



Annual licence fees for 900 MHz and 1800 MHz spectrum

Consultation

Consultation

Publication date: 10 October 2013

Closing Date for Responses: 19 December 2013

Contents

Section		Page
1	Executive summary	3
2	Introduction	7
3	Factual background and legal framework	11
4	Assessment of lump-sum values	18
5	Deriving annual licence fees from lump sum valuations	38
6	Implementing revised annual licence fees	54
Annex		Page
1	Responding to this consultation	58
2	Ofcom's consultation principles	60
3	Consultation response cover sheet	61
4	Consultation questions	63
5	Assessment of the competitiveness of the UK Combined Award	64
6	Network cost modelling and other technical evidence	70
7	European auction evidence	81
8	Sensitivity analysis	118
9	Whether there is an asymmetric risk of inefficient use of spectrum from setting ALFs too high or too low	136

Section 1

Executive summary

Introduction

- 1.1 In December 2010, the Government issued a Direction¹ which, amongst other things, required Ofcom to revise the fees payable for licences to use radio spectrum in the 900 MHz and 1800 MHz bands so that they reflect full market value. The Direction also required that, in revising the fees, Ofcom must have particular regard to the sums bid for licences in the auction of 800 MHz and 2.6 GHz spectrum (the 4G Auction).
- 1.2 This consultation sets out our proposals for revising the annual fees payable for licences to use this radio spectrum.

Our proposals

- 1.3 We have taken into account a range of evidence to inform our estimate of the market value of licences in these two spectrum bands. This includes:
- sums bid in the 4G Auction (as required by the Direction),
 - prices paid in spectrum auctions abroad, and
 - technical and commercial characteristics of spectrum bands.

Evidence provided by the UK's 4G auction

- 1.4 We have analysed the bids in the UK's 4G Auction to determine underlying band values within the multi-band packages for which participants bid. We have then taken a view on how these valuations of 800 MHz and 2.6 GHz spectrum might inform our estimates of the full market value of 900 MHz and 1800 MHz spectrum.
- 1.5 The UK 4G Auction generated prices for multi-band packages rather than individual band prices. We commissioned DotEcon Ltd to analyse bid data using alternative methodologies on which we have previously consulted, and we have published DotEcon's analysis. We favour the linear reference pricing methodology, which indicates an underlying value of £29.85m per MHz for 800 MHz spectrum without a coverage obligation (including co-existence costs) and £4.95m per MHz for paired 2.6 GHz spectrum.

Evidence provided by auctions in other countries

- 1.6 We commissioned a separate study from DotEcon into prices from relevant auctions in other countries, and we have published DotEcon's report alongside this consultation. Informed by DotEcon's analysis, we have reached a view as to what we consider to be the relative importance of different international evidence points in informing our estimates of the value of 900 MHz and 1800 MHz spectrum in the UK (adjusted for differences such as population and licence duration).

¹ See paragraph 3.7 below.

- 1.7 We have considered both the absolute values implied by relevant auctions and the relative values between bands in a single country. For example the auction price for 900 MHz in Spain indicates a UK price of around £25m per MHz, which was around 80% of the value of 800 MHz in Spain. However, applying this 80% ratio to the value of 800 MHz in the UK, rather than in Spain, indicates a value just below £24m per MHz.
- 1.8 In considering the weight that should be attached to evidence we have had regard both to the likelihood that evidential points reflected market value in the country concerned, and their relevance to the value of 900 MHz and 1800 MHz spectrum in the UK.

Deriving lump sum values for UK spectrum

- 1.9 We have also considered the extent to which our evidence base might be sensitive to underlying assumptions, particularly around our estimate of the value of 800 MHz and, to a lesser extent, 2.6 GHz spectrum in the UK, which plays a significant role in our analysis. We therefore considered the validity of the assumptions on which these estimates rely and the potential impact of making alternative assumptions, including some suggested by licence holders.
- 1.10 In order to determine fees we need to identify, for each of 900 MHz and 1800 MHz, a single figure for the lump-sum value of spectrum. We have a limited set of evidence points with a relatively wide distribution of values, and we consider that no specific evidence points can be relied on in a determinative way. Because of this we have not sought to take a mechanistic approach to deriving best estimates from the available evidence. Rather, we have considered the evidence for each band in the round, and used our judgement to decide how much weight to place on the various pieces of evidence to develop a best estimate for each band.
- 1.11 We propose that the following best estimates of lump sum full market value should be used to derive annual fees.

Figure 1.1: Best estimates of lump sum full market value

900 MHz	1800 MHz
£25m per MHz	£15m per MHz

Deriving annual fees from lump sum valuations

- 1.12 The values discussed above are lump sum valuations based on a notional 20 year licence term (the initial term of the 4G licences which we have auctioned). In the case of licences for 900 MHz and 1800 MHz spectrum, we are seeking to apply annual fees rather than lump sum payments. Therefore we propose to convert the relevant lump sum value into an annuity to be paid as an annual fee.
- 1.13 In doing so, we need to determine an appropriate cost of capital, and decide whether to express annual payments as nominal or real values.
- 1.14 We propose to use a cost of capital which is consistent with that used to determine current charge controls for mobile call termination (MCT), updated to reflect changes

to corporation tax made since the MCT controls were implemented. We consider that values placed by bidders in the 4G Auction are likely to reflect their assessment of post-tax cash flows to be generated by the spectrum. As such, we propose to use a cost of capital on a post-tax basis. The real post-tax equivalent to the real 6.2% pre-tax weighted average cost of capital (WACC) used to derive mobile charge control values is 4.1%. The adjustment to reflect changes to corporation tax increases this figure to 4.2%.

- 1.15 We further propose to adjust fees to take into account the tax advantage of lump sum payments compared with annual fees. Both can be used to offset a tax liability but only the sums payable in annual fees are adjusted to take account of inflation and the cost of money for the purpose of calculating the allowance for tax purposes. We propose that annual fees derived from the WACC should be increased by 11% to reflect this factor.
- 1.16 We propose to set a constant level of fees in real terms, so that the fees will be uplifted annually in line with the Retail Prices Index (RPI). We propose that the base date for the purpose of RPI adjustment should be March 2013, this being the month in which the 4G Auction was completed, bids in which are a key component of our benchmarking.
- 1.17 Setting fees with a constant profile is in our view a pragmatic approach that avoids the complexity of modelling and estimating the potential variations in future spectrum values over a long period of time in the presence of uncertainty. Furthermore, setting fees in constant real terms (as opposed to constant nominal) is in our view a reasonable assumption in the absence of clear evidence of a systematic downward trend in value in real terms.
- 1.18 Applying this annualisation approach to the lump sum values set out in Figure 1.1 above generates annual fees as follows:

Figure 1.2: Proposed annual fees per MHz

900 MHz	1800 MHz
£1.99m	£1.19m

Implementation

- 1.19 The annual date on which licence fees currently fall due varies widely between licensees. We propose to implement revised fees to a common “effective” date of the first day of the month following the month in which the new fees regulations come into force. For each licensee’s first payment after the common effective date, we therefore propose to adjust the amount payable by each licensee to reflect the length of the period between the common effective date and that licensee’s next payment date. Thereafter fees payable across the year will be uniform for all licensees.
- 1.20 We do not propose to phase in fees. Licensees have known since December 2010 that fees would be revised to reflect full market value. We believe that revised fees can be implemented in a single step without having an adverse impact on services delivered to customers. Therefore, we consider that it would be in line with the Direction for fees that are reflective of full market value to be implemented at the outset without a period of phasing in.

Next steps

- 1.21 We are inviting stakeholders to provide any comments by Thursday 19th December 2013. The purpose of this consultation is to seek input from stakeholders and any other interested parties. In particular, whilst Annex 4 of this consultation document contains a number of specific questions, we are not seeking to limit the issues on which respondents may wish to comment and respondents are invited to include representations on any issues which they consider to be relevant.

Section 2

Introduction

- 2.1 In December 2010, the Government issued a Direction² which, amongst other things, required Ofcom to revise the fees payable for licences to use radio spectrum in the 900 MHz and 1800 MHz bands so that they reflect full market value. The Direction also required that, in revising the fees, Ofcom must have particular regard to the sums bid for licences in the auction of 800 MHz and 2.6 GHz spectrum (the 4G Auction).
- 2.2 In this document, we are setting out our proposals for revising annual fees payable for licences to use this radio spectrum.

Stakeholder engagement

- 2.3 We set out our provisional thinking on our approach to deriving fees for the 900 MHz and 1800 MHz bands in consultation documents published in March 2011³ (the First Competition Assessment) and January 2012⁴ (the Second Competition Assessment), and in a statement published in July 2012⁵ (the July 2012 Statement). Those documents were concerned mainly with the design of the 4G Auction but they sought to provide our provisional views on the likely approach to revising fees for 900 MHz and 1800 MHz spectrum and provided an opportunity for interested parties to comment.
- 2.4 We set out our view that it was likely to be appropriate to draw on evidence from the following three methodologies to estimate full market value:
- The linear reference pricing methodology described in the First Competition Assessment, using all bids made in the 4G Auction;
 - The Additional Spectrum Methodology described in paragraphs A13.66 to A13.75 of the Second Competition Assessment: and
 - Values from auctions of comparable spectrum in other countries that we considered to be sufficiently competitive, adapted to reflect UK circumstances. We noted that this was likely to include consideration of the relative values of different frequencies in auctions where multiple frequencies were sold.
- 2.5 We did not rule out additional use of technical modelling to inform our decision on annual licence fees. However, we noted that spectrum values derived from technical modelling are subject to a considerable margin of error and such modelling may, therefore, be of limited value.

² See paragraph 3.7 below.

³ *Consultation on assessment of future mobile competition and proposals for the award of 800 MHz and 2.6 GHz spectrum and related issues*, published by Ofcom on 22 March 2011 at <http://stakeholders.ofcom.org.uk/consultations/combined-award/>

⁴ *Second consultation on assessment on future mobile competition and proposals for the award of 800MHz and 2.6GHz spectrum and related issues*, published by Ofcom on 12 January 2012 at <http://stakeholders.ofcom.org.uk/consultations/award-800mhz-2.6ghz/>

⁵ *Assessment of future mobile competition and award of 800MHz and 2.6GHz*, published by Ofcom on 24 July 2012 at <http://stakeholders.ofcom.org.uk/consultations/award-800mhz-2.6ghz/statement/>

- 2.6 We proposed to annualise such lump sum estimates using the real pre-tax cost of capital as the discount rate. We proposed that fees should be subject to some form of adjustment to reflect inflation.
- 2.7 In developing our proposals since July 2012, we have taken into account responses made by stakeholders to the First and Second Competition Assessments, in so far as these relate to this revision of fees for 900 MHz and 1800 MHz spectrum. We have also received further written submissions from licensees and have held informal bilateral meetings to enable licensees to explain their submissions more fully. We have summarised and responded to stakeholder views within the Sections and Annexes which follow.

Our proposed approach to revising fees

- 2.8 In our First Competition Assessment we said:
- “We consider that full market value is the price that would arise in a well functioning spectrum market. This would be the market clearing price when supply equals demand.” (paragraph 10.3);
 - “We interpret the term “full market value” to mean that we do not discount our estimate of the price that would occur in a well functioning market, nor do we set it conservatively compared with the available market information.” (paragraph 10.4).
- 2.9 That remains our view and is the basis on which we have developed the proposals in this document.
- 2.10 We recognise that there is uncertainty about the full market value of these bands and that the process of revising annual licence fees necessarily requires us to use our judgement to estimate the full market value. We have set out in this document our proposed approach for making this estimate, including proposing a figure for each band as our best estimate of full market value, given the available evidence.
- 2.11 We considered whether it would be helpful as part of this process to have an intermediate step of deriving a range for each band within which we considered it likely that full market value fell, before going on to arrive at our best estimate (i.e. a single figure within the range). However, in light of the nature of the evidence on which we propose to rely, and the spread and distribution of the evidence points for each band, we consider that this intermediate step (deriving a range) would not assist us in arriving at our estimate of full market value.
- 2.12 We propose to estimate a full market value for 900 MHz and 1800 MHz spectrum that reflects the inherent value of the spectrum covered by these licences, but in generic terms – i.e. without seeking to reflect the specific circumstances of the existing licensees, or the uses that current licence holders are making or planning to make of the spectrum. So, for example, we are consulting on linear prices which do not distinguish the market value of one specific size of holding from the market value of another size of holding within each of the frequency bands, nor vary between licensees. We note that doing so would be especially problematic given the scope for trading of spectrum blocks which could cause holdings to be combined or divided.
- 2.13 Having reviewed the range of market evidence available to us, it is clear that the vast majority of the data which might inform our valuations is in the form that relates to capital sums paid for long term spectrum access, notably in auctions, rather than in

the form of annual payments. This has necessarily influenced the way in which we have approached the analysis. In particular, there are two distinct aspects to our derivation of fees:

- the lump-sum value of spectrum in each of the 900 MHz and 1800 MHz bands, and
- the conversion of those lump sum values into an equivalent annual fee.

- 2.14 This is reflected in the two main analytical sections of this consultation document: Section 4 addresses lump sum values for a notional 20 year licence and Section 5 considers how these lump sums might be annualised.
- 2.15 This focus on auction valuations, including in particular bids made in the UK's 4G Auction, is also consistent with the requirement of the Direction that we must have particular regard to the sums bid for licences in the 4G Auction.
- 2.16 The UK 4G Auction did not include 900 MHz or 1800 MHz spectrum and, whilst auctions in a number of other countries have included 900 MHz and / or 1800 MHz spectrum, these auction prices may reflect specific national market or auction circumstances that may differ in material respects from the UK. Accordingly, we have exercised our regulatory expertise and judgement in weighing up the available evidence.
- 2.17 We propose to use a range of evidence, as set out in Section 4 below, to estimate the lump sum value of each of the two spectrum bands measured on the basis of a licence with a notional 20 year term and with terms broadly equivalent to those which apply to the licences awarded through the 4G Auction. We go on to use this range of evidence to derive a proposed lump sum value for each band.
- 2.18 We propose to derive annual fees from lump sum values by calculating an annuity based on the relevant lump sum. This calculation will require us to consider, amongst other things, the relevant cost of capital. We are consulting on our view that annual fees should be expressed as values which remain constant in real terms for their duration but should be subject to adjustment to reflect inflation. We have set out (in section 5) the proposed annual licence fee for each band, which is produced by applying our proposed annualisation method to the lump sum value figure proposed in section 4.

Structure of the document

- 2.19 The remainder of this consultation document is structured as follows:
- Section 3 – Factual background and legal framework
 - Section 4 – Assessment of lump sum values
 - Section 5 – Derivation of annual fees from lump sum valuations
 - Section 6 – Implementation of annual licence fees
- 2.20 There are also a number of annexes which provide supporting evidence and analysis.

Impact assessment

- 2.21 The analysis presented in this document (especially in Section 4, Section 5, Section 6 and Annex 9) constitutes an impact assessment as defined in section 7 of the Communications Act 2003. Impact assessments provide a valuable way of assessing different options for regulation and showing why the preferred option was chosen. They form part of best practice policy-making⁶.

Equality Impact Assessment

- 2.22 Ofcom is required by statute to assess the potential impact of all our functions, policies, projects and practices on the following equality groups: age, disability, gender, gender reassignment, pregnancy and maternity, race, religion or belief and sexual orientation. Equality Impact Assessments (EIAs) also assist us in making sure that we are meeting our principal duty of furthering the interests of citizens and consumers regardless of their background or identity.
- 2.23 We have not identified any particular impact of our proposals for revising licence fees in relation to the identified equality groups. Specifically, we do not envisage the impact of any outcome to be to the detriment of any particular group of society.
- 2.24 Nor have we seen the need to carry out separate EIAs in relation to the additional equality groups in Northern Ireland: religious belief, political opinion and dependants. This is because we anticipate that our proposals will not have a differential impact in Northern Ireland compared to consumers in general.

⁶ For further information about our approach to impact assessments, see the guidelines, '*Better policy-making: Ofcom's approach to impact assessment*', which are on our website at http://stakeholders.ofcom.org.uk/binaries/consultations/ia_guidelines/summary/condoc.pdf

Section 3

Factual background and legal framework

Spectrum holdings

- 3.1 Licences to use 900 MHz and/or 1800 MHz spectrum are currently held by Vodafone Ltd (Vodafone), Telefónica UK Ltd (Telefónica), Everything Everywhere Ltd (EE) and Hutchison 3G UK Ltd (H3G).
- 3.2 EE and H3G have agreed that 2x10 MHz of 1800 MHz spectrum shall be transferred from EE to H3G on 1 October 2013 and a further 2x5 MHz on 1 October 2015⁷. The current licences reflect these agreements and set out the dates on which the size of the spectrum holdings will change. From 1 October 2015, when these agreed transfers between EE and H3G have been completed, the holdings of 900 MHz and 1800 MHz spectrum will be as follows:

Figure 3.1 Spectrum holdings by operator

	Vodafone	Telefónica	EE	H3G
900 MHz	34.8 MHz	34.8 MHz	-	-
1800 MHz	11.6 MHz	11.6 MHz	90 MHz ⁸	30 MHz ⁹

Licence conditions

- 3.3 Each of the four licences includes the following core provisions:
- The term is indefinite, but Ofcom may revoke the licence on spectrum management grounds after five years' notice¹⁰.
 - Radio equipment may be used across the whole of the UK, but the licences do not permit the use of equipment on the Isle of Man or any of the Channel Islands.
 - The technical standards to which equipment must conform vary between licences. However, in conformance with European law, we have liberalised all of these licences to permit the 900 MHz and 1800 MHz bands (and 2100 MHz band) to be used with LTE (4G) as well as 2G and 3G standards.

