forecasts for equipment costs[39]and other types of network cost (such as labour, energy etc..), and cost of capital. The model did not focus on future spectrum supply, as this was assumed to be more than ten years away and therefore of limited impact. We explored the impact on results of applying 2025 actuals

[39] Historically, Ofcom has undertaken extensive analysis of equipment costs when setting regulated prices. So there appears to be no reason why Ofcom could not, at least for the backwards inflation adjustment, use a more accurate observed inflation figure for network costs, rather than rely on inflation in the general economy as the relevant measure.

and forecasts concerning inflation, mobile traffic and our internal discount rate versus our assumptions heading into the 2021 award.

96. Our findings are as follows.

    a) Network cost inflation has an upward impact on spectrum values, but our model built in an expectation that equipment cost price increases would be less than general price increases, owing to [REDACTED] and an expectation 5G equipment prices would fall over time as the ecosystem matures.

    b) Increasing the discount rate reduces our valuation of spectrum compared to 2021. It largely offset the upward valuation impact from higher inflation.

    c) Adjusting mobile traffic projections (bringing them in line with recent actuals and revised forecasts) substantially reduces spectrum valuation bringing it well below the level estimated ahead of the 2021 auction.

97. Overall, the simplified model broadly aligns with remodelling using a historical model for spectrum value to VMO2 in 2021. Our legacy model put somewhat greater weight on discount rates, and somewhat less on inflation and data traffic. [REDACTED]

98. Ofcom may be hesitant to rely on valuation models because they are sensitive to assumptions, many of which are hard to estimate. Nevertheless, it cannot ignore the understanding that can be gained from analysing determinants together and their combined impact on valuation. This approach stands in sharp contrast with Ofcom retaining its position that spectrum values likely remain constant in real terms and proposing to adjust both auction prices and fees by inflation alone. Ofcom is mistakenly adjusting for the value of money alone, not the value of spectrum – which it is bound by the Direction to derive. In particular, the error to not account for changes in mobile traffic (as key forward determinant of spectrum values) leads Ofcom to inflate valuations when it should be reducing them.

Section 4: Ofcom has over-estimated the LSV for all three bands

116. With respect to all three bands, we believe there is close to consensus between Ofcom and stakeholders regarding the value of spectrum in 2021. For 900 MHz, stakeholders agree with Ofcom that the observed UK auction value for 700 MHz in the 2021 auction is a good proxy for the market value of 900 MHz in that year.[40] For 2100 MHz, we have a decision on the value in that year, and stakeholders agree that 1800 MHz either has the same value or may be worth a modest premium (which Ofcom estimates is around 5%).

117. Ofcom's task is to identify the market price in 2025, as this the year from which revised ALFs will be determined. This should be based on assumptions about the evolution of UK market values from 2021 onwards. There is obviously uncertainty regarding the evolution of market value from 2021-25, as we lack any further UK auction benchmarks. Ofcom must therefore fall back on either analysis and general assumptions regarding the factors that impact market value in the UK, or international benchmark evidence regarding subsequent movement in spectrum prices. In this respect, applying its own words, Ofcom has an obligation to act "*conservatively*" to mitigate the "*asymmetric risk*" associated with setting prices above rather than below economic value. Given that Ofcom lacks the information to estimate market values in 2025 with precision, its own guidance dictates that it must set each LSV at the lower end of a reasonable range for market value.

118. Unfortunately, in developing LSVs in the Consultation, Ofcom has failed to follow its own guidance. Its proposed LSVs for all three bands are essentially just the observed 2021 values inflated with CPI. This is explicitly the approach for 900 MHz. For 1800 and 2100 MHz, Ofcom arrives at a similar conclusion, but indirectly via a (flawed) analysis of European benchmark evidence. As we set out in the previous section, inflation is just one of several factors that impact spectrum value over 2021-25. This results in Ofcom claiming that nominal market values for all bands rose 26% from 2021-25, even though we all (including Ofcom) agree that nominal values fell over 2018-21, and all evidence other than inflation pointing to an ongoing fall in values.

119. As we set out in this section, there are several methodologies available to Ofcom to estimate market value in 2025. These include (1) extrapolating from pre-2021 trends in market value through to 2025; (2) focusing on recent benchmark evidence for nominal prices; or (3) applying a multi-factor model that considers a range of factors that impact market value, including but not limited to inflation.

120. When we apply these methodologies to the three spectrum bands, we arrive at the following estimates for LSVs:

    a) 900 MHz: Between £9.3m and £14m, with a central estimate of around £12m.

[40] Both Vodafone and VMO2 said that the 900 MHz value should be set based on the UK 700 MHz auction price. We refer to operators' own submissions and the consultancy reports (from Frontier Economics for Vodafone, and NERA for VMO2) they commissioned.

b) 1800 MHz: Between £8.2m and £11.1m, with a central estimate of £9.1m.

c) 2100 MHz: Between £7.7m and £10.5m, with a central estimate of £8.7m.

121. Beyond 2025, Ofcom's default position is that annual fees should be increased by inflation. Our view is that this is too aggressive (see discussion in Section 6). Nevertheless, we recognise that the decision on how to adjust future annual fees is a separate decision from how to estimate LSVs in 2025. If Ofcom ultimately decides to maintain the approach of adjusting fees by inflation, it becomes even more important that Ofcom does not start with inflated estimates of market value, as any overstatement will be compounded by future inflation adjustments.

Section 4.1: Determining the LSV for 900 MHz in 2025

122. With respect to 900 MHz, there is a consensus between Ofcom and stakeholders that the observed UK value for 700 MHz in the 2021 auction is a good proxy for the market value of 900 MHz in that year.[41] In short, as of 2021, we have an exact benchmark for market value of low frequency spectrum in the UK. The challenge is how to convert this to a 2025 estimate of market value.

123. In Figure 5, we illustrate Ofcom's challenge and highlight the range of values in which Ofcom and stakeholders think the LSV for 900 MHz in August 2025 may lie:

    a) The **grey line** follows the implied LSV associated with the existing ALF regime, starting with the 2018 value of £19m per MHz and climbing to £24.5m in 2025, owing to inflation adjustments. Ofcom and stakeholders all agree that this line significantly overstates current market value.

    b) The **purple line** connects Ofcom's actual estimates of value of £19m in 2018 and £14m in 2021. This tells us that, whereas fees were rising in this period, actual market value fell.

    c) We illustrate three possible paths for the 900 MHz LSV from 2021-2025:

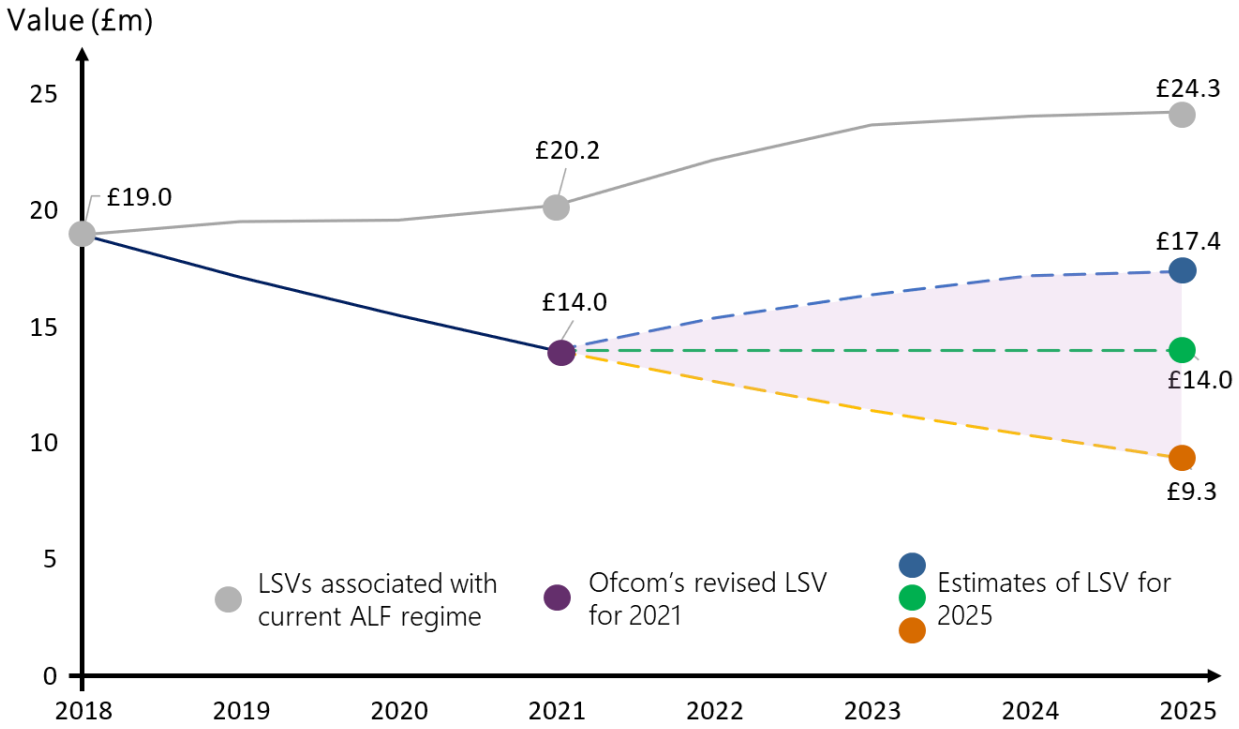
        i. A **blue dotted line**, that assumes that the LSV grew by inflation alone. This is the path that Ofcom has proposed to adopt.

        ii. A **green dotted line**, that maintains a fixed nominal price of £14m.

        iii. A **orange dotted line**, with a CAGR-based extrapolation of the downward price trend from 2018-21 through to 2025. This produces a price of £9.3m.

124. We have shaded the area between the blue and orange lines in pink. We think that all stakeholders, including Ofcom, agree that market value lies in this range.

Figure 5: Potential paths for UK lump sum value for 900 MHz



Notes: All values at nominal prices in August of each year, except 2018 which uses April 2018 prices. Values for 2025, where relevant, assume inflation of 2% for year to August 2025.