⁷ The transfer took place in pursuance of commitments given by Deutsche Telekom and France Telecom to the European Commission in connection with the merger of Orange UK and T-Mobile UK (see further M.5650 T-Mobile / Orange

http://ec.europa.eu/competition/mergers/cases/decisions/M5650_20100301_20212_247214_EN.pdf)

⁸ EE's licence specifies that 2x60 MHz may be used until 30 September 2013, falling to 2x50 MHz on 1 October 2013, and further reducing to 2x45 MHz on 1 October 2015.

⁹ H3G's licence specifies 2x10 MHz to be used from 1 October 2013 and a further 2x5 MHz from 1 October 2015. The licence does not authorise the use of any 1800 MHz spectrum before 1 October 2013.

¹⁰ The licence may also be revoked or varied for breach of licence terms (including failure to pay licence fees), for reasons to do with national security, to enable the UK to comply with an international obligation and in cases where there is a breach of the relevant regulations on spectrum trading in connection with a transfer of rights under the licence.

- 3.4 Since 4 July 2011¹¹, the rights afforded by the licences may be traded. Ofcom's consent is required, but this may be withheld only in specific circumstances, including where we consider competition is likely to be distorted by the transfer. Licensees may trade all or some of their rights, and they may choose either to retain rights concurrently with the acquirer or to give the acquirer outright use of the rights concerned.

Current fee regulations

- 3.5 Current fee regulations require payment of £142,560 for each 2x200 kHz national channel of 900 MHz spectrum (ie £712,800 per 2x1 MHz), and £110,880 for each 2x200 kHz national channel tranche of 1800 MHz spectrum (ie £554,400 per 2x1 MHz).
- 3.6 On this basis, the spectrum holdings set out in Figure 3.1 above, on completion of the agreed transfers between EE and H3G, would attract fees as follows at current rates.

Figure 3.2 Fees per operator at current rates

	Vodafone	Telefónica	EE	H3G
900 MHz	£12.4m	£12.4m	-	-
1800 MHz	£3.2m	£3.2m	£24.9m	£8.3m
Total	£15.6m	£15.6m	£24.9m	£8.3m

Government direction to Ofcom

- 3.7 In January 2009 the Government published its interim Digital Britain report¹² setting out a series of actions designed to maximise the opportunities for the UK in the digital age. It identified a complex set of challenges that it considered were hindering the release of spectrum for next generation broadband services and appointed an independent spectrum broker ("ISB") to examine possible solutions to these challenges. The ISB's report was published in May 2009 and in the Government's final Digital Britain report¹³ it indicated it was minded to implement the ISB's proposals, subject to further work designed to address a number of issues. One of the proposals was that the licences for the use of frequencies in the 900 MHz and 1800 MHz bands should be liberalised in the hands of existing licensees, and that annual licence fees should be revised to reflect the full economic value of this spectrum.
- 3.8 The Government noted that there was an option to direct Ofcom to implement any decision to take forward the proposals and that it would be obliged to consult on any such direction. Following the ISB's final report it decided to proceed in this way. On

¹¹ *Statement on proposals to make 900 MHz, 1800 MHz and 2100 MHz public wireless network licences tradable* published by Ofcom on 20 June 2011 at

<http://stakeholders.ofcom.org.uk/binaries/consultations/trading-900-1800-2100/statement/900-1800-2100-statement.pdf>

¹²

http://webarchive.nationalarchives.gov.uk/20100511084737/http://www.culture.gov.uk/what_we_do/broadcasting/5944.aspx

¹³ <http://www.bis.gov.uk/assets/biscore/corporate/docs/d/digital-britain-final-report.pdf>

16 October 2009 it published its consultation¹⁴ on a direction to Ofcom to implement the Wireless Radio Spectrum Modernisation Programme. This consultation proposed (amongst other things) that the Government would direct Ofcom to liberalise existing 900 MHz and 1800 MHz licences in the hands of the existing holders¹⁵. These licences would be clarified as being indefinite, and would be subject to revocation at five years' notice for spectrum management reasons. The licences would, in due course, be made tradable, and would be subject to revised licence fees reflecting their full market value. Ofcom would consult on the appropriate level for the fees after the 4G Auction.

- 3.9 In March 2010, the Government published its response to the consultation¹⁶ and subsequently laid a draft statutory instrument before Parliament in March 2010 directing Ofcom to undertake a number of measures including the revision of licence fees for the Licences. The direction was however not considered by Parliament prior to the General Election.
- 3.10 Following the General Election the coalition Government decided to make a revised direction comprising a sub-set of the proposals set out in the previous draft. A revised draft direction was laid before Parliament in July 2010. The Wireless Telegraphy Act 2006 (Directions to OFCOM) Order 2010 (the "Direction")¹⁷ was made on 20 December 2010 and came into force ten days after being made.

Legal Framework

- 3.11 The legal framework for the setting of licence fees derives from our duties under both European and domestic legislation, specifically from:
- the Common Regulatory Framework¹⁸ for electronic communications networks and services, in particular the Framework Directive and the Authorisation Directive;
 - the Communications Act 2003 (the "Communications Act") and the Wireless Telegraphy Act 2006 (the "Wireless Telegraphy Act") which transpose the provisions of those directives into national law; and
 - in the case of licences for frequencies in the 900 MHz and 1800 MHz bands, the "Direction".

¹⁴ <http://www.bis.gov.uk/consultations/ofcom-wireless-modernisation-programme>

¹⁵ The UK was required to liberalise use of the 900 MHz and 1800 MHz frequencies under two EC instruments made in 2009.

¹⁶ <http://www.bis.gov.uk/assets/biscore/business-sectors/docs/10-737-government-response-consultation-ofcom-implement-spectrum-modernisation>

¹⁷ The Wireless Telegraphy Act 2006 (Directions to OFCOM) Order 2010 (S.I.2010 No. 3024) which can be found at: <http://www.legislation.gov.uk/ukSI/2010/3024/contents/made>. The Direction implemented Directive 2009/114/EC of the European Parliament and of the Council amending Council Directive 87/372/EEC on the frequency bands to be reserved for the coordinated introduction of public pan-European cellular digital land-based mobile communications in the Community (OJ L 274, 20.10.2009, p25) and Commission Decision 2009/766/EC on the harmonisation of the 900 MHz and 1800 MHz frequency bands for terrestrial systems capable of providing pan-European electronic communications services in the Community (OJ L 274, 20.10.2009, p32).

¹⁸ The Common Regulatory Framework comprises the Framework Directive (Directive 2002/21/EC), the Authorisation Directive (Directive 2002/20/EC), the Access Directive (Directive 2002/19/EC), the Universal Service Directive (Directive 2002/22/EC) and the Directive on privacy and electronic communications (Directive 2002/58/EC), as amended by the Better Regulation Directive (Directive 2009/140/EC).

European Regulatory Framework

- 3.12 Article 8 of the Framework Directive sets out the objectives which national regulatory authorities must take all reasonable steps to achieve. These include:
- the promotion of competition in the provision of electronic communications networks and services by, amongst other things, ensuring there is no distortion or restriction of competition in the electronic communications sector and encouraging efficient use of radio frequencies; and
 - contributing to the development of the internal market by, amongst other things, removing obstacles to the provision of electronic communications networks and services at a European level, and encouraging the interoperability of pan-European services.
- 3.13 In pursuit of these policy objectives, Article 8 requires national regulatory authorities to apply objective, transparent, non-discriminatory and proportionate regulatory principles by (amongst other things):
- ensuring that, in similar circumstances, there is no discrimination in the treatment of undertakings providing electronic communications networks and services; and
 - promoting efficient investment and innovation in new and enhanced infrastructures.
- 3.14 Article 8 also requires Member States to ensure that in carrying out their regulatory tasks, national regulatory authorities take the utmost account of the desirability of making regulations technologically neutral.
- 3.15 Article 9 of the Framework Directive requires Member States to ensure the effective management of radio frequencies for electronic communications services in accordance with Article 8, and to ensure that spectrum allocation used for electronic communication services and issuing general authorisations or individual rights of use of such radio frequencies are based on objective, transparent, non-discriminatory and proportionate criteria. Article 9 also requires Member States to promote the harmonisation of use of radio frequencies across the Community, consistent with the need to ensure effective and efficient use of frequencies. It further requires Member States to ensure technology and service neutrality.
- 3.16 Article 13 of the Authorisation Directive states that Member States may impose fees for the rights of use of radio frequencies which reflect the need to ensure the optimal use of that resource. Fees must be objectively justified, transparent, non-discriminatory and proportionate in relation to their intended purpose and must take into account the objectives in Article 8 of the Framework Directive.
- 3.17 Recital 32 to the Authorisation Directive states that in addition to administrative charges, usage fees may be levied for the use of radio frequencies as an instrument to ensure the optimal use of such resources, and provides that such fees should not hinder the development of innovative services and competition in the market.
- 3.18 Recital 33 to the Authorisation Directives states that Member States may need to amend charges and fees relating to rights of use of radio frequencies where this is objectively justified, and provides that such changes should be duly notified to all interested parties in good time, giving them adequate opportunity to express their views on any such amendments.

- 3.19 The legal duties imposed on the UK by the Framework and Authorisation Directives are transposed into UK law and given effect to by the Communications Act and the Wireless Telegraphy Act (see below).

The duties imposed by the Communications Act

- 3.20 Section 3 of the Communications Act sets out Ofcom's general duties including its principal duty:
- to further the interests of citizens in relation to communications matters; and
 - to further the interests of consumers in relevant markets, where appropriate by promoting competition.
- 3.21 In carrying out its functions, section 3(2) provides that Ofcom is required, amongst other things, to secure the optimal use for wireless telegraphy of the electro-magnetic spectrum, the availability throughout the UK of a wide range of electronic communication services and the availability throughout the UK of a wide range of television and radio services.
- 3.22 Section 3(3) of the Communications Act provides that in performing its duties, Ofcom must in all cases have regard to the principles of transparency, accountability, proportionality and consistency, as well as ensuring that its actions are targeted only at cases in which action is needed.
- 3.23 Section 3(4) of the Communications Act requires Ofcom in performing its duties, to have regard to a number of factors as appropriate, including the desirability of promoting competition, encouraging investment and innovation in relevant markets, encouraging the availability and use of high speed data transfer services throughout the UK, the different interests of persons living in rural and in urban areas and the different needs and interests of everyone who may wish to use the spectrum for wireless telegraphy.
- 3.24 In performing our duty under section 3 of furthering the interests of consumers, we must have regard, in particular, to the interests of those consumers in respect of choice, price, quality of service and value for money.
- 3.25 Section 4 of the Communications Act requires Ofcom to act in accordance with the six Community requirements, which give effect to the requirements of Article 8 of the Framework Directive.

The duties imposed by the Wireless Telegraphy Act

- 3.26 Section 3 of the Wireless Telegraphy Act imposes a number of further duties relating to spectrum management. Amongst other things, in carrying out its spectrum functions Ofcom is required to have regard to the extent to which spectrum is available for use, and the demand (both current and future) for the use of spectrum.
- 3.27 Section 3 of the Wireless Telegraphy Act also requires Ofcom to have regard to the desirability of promoting the development of innovative services and competition in the provision of electronic communications services.

Ofcom's power to set fees

- 3.28 Under section 12 of the Wireless Telegraphy Act Ofcom has power to require licensees to pay fees to Ofcom on the grant of a licence and subsequently. The requirement to pay fees at times after the grant of a licence must be imposed by way of regulations made by Ofcom. The timing of the fee payment must be set out in the regulations, and the amount of the fee can be prescribed in the regulations, or alternatively the regulations may provide for the amount to be determined by Ofcom in accordance with the regulations.
- 3.29 Section 13 of the Wireless Telegraphy Act provides for Ofcom to set fees at an amount that is higher than the cost to us of carrying out our radio spectrum functions. This power may be exercised if we think fit in the light (in particular) of the matters to which we must have regard under section 3 of the Communications Act.
- 3.30 Section 122 of the Wireless Telegraphy Act is a general provision about matters relating to Ofcom's powers to make statutory instruments (including fees regulations under section 12 of that Act). It includes a requirement that where we are proposing to make regulations we must publish a notice setting out the general effect of the regulations and give a period of at least one month within which representations on the proposed regulations may be made to us¹⁹.

Direction

- 3.31 The Direction made by the Government in December 2010 gave specific instructions to Ofcom about the carrying out of our radio spectrum functions in relation to the frequency bands and licences used to provide mobile services. The Direction was made by the Secretary of State using his powers under section 5 of the WTA to give general or specific directions to Ofcom about the carrying out by us of our radio spectrum functions.
- 3.32 In relation to the 900 MHz and 1800 MHz licences, the Direction required Ofcom to implement a package of measures. These were:
- to vary the licences so that they authorise the provision of 3G and 4G services (GSM and UMTS systems) (Article 4);
 - to vary the licences to extend the notice period for revocations for spectrum management reasons from one year to five years (Article 5(1) and (2));
 - to make the licences fully tradable by amending the Wireless Telegraphy (Spectrum Trading) Regulations 2008 (Article 7);
 - to revise the fees charged for the licences, after completion of the 4G Auction (Article 6(1) and (2)).
- 3.33 More specifically, Article 6(1) and 6(2) of the Direction set out respectively the following requirements:
- after completion of the 4G Auction OFCOM must revise the sums prescribed by regulations under section 12 of the WTA for 900 MHz and 1800 MHz licences so that they reflect the full market value of the frequencies in those bands;

¹⁹ For the avoidance of doubt, this consultation is not a notice under section 122 of the Wireless Telegraphy Act.

- in revising the sums prescribed OFCOM must have particular regard to the sums bid for licences in the 4G Auction.

3.34 All of the requirements in the Direction relating to the Licences have now been implemented except for the revisions to the licence fees.

Application of the legal framework to revising licence fees

3.35 In this document we set out our proposals for implementing the requirement in the Direction that we revise the fees for licences in the 900 MHz and 1800 MHz bands so that they reflect full market value, having particular regard to the sums bid for licences in the 4G Auction. In making these proposals we have considered our principal duty to further the interests of citizens, and the interests of consumers where appropriate by promoting competition, and we have considered our duties relating to the optimal use for wireless telegraphy of the electro-magnetic spectrum, the desirability of encouraging investment and innovation, the desirability of encouraging competition, having regard to the interests of consumers in respect of choice, price, quality of service and value for money. We consider that our proposals for implementing the requirement in the Direction are consistent with our statutory duties.

3.36 We have also taken particular account of the statutory requirement for us to be consistent in relation to the policy framework for spectrum pricing that we have established. In December 2010 Ofcom published *SRSP: The revised framework for Spectrum Pricing*. This document set out the policy and practice for setting fees for rights to use spectrum, focussing on using cost-based pricing or administered incentive price (AIP) as the mechanism for setting those fees. The fee review in this consultation document does not come within the scope of the SRSP²⁰. However, we recognise that some of the analysis in the SRSP could also be relevant to the current fee review, and we refer to the SRSP where appropriate.

²⁰ In paragraph 3.6 of the SRSP we said: "We currently employ three mechanisms for setting fees for rights to use spectrum: cost-based pricing, AIP and auctions. This document focuses on the first two of these. In July 2010 the Government laid a draft Direction before Parliament that would require us to employ a fourth mechanism – the setting of fees to reflect full market value. We do not discuss this fourth mechanism in this document." In paragraph 3.52 of the same document we said: "... If the direction is made we would expect to consult, in due course, on our proposed approach to the implementation of this element of the direction. We would expect the details of our methodology to set annual licence fees to be specific to the requirements of the Government's direction, which could differ from some of the approaches set out in this statement for AIP."