125. We make the following observations from this chart which we would like Ofcom to consider:

    a) **Ofcom's historic approach led to pricing above market value.** From 2018 to 2024, Ofcom applied annual CPI increases to ALFs. This approach led to operators paying an extra premium above market value, one that in hindsight cannot be justified as market value today is lower in nominal terms than it was in 2018.

    b) **Ofcom's proposal for setting LSV for 2025 is the least conservative approach available.** For the period 2021-25, Ofcom proposes to apply inflation to the 2021 LSV to derive the 2025 LSV. It has made this proposal notwithstanding its own evidence that applying inflation to ALF in this period contributed to a significant overstatement of market value. And, in focusing only on inflation, Ofcom has disregarded other evidence which suggests that the market value of low-band spectrum continued to decline in this period (see previous section). In our view, this is inconsistent with Ofcom's commitment to take a conservative approach to assessing the market value of 900 MHz.

126. More generally, Ofcom's proposed ALF for 900 MHz implies that it believes that the LSV for 900 MHz fell 26% in nominal terms between 2018 and 2021 but then rebounded upward by 23% from 2021 to 2025. This is a very peculiar trajectory. Essentially, Ofcom

is saying that market value from 2018-21 was driven by 'other factors' that swamped the impact of inflation, but subsequently these other factors can be ignored and market value has been solely impacted by inflation. If Ofcom stands by its adjustment proposal, it must explain what these other factors were, why they had such as big impact on value between 2018-21 and why they stopped mattering after 2021. Furthermore, if Ofcom believes that the nominal value of mobile spectrum is set to increase with inflation from 2021 for an indefinite period, why isn't Ofcom similarly reserving the upper 6 GHz band for mobile use, like it did the 3.6 GHz band?

127. A more convincing story is that there has been a long-run decline in the price of low-band spectrum, one that started well before 2018, has continued through to the current year, and may continue for many years to come. This decline has been sufficiently large that it has swamped the upward impact of inflation, resulting in year-on-year declines in nominal value. As previously discussed, there is plenty of evidence to support this story: including the long-run impacts of expanding spectrum supply and the recent decline in projected data growth on spectrum values, and the evidence of international low-band spectrum prices falling in the 5G era.

128. Given the evidence presented of the fall in spectrum value over the 2021-2025 period, it becomes obvious that applying inflation on top of the 2021 nominal value will result in an LSV significantly above market value, contrary to Ofcom's statutory duties and the 2010 Ministerial Direction. Accordingly, Ofcom needs an alternative methodology to derive the 2025 LSV based on the agreed 2021 value. Put differently, it needs to decide where in the pink area to set the LSV that provides the starting point for future 900 MHz ALFs.

129. We propose two methodologies that Ofcom can adopt to determine how the market value of 900 MHz has evolved over 2021-25:

    a) **Simple extrapolation.** The value in 2025 is estimated by extrapolating from trends identified from Ofcom's 2018 and 2021 observations.

    b) **Multi-factor model of market value.** The change in market value is estimated using a simple model of the major factors that influence value over time. Specifically, we apply the high-level multi-factor model of market value that we developed in Section 2.4. This focused on four main factors impacting market value between 2021 and 2025 as: spectrum supply; mobile traffic; inflation; and discount rates.

130. The results of applying these methodologies can then be cross-checked against international benchmark evidence for the evolution of spectrum prices in this period. In general, we would expect UK prices to follow as similar trajectory to global and, especially, European prices, although it might lag or lead those trends depending on local developments.

900 MHz LSV methodology 1: Simple extrapolation

131. The simplest methodology that Ofcom could adopt is to estimate a 900 MHz value for 2025 based on the observed path of market value from 2021-25. It could adopt one of the following three approaches:

    a) **CAGR-based depreciation of LSV.** Adopt a CAGR-based depreciation of nominal prices for LSV from 2018 to 2021 extrapolated to 2025. This would follow the orange dotted line in Figure 5 and produces a value of £9.3m.

    b) **Diminishing depreciation of LSV.** Assume that nominal values for LSV have continued to decline but at a diminishing rate. A conservative approach would be to draw a curve through the 2018 and 2021 values that flattens out by 2025. This approach increases the estimated market value to £12.3m.[42]

    c) **Constant nominal LSV.** Assume that nominal values for LSV were unchanged between 2021 and 2025. This approach de facto assumes that the impact of factors driving prices up and pushing them down net each other out. This is illustrated by the green dotted line in Figure 5 and produces a higher estimate of market value of £14.0m.

132. If Ofcom had interpreted its mandate from the UK government as giving it flexibility to set price below its estimate of full market value, then it might reasonably adopt approach (a), the CAGR-based depreciation of nominal prices. In our opinion, this most likely understates market value, as international evidence suggests the decline in low-band prices has slowed in recent years.[43] Looking forward, a significant advantage of this approach is that if Ofcom then applied CPI post-2025, it could be more confident that this does not result in prices exceeding market value for a considerable period because the starting point is so conservative.

133. Given Ofcom's intent to set the LSV at full market value, it may consider that the other two approaches are a better fit with its mandate. We think there is a strong case for approach (b), as it is based on two accepted UK evidence points and the resulting decline in nominal prices aligns with international trends (ongoing but slowed decline in nominal values). Approach (c) is harder to justify and leads to aggressive fees given benchmark evidence that nominal values are declining and our modelling finding that changes in other factors (most notably, less buoyant mobile traffic growth) exerted downward impact on spectrum values.

134. In our prior submission, VMO2 proposed applying a CPI-CPI backward adjustment for the purposes of determining the revised starting price for 900 MHz in 2025. This would keep the 2025 LSV for 900 MHz at £14m, i.e. consistent with approach (c). We think this approach will almost certainly overstate value, given benchmark evidence that prices

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42 We assume a simple functional form of $LSV_t = £11.8m + £7.2m*e^{-0.4*(t-2018)}$, where t is the year. Such a curve goes through the 2018 and 2021 values.

43 We refer Ofcom to the trend line for low-band spectrum reported in Figure 2 of the NERA report.

worldwide have been falling in nominal terms. Nevertheless, we recognise that this approach sets prices broadly in the middle of the plausible zone of uncertainty for the LSV on 900 MHz in 2025 (pink zone in Figure 5). We consider it represents a hard ceiling on the value range that Ofcom could propose without abandoning its commitment to adopt a conservative approach to estimating market values. As we show above, our internal model suggests that taking account of both exogenous factors, inflation and the corresponding changes in interest rates, would lead to a CPI-CPI outcome. However, since our previous submissions, our work on the endogenous factors of supply and demand has led us to conclude that CPI-CPI is very much an upper bound.

135. In the Consultation, Ofcom provisionally rejected our proposal to hold the LSV from 2021-25 constant in nominal terms, as "*Our starting point, consistent with our previous ALF decisions, is that all else equal, the value of spectrum is likely to remain constant in real terms over time*." [emphasis added]. However, as we have highlighted in this response, this is not a situation when "*all else is equal*". Ofcom knows that other factors caused the LSV for 900 MHz to fall in nominal terms from 2018-21, factors that in magnitude have more than offset the upward impact of inflation. As we have set out, we think the primary factors pushing down prices in the period to 2021 were increases in spectrum supply, technology change and declining expectations for data growth rates. In later years, we think the significant reduction in expected data growth has dominated. In simple terms, these factors are shifting the supply curve to the right and lowering the demand curve, developments that any economist will recognise as leading to lower prices. A decision that concludes otherwise would not be sufficient to withstand profound and rigorous scrutiny. Considering the period 2021-25, we expect these factors have led to a continued fall in nominal values and only to have been partially offset by higher inflation.

900 MHz LSV methodology 2: Multi-factor model

136. If Ofcom insists on including inflation in its determination of the 2025 LSV, then it must also consider other factors that impacted market value and derive a net impact. In Section 3.4, we set out a simplified model that identifies relevant factors, describes how they have changed from 2021-2025, and explores how they interact to drive changes in market value.

137. We found that the multi-factor model estimates a reduction in market value of ~20% for generic mobile spectrum. A model for low-band spectrum might not be the same, but most factors should be similar. Applying a 20% discount to the 2021 LSV for 900 MHz of £14m results in a 2025 valuation for 900 MHz of £11.2m.

138. This result sits within the pink zone we mapped in Figure 5, modestly below our preferred diminishing depreciation approach (b). The result aligns with prevailing evidence and the common-sense conclusion that the downward direction of 900 MHz market value from 2018-21 has continued through 2025. It demonstrates that Ofcom's proposal to only adjust for inflation is unsound as **other factors affected market value more than offsetting inflation's upward impact**.

Section 4.2: Determining the LSV for 1800 MHz in 2025

139. Turning to the LSV of 1800 MHz in 2025, a good starting point is to consider what has already been decided and what is broadly agreed by stakeholders[44]:

    a) Ofcom decided that the 1800 MHz LSV was £14.0m in 2018.

    b) Ofcom decided that the 2100 MHz LSV was £10.5m in 2021.

    c) Stakeholders agree that 1800 and 2100 MHz fulfil broadly similar roles in modern mobile networks and have similar value. In the Consultation, Ofcom estimated that the value premium for 1800 MHz is approximately 5%.

140. Collating this information enables us to plot Figure 6, in which we illustrate a range of values in which the 1800 MHz LSV in August 2025 may lie:

    a) The **grey line** follows the implied LSV associated with the existing ALF regime, starting with the 2018 value of £14.0m per MHz and climbing to £17.9m in 2025, owing to inflation adjustments. Ofcom and stakeholders all agree that this line significantly overstates current market value.

    b) The **purple line** connects Ofcom's actual estimate of value of £14.0m in 2018 and an inferred value of £11.1m in 2021, which is based on Ofcom's actual 2100 MHz value plus the 5.8% premium that Ofcom applies for 1800 MHz over 2100 MHz. From this, we can reasonably infer that, whereas UK 1800 MHz annual fees were rising in this period, Ofcom agrees than actual UK market value fell.

    c) We illustrate four possible paths for the LSV from 2021-2025:

        i. A **blue dotted line**, that assumes that the LSV grew by inflation. This is the approach that Ofcom proposed to estimate the 900 MHz LSV. This produces a projected price of £13.4m.

        ii. A **red dotted line**, that follows Ofcom's proposal for the 1800 MHz LSV, based on its interpretation of the distance methodology using European benchmarks. Ofcom's provisional LSV for August 2025 is £12.8m.