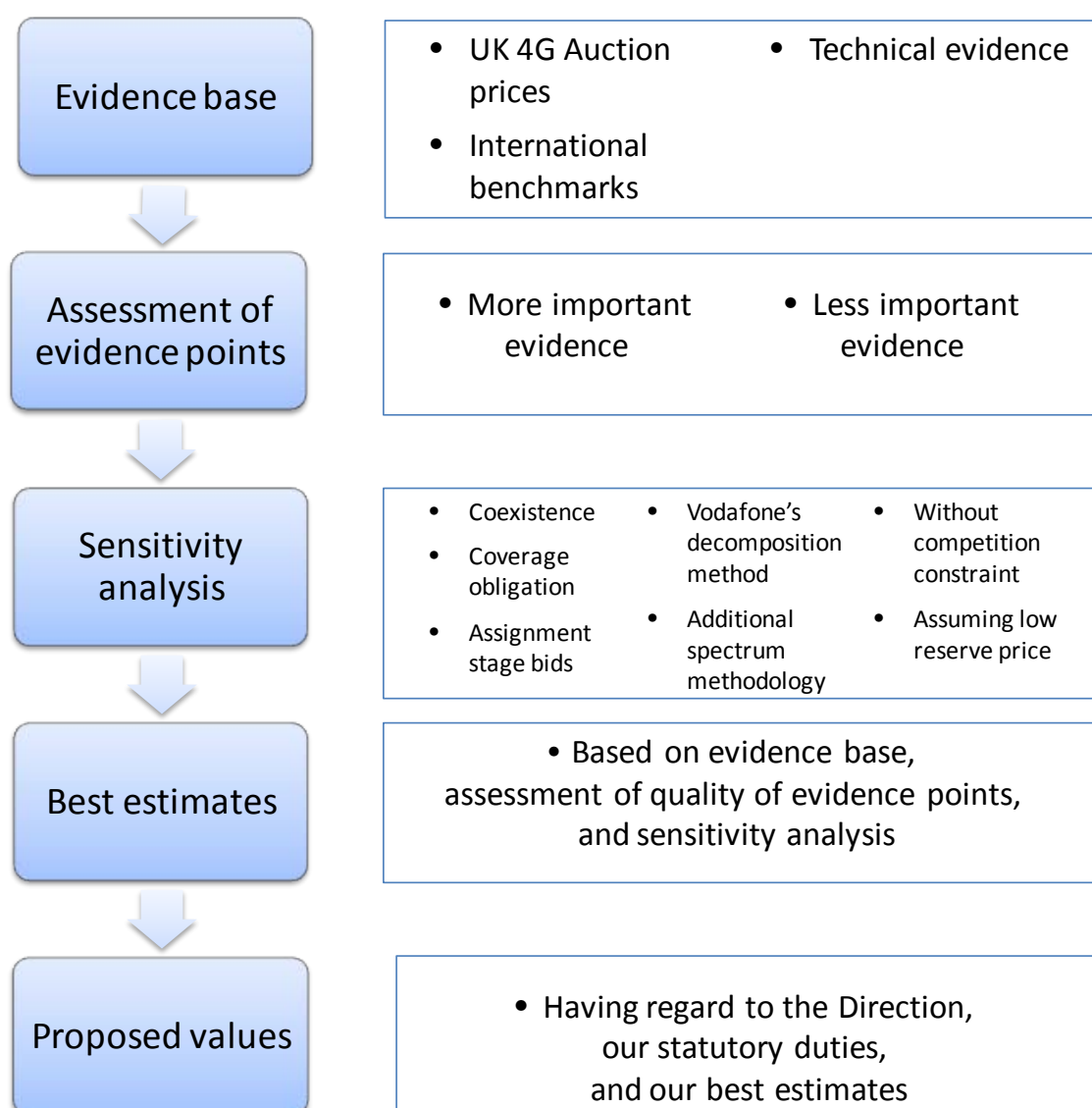
Section 4

Assessment of lump-sum values

Introduction

- 4.1 In this Section we set out the evidence which informs our view of the value of 900 MHz and 1800 MHz spectrum in the UK and our best estimate of the value of spectrum in these bands. We present the specific lump-sum values which we propose to use as a basis for setting revised annual licence fees.
- 4.2 The Direction requires Ofcom, after completion of the 4G Auction, to revise the 900 MHz and 1800 MHz licence fees so that they reflect the full market value of the frequencies in those bands, and also requires that in revising them we must have particular regard to the sums bid for licences in the 4G Auction.
- 4.3 Our July 2012 Statement (Annex 12, paragraphs A12.9 – A12.10) set out the three methodologies we proposed to use to estimate full market value:
- the linear reference price (LRP) methodology described in the First Competition Assessment, using all bids made in the UK auction;
 - the additional spectrum methodology (ASM) described in the Second Competition Assessment, which is also based on UK auction bid data; and
 - values from auctions for comparable spectrum in other countries that we considered to be sufficiently competitive, adapted to reflect UK circumstances.
- 4.4 We commented that:
- We recognised that we need to consider the calculations under each methodology and their outputs with care. They have limitations individually and in combination. However, by using a broad set of relevant data and by using market transaction information in particular, we believe that our approach is likely to be appropriate to the circumstances.
- 4.5 We consider that it is appropriate to derive lump-sum values for 900 MHz and 1800 MHz licences based on a notional licence with a 20-year initial term, reflecting the 20-year initial terms for the 800 MHz and 2.6 GHz licences in the 4G Auction. We then use these lump-sum values to derive annual fees as explained in the following section. Our approach to deriving lump-sum values is illustrated in Figure 4.1. We begin by setting out the different types of evidence we have considered. Next, for each type of evidence, we consider the likely relevance of individual evidence points in informing lump-sum values of 900 MHz and 1800 MHz licences in the UK, and in particular the weight that we should attach to individual evidence points. We distinguish between evidence on which we consider it appropriate to place more weight and evidence on which we place less weight. (For ease of reference we use the term “more important evidence” to refer to evidence on which we have decided to place more weight and the term “less important evidence” to refer to evidence on which we have decided to place less weight.) We then conduct a sensitivity analysis. Finally, we present our best estimate of the lump-sum value of each band.

Figure 4.1 Derivation of lump-sum values



Overview of evidence base

UK 4G Auction

- 4.6 The UK 4G Auction plays an important role in our analysis. This is in line with the Direction and reflects our view that the 4G Auction provides the most recent UK-specific basis for valuing spectrum in use for providing mobile services, albeit not in the bands for which we are revising ALFs. We commissioned DotEcon to analyse bids in the UK 4G Auction to produce estimates of the value of 800 MHz and paired 2.6 GHz spectrum licences in the UK.²¹
- 4.7 As we set out below, our “base case” for the value of the 800 MHz and paired 2.6 GHz spectrum licences in the UK is DotEcon’s estimate of LRP for each of the bands in its report on *800MHz and 2.6GHz linear reference prices and additional spectrum*

²¹ The report can be found at <http://stakeholders.ofcom.org.uk/binaries/consultations/900-1800-mhz-fees/annexes/linear-reference-prices.pdf>

methodology. We have placed materially less weight on the ASM because, when applied to the UK 4G Auction bids, this methodology proved to be highly sensitive to the underlying assumptions (namely the amount of spectrum released, and the identity of the bidder “excluded”²² from the auction). However, in our sensitivity analysis in Annex 8 we have also had regard to alternative ways of deriving estimates from UK auction data – namely the ASM, and a decompositional approach proposed by Vodafone – and to alternative sets of hypothetical assumptions around the UK 4G Auction which would affect the outcome of the LRP approach.

International auction outcomes

- 4.8 We also asked DotEcon to produce a report on *International benchmarking of 900 MHz and 1800 MHz spectrum value*²³, which sets out and comments on international auction results for relevant spectrum bands. In addition, we have received evidence from Vodafone relating to the outcome of several 4G auctions²⁴ in the EU. Alongside these sources, we have looked at publicly available information and commentary on 4G auctions in other countries.
- 4.9 In some countries of particular interest where multi-band combinatorial auctions were conducted – notably Ireland and Netherlands – we have approached National Regulatory Authorities (NRAs) for assistance in decomposing the auction revenues into different bands.²⁵ In general, due to confidentiality of bid data, these NRAs consider that they are not able to provide us such assistance, although Comreg, the relevant Irish NRA, has commented to us on specific evidence submitted by Vodafone about the Irish auction.

Technical evidence

- 4.10 We have considered evidence from stakeholders, including responses to the First Competition Assessment and the Second Competition Assessment, as to the different technical and commercial characteristics of spectrum bands, and the implications of these differences for market value. We have also considered the implications of Ofcom's technical modelling and policy conclusions in our competition assessment in advance of the 4G Auction (the July 2012 statement), and publicly available results from technical models of network costs.
- 4.11 We have not undertaken new technical or cost modelling specifically for the purpose of deriving ALFs. This is consistent with our view in the July 2012 Statement (see Annex 6 for a further discussion). While there is some uncertainty in interpreting international and UK auction prices, the range of evidence has enabled us to take a balanced view of the market value of spectrum in the 900 MHz and 1800 MHz bands. Market values derived from technical and commercial cost modelling are highly sensitive to the range of assumptions that need to be made, such that we consider that an attempt to derive point estimates of value based on this approach would be of limited additional benefit.

²² This concept is explained in footnote 35.

²³ The report can be found at <http://stakeholders.ofcom.org.uk/binaries/consultations/900-1800-mhz-fees/annexes/benchmarking.pdf>

²⁴ By this term we mean an auction including paired spectrum in any of the 800 MHz, 900 MHz, 1800 MHz and 2.6 GHz bands.

²⁵ These auctions, like the UK, used a combinatorial clock auction (CCA) in which bids were made and auction prices were determined for packages, not separately by band. However, unlike the UK there is insufficient information on the bids made in the public domain to apply the LRP or ASM methodologies to derive estimates of prices by band.

Use of the evidence base to derive evidential points

- 4.12 In developing the evidence base, we have considered the weight that should be attached to each evidence point. In doing so, we have distinguished between evidence on which we consider it appropriate to place more weight and evidence on which we consider it appropriate to place less weight (“more important evidence” and “less important evidence”). In doing so we have had regard both to what we consider to be the likelihood that evidential points reflected market value in the country concerned, and what we consider to be their relevance to the value of 900 MHz and 1800 MHz spectrum in the UK. However, while we have sought to identify country-specific factors which might have affected outcomes, it is worth noting that an award of mobile spectrum in a country is a one-off event, typically with a limited number of participants and a limited number of lots for auction.²⁶ As such, the outcomes of these awards are potentially sensitive to uncertain factors such as the design of the award and the strategies adopted by particular bidders at the time of the award. We consider this issue for each of the recent European 4G awards²⁷ in Annex 7 to the extent we have relevant evidence on such country-specific factors.
- 4.13 We have used the evidence outlined above to derive a range of specific evidence points for the value of 900 MHz and 1800 MHz spectrum, of the following types:²⁸
- a) **Absolute measures** of the value of 900 MHz and 1800 MHz spectrum where these have been auctioned in other countries.²⁹ Vodafone has noted the wide range of factors that can lead to different valuations between countries³⁰ and argued that “benchmarks from other jurisdictions are unlikely to provide robust estimates of absolute market values”. DotEcon’s study of international benchmarks considers such country-specific factors. We recognise that given variations between countries, no specific international benchmark is likely in itself to provide robust evidence of the value of spectrum in the UK. However, our view is that measures of absolute value are potentially informative if taken in the round and considered alongside other evidence.
 - b) **Relative measures** of value in cases where auctions in other countries included one or both of the bands auctioned in the UK combined award (800 MHz and 2.6 GHz) and one or both of the bands subject to ALF (900 MHz and 1800 MHz). In these cases we can potentially use the auction results to calculate the relative values of these two sets of bands in the countries concerned, and apply these relativities to our estimates of the UK value of the 800 MHz and 2.6 GHz bands, in order to derive benchmarks for the UK value of the 900 MHz and 1800 MHz bands. This can be explained in an example:

²⁶ In contrast, for example, to market prices for commodities or stocks for which there are many buyers or sellers.

²⁷ We use this term to refer to awards including paired 800 MHz, 900 MHz, 1800 MHz and 2.6 GHz spectrum

²⁸ In some cases, we consider that evidential points do not necessarily support a particular value, but have a risk of understating or overstating market value. For example, in a number of auctions where competition may have been weak or absent, there is a risk that auction prices understate the value of spectrum (in that higher prices could have been achieved in these auctions with a more competitive award).

²⁹ Making appropriate adjustments for currency (purchasing power parity), population, licence duration and date of auction to show figures on a UK-equivalent basis.

³⁰ Such as the general availability of spectrum, supply-side and demand-side factors, mobile market competition, and geography.

- The evidence we have suggests the absolute value of 900 MHz spectrum in Ireland is £36m per MHz.
 - However, an analysis of this evidence also indicates that the value of 900 MHz spectrum in the Irish auction was around 61% of 800 MHz.
 - Applying this relativity to the LRP-based value of 800 MHz in the UK (just under £30m per MHz) gives a value for 900 MHz of £18m per MHz.
 - The difference in these two benchmarks from the same country (£36m and 18m per MHz) arises because the estimated auction price for 800 MHz in the UK is somewhat lower than that in Ireland.
 - It is possible that relative values between bands may be less susceptible to some country-specific factors (such as demand for mobile services). However these relative valuations should also be treated with some caution, because it is possible that country-specific factors will have affected the two bands differently. If the differences in each band compared to the UK values are in different directions, the effect on the ratio is magnified.
- c) Measures derived from **combining** 800 MHz and 2.6 GHz values from the UK auction. These are relevant for 1800 MHz spectrum.³¹ We have included the simple average of the value of 800 MHz and 2.6 GHz as one of the points of evidence of the value of 1800 MHz spectrum (along with other means of combining these values to derive a valuation for 1800 MHz spectrum.³²)

Assessment of evidence points

4.14 We have considered whether the auction conditions in different countries are likely to be informative for our purposes. For example, we have sought to assess whether the auctions have seen sufficient competition and led to results which accurately reflect market value in the country concerned. Informed by DotEcon's work and our own research, we have considered circumstances such as whether the number of eligible bidders exceeded the number of lots, whether bidding might have been restricted by spectrum caps, and the possible effects of conditions attached to licences. We have also considered auction outcomes, looking for example at whether all licences were sold, and whether final prices were above reserve prices.

4.15 Based on this assessment, we have distinguished between:

- Evidence to which we think more weight should be given ("more important evidence"), which comprises:
 - The UK LRP for 800 MHz and 2.6 GHz;

³¹ The difference in frequency from 900 MHz to 2.6 GHz is such that the value of the latter is, in our view, unlikely to be informative as to the value of the former.

³² One of these is a linear interpolation i.e. drawing a straight line from the value of 800 MHz to that of 2.6 GHz on Figure 4.5 below and taking its value at 1800 MHz. The other is an inverse exponential curve including these two points (800 MHz and 2.6 GHz values), again taking the value at 1800 MHz. A recent paper suggests that an inverse exponential fit is a more appropriate representation of the value of spectrum across frequency bands (Kerans, A, Vo, D., Conder, P., Krusevac, S. (2011), 'Pricing of Spectrum Based on Physical Criteria', Proceedings of IEEE DySPAN (2011), pp. 223–230). However, we do not consider that there is a strong basis for expecting that to be true in this case and, for that reason, we have preferred the simpler measure of averaging 800 MHz and 2.6 GHz values.

- Absolute and relative measures from other EU 4G awards, where we consider the auction outcome is more likely to be informative of market values;
- The average of the UK LRP for 800 MHz and 2.6 GHz, as evidence of the value of 1800 MHz spectrum; and
- Technical and commercial evidence as to the value of 900 MHz relative to 800 MHz spectrum, and the value of 1800 MHz spectrum relative to paired 2.6 GHz spectrum
- Assessments of relativities between bands from the range of auctions considered, notably between 800 MHz and 900 MHz, and between 900 MHz and 1800 MHz
- Evidence to which we think less weight should be given (“less important evidence”), which includes benchmarks from auctions where we had greater concerns about whether the auction outcomes were informative of market value, or the country concerned was less comparable to the UK (such as auctions outside the EU), or the auction took place further in the past or for less relevant bands of spectrum or the evidence was not reliable.

Values based on bids in UK 4G auction

- 4.16 The UK values of 800 MHz and paired 2.6 GHz are key reference points, which inform our view of the likely upper limit of plausible values of 900 MHz spectrum, and the likely lower limit of plausible values of 1800 MHz spectrum respectively. They are also a factor in the relative international benchmarks set out in paragraph 4.13 (b) above (because the percentage relativities are applied to the estimated UK values of 800 MHz or 2.6 GHz spectrum),³³ and also the average measure described in 4.13 (c).
- 4.17 As discussed in Annex 5, we consider that the UK 4G Auction was sufficiently competitive for us to use price information from the auction as relevant evidence for the purpose of revising ALF.
- 4.18 The UK 4G Auction was a combinatorial auction and yielded prices for the winning packages, not prices by spectrum band. In principle there are different ways in which values by band can be estimated from such an auction. As noted above, we have identified two methodologies to do this – the LRP methodology and the ASM.
- 4.19 We developed the LRP methodology specifically for the purpose of deriving estimates suitable for informing the setting of ALFs. The LRP methodology is a mathematical algorithm which takes account of both winning and losing bids in an auction to generate linear prices³⁴ that best support the auction outcome in that, at these prices, the incentives for bidders to prefer a different outcome are minimised (and are consistent with the total auction revenue). In this sense the LRP methodology identifies the linear prices that are closest to market clearing.
- 4.20 DotEcon’s results from applying the LRP methodology are as follows:
- £26.85m per MHz for 800MHz without coverage obligation;

³³ The “absolute” international benchmarks are independent of the estimated value of spectrum in the UK.

³⁴ That is, a single price per MHz for each band.

- £25.3m per MHz for 800MHz with coverage obligation;
 - £4.95m per MHz for paired 2.6GHz; and
 - £1.5m per MHz for unpaired 2.6GHz.
- 4.21 The ASM determines the value gained from hypothetically adding additional 800 MHz or 2.6 GHz lots (or both) to the auction. The ASM is based on calculating what bidders would have been willing to pay for additional 800 MHz and 2.6 GHz spectrum if it had been available in the auction, based on the bids that were actually made. This is effectively a proxy for the hypothetical inclusion of 900 MHz and 1800 MHz spectrum in the auction. The ASM is not directly influenced by the bids of the licensee whose spectrum value we are assessing.³⁵
- 4.22 While the LRP methodology generates a single estimate for each band, the ASM generates different results depending on both which bidder is excluded from the auction and the amount of spectrum hypothetically added to the auction (see Annex 8). In the case of 800 MHz spectrum, with 2x5 MHz of additional spectrum, the implied price ranges from £2.5m per MHz (if EE is the excluded bidder) to £38.5m per MHz if Vodafone or H3G is the excluded bidder, while excluding Telefónica gives a result closer to this latter figure at £35.6m per MHz. Results also vary with the amount of additional spectrum assumed. Taking the case of Vodafone, if an additional 2x10 MHz is assumed, the price falls from £38.5m per MHz to £26.4m per MHz. However, if an additional 2x15 MHz is assumed the figure is £30.7m per MHz.
- 4.23 Similarly, the price for 2.6 GHz varies by bidder excluded (£4.5m per MHz for Telefónica, £7.3m per MHz for the other three mobile operators), and the average price per MHz falls as more spectrum is added.
- 4.24 We have used the results from applying the LRP methodology (ie. the numbers in paragraph 4.20 above) for our base case results for the value of 800 MHz and 2.6 GHz spectrum. We consider this preferable to ASM because it is directly based on the spectrum, participants and bids in the auction rather than making hypothetical changes to these variables and because, in practice, the ASM results appear highly sensitive to the underlying assumptions. However, we consider the relevance of the ASM results in the context of sensitivity analysis (see below).
- 4.25 In the analysis below we use as our base case for the value of 800 MHz spectrum the LRP for 800 MHz without coverage obligation (as no coverage obligation is specified for the 900 MHz and 1800 MHz licences). We have added £3m per MHz to the LRP from the auction as the payment required by each 800 MHz licensee to DMSL for the purpose of funding DTT co-existence (on the basis that bidders knew they would have to make such payments and so are likely to have subtracted the DMSL payments from their bids).³⁶ Therefore the figure we use below for the LRP of 800 MHz in the 4G Auction is £29.85m per MHz. In the following, we show the base case figures rounded to one decimal place i.e £29.9m per MHz for 800 MHz and £5.0m per MHz for 2.6 G.

³⁵ So, for example, when deriving an estimate of the ASM relating to Telefónica's spectrum, we "exclude" from the analysis both the bids that Telefónica made in the auction and the spectrum that it won.

³⁶ For simplicity, this assumes that the bidders expected to receive no refund of such payments. In our sensitivity analysis we will explore the implications of relaxing this assumption. Note that there is no equivalent to this co-existence cost to holders of 900 MHz and 1800 MHz licences.

- 4.26 As discussed below, in our sensitivity analysis we explore a range of adjustments (such as different assumptions about coverage and co-existence costs), alternative methods for deriving auction prices (including the ASM) and implications of other hypothetical changes to the auction.

Auctions in other countries

- 4.27 Auction outcomes in other countries determine the evidence points based on absolute international benchmarks (paragraph 4.13 (a)), and also determine the evidence points based on relative international benchmarks (4.13 (b)) along with UK values of 800 MHz and/or 2.6 GHz. DotEcon's benchmarking study considered a wide range of international auction results, over time and in many different markets. We have had regard to this broader evidence, but we have considered it appropriate to place more weight on evidence of 4G auctions in EU countries from 2010 onwards.
- 4.28 Prices from these auctions are set out in Figure 4.2, adjusted to reflect UK-equivalent population and licence duration and converted into a common currency using Purchasing Power Parity exchange rates to account for differences in level of affluence between countries.³⁷ These prices are largely based on DotEcon's benchmarking work. As noted above, several countries (alongside the UK) ran package auctions, in which band-specific prices are not directly observable. For this reason, prices in the Netherlands and Switzerland are not presented.³⁸ However, we have included prices for the following package auctions:
- Romania: As the package prices in this auction were close to the sum of the reserve prices of constituent lots, we consider that these prices are likely to be a close approximation of the band-specific prices;
 - Ireland: Vodafone has provided us with information on the relative values of bands and, having discussed this information with Comreg, we have used this, alongside public information, to derive estimated prices for the Irish auction, as set out in Annex 7.
- 4.29 In this Figure, we distinguish between evidence on which we consider it appropriate to place greater weight (shown in bold), and evidence on which we place less weight (in italics).

³⁷ For reference, the last row in Figure 4.2 shows UK prices, based on DotEcon's calculation of the LRP.

³⁸ We note that, in the Netherlands, T-Mobile did not acquire 800 MHz spectrum but had a substantially lower package price than KPN and Vodafone who did acquire 800 MHz spectrum, despite T-Mobile acquiring more 900 MHz and 1800 MHz spectrum than KPN and Vodafone. In contrast, in Switzerland, Orange had a package price which was one-third that of Sunrise, despite Orange winning as much 800 MHz spectrum and more 1800 MHz spectrum than Sunrise. We do not consider this result can be explained by Sunrise winning more 900 MHz spectrum than Orange. We consider that it is not possible to make reliable inferences about relative prices from these auction results, given the CCA nature of the auctions, and the non-linearity of the package prices.

Figure 4.2 Results of European auctions 2010-2013

£m/MHz (UK equivalent)	800MHz	900MHz	1800MHz	2.6GHz
Austria (2010)				1.8
Belgium (2011)				4.5
Denmark (2010) ⁽¹⁾	10.1	2.4	1.0	9.5
France (2011) ⁽²⁾	34.3			5.2
Germany (2010)	50.1		1.8	1.5
Greece (2011)		31.4	13.9	
Ireland (2012) ⁽³⁾	58.6	35.7	23.1	
Italy (2011)	48.3		15.5	3.5
Netherlands (2012) ⁽⁴⁾	Not known			
Portugal (2011)	36.1	24.1	3.1	2.4
Romania (2012) ⁽³⁾	21.8	24.9	6.2	2.5
Spain (2011) ⁽⁵⁾		17.2	2.9	
Spain (2011) ⁽⁶⁾	31.4	24.9		3.1
Sweden (2011)	14.3		9.1	9.7
Switzerland (2012)	Not known			
UK (2013) ⁽⁷⁾	29.85			4.95

Source: DotEcon, except where noted

(1) 2.6 GHz awarded in May 2010; 900 MHz and 1800 MHz awarded in September 2010; 800 MHz awarded in June 2012.

(2) 2.6 GHz awarded in September 2011; 800 MHz in December 2011.

(3) Based on estimates from Vodafone: Ireland - all bands; Romania - 1800 MHz and 2.6 GHz.

(4) We have considered estimates from New Street Research as less important evidence.

(5) May 2011 "beauty contest" in which largest operators were prevented from bidding.

(6) Multiband auction in July 2011. One lot of unsold 900 MHz re-auctioned in November 2011. 900 MHz price shown is from November 2011.

(7) Linear reference prices.

- 4.30 We have treated values of 800 MHz and 2.6 GHz in countries other than the UK as less important evidence although, as discussed below, in some cases they inform the relative values between the 900 MHz or 1800 MHz band and the 800 or 2.6 GHz band within a country where these relative values in our view constitute more important evidence.
- 4.31 We have considered whether the circumstances of these auctions were likely to have led to prices which reflected the value of spectrum in the markets concerned. For example we have assessed:
- Whether auction conditions (such as the number of auction participants, the presence of spectrum-sharing deals, or constraints such as spectrum caps or reservation for a new entrant) may have meant that bidders did not have to outbid one another in order to acquire the spectrum they needed. If so, we considered

how these conditions compared to those prevailing in the UK (for example whether tighter caps applied in other countries than in the UK).

- Whether spectrum sold at reserve prices, but there were few bidders relative to the amount of spectrum available (and these bidders may have been constrained by spectrum caps). In such cases, winners might have been able to acquire spectrum at prices below market value.

4.32 These auctions are discussed in more detail in Annex 7. We consider that we should place less weight on evidence from the following auctions:

- Austria and Belgium and France have not auctioned 900 MHz or 1800 MHz spectrum within the time period from 2010 onwards;
- In Denmark, the three largest operators were excluded from bidding for 900 MHz and 1800 MHz licences, and the resulting prices appear very low;
- In Germany, there is some evidence of a lack of excess demand for 1800 MHz spectrum, and the results imply a UK value for 1800 MHz below the UK LRP for 2.6 GHz spectrum, which we do not consider plausible.
- In Portugal, some 900 MHz spectrum was unsold, which may have been due to specific factors surrounding the auction or country-specific circumstances. We note that 900 MHz spectrum has not generally gone unsold in recent EU auctions in the absence of strong spectrum caps. In the case of 1800 MHz spectrum, spectrum caps may have led to the outcome in which some spectrum was unsold. In addition, the implied price is less than the 2.6 GHz LRP in the UK.
- Spain ran a “beauty contest” for 900 MHz and 1800 MHz spectrum in May 2011, in which the two largest operators could not bid for 900 MHz, and the three largest could not bid for 1800 MHz.

4.33 We consider that we should place greater weight on evidence from the awards in Greece, Romania, Spain in November 2011, and Sweden, but that there is a risk that these auction prices understate the value of 900 MHz and 1800 MHz spectrum in these countries. In each of these cases, realised prices were at or close to reserve prices. We consider that there is a significant risk that this may have been symptomatic of limited competition in these auctions, as in a competitive auction bidding would tend to drive prices above any reserve price which was set below market value, while a reserve price set above market value would lead to unsold spectrum. It is possible that reserve prices happened to be set close to market value in these countries, but there is no basis for assuming this to be the case.³⁹ There may also be country-specific reasons why we may consider it appropriate to place less weight on some of these results as a guide to values in the UK. In particular, in Romania the income per capita is a fraction of that in the UK. We recognise that there may be a case, despite the use of purchasing power parity exchange rates, for placing less weight on Romania than on other countries which may be more closely comparable to the UK. However, the absolute value of 900 MHz and 1800 MHz spectrum in Romania is broadly consistent with other benchmarks, while relative values between bands are arguably less likely to be affected by within-country economic conditions (albeit that in the case of Romania these relative values appear to reflect the reserve prices set in the award).

³⁹ In Romania, 900 MHz may have sold slightly above reserve price, but it is not possible to determine whether this was the case as Romania held a package auction for which we do not have bid data.

- 4.34 In Ireland, 900 MHz and 1800 MHz spectrum licences were sold above reserve price, and in Italy 1800 MHz licences were also sold above reserve price. We consider both of these awards to offer more important evidence of the value of these bands in the UK.
- 4.35 As discussed, where 800 MHz and either or both of the 900 MHz or 1800 MHz bands were included in the same award, or where 1800 MHz and 2.6 GHz were in the same award, we have also looked at the **relative** values of bands. Figure 4.3 shows the relative values which we consider to be more important evidence (together with the implied UK value – as explained in paragraph 4.13 (b) above - in the lower half of the figure). We note that in Spain not all of the 900 MHz spectrum was awarded at the same time as 800 MHz spectrum. In Sweden, we consider the relative value for 1800 MHz to 800 MHz risks understating the value of the former, as 1800 MHz was sold at reserve price. In Romania, we consider that the relative values risk understating the value of 900 MHz and 1800 MHz because these bands were sold at or close to reserve price, while some 800 MHz spectrum was unsold.⁴⁰

Figure 4.3 Ratios to other bands and implied UK values

	900 MHz	1800 MHz	1800 MHz
Ratios to other bands (%)	/ 800 MHz	/ 800 MHz	/ 2.6 GHz
Ireland	61%	39%	
Italy		32%	455%
Romania	114%	33%	
Spain	79%		
Sweden		64%	
Implied values in the UK (£m per MHz)			
Ireland	18.2	11.7	
Italy		9.6	21.9
Romania	34.1	8.5	
Spain	23.7		
Sweden		17.3	

- 4.36 Looking at relativities for 900 MHz, the highest figure is in Romania, where a higher reserve price was set for 900 MHz than 800 MHz, and all spectrum sold close to

⁴⁰ This suggests that the auction prices may risk understating the value of 900 MHz spectrum *in Romania*, but there may be other reasons why the relative prices in Romania may not be a good guide to the value of 900 MHz spectrum in the UK.

reserve. We note that in the cases of Ireland and Spain, 900 MHz has a lower value than 800 MHz, and this is true more generally across the evidence we have considered on which we consider it appropriate to place less weight (namely in Denmark and Portugal – see Figure 4.2 above).

- 4.37 Comparing absolute and relative results within countries, we see that the implied value of 900 MHz in UK, based on the relative price from Ireland (£18.2m per MHz) is much lower – around half – of the estimated absolute value (£35.7m per MHz) (absolute values are in Figure 4.2 above), reflecting the high estimated value of 800 MHz in that award (compared to the UK LRP). In contrast, for Romania, the absolute value of 900 MHz (£24.9m per MHz) is somewhat lower than the implied relative value (£34.1m per MHz), while in Spain the absolute and relative values are similar (£24.9m per MHz and £23.7m per MHz).
- 4.38 Turning to 1800 MHz, in Ireland, the relative price (£11.7m per MHz) is around half of the absolute price (£23.1m per MHz), and again this is driven by the relatively high value of 800 MHz in that award (compared to the UK LRP). In contrast, the relative price of 1800 MHz in Sweden (£17.3m per MHz) is almost twice that of the absolute price (£9.1m per MHz). In Romania, the relative price (£8.5m per MHz) is higher than the absolute price (£6.2m per MHz), but both are low relative to other benchmarks. In Italy, the implied value derived from the relative price of 1800 MHz to 800 MHz (£9.6m per MHz) is lower than the absolute price (£15.5m per MHz), while the implied value derived from the relative price of 1800 MHz to 2.6 GHz (£21.9m per MHz) is higher than the absolute price.
- 4.39 Of the awards listed in Figure 4.2, there was only one case, Greece, in which 900 MHz and 1800 MHz were awarded but 800 MHz was not. We consider it appropriate to include the absolute values of 900 MHz and 1800 MHz in this award as more important evidence, as set out above. We note that both bands were awarded at reserve price, and the reserve price of 1800 MHz was 45% of the reserve price of 900 MHz spectrum. We have had regard to this relativity, but, unlike the other relativities considered, it cannot be related to a UK 4G Auction price of 800 MHz or 2.6 GHz spectrum to generate a further evidence point, because these bands were not awarded in Greece.⁴¹
- 4.40 We note that neither absolute benchmarks nor relative benchmarks, taken separately, present a tight grouping of evidence points. In the case of 900 MHz, the absolute benchmarks range from around £25m per MHz to £36m per MHz, while relative benchmarks range from £18m per MHz to £34m per MHz. For 1800 MHz, absolute benchmarks range from around £6m per MHz to £23m per MHz, while relative benchmarks range from around £8m per MHz to £22m per MHz.

Technical and other evidence

- 4.41 As noted above, the relative merits of 900 MHz and 800 MHz spectrum were discussed by mobile operators in response to our First and Second Competition Assessments on the 4G Auction. Telefónica and Vodafone argued that 900 MHz spectrum was worth less than 800 MHz, while EE and H3G argued that the reverse was true. In essence, EE and H3G focused on the short-term advantages of 900 MHz, including equipment availability, the value of existing 3G customer bases, and

⁴¹ We also note the two other cases – Ireland and Romania – in which we consider it appropriate to categorise both 900 MHz prices and 1800 MHz prices as more important evidence. In Ireland, prices for 1800 MHz were around 65% of the 900 MHz price, while in Romania prices for 1800 MHz were around 25% of the 900 MHz price.

the ability of HSPA/HSPA+ to compete with nascent LTE services. Telefónica and Vodafone focused more on difficulties of using 900 MHz spectrum to compete in LTE provision in the medium term, noting the lack of 900 MHz LTE equipment, and the time and cost of clearing the band for LTE use.

- 4.42 We noted that any competitive advantage from early deployment of LTE (in bands other than 900 MHz) could persist for some years, but suggested that the importance of these advantages might be limited. We note from our international benchmarks that 800 MHz spectrum has tended to command a higher price than 900 MHz spectrum, notably in Ireland and Spain which we see as providing more important evidence, and also in Denmark and Portugal. The one exception was Romania, where the relative prices appeared to reflect reserve prices in the auction. As discussed in Annex 6, the technical evidence is not sufficiently clear-cut or robust to derive a reliable inference about the relative value of 900 MHz and 800 MHz. On this basis we consider on balance that 900 MHz is unlikely to have a higher value than 800 MHz spectrum in the UK, i.e. the value of the 800 MHz spectrum in the UK is likely to set an upper limit on the value of 900 MHz in the UK.
- 4.43 Next we consider evidence as to the relative value of 1800 MHz and 2.6 GHz spectrum. Our view in the July 2012 Statement was that 1800 MHz shared LTE advantages with 800 MHz and 2.6 GHz, but that its propagation characteristics, and hence its ability to support UK-wide LTE rollout, were substantially better than 2.6 GHz spectrum (though below those of sub-1 GHz spectrum). In light of this, we concluded that a fourth national wholesaler would need a portfolio of spectrum which included at least some lower frequency spectrum with LTE advantages (i.e. 800 MHz or 1800 MHz spectrum) in order to be capable of being credible, so that even reserving a large amount of 2.6 GHz spectrum for a fourth national wholesaler would not, in itself, have been sufficient for the credibility of that wholesaler.
- 4.44 We note that in the UK 4G Auction, the two incumbent mobile operators (Telefónica and Vodafone) who did not have substantial holdings of 1800 MHz spectrum (or, more generally, any holdings of sub-2 GHz spectrum with an early route to LTE) bid strongly for 800 MHz spectrum and each won 2x10 MHz. Meanwhile, the other two incumbent mobile operators, who each had, or will have, at least 2x15 MHz of 1800 MHz spectrum, bid less strongly for 800 MHz and acquired only 2x5 MHz of 800 MHz each. While there may have been other factors contributing to this outcome, we consider it is consistent with the view that 1800 MHz spectrum has significant advantages which are not provided by 2.6 GHz spectrum. We recognise that there were also examples of strong bidding for 2.6 GHz spectrum – notably by EE – but the relevant point is that bidding behaviour is consistent with 1800 MHz being a closer substitute (than 2.6 GHz) for 800 MHz spectrum.
- 4.45 On this basis we do not consider it credible that 1800 MHz spectrum has a lower value than 2.6 GHz spectrum in the UK, and we consider that any international auction benchmarks which imply a lower value for 1800 MHz than for paired 2.6 GHz spectrum should be treated as less important evidence.
- 4.46 Also reflecting this assessment, we have estimated a value for 1800 MHz based on a simple average of the prices of 800 MHz and 2.6 GHz spectrum, at £17.5m per MHz. This provides a benchmark for consideration of whether 1800 MHz is closer in value to 800 MHz (in which case it would be above the simple average) or closer in value to 2.6 GHz (below the simple average). On this basis we consider it appropriate to include this simple average value with the more important evidence.