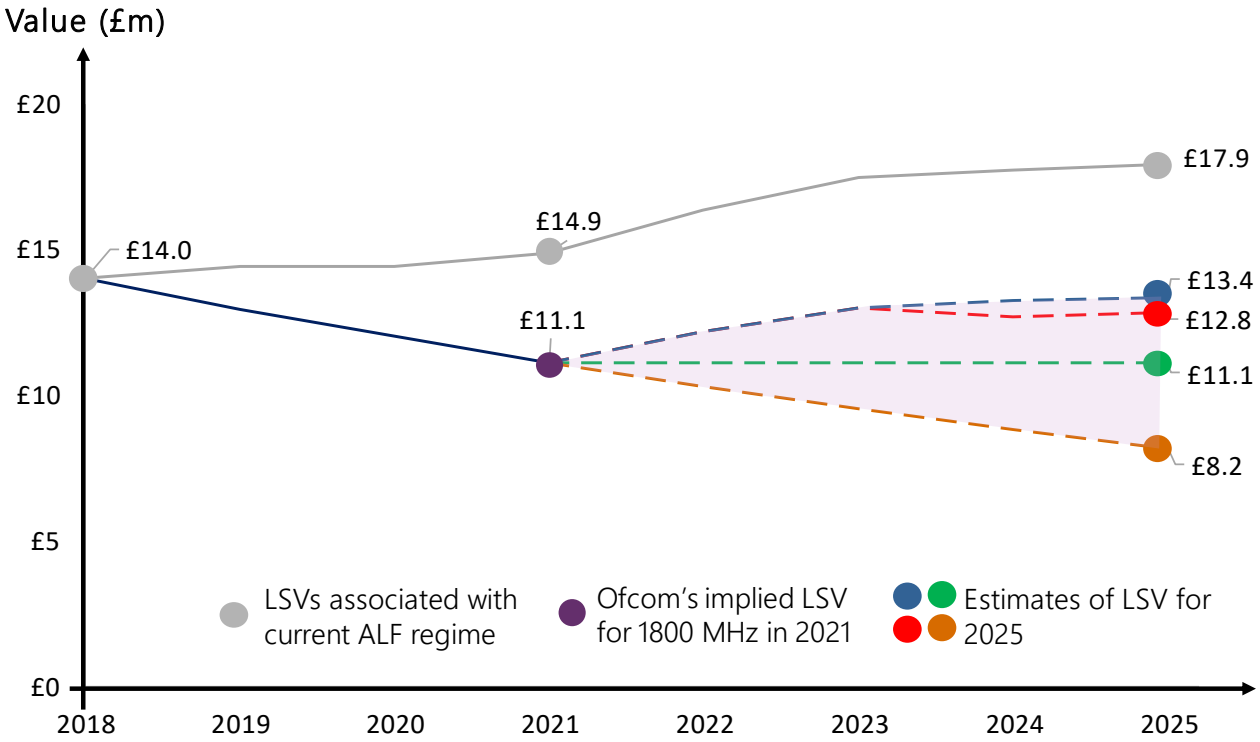
        iii. A **green dotted line**, that maintains a fixed nominal price of £11.1m.

        iv. A **orange dotted line**, with a CAGR-based extrapolation of the downward price trend from 2018-21 through to 2025. This produces a price of £8.2m.

[44] Both Vodafone and VMO2 observed in their pre-Consultation submissions that (near) functional equivalence of 1800 and 2100 MHz aligns with setting the same or a similar fees for spectrum in both bands.

We have shaded the area between the blue and orange lines in pink. We think that all stakeholders agree that market value lies in this range.

Figure 6: Potential paths for UK lump-sum value for 1800 MHz



Notes: All values at nominal prices in August of each year, except 2018 which uses April 2018 prices. Values for 2025, where relevant, assume inflation of 2% for year to August 2025.

141. We make the following observations from this chart which we would like Ofcom to consider:

a) **Ofcom's historic approach led to pricing above market value.** As with 900 MHz, from 2018 to 2024, Ofcom applied annual CPI increases to 1800 MHz ALFs. This approach led to operators paying an extra premium above market value, one that in hindsight cannot be justified as market value today is lower in nominal terms than it was in 2018.

b) **Ofcom's benchmark methodology is little different from applying CPI to 2021 value.** Although Ofcom used a benchmarking methodology to arrive at an estimate of LSV, the result is almost identical to adopting its 2018 estimate for 2100 MHz, plus inflation and a 5.8% adjustment to convert from 2100 MHz to 1800 MHz. We do not think it plausible that the nominal value of 1800 MHz grew with inflation from 2021-25, given that other factors (especially lower data traffic expectations) also affected value. If we are correct, this implies that there are errors in how Ofcom has applied its benchmarking methodology.

c) **Ofcom's 1800 MHz LSV for 2025 is not conservative.** Ofcom's LSV is at the very top end of the pink zone in Figure 6. De facto it assumes that the 1800 MHz LSV has grown with inflation from 2021-25, even though it has recognised inflation in this same period contributed to a material misalignment in the 1800 MHz ALF, as illustrated by the grey line in Figure 6. As with low-band 900 MHz, is apparent that Ofcom's methodology for 1800 MHz fails to consider that the market value of lower mid-band spectrum continued to decline in this period.

142. Ofcom's proposed LSV for 1800 MHz implies that it believes that the LSV for 1800 MHz fell 21% in nominal terms between 2018 and 2021 but then rebounded upward by 15% from 2021 to 2025. As with 900 MHz, we say that this is a peculiar trajectory, and entirely inconsistent with broader evidence that spectrum values have been falling. Essentially, Ofcom is saying that market value from 2018-21 must have been driven by "other factors" that swamped the impact of inflation, but subsequently these other factors can be ignored and market value has been solely impacted by inflation. If Ofcom stands by this story, it must explain what these other factors were, why they drive down 1800 MHz value between 2018-21 and why they stopped mattering after 2021. In our opinion, a far more convincing story is that the prices of lower-mid band spectrum, including both 1800 and 2100 MHz, have fallen consistently over time.

143. In short, the major flaw with Ofcom's estimate of LSV, based on its benchmarking exercise, is that the estimate it produces simply cannot be reconciled with its 2021 estimate of the LSV for 2100 MHz, and its conclusion that 1800 and 2100 MHz have similar value. To address this, we urge Ofcom to take its 2021 value for 2100 MHz as a starting point, use this to estimate the value of 1800 MHz in the same year, and consider what has changed between 2021-25 to arrive an LSV for 2025.

144. We present three methodologies that Ofcom can adopt to determine how the market value of 1800 MHz has evolved over 2021-25:

a) **Simple extrapolation.** The value in 2025 is identified by extrapolating from trends identified from Ofcom's 2018 and 2021 observations.

b) **Distance method (benchmarking).** Ofcom uses its standard distance method approach but with adjustments to benchmarks consistent with the observation that the nominal value of 1800 MHz was falling at least until 2021, and with greater weight placed on more recent evidence (as opposed to the current approach of putting equal weight on observations between 2015 and 2025).

c) **Multi-factor model.** We apply the high-level model of market values that we developed in Section 3.4 and which includes the main factors that impacted market values between 2021 and 2025.

1800 MHz LSV methodology 1: Simple extrapolation

145. The simplest methodology is to extrapolate from Ofcom's 2018 value for 1800 MHz and its inferred 2021 value for 1800 MHz based on its 2100 MHz LSV. Three possible approaches to extrapolation are as follows:

a) **CAGR-based line depreciation of LSV.** This would follow the orange dotted line in Figure 6 and produces a value of £8.2m.

b) **Diminishing depreciation of LSV.** Drawing curve through the 2018 and 2021 values and making certain assumptions about the rate of depreciation[45] produces an LSV of £10.1m.

c) **Constant nominal LSV.** The least conservative approach is to assume that nominal values for LSV were unchanged between 2021 and 2025 (the green dotted line in Figure 6). This produces a higher estimate of market value of £11.1m.

146. On balance, simple extrapolation is not our preferred approach for 1800 MHz. Given that the 2021 value for 2100 MHz LSV was itself developed using a benchmarking methodology, we prefer to explore how new benchmarks (even if limited in number) impacted value estimates for the subsequent period.

147. Notwithstanding this position, we think these simple extrapolations provide a useful cross-check on the output from the distance method benchmarking. In our view, any result from benchmarking that exceeds the constant nominal line is suspect because it implies a story in which the nominal value of 1800 MHz fell significantly from 2018-21 but re-bounded from 2021. To repeat, this simply is not a likely trajectory, and Ofcom should not adopt estimates of LSV that follow this path without very strong evidence that something changed significantly after 2021. As we explain below, we do not see any evidence from international benchmarking to suggest such a change (quite the contrary – we see more evidence that market values continue to decline). We also observe that Ofcom, as with 900 MHz, has de facto taken a position that market value is only impacted by inflation, and has ignored factors that exerted downward pressure on 1800 MHz value over time.

1800 MHz LSV methodology 2: Distance method benchmarking

148. Ofcom relies on distance method benchmarks to estimate the LSV for both 1800 and 2100 MHz spectrum. We support the use of this approach but we think that Ofcom has made four significant errors in applying it to determine the 2025 LSV of 1800 MHz:

1. It applies CPI to all historic benchmarks as far back as 2015 despite evidence that lower mid-band spectrum values have declined across the 5G era.

2. It relies on an unduly thin samples of awards for 1800 MHz, with only one new benchmark after 2021.

3. It puts equal weight on the 2018 and 2021 UK auctions for valuation of 3.5 GHz spectrum, when it should rely solely on the 2021 auction.