Sensitivity analysis

- 4.47 We have considered the extent to which our evidence base might be sensitive to underlying assumptions. Our international benchmarks reflect actual prices in a range of different auctions and generate a wide range of values which we consider carefully in our analysis. In the absence of clear evidence of a systematic bias it is not clear that conducting a sensitivity analysis around prices in other countries would be particularly informative. However, we recognise that our estimate of the value of 800 MHz and, to a lesser extent, 2.6 GHz spectrum in the UK plays a significant role in our analysis, and that these estimates rely on a number of assumptions. We therefore considered it appropriate to consider the validity of these assumptions and the potential impact of making alternative assumptions.
- 4.48 The results of this analysis are set out in Annex 8. In this annex we note that our base case valuations of the value of 4G auctioned spectrum in the UK are the LRPs plus, in the case of 800 MHz, a co-existence cost. We set out a range of possible variations to the approach used to derive these results, distinguishing between:
- Basic adjustments to these LRPs based on the treatment of coverage obligations, coexistence costs, and assignment-stage bids;
 - Alternative methods of calculating 4G spectrum prices – namely the ASM and a decomposition approach which was proposed by Vodafone;
 - Hypothetical changes to the auction rules, licences available, and participation, namely (i) the removal of the competition constraint, (ii) the assumption of nominal reserve prices, and (iii) the removal of H3G (both the bids it made, and the spectrum it acquired) from the auction.
- 4.49 Some of these variations would tend to increase the value of 800 MHz and 2.6 GHz spectrum relative to our base case, others would tend to decrease the value, while other variations (notably ASM and the use of a nominal reserve price) can increase or decrease the value depending on the specific assumptions under which they are applied.
- 4.50 We considered the appropriateness of each of these variations in turn. However, our view is that it is not appropriate to place significant weight on these variations compared to the base case. Whilst we have taken these variations into account, as discussed in detail in Annex 8, we consider it is appropriate to place materially more weight on our base case estimates of the value of 800 MHz and 2.6 GHz spectrum in the UK.

Best estimates of lump-sum values

- 4.51 In order to set ALFs we need to identify, for each of 900 MHz and 1800 MHz, a single figure for the lump-sum value of spectrum. We have a limited set of evidence points with a relatively wide distribution of values, and we consider that no specific evidence points can be relied on in a determinative way. Because of this we have not sought to take a mechanistic approach to deriving best estimates from the available evidence. Rather, we have considered the evidence for each band in the round, and used our judgement to develop a best estimate for each band. We explain how we consider that each of these best estimates is supported by the evidence.

- 4.52 In addition to looking at the distribution of benchmarks within bands, our assessment was also informed by some comparisons across bands:
- For the reasons set out in paragraphs 4.41 and 4.42 above, we consider that 900 MHz is unlikely to have a higher value than 800 MHz spectrum.
 - For the reasons set out in paragraphs 4.43 to 4.45 above we do not consider it credible that 1800 MHz spectrum has a lower value than 2.6 GHz spectrum.
 - As regards the relative value of 900 MHz and 1800 MHz spectrum, we note that while the 1800 MHz band may have short-term LTE advantages over 900 MHz, there are significant propagation advantages to sub-1 GHz spectrum. In view of this, we would expect 900 MHz spectrum to have a higher value than 1800 MHz spectrum. This is supported by the benchmarking data (Figure 4.2), in that prices for 900 MHz were consistently higher than for 1800 MHz where both were included in the same award and, with the exception of Ireland, 900 MHz prices were more than twice as high as for 1800 MHz.
- 4.53 Figure 4.4 sets out in diagrammatic form the evidence we have considered on which we place more weight (“more important evidence”), while Figure 4.5 adds the evidence which we have also considered for the values of 900 MHz and 1800 MHz on which we place less weight (“less important evidence”).

Figure 4.4 Values of 900 MHz and 1800 MHz: “more important evidence”

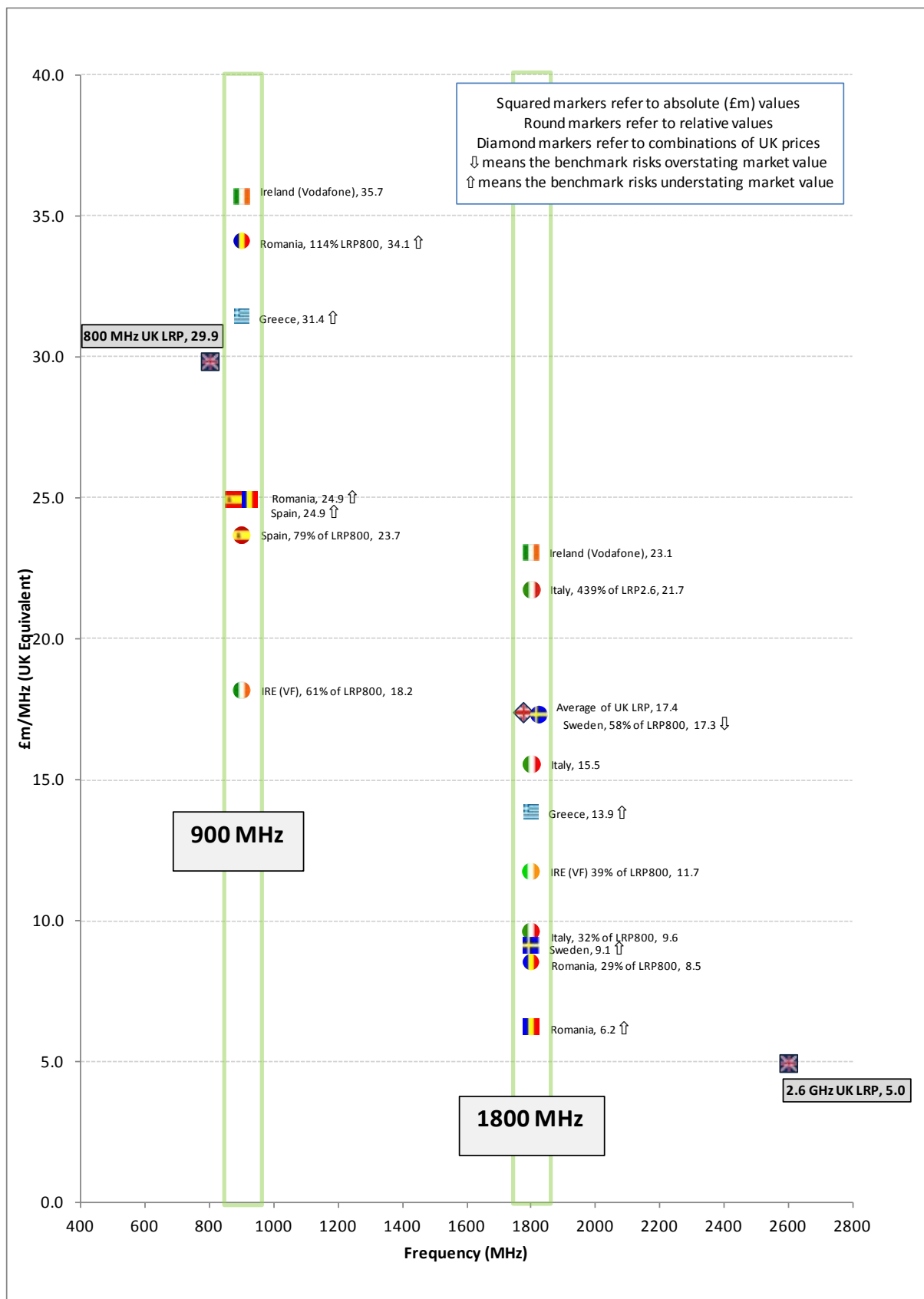
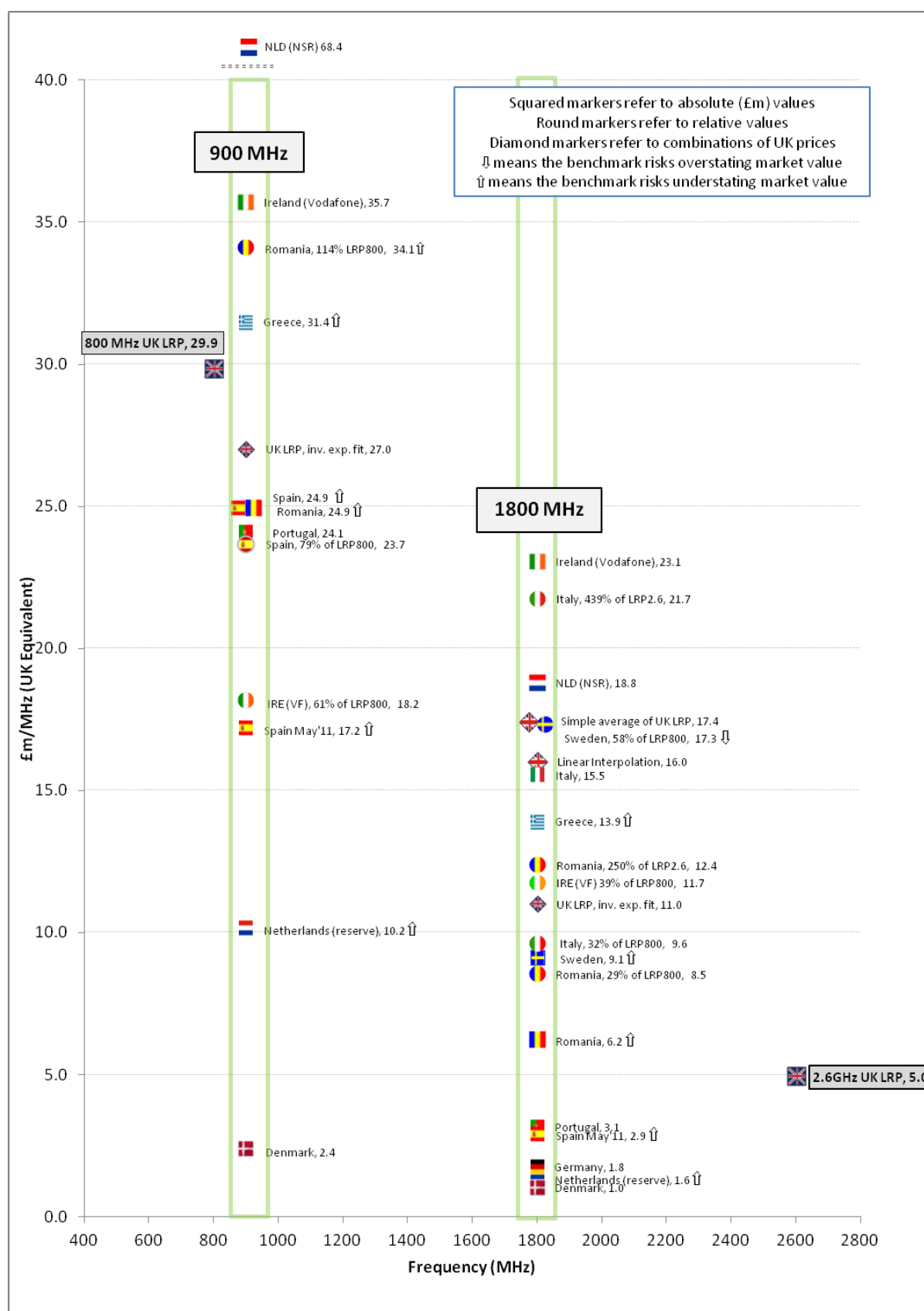


Figure 4.5 Values of 900 MHz and 1800 MHz: including “less important evidence”



Best estimates of lump-sum values

- 4.54 For each of the 900 MHz and 1800 MHz band in turn, we now set out our best estimates, and the evidence which informs them, in terms of: UK 4G Auction results; more important benchmark evidence; less important benchmark evidence; and technical and other evidence to which we have had regard.
- 4.55 As discussed above, deriving lump-sum values has been a matter of judgement in light of the available evidence. In deriving these values, we have considered all of the significant evidence, but we have placed materially more weight on what we consider to be more important evidence.
- 4.56 As Figure 4.4 illustrates, we have treated more international benchmarks as “more important evidence” for 1800 MHz (ten) than for 900 MHz (seven), and these benchmarks are more evenly distributed in the case of 1800 MHz than 900 MHz.
- 4.57 For **900 MHz**, taking the evidence in Figures 4.5 and 4.6 in the round, our best estimate of the lump-sum value is **£25m per MHz**:
- a) Our assessment is informed by the value of 800 MHz spectrum in the UK 4G Auction: as set out below, we have considered evidence points derived from a combination of this value with implied 900 MHz / 800 MHz values in other countries. More generally we have considered the likely value of 900 MHz relative to 800 MHz informed by technical analysis and international evidence.
 - b) This lump-sum value is supported by several more important evidence points around the same level, namely the absolute values in Spain and Romania (both £24.9m per MHz), both of which we have noted risk understating the value of 900 MHz in those countries, and by the relative value of 900 MHz to 800 MHz spectrum in Spain, which suggests a slightly lower price (£23.7m per MHz).
 - c) Also among the evidence points that we consider to be more important, the relative value of 900 MHz to 800 MHz in Ireland is substantially lower (£18.2m per MHz), while the absolute values of 900 MHz in Ireland and Greece are substantially higher (£35.7m per MHz and £31.4m per MHz respectively), as is the relative value of 900 MHz to 800 MHz in Romania (£34.1m per MHz).
 - d) We recognise that (c) above, taken in itself, might be seen to indicate a higher number than the best estimate we have presented, particularly as we consider that four of the evidence points that we have treated as more important (absolute value in Greece, absolute and relative values in Romania, and absolute value in Spain) risk understating the value of 900 MHz spectrum in those countries. However we note that:
 - The three more important evidence points in (c) above which are above our best estimate also imply a 900 MHz value which is above the value of 800 MHz spectrum in the UK. This is inconsistent with our view, noted in paragraph 4.52 (a) that 900 MHz is unlikely to have a higher value than 800 MHz spectrum. This view is supported by the fact that Romania was the only country in our evidence set in which the value of 900 MHz was higher than that of 800 MHz: in Ireland, Spain, Portugal and Denmark 900 MHz had the lower value of the two bands.
 - Some evidence points that we have treated as less important are below this lump-sum value: from Portugal (£24.1m per MHz), Spain’s “beauty contest”

which risks understating value (£17.2m per MHz); and the Netherlands' reserve price which also risks understating value (£10.2m per MHz).

- o As discussed in Annex 8, assuming lower co-existence costs would lead to the 800 MHz value in the UK, and three of the more important benchmarks for 900 MHz, having a lower value.
- e) As noted in 4.58 (e) below, this value for 900 MHz is consistent with our view of the likely relative value of 900 MHz and 1800 MHz spectrum.

4.58 For **1800 MHz**, taking the evidence in Figures 4.5 and 4.6 in the round, our best estimate of the lump-sum value is **£15m per MHz**:

- a) Our assessment is informed by the value of 800 MHz and 2.6 GHz spectrum in the UK 4G Auction: as set out below, we have considered evidence points derived from a combination of these values with implied relative values between 1800 MHz and these bands in other countries. We have also considered the likely value of 1800 MHz relative to 2.6 GHz informed by technical considerations.
- b) This lump-sum value is supported by two evidence points that we have categorised as more important around the same level, namely the absolute value in Greece (which we consider risks understating value) (£13.9m per MHz) and the absolute value in Italy which we consider suggests a slightly higher price (£15.5m per MHz).
- c) Several evidence points that we have categorised as more important are substantially above this value – namely the relative value of 1800 MHz to 2.6 GHz in Italy (£21.7m per MHz), the value of 1800 MHz in Ireland (£23.1m per MHz), and the relative value of 1800 MHz to 800 MHz in Sweden (which we consider risks overstating value) (£17.3m per MHz). Other evidence points that we have categorised as more important are substantially below – namely the relative value of 1800 MHz to 800 MHz in Ireland (£11.7m per MHz), Romania (£8.5m per MHz) and Italy (£9.6m per MHz), and the absolute values in Sweden (which we consider risks understating value) (£9.1m per MHz) and Romania (£8.5m per MHz).
- d) As regards evidence that we have categorised as less important, the relative value of 1800 MHz to 2.6 GHz in Romania is below this value (£12.4m per MHz), while other less important evidence points are substantially lower, although they suggest a price for 1800 MHz below that of 2.6 GHz spectrum in the UK, which we do not consider to be credible.
- e) The implied relativity of this lump-sum value to our best estimate of the value of 900 MHz spectrum appears consistent with our view – supported by technical considerations and the international benchmarks generally – that 900 MHz spectrum has a higher value than 1800 MHz spectrum (see paragraph 4.52 (c)). The specific relativity of 60% sits within, although towards the top of, the range of relativities in Ireland (65%) Greece (45%) and Romania (25%) (see paragraph 4.39 and footnote 41).

Lump-sum values on which we are consulting

4.59 We are required by the Direction to revise ALFs to reflect full market value. In meeting that requirement we have exercised our regulatory expertise and judgement

as to the weight that we should attach to the various evidence that is available to us and we have reached a view on our best estimate for each band of full market value (as a lump sum). We propose to use these best estimates for the purposes of deriving ALF. We consider that implementing the requirement in the Direction in this way is consistent with our statutory duties.

- 4.60 Some of the current licence holders have put to us a number of ways in which setting ALFs above market value could, in their view, lead to inefficient use of spectrum. In addition they have argued that the risks of setting ALF too high and setting ALF too low are asymmetric, with the risks of setting ALF too high being greater. They argue that, in light of the uncertainty over the true market value of spectrum, we should set ALF more conservatively as a consequence of this asymmetry. We consider these arguments in Annex 9. Our provisional conclusion (for the reasons set out in Annex 9) is that it is not appropriate to set ALFs either below or above the levels implied by our best estimates of market value for reasons of spectrum efficiency.

Section 5

Deriving annual licence fees from lump sum valuations

Introduction

- 5.1 The task we now need to address is how best to translate the lump sum values derived in section 4 above into an annual fee rate for each of the 900 MHz and 1800 MHz spectrum bands. In this section we consider the following:
- The manner in which the lump-sum value is spread out over time which, in turn, requires us to consider:
 - the number of years over which it should be spread;
 - the profile that we should use in spreading it over this number of years (eg. flat profile versus some other profile); and
 - the approach to indexation.
 - the weighted average cost of capital (WACC) that is used to reflect the time value of money in spreading out the lump-sum value over time, which in turn requires us to consider:
 - the choice of a pre-tax or post-tax approach and the handling of the different tax treatments of lump sum payments and ALF in the context of a post-tax approach; and
 - the choice of a WACC which reflects the risk profile of ALF-paying bands.
- 5.2 This section also addresses the question of whether to make an adjustment for delayed spectrum availability (the difference between the time of the auction and the time that spectrum is available for use).
- 5.3 We set out our calculations of the proposed base level of ALF at the end of this section.

Profile over time

The time period relevant to lump sum values

- 5.4 When determining the level of ALF from a lump sum estimate of the market value of the spectrum, we consider that it is important that the time period used is consistent with the time period to which the lump sum relates.
- 5.5 In the First Competition Assessment (paragraph 10.20) we said:

“We propose to calculate the annual licence fees as an annuity whose present value is equivalent to the lump sum amount derived from the auction. The period over which we propose to spread the

amount derived from the auction will be the initial term of the licence from which the full market value was derived...”

- 5.6 We remain of the view that a reasonable approach is to spread the lump sum value over a period of 20 years. We note that the sums bid in the UK 4G Auction (to which we have had particular regard in deriving the lump sum value) refer to spectrum licences awarded for an indefinite period with a 20 year initial term (during which the licences cannot be revoked on spectrum management grounds and will not be levied annual fees).⁴² Similarly, the analysis of international benchmarks applies adjustments to express values on a 20-year equivalent basis, in cases where the duration of the licence was different from the UK initial period.

Terminal value

- 5.7 Prior to the present consultation, one licence holder told us that the valuation models it had used to help in preparing its bids in the 4G Auction included a significant amount of value associated with expected revenues in the period following this initial twenty-year term, notwithstanding its expectation that licence fees would be charged for 4G licences from the end of the initial term onwards. In essence, the licence holder expected its private value of these licences following the initial term to exceed the market value on which such licence fees would be set.
- 5.8 The licence holder also argued that it was standard for spectrum licence valuation models to take account of terminal value, and this had a clear economic rationale. In particular it noted that capital costs were front-loaded, creating assets with a long life span which generated positive cash flows later. The licence holder said that in its bid decisions there was no distinction between the value in the first twenty years and the terminal value, but that its own post-auction analysis of packages for which the licence holder bid showed that terminal value accounted for between one-third and two-thirds of its total value.
- 5.9 The licence holder argued that, in order to recognise this significant “terminal value” attaching to auctioned licences to which we have had regard in deriving the lump sum value, we should either discount our estimates of the lump-sum values of ALF licences by the amount of this terminal value, or else convert the lump-sum values into a perpetuity, rather than a twenty-year annuity as we have proposed. We now consider the two alternative approaches suggested by this licence holder.
- 5.10 The relevant consideration for the purpose of our analysis is the nature of the bids made in the 4G Auction. We note a potential complicating factor is that the licence holder’s bids in the auction may not have followed its valuation model exactly. It may have taken into account a number of other considerations (such as budget constraints) leading to a divergence between the bid for a package and the figure established in the valuation model.
- 5.11 Our provisional view is that the adjustments for terminal value which the licence holder proposes are not appropriate when calculating ALFs. Our reasons for this view are that:

⁴² The conditions on which we might revoke a 4G Auction licence are set out in the Information Memorandum, paragraph 4.10. Essentially, a licence holder who meets the licence terms, relevant trading regulations, and certain requirements of the Regulations, will not face revocation without consent unless it appears, requisite, necessary or expedient to do so (a) in the interests of national security or for the purposes of complying with an international obligation of the UK; or (b) for the purpose of complying with a direction by the Secretary of State to us under section 5 of the Communications Act 2003 or section 5 of the WT Act.

- For the reasons set out below, we consider that it is appropriate to maintain consistency of treatment between licences awarded in the 4G Auction and ALF licences for the purpose of setting the level of ALF, and spreading the lump-sum value of ALF licences over twenty years, reflecting the initial term of 4G Auction licences, achieves this.
- One way of thinking about market value over the initial 20 year term of the auctioned 4G licence is the difference in value in a competitive market at the start and end of the 20 years - if annual fees apply after the initial period of the auctioned licences and if such fees are set at market value, we think that it is reasonable to take the view that the present value of holding the licence at the end of the initial term is zero to the marginal operator in a competitive market.⁴³

5.12 We now consider each of these points in further detail.

Consistency of treatment between 4G auctioned licences and ALF licences

5.13 First, with respect to the consistency of treatment (for the purpose of setting ALF) between 4G auctioned licences and ALF licences, we note that Ofcom awarded indefinite spectrum licences in the 4G Auction with a 20 year initial term. The market value of an 800 MHz licence⁴⁴ (and hence the price it would command in a competitive auction) can be seen as having two principal components:

- The expected value of using the spectrum for years 1-20, which is the minimum initial term we have specified; and
- The expected value of using the spectrum from year 21 onward.

5.14 This block of spectrum would have a positive terminal value (i.e. component (b) above) if its private value to the licence holder were greater than the expected ALF in years 21 onward. This situation could arise if, as the licence holder mentioned above claims to be its own position, the initial expenditure on infrastructure in the first period were expected to be higher than ongoing expenditure in subsequent periods. To the incumbent, this initial expenditure would be a sunk cost which it would not factor into its valuation in the second period, but any new buyer of / bidder for the licence would

⁴³Infra-marginal (i.e. higher value) operators may well have a positive present value of holding the licence at the end of the initial term, which would make their average present value positive. However, this element of private value is over and above market value.

⁴⁴ For ease of exposition we focus here on the comparison between the 800 MHz licences awarded in the 4G Auction and a hypothetical ALF-paying licence for the same band, but the argument applies more generally to auctioned licences (800 MHz and 2.6 GHz) and ALF licences (900 MHz and 1800 MHz). We also make a number of simplifying assumptions to focus on the specific point at issue, for example:

- Annual licence fees may apply to licences auctioned in the 4G Auction after the initial 20 year term and for simplicity for the purpose of this discussion we are assuming that annual fees would apply;
- Such annual fees would be set on a consistent basis to annual fees for comparable spectrum at that time (such as 900MHz and 1800MHz licences);
- The holder of an ALF-paying licence expects that Ofcom would not revoke the licence within the first twenty years so long as the licence holder paid annual licence fees over that period, so that the perceived regulatory risk is the same across licences. We recognise that in the case of the actual 900 MHz and 1800 MHz licences there is a risk that a five-year notice may be served to licence holders at any point in time.
- New network for ALF-paying and auctioned licences is deployed in the same way and same timing.

have to incur this cost anew, and its value of the licence (and hence the market value) would be discounted accordingly.

- 5.15 In a competitive auction, we would expect the auction price to reflect the market value, taking both of these components into account.
- 5.16 We now consider the case of a hypothetical 800 MHz licence on which annual licence fees are payable (which we refer to as an “ALF licence”). Suppose that Ofcom awarded such a licence today for an indefinite period of time. For the purposes of this discussion, we are seeking to determine what annual licence fees would reflect the market value of such a licence.
- 5.17 The position of such an ALF licence holder **in year 21** would be identical to the position in year 21 of an 800 MHz licence holder who had won its licence at auction: both would hold an indefinite licence, subject to a notice period for licence revocation, and both could be liable for annual licence fees at full market value from this point in time.
- 5.18 The ALF licence holder would also face the equivalent cashflow and infrastructure costs as the 800 MHz licence holder over the initial 20 year period.
- 5.19 This suggests that the full market value of the spectrum over this 20 year period should be equal to the auction value of the 800 MHz licence, which may include a terminal value. The holder of the ALF licence would be willing to pay an ALF which included this terminal value as handing back the licence would deprive it of the terminal value. Essentially, the value of holding the licence over the initial 20 year period includes an option value, for the option of continuing to hold it in future periods.
- 5.20 Our proposed approach to annualisation is equivalent to translating the lump-sum value for the auctioned 800 MHz spectrum into a set of annual payments for a hypothetical ALF spectrum licence which has identical terms and conditions (to the auctioned 800 MHz licence) with the exception of the payment basis over the first 20 years: upfront payment for the auctioned 800 MHz licence, and annual licence fee for the first 20 years for the hypothetical 800 MHz ALF licence.
- 5.21 Noting that both the actual 800MHz and hypothetical 800MHz ALF licences have identical terms from year 20 onwards, the “equivalent” annual licence fee would be the amount that could be charged as an annual fee for 20 years under the hypothetical ALF licence, such that the licence holder would be indifferent between paying the annual fee and paying the lump-sum value. This fee would be equivalent to the lump-sum value annuitized over the first 20 years during which the licence terms differ.
- 5.22 In view of this, we consider that it is appropriate that the cost of holding either the auctioned or the hypothetical licence for the first twenty years should be consistent, whether this cost is based on auction payments (in the case of the auctioned 800MHz licence) or ALF payments (in the case of the hypothetical 800 MHz ALF licence, or the actual 900 and 1800MHz licences). Discounting annual licence fee payments by the terminal value of the licence after year twenty, would not give a consistent outcome between the two sets of licences. Effectively it would mean that it is cheaper to hold an ALF licence over this period, than to hold a licence that was acquired in the 4G Auction (all else being equal).

Difference in value in a competitive market at the start and end of the 20 year period

- 5.23 Second, with respect to the value in a competitive market, one way to characterise market value over a defined period of time is the difference in present value (PV) between the start and end of that period in a competitive market. Taking the 20-year initial term of the 800 MHz / 2.6 GHz licences in the 4G Auction, it is the difference between the PV:
- at the start of the licence period for the marginal bidder/operator in a competitive market; and
 - at the end of the initial 20-year period for the marginal bidder/operator in a competitive market at that time.
- 5.24 The former is reflected by the price in the 4G Auction (if sufficiently competitive).
- 5.25 The latter is in some sense the terminal value, although it is the terminal value for the marginal player in a competitive market at the 20-year point, which could be different from any specific bidder's terminal value (e.g. the incumbent licence holder's private value at the end of the 20-year period might be higher than the market value for reasons discussed above).
- 5.26 There is a sound reason for considering that the PV of the marginal operator at the end of the 20-year period might be zero. This reason is that annual fees might be expected to apply after 20 years and the level of annual fees might be set at the PV for the marginal operator in a competitive market at that time, since this might represent full market value. On this basis the PV, net of ALF, would be zero for the marginal operator. Any positive private value enjoyed by infra-marginal operators would be in excess of the market value of spectrum and it would be inappropriate for ALF to reflect this additional value.

Provisional conclusion

- 5.27 Therefore, we consider that a reasonable view of the market value over the first 20 years is that it is the entirety of the auction prices. We therefore do not propose to make any adjustment for terminal value when setting ALF.
- 5.28 Relaxing some of the simplifying assumptions made for the purpose of the discussion above, we note that there are differences between auctioned licences and 900MHz/1800MHz licences which could imply that the level of ALF for the latter should be either higher or lower than implied by in the annualisation of auction prices:
- ALF payers have the option of handing back the licence and avoiding future ALFs (whereas purchasers of auctioned licences pay the lump sum fee upfront – entirely upfront in the case of the UK, but partially so for some other countries eg Ireland). H3G argued in their response to the Second Competition Assessment that this factor contributes to making 900 MHz spectrum more valuable than 800 MHz.⁴⁵
 - Licences of ALF payers include potential for licence revocation on 5 years' notice for spectrum management reasons whereas grounds for revocation are more limited for auctioned licences in the initial 20-year period.

⁴⁵ See H3G's non-confidential response to the second competition assessment, page 165.

- 5.29 These considerations work in opposing directions (the first consideration could increase, and the second consideration could reduce, the value of the ALF licence relative to the auctioned licence). The effect of the first consideration could be the more relevant if the risk of licence revocation is considered low. But because of the difficulties of quantification we have not sought to adjust ALFs for either potential effect.

Profiling of value over time

- 5.30 The value of the spectrum at any point in the future is likely to vary. These variations may be due to a range of factors, for example technological developments, macroeconomic conditions or changes in the competitiveness of the mobile market.
- 5.31 If we set ALF with a profile that is markedly different from the value of spectrum for a sustained period of time, even when overall the present value of the schedule of ALF is the same, there is a risk that this may result in inefficient allocation of the spectrum.
- 5.32 The question here is whether or not we should attempt to develop a profile of ALF that seeks to match a profile of changing value over the 20 years that we are spreading the lump sum value or whether we approximate the value of spectrum over time with a flat ALF profile (that is, the same fee level in each year).
- 5.33 We consider that using a flat profile is the most pragmatic approach, as in reality the many factors underlying changes in the future value of the spectrum are difficult to forecast for Ofcom, which risks making any more sophisticated approach spuriously precise.
- 5.34 One situation where a flat profile might not be optimal is when there is likely to be a systematic trend, upward or downward, in the value of spectrum. However, we are not aware of clear evidence which suggests that there is likely to be a systematic trend, whether upwards or downwards, in the long term value of ALF-paying bands. For example, while the 900 MHz band may not be readily available for LTE it is profitably used at present as a 2G band where revenues are driven by voice services⁴⁶ bundled with other services, and as a 3G band. Similarly, while we anticipate that there may be further releases of sub-1 GHz and above-1 GHz spectrum bands which could provide a substitute for ALF-paying bands, demand is also forecast to increase very substantially. Furthermore, we note that if the market expects the value of licences to increase or decrease in future periods, this affects the option value of holding licences in earlier periods. This tends to reduce the scope for licence values to change substantially between periods, except in response to unpredictable events.
- 5.35 If we were to use the alternative approach and profile the LSV over time in a way that reflects the underlying variation in value of the licence across the 20 years, then it would be sensible to focus on the broad trend in value across the 20 years (rather than trying to reflect short term, year to year fluctuations).⁴⁷ But we consider that there are significant drawbacks in trying to do even this long run profiling:

⁴⁶ Conversely, LTE at present has no voice capability and this may reduce the short-term value of frequency bands relying on it.

⁴⁷ First, short term fluctuations would be much more difficult to predict than longer term trends, which could make any attempt to model them substantially inaccurate. Second, an alternative approach which relies on the latest available data over time on the relevant drivers of spectrum value would generate substantial regulatory uncertainty about the future level of ALF, which may negatively impact

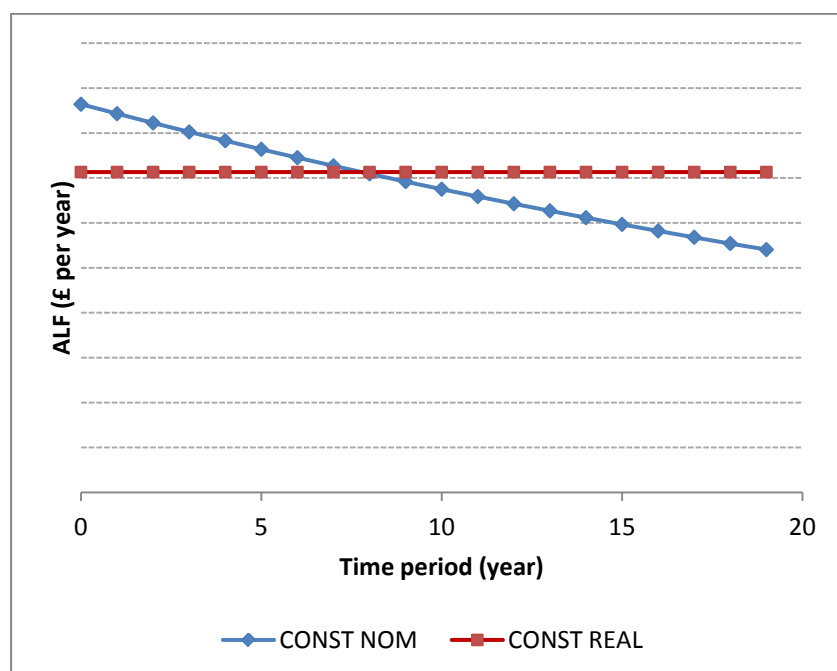
- Since forecasting such trends would be difficult to do, we would have little confidence, in light of all the uncertainties, that the modelled profile would give a better result in practice than just taking a constant profile.
 - There are also practical challenges in implementing a profile that changes over time: we would have to state what the expected profile would be and then change the regulations to implement this profile when the level of ALF changes from year to year. This is not only likely to be an inefficient use of regulatory resources (for both the industry and the regulator), but also generates regulatory uncertainty as to the outcome of such consultation every year, which may result in dynamic inefficiency.
- 5.36 Therefore, we currently consider there is insufficient reliable evidence on which to forecast accurately the changes over time in full market value that it would be appropriate to reflect in ALF. Instead we propose to use the pragmatic approach of a flat profile which is “time consistent” over the initial period of the auctioned 4G licences. That is, the profile of ALF is “time consistent” if the net present value of the (historic and prospective) ALF payments over time is equal to the lump-sum value from which the projected ALF profile was derived.
- 5.37 We acknowledge that it is, however, possible that the long term value of these bands may be changing over time and hence may, at any point, be different from the level implied in the flat ALF profile. When this discrepancy is not due to a change to the fundamentals underlying the constant level of ALF, adopting a flat profile of ALF could potentially generate a tension between the forward looking value of the spectrum in the future and the time consistency in the flat profiling of ALF. Resolving any such tension would be a matter for a future review, but our current view is that it is appropriate for us to place significant weight on the time consistency of ALF profiling, and we consider that we would need clear evidence that spectrum efficiency would be materially improved by a change in ALF (such as a change in fundamentals).

Nominal or real constant ALF

- 5.38 When we referred to “constant” profile in the discussion above, we were silent on whether it would be better to use a constant nominal or constant real price profile (a constant real price profile meaning that the ALF moves each year in line with a specified inflation index set out in the fees regulations). With the first option, the level of ALF would be constant in nominal terms, but decreasing over time in real terms (assuming positive inflation). With the second option, the level of ALF would be increasing over time in nominal terms (assuming positive inflation) but remain constant in real terms. This is shown in Figure 5.1, where the level of ALF on the vertical axis is expressed in real terms, based on an assumption of 2.5% inflation. To deliver the same PV, the level of ALF in the first year would need to be about 20% higher under the constant nominal case than under the constant real case.

dynamic efficiency, if MNOs were to defer or renounce otherwise efficient investments because the level of ALF was unpredictable. Third, we consider that the long term value of the spectrum is relevant here, as 4G services require substantial long-term investments, for example for network deployment and to build up a critical mass in the customer base. Frontier Economics, in a report commissioned by Vodafone, argues that annual licence values do not need to take account of short term fluctuations in value, as sunk costs mean that operators will take a medium term view of value.