45 We assume a simple functional form of $LSV_t = £9.9m + £4.3m*e^{-0.4*(t-2018)}$, where t is the year.

4. It includes benchmark sets that price higher frequency spectrum above lower frequency spectrum as Tier 1, even though they are fundamentally inconsistent with the distance model concept.

149. In the following, we discuss each error and propose an adjustment to Ofcom's methodology to remedy the error.

150. **Error 1: Backwards application of CPI.** In its previous determinations of ALF, Ofcom adjusted benchmarks for inflation so as to arrive a value for all benchmarks in today's money. Stakeholders previously accepted this approach, in large part because inflation rates were low, so the impact on benchmark values was limited. However, this has now become a major area of contention, as the period 2021-25 has seen abnormally high inflation, when, contemporaneously, there is broad evidence of declining nominal spectrum values. At paragraph 3.18, Ofcom notes that BT/EE, Vodafone and VMO2 all agree that adjusting auction prices for past inflation is no longer appropriate. This is especially so if no offsetting adjustments are made to account for other factors that affect market values.

151. We understand that Ofcom is reluctant to change a methodology that it has relied on in the past. However, it must now recognise that when not adjusting for other factors, backwards application of inflation has the effect of increasing the weight on historic benchmarks in its benchmark samples. For example, Ofcom's benchmark for the German 2015 auction, which produced an exceptionally high price for 1800 MHz in both relative and absolute terms, when expressed in 2025 money, is now 34% higher.

152. At paragraph 3.39-3.40, Ofcom sites a proposal by NERA to focus on 5G-era awards from 2015 onwards as "*a reasonable approach*" and then goes on to say:

> *"accordingly, we propose to:*
> *a) place more weight on the UK 2018 and 2021 auctions than the UK 2013 auction;*
> *b) place more weight on international benchmarks where all the UK and international auctions used to derive the benchmark are from 2015 onwards; and*
> *c) consider the post-2015 auction evidence in the round, rather than segmenting this data further by date."*

153. We agree with the decision to focus on 5G-era benchmarks. However, Ofcom's treatment of those benchmarks is inconsistent with NERA, which advised Ofcom to:

    a) place more weight on the 2021 auction than 2018 auction, as it is more recent and better reflects existing supply and demand conditions for spectrum, and;

    b) place greater weight on more recent benchmarks within the 2015-24 period, again because more recent awards likely better reflect today's market value.

154. We note that the distance methodology relies on ratios of spectrum prices. An ideal benchmark would combine values for different bands from the same year. In this case, a discussion of the application of inflation is redundant as regards other countries, as its application has no impact on ratios. The reason this matters is because when comparing

values across different years, inflation has a disproportionate impact on older benchmarks. Within the full sample, 1800 MHz benchmarks tend to be older than 700 MHz and 3.5 GHz benchmarks, so adding inflation is biasing the 1800 MHz value upwards. Furthermore, adjusting for inflation further distorts benchmark results by over-stating the UK LSVs for 700 MHz and 3.4-3.6 GHz spectrum, between which the value of lower mid-band spectrum is interpolated.

155. **Remedy to Error 1**: As Ofcom notes at paragraph 3.2, NERA proposed that Ofcom revert to nominal prices as a way of reducing the overstatement associated with historic benchmarks stretching back up to 10 years. VMO2 also endorsed this approach in its pre-Consultation submission. For avoidance of doubt, we do NOT think such an adjustment is particularly conservative. There is abundant evidence that spectrum prices for lower-mid band spectrum have declined significantly over the last decade, and Ofcom has de facto acknowledged this in its acceptance that a material misalignment in the price of 1800 MHz has occurred. In the absence of Ofcom making any other offsetting adjustments for the declining value of spectrum, it must not adjust auction prices for inflation alone.

156. Making this change will have a material impact on Ofcom's estimate of 1800 MHz market value. Repeating Ofcom's benchmarking exercise with the removal of inflation adjustment (and making no other changes), we find that the average of Ofcom's lower mid-band Tier 1 benchmarks is reduced by 16%.[46]

157. **Error #2: Thin sample size and lack of recent evidence.** When benchmarking 1800 MHz in 2025, a fundamental challenge is the lack of recent European awards. Once Ofcom removes lower-quality Tier 2 and 3 evidence from its sample, Ofcom's LSV estimate for 1800 MHz is underpinned by benchmarks from just three countries: Germany, Hungary, and Belgium. And Ofcom's continued reliance on Germany is hard to justify: the underlying price data is over ten years old and produces a benchmark that is over twice as high as those from Belgium and Hungary.

158. It is unclear whether it is by accident or design that Ofcom's proposed September 2024 LSV for 1800 MHz is almost identical to its 2021 LSV for 2100 MHz plus 5% plus CPI between 2021 and 2024. Either way, an implication is that 1800 and 2100 MHz values are closely related and must be examined together.

159. **Remedy to Error #2**: To alleviate the issue of small sample size, we propose that Ofcom combine its samples of 1800 and 2100 MHz benchmarks. These bands serve very similar functions in mobile networks, so their values should be informative of one another. We accept that the 1800 MHz band's superior propagation characteristics may warrant a small premium of c. 5%, consistent with that applied by Ofcom. To reflect this, when pooling the sample of 1800 and 2100 MHz awards, we propose that Ofcom applies a premium of 5.8% to the 2100 MHz benchmarks when using them to estimate the LSV of

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[46] We compute the average across the sample of 1800 and 2100 MHz distance method benchmarks where Tier = 1 and recency = 1 in Ofcom's 2024 *ALF 1800 MHz Benchmark Valuation Model* and *ALF 2100 MHz Benchmark Valuation Model*

1800 MHz spectrum, and applies an equivalent discount of 5.5% on 1800 MHz benchmarks when using them to estimate the LSV of 2100 MHz spectrum.

160. Pooling the sample produces more sensible and robust results, particularly for 1800 MHz. Using Ofcom's three observations only, the average of Ofcom's Tier 1 1800 MHz benchmarks is £18.0m, which we all agree is much too high. Extending the sample to include adjusted 2100 MHz benchmarks (but before correcting for other errors) reduces this average by 25%.

161. **Error #3: Failure to prioritise prices from UK 2021 award.** UK prices for 3.5 GHz spectrum are a key reference point for estimating UK 1800 MHz (and 2100 MHz) LSV. For every international benchmark available, Ofcom produces two UK equivalent LSV estimates: one based on the 2018 UK 3.4 GHz auction; and one based on the more recent 2021 UK 3.6 GHz auction.

162. Ofcom places equal weight on the two sets of benchmarks on the basis that:

> "*(a) neither auction had unsold spectrum, (b) both sold above reserve price (albeit not by much in the case of the more recent 3.6 GHz auction), and (c) there was evidence of competitive bidding in both auctions*."

163. We strongly disagree with the application of equal weight to the two auctions. The two awards took place three years apart and their very different price levels suggest a significant downward shift in per MHz prices, which aligns with Ofcom's own findings that the market value of other UK spectrum fell over this period.

164. The lower price in 2021 can readily be explained by the three factors:

    a) the spectrum in the earlier auction was intrinsically more valuable owing to the greater scarcity in the early 5G period up until the next auction, the date of which was not certain in 2018;

    b) Three's existing holdings created a strategic dynamic in which one or more rival operators were at risk of not securing a critical mass of 5G spectrum in 2018 and therefore entering the next auction at a strategic disadvantage; and

    c) industry expectations regarding data growth were higher in 2018 than in 2021.

165. This is reflected in the fact that VMO2's marginal value for the fourth 10 MHz block that it won in 2018 was significantly higher than the fourth block that we won in 2021. For us, [REDACTED]

166. When estimating market value in 2025, it is beholden on Ofcom to consider such factors. A simplistic conclusion that the two auctions can be treated equally is unsound. Ofcom should put much greater weight to prices in the 2021 auction given that spectrum supply and demand conditions in that auction are more reflective of the situation in 2025.

167. Moreover, benchmarks based on the UK 3.4 and 3.6 GHz auction can produce counter-intuitive pairs of benchmarks. Given the higher price paid for UK 3.4 GHz versus 3.6 GHz spectrum, one would expect benchmarks based on the UK 3.4 GHz award to exceed those based on the 3.6 GHz award. However, this is not always the case. Consider Ofcom's Figure 4.2, which shows Ofcom's post-2015 Tier 1 benchmarks for 1800 MHz. The 3.4 GHz-based benchmarks for Belgium and Hungary are higher than their corresponding 3.6 GHz-based benchmarks, as expected. Yet the German 1800 MHz benchmark based on 3.4 GHz is lower than its corresponding 3.6 GHz based benchmark. This makes little sense and is an artefact of the German 1800 MHz benchmark exceeding the German 700 MHz benchmark.[47]

168. **Remedy to Error #3**: Ofcom should base its LSV estimates on the set of benchmarks produced by the 2021 UK auction of 3.6 GHz spectrum only, or, at the very least, place more weight on the more recent 2021 evidence. Repeating Ofcom's benchmarking exercise with the exclusion of benchmarks based on UK 2018 prices and dropping Germany (and making no other changes), we find that the average of Ofcom's lower mid-band Tier 1 benchmarks is reduced by 22%.

169. **Error #4: Reliance on awards with weird price ratios.** Ofcom suggests that the value of 1800 and 2100 MHz spectrum "*lies somewhere between the value of higher frequency spectrum bands (i.e. 2.3 GHz – 3.6 GHz) and sub-1 GHz bands*". We agree. It is consistent with observable data and is the motivating assumption behind the distance method. It follows that Ofcom should rely on evidence that conforms to the logical relative value ordering of bands when estimating the LSV of lower mid-band spectrum in the UK.