Figure 5.1 - ALF profile in real terms (assumes 2.5% inflation)



- 5.39 We consider that a constant real profile is the better option. It avoids a higher initial value which reduces over time in real terms and, as noted in 5.34 above, we are not aware of clear evidence that suggests there is likely to be a systematic downward trend in value.
- 5.40 In these circumstances we consider that the constant real profile is at less risk of being out of line with underlying spectrum value.

Choice of inflation index

- 5.41 Given our proposal to set ALF in constant real terms, the question arises as to what price index to apply to ALF from year to year. First of all, we note that inflation affects our methodology in two ways. Most obviously, it is needed to derive the change in ALF each year in line with this measure of inflation. In addition, the real WACC we adopt at various stages of our ALF methodology⁴⁸ embeds inflation expectations. More specifically, the real WACC as calculated in the March 2011 Mobile Call Termination Statement incorporates expectations about the RPI measure of inflation, forecast at the time to be 2.5%.⁴⁹ This real WACC underpins the cost modelling by which the current charge controls for mobile call termination are set.
- 5.42 We understand that, although the accounting is complex, it is broadly accepted that provided the inflation assumption built into the calculation of the WACC and the inflation adjustment written into fee regulations both use the same index, licensees should be indifferent as to whether this is CPI or RPI. We have a choice, therefore, whether to use CPI or RPI for both of these.

⁴⁸ WACC is involved in estimating the lump sum value of spectrum: for example, to make international benchmarks with different licence periods comparable to the UK 20 year initial licence term, or when winning bidders will have to pay annual fees over time. WACC is then an input as the discount rate in the annualisation of such lump sums into ALF.

⁴⁹ See A8.54 et seq. of the our March 2011 Wholesale mobile voice call termination statement, available at: http://stakeholders.ofcom.org.uk/binaries/consultations/mtr/statement/MCT_statement_Annex_6-10.pdf

- 5.43 In the different context of charge controls for LLU and WLR we have recently considered the choice of inflation index, CPI or RPI.⁵⁰ In that consultation document we proposed to make CPI the default inflation index for the LLU/WLR and future charge controls instead of RPI (taking into account a range of considerations: official status of the index, cost causality, exogeneity, availability of independent forecasts, and regulatory predictability).⁵¹ We recognise that there is an argument for using CPI for the purpose of revising ALF for broadly similar reasons, i.e. that CPI may provide a preferable measure of inflation.
- 5.44 However, as noted above, the WACC calculations in the March 2011 Mobile Call Termination Statement were on the basis of RPI as the measure of inflation, not CPI. In order to use CPI in our ALF methodology we would need to derive the appropriate inflation forecasts and real WACC consistent with the CPI measure of inflation and there are different ways in which such a calculation could be implemented.⁵² If, instead, we use RPI in our ALF methodology, we already have the real WACC derived on this basis and no further adjustment is required to derive the appropriate real WACC.
- 5.45 Therefore, in the circumstances, we favour using the same real WACC as determined in the March 2011 Mobile Termination Statement as it provides the more straightforward approach. In order to maintain consistency in the indexation for ALF, we propose also to use the Retail Price Index (RPI), from a base date of March 2013.
- 5.46 However, we welcome views on whether we should use the RPI or CPI measure of inflation.
- 5.47 Some respondents argued that a telecom-specific input price index would be more appropriate than a general inflation index. However, we consider that there would be some significant drawbacks to this approach:
- First, the annualisation approach requires consistency between the way that the real WACC is derived and way that ALF is indexed (as noted above in the context of choosing between RPI and CPI). Exactly the same issue arises if we were to use a telecoms specific index (rather than CPI) instead of RPI; we would have to adjust the real WACC assumption to reflect the difference between the projection of this telecoms specific index and the projection of RPI. This should not change the PV of the ALF payment stream over time, though it would lead to a different expected profile if the projections of RPI and of the telecoms specific index were different (analogous to the difference in nominal versus real profile in Figure 5.1 above). However, this approach would add significant complexity to the analysis.
 - Second, it is not clear that a telecoms specific index would be any better than RPI in matching the change in underlying value of 4G spectrum over time.

⁵⁰ See paragraphs 3.155-3.191 in *Fixed access market reviews: Approach to setting LLU and WLR charge controls*, July 2013, available at: http://stakeholders.ofcom.org.uk/binaries/consultations/llu-wlr-cc-13/summary/LLU_WLR_CC_2014.pdf

⁵¹ The July 2013 *Review of the Wholesale Broadband Access Markets* argued along similar lines in favour of CPI, see paragraphs A12.82 et seq., available at: http://stakeholders.ofcom.org.uk/binaries/consultations/review-wba-markets/annexes/WBA_July_2013_annexes.pdf published also 11 July 2013

⁵² Since CPI inflation tends to be lower than RPI inflation, using CPI in our ALF methodology would involve (compared to using RPI) higher initial fees that rise with inflation at a slower rate.

- Third, from a practical point of view we consider that such sector-specific indices are less well established and less widely understood than generic price indexes and may not be sufficiently clear and certain to be used in the context of a statutory instrument setting fees (whereas CPI and RPI are published by the Office of National Statistics). There is also a risk (which Ofcom has no ability to control or mitigate) that they may not be available in the future, or the underlying calculation methodology may change in a way that may not make them more cost reflective than a general inflation index for the purposes of calculating the level of ALF. While these risks also apply to CPI and RPI, we consider that the risk is lower.

WACC

Pre or post tax discount rate

- 5.48 In the First Competition Assessment, at paragraph A11.37, we proposed to use the real pre tax cost of capital of a notional efficient mobile operator as the relevant discount factor.
- 5.49 We also recognised that it would be possible to use a real post-tax cost of capital, provided that an adjustment is also made in respect of the expected differences in tax treatments between lump sum⁵³ and the annual payments.
- 5.50 We noted that the post-tax approach would make the calculation more complex as it requires us to make assumptions about the differing tax treatments. For that reason, in the First Competition Assessment, we proposed to use a pre-tax WACC as the relevant discount factor.
- 5.51 However, our underlying rationale for proposing the use of a real pre-tax cost of capital was that, when the likely tax advantage of annual licence fees compared to a lump sum payment was taken into account, using a real pre-tax cost of capital (and ignoring the different tax treatments) gave a similar result to using the real post-tax cost of capital. As this rationale ultimately depended on a calculation using the real post-tax rate, we now consider that it would be more transparent to do the calculation on a post tax basis, and to make explicit our assumptions on the more favourable tax treatment of annual licence fees compared to a lump sum payment. The implications for the level of ALF are broadly similar whether using this post-tax approach (with its adjustment for the differential tax treatment) or using a real pre-tax approach.
- 5.52 We consider that a post-tax approach is more appropriate in principle, as we would expect a rational company to calculate the value of any given investment by reference to the cashflows after tax. Cashflows after tax are what is ultimately available for distribution to shareholders.

Tax adjustment

- 5.53 Since we are proposing to use a post-tax real WACC, in the rest of this sub-section we consider the tax implications impact of our proposal. First, we compare the difference between the tax treatment of a lump sum payment (as in the case of the up-front payment made for a licence awarded by auction) and the tax treatment of

⁵³ For the purposes of considering the appropriate tax position, we are treating the lump sum value that we have derived as though it is an amount bid in a hypothetical auction for the 900MHz and 1800MHz licences.

an annual licence fee. Second, we describe how we take account of this difference in the ALF calculations.

Tax treatment of lump sum payment

- 5.54 In general, the tax treatment of Intangible Fixed Assets (IFAs) follows the accounting treatment (2002 IFA regime).
- 5.55 This means that a debit (deduction) is recorded in arriving at profits chargeable to corporation tax when a cost is recorded in the profit and loss account for:
- Amortisation of the asset
 - Impairment of the asset
- 5.56 Alternatively, the company can elect to take a deduction at a fixed rate (4% of the cost of the asset). This would be appropriate if, for example the asset was not being amortised in the accounts.
- 5.57 Under International Accounting Standards 38:
- Intangibles are amortised based on the expected pattern of benefits. Where this is not readily identifiable, they are amortised on a straight line basis.
 - Assets must be impaired where there is evidence to support impairment.
- 5.58 Based on the accounting rules, we consider it reasonable to assume that the intangible asset to which the lump sum payment arose would be amortised on a straight line basis over the period of the licence. In this situation, the tax deduction in the calculation of profits chargeable to corporation tax would be equal to the amortisation in the accounts.

Tax treatment of annual licence fees

- 5.59 Annual payments for the use of spectrum as part of the company's trade⁵⁴ are allowed as a deduction in computing the profits chargeable to corporation tax. This assumes that the expenditure is wholly and exclusively for the purposes of the trade.
- 5.60 This is because the payments constitute 'revenue expenditure' which is allowable if it is wholly and exclusively for the purposes of the trade, unless there is a specific statutory prohibition.
- 5.61 The deduction will be in line with generally accepted accounting practice. This means that when the costs are incurred, they will be reported in the accounts. The amount reported in the profit and loss account will normally be taken as the deduction in computing the profits chargeable to corporation tax. While we do not have any control over the tax regime and its treatment of ALF, we consider it important to reflect the tax implications in our analysis.

⁵⁴ We are referring to the company's trade, as it is consistent with the terminology used in tax legislation. We note that in this instance we are referring to the ongoing operating business of the company and not to spectrum trading.

Approach to tax neutrality

5.62 Although the tax treatment of the two alternatives is broadly consistent, the tax treatment of annual licence fees is more favourable than that for a lump sum payment for two reasons:

- **Time value of money:** The tax deduction for the lump sum is the annual amortised amount of the lump sum. This is likely to be calculated on a straight line basis. Assuming this is done over a 20 year period, the annual deduction would be $1/20^{\text{th}}$ of the lump sum value. But this calculation takes no account of the time value of money. In contrast, in arriving at the annual licence fee, we use the WACC to calculate the annual stream of payments from the lump sum value. This takes into account the time value of money, whereby a £1 today is worth more than £1 in the future. In order to ensure that the present value of the annual licence fees is equal to the lump sum value, the annual licence fees are increased to reflect the time value of money. This means that the annual licence fee is greater than $1/20^{\text{th}}$ of the lump sum value. Therefore the deduction from taxable profits each year is greater for the annual licence fee payer.
- **Inflation:** The tax deduction for the lump sum is calculated by amortising the amount of the lump sum over the period without taking account of general inflation. For example, if the lump sum were £100 and were amortised on a straight line basis over 20 years, the amount allowed would be £5 in each year in nominal terms. In real terms, the amount allowed would fall over time. When the amounts allowed for tax over the 20 years were added together (ignoring the time value of money), they would be less than £100 in real terms. In contrast, our calculation of annual licence fees is made in real terms and so takes account of general inflation.

5.63 When using the post tax WACC we need to make an adjustment for these effects. In modelling this adjustment, we have used the latest forecasts for the main rate of corporation tax of 23% for 2013/14, 21% for 2014/15 and 20% for 2015/16⁵⁵. We have assumed it remains constant after 2015/16. We have also assumed an inflation rate of 2.5% and (as noted above) spread the lump sum payment over 20 years. Because we consider that the lump sum values relate to the 20 years after the auction completed, we make this tax calculation for the years 2013/14 to 2032/33.

5.64 We calculate that the impact this tax advantage is equivalent to an increase of 11% in the lump sum value. The full derivation of our ALF proposals summarised at the end of this section incorporate a tax adjustment factor of this amount in order to reflect the more advantageous tax treatment.

5.65 We are publishing the spreadsheet used to derive the value of the tax adjustment factor alongside our consultation document⁵⁶. Because of the changing rates of corporation tax the model derives the value of the tax adjustment factor through iteration.

⁵⁵ HMRC corporation tax rates, as reported on 2nd September 2013:

<http://www.hmrc.gov.uk/rates/corp.htm>

⁵⁶ <http://www.ofcom.org.uk/static/models/alf.xlsm>.

MCT vs ALF-specific WACC

- 5.66 In the First Competition Assessment, we proposed to use the WACC estimated for the Mobile Call Termination Statement in March 2011 ("MCT WACC"), which reflects the cost of capital of a notional efficient mobile operator.
- 5.67 We consider that the MCT WACC remains a reasonable proxy for the discount rate which would have been used to calculate the lump sum values.⁵⁷ As the MCT WACC aims to estimate the WACC applicable to a hypothetical UK mobile-only operator we consider that this is likely to capture the systematic risks which would apply to the licences covered by the annual licence fees. We think that the systematic risk associated with the 4G spectrum, the value of which has been used to inform our analysis of the lump sum value, would also be consistent with the systematic risk of a hypothetical UK mobile-only operator⁵⁸. This is why we consider that it would be inappropriate to use the Government's social preference rate as set out in the Green Book, as argued by EE.⁵⁹
- 5.68 In particular, we have not seen any clear evidence to suggest systematic differences in the cash flow risk associated with 4G as compared to the cash flow risks which are captured within the observed beta of mobile operators and used to estimate the MCT WACC.
- 5.69 The MCT WACC was estimated for the purposes of a 3 year charge control. As the calculation of the annual licence fee spans a 20 year period we need to ensure that a 3 year period is appropriate for forecasting forward. In estimating the WACC for a 3 year charge control, we take into account both long term and recent movements. We do not rely heavily on spot rates and instead look at longer term trends.
- 5.70 For example our estimate of the Equity Risk Premium is based on historical data (over 100 years). For certain aspects of the cost of capital, it is necessary to use more up to date data as it provides a better basis for forecasting, taking into account recent information. One example of this is the equity beta. In estimating the equity beta, we generally place most weight on the 2 year equity beta as it provides a good balance between having sufficient data points to provide a statistically robust estimate with being sufficiently recent to be appropriate for forecasting forward.
- 5.71 It is not clear that in estimating a WACC appropriate for a longer period, we would take into account different evidence or would arrive at a different WACC than that estimated for the MCT. In addition, we note that we are trying to estimate a WACC which would have been appropriate for arriving at the lump sum valuation, and consider that the MCT WACC should be a reasonable proxy for this. Hence we are not proposing to change the assumptions used to calculate the WACC in the MCT

⁵⁷ Table A8.9 in Annex 8 of our March 2011 Wholesale mobile voice call termination statement shows the derivation of the WACC of 6.2% on a pre-tax real basis. This is consistent with a post-tax real basis of 4.1%, based on the transformation: $\text{post-tax real WACC} = (1 + \text{pre-tax real WACC}) / (1 + \text{inflation rate}) - 1$.

Annex 8 to is available here:

http://stakeholders.ofcom.org.uk/binaries/consultations/mtr/statement/MCT_statement_Annex_6-10.pdf

⁵⁸ The First Competition Assessment was published in March 2011, however Ofcom had announced its proposed timeline for the auction announced in November 2010. This means that the equity beta estimated for the March 2011 Mobile Call Termination Statement is likely to incorporate investor's perceptions of the risk associated with 4G services. See:

<http://media.ofcom.org.uk/2010/11/16/ft-world-telecoms-conference/>

⁵⁹ EE's non-confidential response to the First Competition Assessment, answer to question 10.3.

charge control, to account for the longer period of time it is applied for in the context of ALF.

- 5.72 We have reviewed whether we should update the parameters used in the main assumptions and found no material change in circumstances, for the majority of parameters, from those estimated in March 2011 and the WACC estimated prior to bidder applications being submitted in December 2012. We consider that the date on which the bidders estimated the value of the 4G spectrum is important as we are using the auction prices as an important source of evidence to inform our estimate of the lump sum value.
- 5.73 However, we have noted that the March 2011 Mobile Call Termination Statement used a corporation tax rate of 24%. The main rate of corporation tax for 2013/14 is 23% and for 2014/15 this falls to 21% and for 2015/16 this falls further to 20%. Therefore we have reduced the corporation tax rate used in the calculation. The impact of this is to increase the real-post tax WACC from 4.1% to 4.2%.⁶⁰
- 5.74 We therefore propose to use the MCT WACC as estimated in March 2011, and updated to reflect the revised corporation tax rate as published by HMRC for the purposes of calculating the annual licence fees.

Delayed spectrum availability

- 5.75 In the First Competition Assessment we considered that an adjustment to the value of the spectrum estimated from the auction bids might be required if bidders paid for spectrum before the date of its availability and therefore committed funds that they could have otherwise have invested elsewhere.
- 5.76 We consider that this issue is no longer relevant and we do not propose to make an adjustment to the lump sum values set out in Section 4 for the following reasons:
- the date at which the winning bidders paid for the spectrum they won in the auction was, in the event, set at the same time as the licence start date (1 March 2013)⁶¹; and
 - bidders in the auction were aware that the 800 MHz blocks would be subject to transitory limitations in the maximum permitted field strengths in areas where the DTT transmitter had yet to be cleared; however, in light of the limited geographical and temporal scope of these limitations, we consider that this was unlikely to have materially affected bidders' valuation of the spectrum in the auction.

Summary of Ofcom proposals on annualisation and base level of ALF

- 5.77 To sum up, we propose to:
- spread the lump sum value of spectrum over 20 years, using an ALF profile that is flat in real terms, that is a 20-year annuity;

⁶⁰ The real pre-tax WACC falls from 6.2% to 5.9% as a result of reducing the corporation tax rate from 24% to 20%

⁶¹ At the time of the First Competition Assessment it was not clear that this would necessarily be the case (eg. if the auction was held significantly in advance of the spectrum being available for use)

- apply a post tax WACC of 4.2% when deriving the annuity payment;
- take into account the differential tax benefits of the lump sum value and the ALF in calculating the ALF; and
- use the RPI index to adjust base year ALF level each year when the licence fee comes due for payment.