170. Unfortunately, Ofcom's analysis continues to rely on several designated Tier-1 distance benchmarks that valued higher frequencies above lower ones, i.e. they priced 1800 or 2100 MHz above sub-1 GHz or upper mid-band spectrum above 1800 MHz or 2100 MHz spectrum. The German 1800 MHz award is the most egregious outlier among these benchmarks, in implying that 1800 MHz *spectrum's* value is 39% higher than the value of 700 MHz spectrum. At the opposite extreme, the 2100 MHz benchmarks from Sweden implies that the market value of lower mid-band spectrum in the UK lies below the benchmarks for 3.4 and 3.6 GHz UK auctions. We urge Ofcom to recognise that these ratios are not informative of UK values. There are a myriad of reasons why individual awards in other countries may produce peculiar outcomes for individual bands, and we recommend that Ofcom focuses on benchmarks that produce sensible results.

171. **Remedy to error #4**: Ofcom should not treat distance method benchmarks that do not conform to logical relative value ordering of spectrum bands as Tier-1 evidence. We propose that all such benchmarks be *removed* from the Tier-1 sample. Certainly, the aging German benchmarks with a Y/X ratio above 2 should be removed from the set of Tier-1 evidence.

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[47] In effect, because the difference between the UK 3.6 GHz and 700 MHz prices is larger than between the UK 3.4 and 700 MHz prices, the implied 1800 MHz LSV is pushed up more when using the UK 3.6 GHz benchmark to maintain the same relative value ratios between bands as in Germany.

172. **Revised distance method benchmark results after applying our remedies.** We apply our proposed remedies to Ofcom's benchmark sample and make no further adjustments to the sample. Specifically, we limit our analysis to benchmarks identified by Ofcom as Tier-1 and apply the following changes:

    a) we remove inflation adjustment;

    b) we pool 1800 and 2100 MHz benchmarks, applying a c. 5% premium or discount to each band as appropriate;

    c) we use the 2021 UK 3.6 GHz prices when determining UK benchmarks (and we exclude adjustments involving the UK 3.4 GHz award price); and

    d) we only consider benchmarks that produce strictly declining prices with higher frequencies (i.e. a Y/X ratio between 0 and 1) as Tier-1 evidence.

173. These adjustments result in a modest but material sample of six benchmarks for the value of 1800 MHz in 2025. Benchmark results for 1800 MHz are highlighted in green in Table 4. For reference, we have also included the high and low outliers with Y/X ratio outside the range 0-1, but these are crossed out as they do not form part of our analysis. For comparison, we also show the equivalent values for 2100 MHz and Ofcom's consultation estimates. We note that, contrary to Ofcom's divergent sample, the remaining benchmarks are all in a reasonably tight range, lying between £7.6m and £10.7m for 1800 MHz. The mean value is £9.2m per MHz and the median value is £9.1m per MHz. We note that these averages lie within the lower end of the pink zone in Figure 6, and accordingly, they align with other evidence that the nominal value of spectrum continued to fall between 2021-25 but at a slower rate than in 2018-21.

Table 4: Revised distance method benchmarks for 1800 MHz

Benchmark (using UK 3.6 GHz 2021)	**Y/X ratio**	**1800 MHz LSV (5.8% premium applied to 2100 MHz LSVs)**	**2100 MHz LSV (5.5% discount applied to 1800 MHz LSVs)**	**Ofcom's Sep 2024 LSV estimates (for reference)**
~~Germany 700-1800-3.6 ('19)~~	~~2.20~~	~~£28.1m~~	~~£25.3m~~	~~£31.7m~~
~~Germany 700-1800-3.6 ('19)~~	~~1.06~~	~~£19.8m~~	~~£17.5m~~	~~£17.9m~~
~~Belgium 700-1800-3.5 ('22)~~	~~1.13~~	~~£16.1m~~	~~£15.3m~~	~~£18.8m~~
Belgium 700-1800-3.5 ('22)	0.62	£10.7m	£10.3m	£12.6m
Netherlands 700-2100-3.5 ('24)	0.61	£10.2m	£9.8m	£12.5m
Austria 700-2100-3.6 ('20)	0.49	£9.3m	£8.9m	£11.1m
Hungary 700-1800-3.6 ('21)	0.43	£8.9m	£8.5m	£10.4m
Hungary 700-2100-3.6 ('20)	0.43	£8.4m	£8.1m	£10.3m
Slovenia 700-1800-3.6 ('21)	0.32	£7.6m	£7.4m	£9m
~~Sweden 700-1800-3.5 ('21)~~	~~-0.03~~	~~£4m~~	~~£4m~~	~~£4.7m~~
Mean (excl. outliers)		**£9.2m**	**£8.8m**	**£11m**
Median (excl. outliers)		**£9.1m**	**£8.7m**	**£10.7m**

1800 MHz LSV methodology 3: Multi-factor model

174. An alternative way to estimate the LSV of 1800 MHz in 2025 is to make a series of adjustments to the 2021 value accounting for each of the major factors that affect value. As with 900 MHz, we apply the multi-factor model that we developed in Section 2.4 which adjusts for inflation, spectrum supply, data traffic growth and changes in discount rates.

175. We found that the multi-factor model estimates a reduction in market value of ~20% for generic mobile spectrum. A model for lower mid-band spectrum might not be the same, but most factors should be similar. Applying a 20% discount to the 2021 LSV for 1800 MHz of £11.1m results in a 2025 valuation for 1800 MHz of £9.0m.

176. This result sits within the pink zone we mapped in Figure 6, in the mid-range of European benchmarks and only just below the median value. The result aligns with prevailing evidence and the common-sense conclusion that the fall of 1800 MHz market value from 2018-21 has continued through 2025.

Section 4.3: Determining the LSV for 2100 MHz in 2025

177. We agree with Ofcom that 1800 and 2100 MHz "*have similar values*" (para 4.52). In our pre-Consultation response, we argued that, at least for benchmarking purposes, the bands play such similar roles in modern mobile networks, that they can be treated as having equivalent value. In the Consultation, Ofcom proposed to set the LSV for 2100 MHz ~5.5% below the value for 1800 MHz. This is consistent with Ofcom's view that the bands have similar value, but with a modest premium for the limited superior propagation of 1800 MHz spectrum. The proposed value differential is sufficiently modest that it broadly aligns with our views.

178. Accordingly, we consider the following to be broadly agreed by stakeholders:

    a) Ofcom estimates that the value differential in 2025 between 1800 and 2100 MHz is approximately 5%, and it seems reasonable to assume that this ratio was the same in 2018 and 2021.

    b) Ofcom previously decided that the 1800 MHz LSV was £14.0m in 2018, which implies a 2018 value for 2100 MHz of £13.2m.

    c) Ofcom previously decided that the 2100 MHz LSV was £10.5m in 2021.

179. Collating this information enables us to plot Figure 6, in which we illustrate a range of values in which the 2100 MHz LSV in August 2025 may lie:

    a) The **purple line** connects the implied value in 2018 to Ofcom's actual estimate in 2021.

    b) We illustrate four possible paths for the LSV from 2021-2025:

        i. A **blue dotted line**, that assumes that the LSV grew with inflation. This produces a projected price of £12.6m.

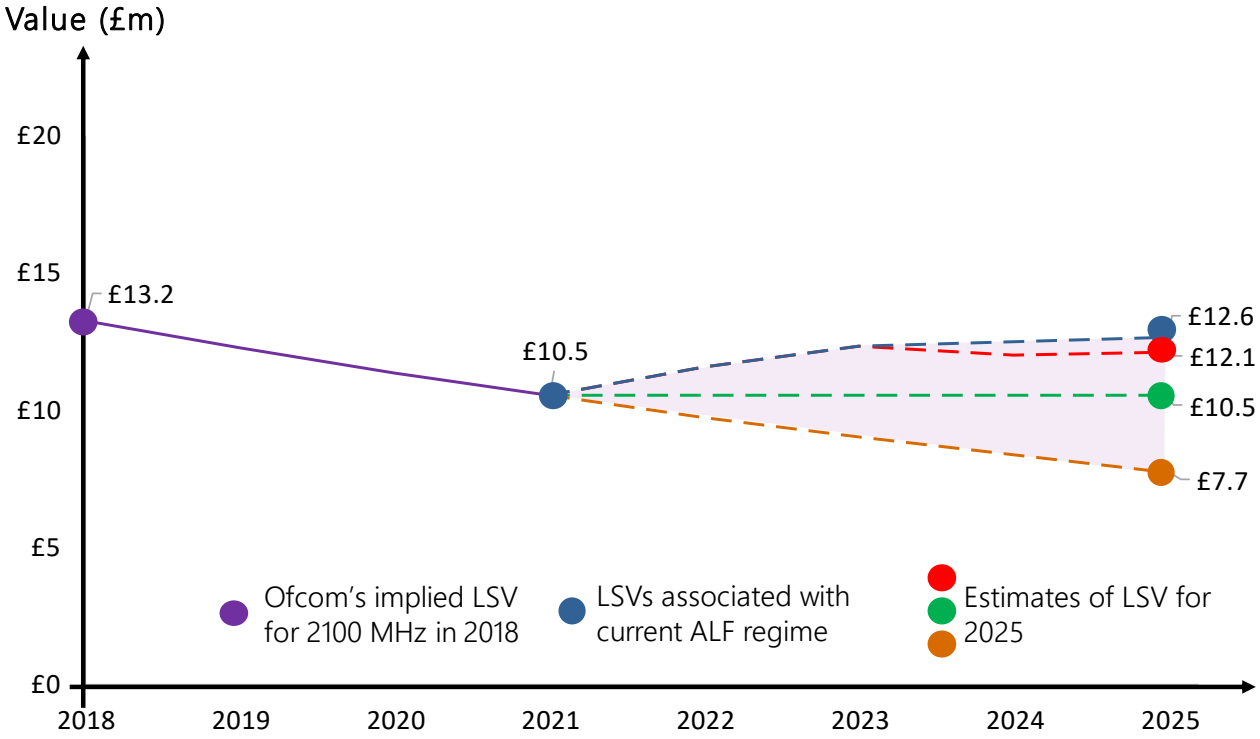
ii. A **red dotted line**, that follows Ofcom's provisional proposal for the 2100 MHz LSV, based on its interpretation of the distance methodology using European benchmarks. Ofcom's provisional LSV for August 2025 is £12.1m.

iii. A **green dotted line**, that maintains a fixed nominal price of £10.5m.

iv. A **orange dotted line**, with a CAGR-based extrapolation of the downward price trend from 2018-21 through to 2025. This produces a price of £7.7m.

We have shaded the area between the blue and orange lines in pink. We think that Ofcom and stakeholders agree that market value lies in this range.

Figure 7: Potential paths for UK lump sum value for 2100 MHz



Notes: All values at nominal prices in August of each year, except 2018 which uses April 2018 prices. Values for 2025, where relevant, assume inflation of 2% for year to August 2025.

180. We make similar observations from this chart as we do with 1800 MHz. Ofcom de facto recognises that the nominal value of 2100 MHz declined between 2018 and 2021, but its approach assumes that nominal value will rise between 2021 and 2025. It has no explanation for this peculiar trajectory. Although Ofcom used a benchmarking methodology to arrive at an estimate of LSV in 2025, the result is almost identical to inflating its 2021 LSV for 2100 MHz. In doing so, we think it has made mistakes in its benchmarking because it is inflating historic benchmarks and giving them equal weight to new ones. Overall, the methodology is highly aggressive because Ofcom disregards

other evidence which suggests that the market value of lower mid-band spectrum continued to decline in this period (and the factors that have driven this).

181. Given the similarity between 1800 and 2100 MHz, the same methodologies of simple extrapolation, distance method (benchmarking) and a multi-factor model are available to determine how 2100 MHz value evolved from 2021-25. We elaborate on each approach in the following.

2100 MHz LSV methodology 1: Simple extrapolation

182. The simplest methodology is to extrapolate from Ofcom's prior implied and actual values for 2100 MHz from 2018 and 2021 respectively. Three possible approaches to extrapolation are as follows:

    a) **CAGR-based line depreciation of LSV.** This would follow the orange dotted line in Figure 7 and produces a value of £7.7m.

    b) **Diminishing depreciation of LSV.** Drawing a curve through the 2018 and 2021 values and making certain assumptions about the rate of depreciation[48] produces an LSV of £9.6m.

    c) **Constant nominal LSV.** The least conservative approach is to assume that nominal values for LSV were unchanged between 2021 and 2025 (the green dotted line in Figure 7). This produces a higher estimate of market value of £10.5m.

183. Simple extrapolation is not our preferred methodology for 2100 MHz, given that benchmarks are available and can be accounted for, but it is a good cross check on results. As with 900 MHz and 1800 MHz, we think that approach (b) is the closest fit with Ofcom's aim to estimate market values conservatively. In our opinion, an estimate that was above approach (c) could be described as conservative.

2100 MHz LSV methodology 2: Distance method benchmarking

184. We have previously described a combined approach to benchmark LSVs for 1800 and 2100 MHz spectrum. For brevity, we do not repeat our description of errors and corrections to Ofcom's methodology here, as our analysis applies equally to both bands.

185. Our benchmarks for 2100 MHz are highlighted in green in Table 5. We apply our proposed remedies to Ofcom's benchmark sample as described for 1800 MHz. For reference and comparison, we also show our results for 1800 MHz, Ofcom LSV estimates, and benchmarks dropped owing to outlying Y/X ratios. The remaining benchmarks for 2100 MHz are all in a reasonably tight range between £7.4m and £10.3m. The mean value is £8.8m per MHz and the median value is £8.7m per MHz. These averages lie

48 We assume a simple functional form of $LSV_t = £9.3m + £3.9m*e^{-0.4*(t-2018)}$, where t is the year.

within the lower end of the pink zone in Figure 7, and accordingly, align with other evidence that the nominal values continued to fall between 2021-25.

Table 5: Revised distance method benchmarks for 2100 MHz

Benchmark (using UK 3.6 GHz 2021)	Y/X ratio	1800 MHz LSV (5.8% premium applied to 2100 MHz LSVs)	2100 MHz LSV (5.5% discount applied to 1800 MHz LSVs)	Ofcom's Sep 2024 LSV estimates (for reference)
~~Germany 700-1800-3.6 ('19)~~	~~2.20~~	~~£28.1m~~	~~£25.3m~~	~~£31.7m~~
~~Germany 700-1800-3.6 ('19)~~	~~1.06~~	~~£19.8m~~	~~£17.5m~~	~~£17.9m~~
~~Belgium 700-1800-3.5 ('22)~~	~~1.13~~	~~£16.1m~~	~~£15.3m~~	~~£18.8m~~
Belgium 700-1800-3.5 ('22)	0.62	£10.7m	£10.3m	£12.6m
Netherlands 700-2100-3.5 ('24)	0.61	£10.2m	£9.8m	£12.5m
Austria 700-2100-3.6 ('20)	0.49	£9.3m	£8.9m	£11.1m
Hungary 700-1800-3.6 ('21)	0.43	£8.9m	£8.5m	£10.4m
Hungary 700-2100-3.6 ('20)	0.43	£8.4m	£8.1m	£10.3m
Slovenia 700-1800-3.6 ('21)	0.32	£7.6m	£7.4m	£9m
~~Sweden 700-1800-3.5 ('21)~~	~~-0.03~~	~~£4m~~	~~£4m~~	~~£4.7m~~
Mean (excl. outliers)		**£9.2m**	**£8.8m**	**£11m**
Median (excl. outliers)		**£9.1m**	**£8.7m**	**£10.7m**

2100 MHz LSV methodology 3: Multi-factor model

186. An alternative way to estimate the LSV of 2100 MHz in 2025 is to use the multi-factor model we developed in Section 3.4.

187. We found that the multi-factor model estimates a reduction in market value of ~20% for generic mobile spectrum. A model for lower mid-band spectrum might not be the same, but most factors should be similar. Applying a 20% discount to the 2021 LSV for 2100 MHz of £10.5m results in a 2025 valuation for 1800 MHz of £8.4m.

188. This result sits within the pink zone we mapped in Figure 7, in the mid-range of European benchmarks and only a little below the median value. The result aligns with prevailing evidence and the common-sense conclusion that the downward direction of 2100 MHz market value from 2018-21 has continued through 2025.

Section 5: Ofcom has not adequately updated and applied its approach to annualisation

Ofcom must resolve a disconnect inherent in its approach

189. Ofcom has not recognised that the seismic change in capital markets in recent years has given rise to a disconnect because the market conditions that underlie LSV determination differ greatly from those that Ofcom used to calculate the annualisation rate that it applies to convert LSVs into annual fees. When relevant conditions do not materially change between conducting the individual steps (as was the case at earlier ALF reviews), the impact of separately undertaking LSV determination and conversion into annual fees is limited but this does not reflect capital markets in recent years.

190. It is instructive to compare 2021 (as key benchmarking year) to today in terms of capital market conditions. The 2021 UK auction prices have a major bearing, and rightly so, on the determination of historic LSVs. These prices reflect supply and demand, and other economic conditions, at the time of this auction. This includes the level of prices in 2021, inflation projections, discount rate, future supply, mobile traffic projections and expectations around technologies. It was the set of economic conditions at the time that affected operator valuations going into that auction, and subsequently, auction prices.

191. A lot has changed since 2021 as we described in Section 3. Inflation has peaked yet remains much higher than before, and this has led to rising interest and discount rates. Whilst inflation and rates may have peaked, they are projected to remain at a much higher level compared to 2021. Moreover, mobile traffic projections have been revised downward compared to in 2021. In Section 3, we estimated the joint impact of changes in factors using our multi-factor model at a 20% reduction in market values over the 2021-2025 period.

192. Ofcom calculates the annualisation rate based on evidence from today's capital markets and a forward-looking view on parameters used to determine its discount rate. This calculation thus accounts for the changes in capital market conditions that occurred since 2021.

193. The problem is that Ofcom combines a determination of historic LSVs based on 2021 capital market conditions with the calculation of an annualisation rate based on today's conditions. This is a fundamental problem that NERA identifies in Chapter 3 of their report. NERA outlines how changes in the capital market environment between 2021 and today have led to a **disconnect** between the discount rate that underlies the LSV versus the discount rate that feeds into the annualisation rate which used to convert LSVs into annual fees. Whilst other factors (mobile traffic, inflation) have changed in recent years, we focus here on the discount rate as it is most directly affected by changes in capital market conditions. Based on Ofcom's finding presented in this consultation, the discount rate increased significantly from 2021 onward. From 0.1% in Ofcom's 2100 MHz ALF Statement to 1.7% in Ofcom's December 2024 Consultation.

194. When the low discount rate from 2021 determined 2021 auction prices and subsequently impacted on determination of today's LSVs and the current higher discount rate feeds into annualisation of today's LSVs into annual fees then this results in fees that exceed market values.

195. NERA identifies two options to resolve the disconnect: either modify the LSV to account for changes in the discount rate in recent years or calculate the discount rate used to convert the LSV into annual fees based on capital market conditions that prevailed when key UK auctions for LSV determination occurred. We prefer the former as we set out in above sections where we argue that adjustment of auction prices must account for changes in a range of factors, including the discount rate. However, if Ofcom does not accept our proposal, it must consider the second option (i.e. altering the discount rate) to resolve the disconnect.

196. NERA uses an illustration to explain that using the 2021 discount rate instead of the one estimated by Ofcom in the Consultation addresses the disconnect as it allows to account for the capital market conditions as they were present at the time of the 2021 auctions. This prevents Ofcom using a high market valuation arising from the low discount rate in 2021 to determine LSVs and then using a high discount rate reflecting today's capital market conditions to convert LSVs into annual fees. The latter is both inconsistent and results in fees being set above market values.

Concerns in relation to estimation of the discount rate

197. NERA identifies three shortcomings with how Ofcom estimated the discount rate: using an underestimated projected inflation, using a too low estimate of the inflation risk premium and the inclusion of unsystematic risk affecting Ofcom's estimate of WACC. These issues have the effect of increasing the discount rate above the level that robust application of Ofcom's methodology supports. NERA identifies corrections that can address these shortcomings, and in doing so, support estimation of a more appropriate discount rate.

Ofcom underestimated projected inflation

198. Inflation projection is a key variable in determining the lower and upper polar cases. Ofcom used an inflation projection of 2% in line with the Bank of England's target. But inflation has been substantially above 2% in recent years, and all market participants forecast inflation to materially exceed 2% for the next years and possibly longer. NERA reports that inflation surveys project average inflation at 3.4%-3.7% over the longer-run, that Bank of England and OBR forecast inflation above 2% for at least the next three years, and derives an expected inflation – based on breakeven inflation and Ofcom's estimate of the inflation risk premium at 0.4% - of 2.45% from a calculation of break-even inflation.

199. NERA draws two conclusions. First, that it is not reasonable to use an inflation expectation of 2% in estimating the lower and upper polar cases as this expectation is well below any evidence-based inflation projection, is inconsistent with Ofcom's determination of the inflation risk premium and does not account for asymmetry in out-turn inflation (which means out-turn inflation is biased to exceed the target). Second, it recommends

that Ofcom uses an inflation projection from the 2.45%-2.80% range (when not revising its inflation risk premium) to be consistent with inflation projections.

Ofcom's estimate of the inflation risk premium is too low

200. To compensate operators for the risk of out-turn inflation differing from inflation projections, Ofcom proposed deducting an inflation risk premium of 40 bps from the real discount rate in the lower polar case.

201. NERA identifies two shortcomings in Ofcom's estimate of this premium both originating from Ofcom not fully accounting for RPI retirement in 2030. First, the breakeven inflation rate is not solely based on RPI as it will be replaced by CPIH from 2030 onwards. This makes it inconsistent to subtract a pure RPI forecast from a breakeven inflation based on a mix of RPI and CPIH. Second, CPIH is less volatile than RPI which means that CPIH lower volatility (and not RPI volatility alone) must be considered in estimating the inflation risk premium. NERA estimates the inflation risk premium at 64 bps to 70 bps when correcting for these shortcomings.

Upper polar case biased because of the inclusion of unsystematic risk within Ofcom's WACC estimate

202. NERA identifies two limitations with Ofcom's proposed estimation of the upper polar case. First, as explained in relation to the lower polar case above, using an expected inflation of 2% where market projections are 2.45%-2.80%. Second, the estimation being at odds with Ofcom's view to account only for systematic risk in determining appropriate WACC and with the Modigliani-Miller theorem which requires that the post-tax vanilla WACC does not depend on capital structure. This inconsistency enters the estimation of WACC through the inclusion of unsystematic risk in calculating the cost of debt. Correcting for both limitations reduces the WACC to below 3%.

203. We refer Ofcom to the NERA report for a full analysis of the issues set out in this Section.

Section 6: Adjusting fees for inflation alone is equally wrong

204. Ofcom's provisional view is that it remains appropriate to adjust annual fees by out-turn inflation alone. Its justification – as for backward adjustment – rests on its view that, all else equal, spectrum values likely remain constant in real terms over time. It is helpful that Ofcom separately considered its approach to backward and forward adjustment as that shows that it is possible and may be merited for different adjustment approaches to be applied because of differences between the two settings.

205. We make two key points that challenge the validity of Ofcom's proposal before discussing how Ofcom can more appropriately adjust fees and why a different approach may be warranted to adjust fees compared to auction prices.

206. First, adjustment of fees for inflation alone is not justified for the same reasons set out above for backward adjustment. Ofcom has not proven that spectrum values remain constant in real terms, and the evidence we presented shows that spectrum values have fallen in nominal terms and will continue to do so (albeit with uncertainty around possible flattening over the longer term). Adjusting for inflation alone when spectrum values are not expected to increase in nominal terms (and more likely to fall) will inevitably lead to fees rising above market values even when they are set conservatively initially.

207. Ofcom rejected our suggestion to revise fees by CPI-X with X=CPI for this review period as "*this would mean keeping ALFs constant in nominal terms until the next review*".[49] The latter is of course true but is the right action when spectrum values are not expected to materially change in nominal terms. We showed above that Ofcom has failed to establish that spectrum values increase by inflation and that evidence and story align with an ongoing fall of nominal spectrum values. Hence, keeping fees constant in nominal terms likely means that fees will rise relative to spectrum values from when fees are set at Statement. Hence, any undue concern of setting 'too low' fees is not warranted.

208. Second, we reiterate that material misalignment arose in recent years because of the combination of falling spectrum values and fees rising by inflation. This should make Ofcom cautious about adjusting fees for inflation alone. It should only consider such an approach when it is confident that it sets fees conservative initially and when evidence supports its view that spectrum values will likely remain constant in real terms. Neither tenet required for this approach to be valid holds.

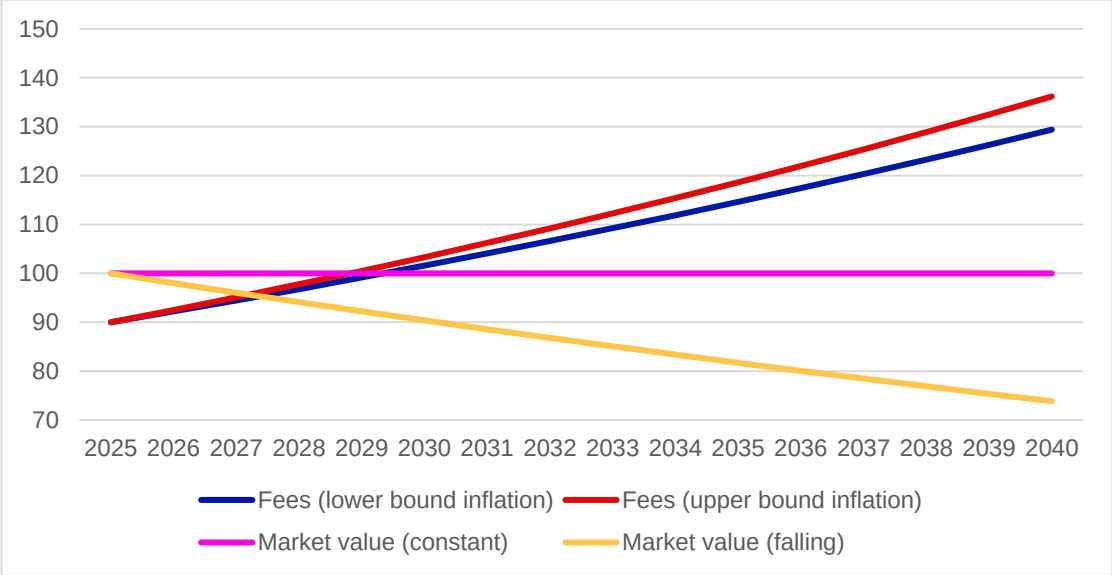
209. We developed differing scenarios of fees relative to market values when adjusting fees by future inflation and when considering that market values evolve in line with the declining trend or remain constant in nominal terms. These scenarios demonstrate that significant material misalignment will arise when Ofcom adjusts fees by inflation alone even when fees are set conservatively initially.

210. Figure 8 presents index numbers of fees and market values over the period 2025-2040 for a range of fees and market values scenarios. In line with NERA's report submitted

[49] Ofcom made this point in paragraph 7.4 of its Consultation.

alongside our own response, we use 2.45% as a lower and 2.80% as an upper projection of future average inflation to adjust fees over time.[50] We assume that fees are set conservatively: index number of 90 for fees compared to 100 for spectrum values in 2025. Put differently, we model a case where fees were set based on an estimate of full market value that, owing to conservative assumptions, were 10% less than a hypothetical perfect estimate of market value. Regarding development of market values, we consider values remain constant in nominal terms or will fall by 2% per annum.[51] Given the evidence presented in our response, we deem that projecting values to remain constant in nominal terms is very conservative.

Figure 8: Material misalignment owing to inflation adjustment arises within years in all scenarios



Source: VMO2 analysis based on the assumptions and methodology explained in the main text. Market values and fees reported as index numbers with fees set at 90, and market values at 100, in 2025.

211. Fees (red, blue) surpass market values (pink, yellow) within five years and the differential grows over time. The scale of misalignment is a 15% difference by 2035 in the conservative scenario in which market values remain constant in nominal terms and using lower bound average inflation. Any change to this scenario (in particular, when market values fall in nominal terms) greatly amplifies the misalignment (i.e. 15% misalignment by 2030 and +40% by 2035). Critically, we assumed that fees are set well below market values initially. Misalignment is much greater and arises sooner when initial fees are set higher.

[50] See page 15 of NERA, 7 March 2025, *Deriving ALFs from LSVs – A Response to Ofcom's 2024/25 Consultation on the calculation of the annualisation rate for use in determining ALFs*, submitted to Ofcom by VMO2.

[51] A 2% annual reduction in market values is consistent with our model-based analysis of how spectrum values developed from the 2021 auction to today.

212. This analysis shows that great caution is required in deciding on fee adjustment and that such decision must be informed by looking at differing scenarios of how fees may develop relative to market values. Not having done so, Ofcom proposes an adjustment that leads to fees greatly exceeding market values within years. Our concern is amplified owing to other Ofcom proposals resulting in fees being set above today's market values as that removes any cushion to absorb initial fee increases.

213. Our discussion of these two points establishes that the risk is very high that adjustment of fees by inflation alone contributes to fees that exceed market values and means that Ofcom will not meet the Direction, its statutory duties and its aim to set fees conservatively. To assist Ofcom, we now discuss how Ofcom can adjust fees more appropriately and why the adjustment approach for forward adjustment does not have to be the same as that used for backward adjustment.

214. The similarity between deciding on backward and forward adjustment is that Ofcom must take a view on how spectrum values develop during a period when there are no further observed market values to rely on. Ofcom proposes to do so by adjusting for inflation alone as it considers that spectrum values likely remain constant in real terms. There are at least two problems with this approach. First, evidence is consistent with a fall of spectrum values likely because other factors offset the impact of inflation. Secondly, it means using observed values of one factor (inflation) whilst not those of other factors to adjust fees over time. The observability of all factors implies that changes in factors and the known relation between factors and spectrum values can be used to estimate how spectrum values evolve. We explained this for backward adjustment but it extends to forward adjustment. It means that fees can be adjusted for changes in a range of factors, not solely inflation.

215. But there is also a difference. Values of factors are realised and observable for backward adjustment. This implies that Ofcom, in the case of backward adjustment, can review the development of spectrum values as a function of observed changes in factors and their impact on spectrum values. This allows it to robustly estimate spectrum values and to check estimates relative to international spectrum pricing, indicators of spectrum value, and changes in factors.

216. In the case of forward adjustment, values of factors will realise and become observable over time. This means that Ofcom can develop an adjustment approach and apply it as a function of changes in observed factors over time but will be more uncertain whether its approach appropriately corrects for the impact of changes in factors on spectrum values.[52] For instance, the relation between factors and spectrum values may change and evidence to validate its approach will become available over time. We do not consider this a

[52] This said, such approach performs considerably better than adjusting for inflation alone as that does not account for any impact from factors other than inflation. This is particularly problematic as we know that inflation has an upward whilst other factors tend to have a downward impact on spectrum values.

serious limitation as an approach that adjusts for multiple factors will be more evidence-driven and robust compared to what Ofcom proposed.

217. We deem it possible and desirable for Ofcom to develop an approach that adjusts fees for changes across the factors we identified. But at a minimum, Ofcom can project by reviewing how spectrum values will directionally change as a function of likely changes in factors. This would provide a marker that any approach that Ofcom considers for adjusting fees can be assessed against.

218. Given the greater uncertainty around forward adjustment, Ofcom may be reluctant to mechanically adjust for changes in factors as it may feel that this risks market values potentially moving away from fees. We do not think this is warranted given the robust modelling that can be developed. But it could, for instance, be that Ofcom instead of adjusting for observed changes in factors prefers to make fixed adjustments (or decide on an *ex ante* X for inclusion in CPI-X) that align with evidence of how market values developed and likely will develop.

219. In all, we recognise that Ofcom faces a more complex judgement in deciding on forward adjustment. When fees are set conservative at Statement and when a reasonable approach to forward adjustment is adopted, it would take time for material misalignment to arise as a function of the development of out-turn inflation and spectrum values, and misalignment would only become more material over time. This combined with the opportunity for operators to request Ofcom to review ALFs on the ground of material misalignment means that the scope for adverse impact is more limited as long as Ofcom avoids an approach that materially increases nominal values over time.

220. We consider that an approach that accounts for all factors is merited backwards and forward but that it can be applied differently for forward adjustment because of differences in evidence base and considerations. As long as Ofcom adopts a suitably conservative approach for backward adjustment, there is less risk inherent in how Ofcom decides to adjust fees going forward. The combination of lower risk and potentially evidence of slowdown in the fall of spectrum values could support and justify a slightly more risk-inclined adjustment of fees going forward.

221. NERA has found that 2.45-2.80% (well above the 2% used by Ofcom) is the range for expected average inflation over the next 10 years.[53] It is incumbent on Ofcom to use an inflation correction that aligns with market expectations and that ensures consistency between the forward inflation risk borne by operators and determining the discount rate used for annualisation. This requires using an inflation projection from the identified range instead of the proposed 2%. Not doing so means that fees are initially set for a low inflation world and then adjusted by the higher inflation that is used to increase fees over

[53] See page 15 of NERA, 7 March 2025, *Deriving ALFs from LSVs – A Response to Ofcom's 2024/25 Consultation on the calculation of the annualisation rate for use in determining ALFs*, submitted to Ofcom by VMO2.

time. It would be inappropriate for such outcome to be baked in through how Ofcom determines the discount rate.

222. Separately, Ofcom identified that it could adjust annual fees for inflation by using out-turn or forecast inflation at 2%. Its provisional view consistent with its historic approach is to adjust by out-turn inflation though it is open to views and arguments to adjust by forecast inflation instead. It indicated that in the latter case it would remove the inflation risk premium from the annualisation rate. We consider that discussion of which inflation rate to use distracts from the serious concerns we have with the approach that Ofcom proposed for forward adjustment, i.e. to account for inflation alone and to calculate the annualisation rate using an inflation projection that is inconsistent with the inflation-driven increase in ALFs that operators expect going forward.

Appendix

223. In this appendix, we develop a simple cost-avoidance spectrum valuation model, s described in Section 3.4. In the model, the value of a quantity BW_1 MHz of spectrum is the net present value of the difference in cash flows between a scenario with and without this additional spectrum.

224. The model assumes that the operator already has BW_0 MHz of spectrum available and faces an initial annual volume of traffic equal to V_0. The volume of traffic grows at a CAGR of r, therefore, traffic in a given year is given by $V_t = V_0(1+r)^t$.

225. The model assumes that the operator has a network capable of satisfying existing traffic, but additional traffic will require additional sites. In particular, every year, the operator needs to install S_t new sites to satisfy the additional demand $V_t - V_{t-1} = V_o(1+r)^{t-1}r$.

226. The number of sites depends on a collection of constants, including a constant to convert annual traffic to daily traffic, daily traffic to BH traffic, bytes to bits, and spectral efficiency. We denote the multiplication of all these constants by B. Therefore, the number of new sites installed in a year is given by $S_t = (BV_o r(\frac{1+r}{1+\delta})^{t-1})/(BW_0)$, where δ is the CAGR of the spectral efficiency.

227. Finally, the cash flow associated with the investment in new sites is equal to PS_t, where P is the average cost of installing and maintaining a site. We denote all the constants involved by $A = BP$.

228. The net present value of these cash flows for T years with a discount rate i and inflation π is equal to $A * V_0 * \frac{1}{BW_0} * r * \frac{1-(\beta(1+r))^T}{1-\beta(1+r)}$, where $\beta = \frac{1+\pi}{(1+i)(1+\delta)}$

229. Therefore, the value of BW is equal to $A * V_0 * \left[\frac{1}{BW_0} - \frac{1}{BW_0+BW}\right] * r * \frac{1-(\beta(1+r))^T}{1-\beta(1+r)}$

230. This formula can be used to derive relative values between different scenarios in terms of initial traffic volumes, discount rates, forecasted growth rates, and quantities of spectrum.

231. The effect of expected changes in supply is accommodated by breaking down the total license duration T into two parts. The operator holds BW_0 for T_0 years and BW_1 for T_1 years, which produces the following formula for spectrum value (after multiplying by $A * V_0$):

$$\left[\frac{1}{BW_0} - \frac{1}{BW_0+BW}\right] * r * \frac{1-(\beta(1+r))^{T_0}}{1-\beta(1+r)} + \left[\frac{1}{BW_0} - \frac{1}{BW_0+BW}\right] * r * \frac{1-(\beta(1+r))^{T_1}}{1-\beta(1+r)} * (\beta(1+r))^{T_0}$$

232. The extra term in the second summand,$(\beta(1+r))^{T_0}$, is required to account for inflation, data growth, and time value between T_1 and T_0.

Numerical implementation

233. We use this model to illustrate the impact of changes between 2021 and 2025 as shown in Table 6:

Table 6: Parameters used in the numerical implementation of the model

Term	Equation term	2021	2025
Inflation 2021-2025			23.77%
Data growth 2021-2025			86.51%
Efficiency 2021 – 2025			46.41%
Base Traffic Value[1]	$A * V_0$	10^6	1.58 * 10^6
Inflation forecast	π	2.00%	2.50%
Data forecast	r	19%	13%
Discount rate	i	7.00%	8.60%
Efficiency	δ	14%	10%
BW0	BW_0	300	300
BW1	BW_1	400	400
T0	T_0	11	7
T1	T_1	9	13
BW	BW	10	10
Beta	β	0.8362	0.8580
Value		316	250
Change			**-20.81%**

Notes: 1: (1+inflation 2021-2025)*(1+data growth 2021-2025)/(1+efficiency 2021-2025) to account for changes between 2021 and 2025, and a scaling factor to have the values in the hundreds

Comparative statics

234. We use this model to illustrate the individual and joint impact of changes between 2021 and 2025. Table 7 shows the changes vs the 2021 valuation in each of the components in the model. All parameters are identical to those used in the 2021 valuation except those in the 'Change vs 2021' column. The impact column represents the change in value versus the 2021 base valuation due to exclusively changing the parameters in the 'Change vs 2021' column. The weight column is the percentage of the total change attributable to each variable, and the column Weighted Impact distributes the total change based on the weight of each factor.

Table 7: Comparative statics

Factor	Change vs 2021	Impact	Weight1	Weighted Impact
Supply	$T_0 = 7$ $T_1 = 13$	-10.7%	48%	-9.9%
Data growth	$A * V_0 = 1.27 * 10^6$ $r = 13\%$ $\delta = 10\%$	-23.0%	110%	-22.9%
Inflation	$A * V_0 = 1.24 * 10^6$ $\pi = 2.5\%$	28.8%	-106%	22.1%
Discount rate	$i = 8.6\%$	-10.9%	49%	-10.1%
Total			**100.00%**	**-20.81%**

235. Our valuation model includes many variable interactions that make it difficult to assign an unambiguous impact to each variable. However, as interactions are almost entirely multiplicative, we have assigned weights as if the model were multiplicative. In a multiplicative model, the value of 2025 would be the value of 2021 adjusted by the individual impact of each variable, namely $V_{2025} = V_{2021}(1 + SI)(1 + DI)(1 + II)(1 + DI)$, which implies that the impact of each factor is $ln(1 + SI)/\ln\left(\frac{V_{2025}}{V_{2021}}\right)$.

236. By analogy, we derive the weight of each component as the share of the sum of logarithms. For example, the weight for the supply is $\frac{ln(1+SI)}{\ln((1+SI)(1+DI)(1+II)(1+DI))}$.

237. As a reference, $\frac{\ln\left(\frac{V_{2025}}{V_{2021}}\right)}{\ln((1+SI)(1+DI)(1+II)(1+DI))} = 97.85\%$, which means that the model is almost multiplicative.