5.78 We propose using the uniform (i.e. not operator specific) post-tax real WACC used in 2011 to determine the level of mobile call termination charge (MCT) controls to apply until 2014/15. The post-tax real WACC for the current MCT charge control is set at 4.1%, which includes inflation expectations at 2.5%. However, we have updated the MCT WACC to take account of changes to the main rate of corporation tax which increases the real post tax WACC to 4.2%.

5.79 Given that, in the case of fees for 900 MHz and 1800 MHz spectrum, we are potentially looking across a much longer timeframe (given that the lump sum values relate to 20 years), and that interest rates today are at an all-time low, we invite stakeholders to comment on the appropriateness of this rate.

5.80 We propose to use the following formula for calculating the base level of ALF from the lump sum value of spectrum. This formula assumes an annuity payment with the payments made at the beginning of the year.

$$ALF_t = LSV * TAF * \left[\frac{WACC}{1 - (1 + WACC)^{-t^*}} \right] * \left[\frac{1}{(1 + WACC)} \right] * \left[\frac{RPI_t - RPI_{t0}}{RPI_{t0}} \right]$$

5.81 Where:

- ALF_t is the value of ALF in year t ;
- LSV is the lump sum value of spectrum, as discussed in Section 4;
- TAF is an adjustment factor that reflects the tax advantages of ALF over lump sum payments (equal to 1.11)⁶²
- $WACC$ is the real post-tax weighted average cost of capital, as determined in the March 2011 Mobile Call Termination statement (and updated for the fall in the main rate of corporation tax), i.e. 4.2%;
- t^* is the length of, period over which we spread the LSV for the purposes of calculating ALF, which is equal to the initial term of the licence, i.e. 20 years;
- RPI_{t0} is the level of the RPI (all items) index in March 2013 and RPI_t is the latest available figure for the same index published in the Consumers Price Inflation Reference Tables by the ONS in the month preceding the common ALF implementation date is set (and on each anniversary of the date thereafter).

5.82 On the basis of the methodology set out above, we propose the following base level of ALF.⁶³

⁶² The tax adjustment factor is calculated as: $1 + \{(\text{present value of the tax benefits of ALF} - \text{present value of the tax benefits of the lump sum value}) / \text{lump sum value}\}$.

Figure 5.2 Proposed Annual Licence Fees (£ per MHz)

	900 MHz	1800 MHz
Ofcom proposal	£1.99m	£1.19m

5.83 Figure 5.3 below summarises the annual sums that each licensee is liable to pay under the current fees and under the proposed base level of ALF.

Figure 5.3 Comparison of current fees and proposed fees at base level of ALF (£ million)

	Vodafone		Tele		EE		H3G		Total	
	Current	Proposal	Current	Proposal	Current	Proposal	Current	Proposal	Current	Proposal
900 MHz	12.4	69.3	12.4	69.3	0.0	0.0	0.0	0.0	24.8	138.5
1800 MHz	3.2	13.8	3.2	13.8	24.9	107.1	8.3	35.7	39.7	170.4
Total	15.6	83.1	15.6	83.1	24.9	107.1	8.3	35.7	64.5	308.9

5.84 In section 6 below we set out *inter alia* how we propose to make an MNO-specific adjustment to such base level of ALF in the first year only, to account for the proposed common implementation date and the different fee payment dates

⁶³ For the avoidance of doubt, the proposed fees would be pro-rataed for holdings that are fractions of 1MHz.

Section 6

Implementing revised annual licence fees

- 6.1 In the previous sections we have set out our proposals for revising ALF to reflect full market value. This section considers the timing of the introduction of the revised ALF. In particular, we consider:
- whether there should be a common effective date from which the revised ALF is applied to all holders of 900 MHz and 1800 MHz licences, and if so what that date should be; and
 - whether the revised level of ALF should be applied in full from its introduction or, alternatively, whether there should be a period over which the increase in ALF is phased-in.
- 6.2 This section also considers briefly the circumstances in which we might review the level of ALF for 900 MHz and 1800 MHz licences in future.

Date from which the revised ALF will take effect

- 6.3 Holders of the 900 MHz and 1800 MHz licences are currently required to make payment of the amount specified in the Wireless Telegraphy (Licence Charges) Regulations 2011 (the “Charges Regulations”) at 12-monthly intervals. Under the Charges Regulations, this payment is due on the last day of the 12-month period since the last payment date; in effect, payment is due on the day before the anniversary of the date on which the licence was issued⁶⁴.
- 6.4 In addition, the Charges Regulations provide for holders of these licences (and other types of licence) to have the option to pay in ten equal instalments, with the first instalment payable on the day the full amount would have been payable, and the remaining instalments payable at monthly intervals over the following nine consecutive months⁶⁵.
- 6.5 Each licence has a condition requiring the holder to pay the fee due under regulations made under section 12 of the Wireless Telegraphy Act 2006 on or before the fee payment date set out in the licence⁶⁶, failing which Ofcom may revoke the Licence.
- 6.6 The licences have different fee payment dates, reflecting the difference in the dates on which the licences were initially granted (or in the case of H3G, the date on which the rights transferred to them take effect⁶⁷).

⁶⁴ Regulation 4(1)(b) of the Wireless Telegraphy (Licence Charges) Regulations 2011.

⁶⁵ Regulation 4(6) and (8) of the Wireless Telegraphy (Licence Charges) Regulations 2011.

⁶⁶ Or on or before such dates as shall be notified in writing to the Licensee.

⁶⁷ H3G’s rights to use frequencies in the 1800 MHz band take effect on 1 October 2013 (in respect of certain frequencies specified in the licence), and on 1 October 2015 (in respect of certain other frequencies specified in the licence).

Figure 6.1 **Fee payment dates**

Name of licensee	Fee payment date
EE	28 February
Vodafone	31 July
Telefónica	31 July
H3G	31 October

- 6.7 These differences in payment dates mean that if the revised ALF is introduced so that it is payable as from each licensee's fee payment date (whether in full or in instalments), the introduction of the revised ALF will be 'staggered' across the licensees, with some licensees paying at a rate that reflects full market value sooner than other licensees.
- 6.8 The principle that licence charges are due on a date calculated by reference to the anniversary of the date the licence was issued has been applied to the Licences since they were first granted. It applies to many other categories of wireless telegraphy licence. It is well-understood by stakeholders and provides a clear and consistent basis for periodic licence payments.
- 6.9 However, given the scale of increase that we are proposing, this timing effect could lead to significant differential impacts on the licensees in this particular case, given that the payment dates on which the new ALF rates would come into effect would be separated by between 7 and 9 months (depending on precisely when the new fees regulations come into force). Using the 9 month separation for illustrative purposes, the size of effect associated with this difference in payment dates would be equivalent to £1.5 million for each 1 MHz of 900 MHz spectrum and £0.9 million for each 1 MHz of 1800 MHz spectrum held by a licensee. This would be a one-off effect that would arise only in the year that the revised ALF is introduced (all licensees will pay at the new ALF rate in subsequent years).
- 6.10 There is the potential for such a payment separation to have an effect on competition although, given the scale of the differential effect compared to the size of operators' relevant business, any such effect may be limited. However, this differential impact could give rise to a question of fairness as between the licensees. An alternative approach which we think is preferable because it would address this potential issue of fairness, would be to implement a common effective date so that all of the licensees are paying a rate that reflects the full market value of their spectrum from the same point in time.
- 6.11 There are two ways in which we could implement a common effective date:
- change the payment dates applying to the Licences so that they are identical;
 - adjust the size of fee payment in the first year following the common effective date (in the manner described below) so that each licensee makes payments over a period of time that are effectively equivalent.
- 6.12 The first way of achieving a common effective date would be to change the payment dates applying to the Licences so that they are identical. We recognise that the

arrangements for licence fee payments under these licences are of longstanding duration and changing them may be unnecessarily disruptive to licensees.

- 6.13 The second way of implementing a common effective date would be to adjust the size of fee payment in the first year following the common effective date. The amount of the first payment following the common effective date would be made up of two sums:
- the revised ALF applied to the licensee's spectrum holdings; plus
 - a sum equal to the difference between the revised ALF and current ALF, pro-rated in relation to the number of months between the common effective date for the introduction of the revised ALF and the licensee's payment date.
- 6.14 To illustrate the calculation of this proposed pro-rated amount, take a hypothetical licensee with a payment date that is seven months after the common effective date. The pro-rated amount would be the difference between the revised ALF for that licensee and current ALF, multiplied by 7/12. The fewer the number of months between the common effective date and the licensee's payment date, the smaller the size of the pro-rated amount (and vice-versa).
- 6.15 It seems to us that it would be preferable to achieve a common effective date by leaving the payment dates for the licensees as they currently are, but set the amount of the first payment so that it has the effect of adjusting for the differences in payment dates. However, if licensees would prefer to bring forward their payment date to the common effective date we consider that this would be an acceptable alternative approach.
- 6.16 The choice of common effective date depends on the implementation of the new ALF rates through regulations. We will set out our decision on the ALF for 900 MHz and 1800 MHz in a statement, following consideration of the responses to this Consultation. We expect to issue a Notice on the draft Fees Regulations (that will give effect to these new ALF rates) at the same time as the statement. We previously stated that our provisional view was that we expected that the revised annual fee level would start when the Fees Regulations come into force, and that we expected to start charging the new ALF rates as soon as practically possible⁶⁸. We continue to consider that this is appropriate. We envisage that the new Fees Regulations will come into force shortly after the Regulations have been made, following our consideration of any representations made to us on the Notice of draft Fees Regulations. We therefore propose to set the common effective date to be the first day of the month following the new fees regulations coming into force. We consider that this approach would be in line with the Direction requiring Ofcom to set ALF for 900 MHz and 1800 MHz at full market value after completion of the 4G Auction.

Phasing-in of fee increases

- 6.17 Increases in spectrum fees are sometimes phased in to avoid potential detrimental impacts to spectrum users, consumers and citizens. In the SRSP we set out that we balance the considerations and manage the risks case by case as part of the assessment of the impact of licence fee changes⁶⁹.

⁶⁸ First Competition Assessment paragraphs 10.21 and A11.42.

⁶⁹ SRSP consultation document paragraphs 4.50 to 4.54; SRSP discussion of methodology 4 paragraphs 5.141 to 5.170.

- 6.18 Although the fee increases for 900 MHz and 1800 MHz licences do not fall within the framework established by the SRSP, we have considered whether the proposed increase in ALF would be likely to create detrimental impact absent any phasing-in.
- 6.19 We do not consider that the proposed increase in ALF would be likely to create detrimental impacts absent any phasing-in for the following reasons:
- the licensees will have been well aware of the impending increase in ALF for more than three years by the time revised ALF fees are implemented (i.e. since the December 2010 Direction). They should also have been able to make well informed estimates of the broad scale of increase that will take place, given the requirement in the Direction for Ofcom to have particular regard to the sums bid in the 4G Auction. In view of this, we consider it unlikely that the absence of a phase-in period will create shocks which are so out of line with the broad expectations of the licensees such that these might have harmful impacts on delivery of services to customers;
 - the level of the bids made by the licensees for 800 MHz and 2.6 GHz licences provides a point of comparison for the level of increase in ALF proposed in this document. We note that licensees made bids for the spectrum packages that they won that exceeded the prices they paid by between 80% and 160%. In other words, the licensees made bids which they knew could have required them to make a significantly higher up-front payment than they actually had to make for the spectrum they won in the 4G Auction. The size of their additional financial exposure, which they knew they could have had to absorb in their business plans, significantly exceeds the size of proposed increases in first-year ALF payments that they now face.
- 6.20 We therefore propose to implement fees reflective of full market value, as required by the Direction, without phasing these in over a period of time.

Duration of revised fees

- 6.21 We propose that the revised fees should be introduced for an indefinite period and should not be time-limited. Elsewhere, when spectrum fees are introduced, or changed, so as to make them reflective of opportunity cost, we would normally expect to set out a period during which we would not expect to carry out a further review. As was explained in the SRSP, the purpose of this is to provide a degree of certainty about the future level of fees when licensees take investment decisions or consider options for trading.
- 6.22 We welcome stakeholders' comments on what such a period should be in the case of annual fees for 900 MHz and 1800 MHz spectrum. We would expect to provide some guidance on this issue in our concluding statement. Even where we provide guidance on the length of an initial period (during which we would not expect to undertake a further review), our policy is to undertake a review of fees only where there is clear evidence of significant changes in long term circumstances that suggest that fees might be materially out of line with the value of this spectrum and where we believe that we will be able to derive a more reliable estimate. We would generally expect to consult on the desirability of a carrying out such a review when consulting on our Annual Plan.

Annex 1

Responding to this consultation

How to respond

- A1.1 Ofcom invites written views and comments on the issues raised in this document, to be made **by 5pm on 19 December 2013**.
- A1.2 Ofcom strongly prefers to receive responses using the online web form at <http://stakeholders.ofcom.org.uk/consultations/900-1800-mhz-fees/howtorespond/form>, as this helps us to process the responses quickly and efficiently. We would also be grateful if you could assist us by completing a response cover sheet (see Annex 3), to indicate whether or not there are confidentiality issues. This response coversheet is incorporated into the online web form questionnaire.
- A1.3 For larger consultation responses - particularly those with supporting charts, tables or other data - please email ALF@ofcom.org.uk attaching your response in Microsoft Word format, together with a consultation response coversheet.
- A1.4 Responses may alternatively be posted or faxed to the address below, marked with the title of the consultation.
- Alan McNaboe
3rd Floor
Spectrum Policy Group
Riverside House
2A Southwark Bridge Road
London SE1 9HA
- A1.5 Note that we do not need a hard copy in addition to an electronic version. Ofcom will acknowledge receipt of responses if they are submitted using the online web form but not otherwise.
- A1.6 It would be helpful if your response could include direct answers to the questions asked in this document, which are listed together at Annex X. It would also help if you can explain why you hold your views and how Ofcom's proposals would impact on you.

Further information

- A1.7 If you want to discuss the issues and questions raised in this consultation, or need advice on the appropriate form of response, please contact Alan McNaboe on 020 7783 4522.

Confidentiality

- A1.8 We believe it is important for everyone interested in an issue to see the views expressed by consultation respondents. We will therefore usually publish all responses on our website, www.ofcom.org.uk, ideally on receipt. If you think your response should be kept confidential, can you please specify what part or whether

all of your response should be kept confidential, and specify why. Please also place such parts in a separate annex.

- A1.9 If someone asks us to keep part or all of a response confidential, we will treat this request seriously and will try to respect this. But sometimes we will need to publish all responses, including those that are marked as confidential, in order to meet legal obligations.
- A1.10 Please also note that copyright and all other intellectual property in responses will be assumed to be licensed to Ofcom to use. Ofcom's approach on intellectual property rights is explained further on its website at <http://www.ofcom.org.uk/about/accoun/disclaimer/>

Next steps

- A1.11 Following the end of the consultation period, Ofcom intends to publish a statement and draft fee regulations.
- A1.12 Please note that you can register to receive free mail Updates alerting you to the publications of relevant Ofcom documents. For more details please see: http://www.ofcom.org.uk/static/subscribe/select_list.htm

Ofcom's consultation processes

- A1.13 Ofcom seeks to ensure that responding to a consultation is easy as possible. For more information please see our consultation principles in Annex 2.
- A1.14 If you have any comments or suggestions on how Ofcom conducts its consultations, please call our consultation helpdesk on 020 7981 3003 or e-mail us at consult@ofcom.org.uk . We would particularly welcome thoughts on how Ofcom could more effectively seek the views of those groups or individuals, such as small businesses or particular types of residential consumers, who are less likely to give their opinions through a formal consultation.
- A1.15 If you would like to discuss these issues or Ofcom's consultation processes more generally you can alternatively contact Graham Howell, Secretary to the Corporation, who is Ofcom's consultation champion:

Graham Howell
Ofcom
Riverside House
2a Southwark Bridge Road
London SE1 9HA

Tel: 020 7981 3601

Email Graham.Howell@ofcom.org.uk

Annex 2

Ofcom's consultation principles

A2.1 Ofcom has published the following seven principles that it will follow for each public written consultation:

Before the consultation

A2.2 Where possible, we will hold informal talks with people and organisations before announcing a big consultation to find out whether we are thinking in the right direction. If we do not have enough time to do this, we will hold an open meeting to explain our proposals shortly after announcing the consultation.

During the consultation

A2.3 We will be clear about who we are consulting, why, on what questions and for how long.

A2.4 We will make the consultation document as short and simple as possible with a summary of no more than two pages. We will try to make it as easy as possible to give us a written response. If the consultation is complicated, we may provide a shortened Plain English Guide for smaller organisations or individuals who would otherwise not be able to spare the time to share their views.

A2.5 We will consult for up to 10 weeks depending on the potential impact of our proposals.

A2.6 A person within Ofcom will be in charge of making sure we follow our own guidelines and reach out to the largest number of people and organisations interested in the outcome of our decisions. Ofcom's 'Consultation Champion' will also be the main person to contact with views on the way we run our consultations.

A2.7 If we are not able to follow one of these principles, we will explain why.

After the consultation

A2.8 We think it is important for everyone interested in an issue to see the views of others during a consultation. We would usually publish all the responses we have received on our website. In our statement, we will give reasons for our decisions and will give an account of how the views of those concerned helped shape those decisions.

Annex 3

Consultation response cover sheet

- A3.1 In the interests of transparency and good regulatory practice, we will publish all consultation responses in full on our website, www.ofcom.org.uk.
- A3.2 We have produced a coversheet for responses (see below) and would be very grateful if you could send one with your response (this is incorporated into the online web form if you respond in this way). This will speed up our processing of responses, and help to maintain confidentiality where appropriate.
- A3.3 The quality of consultation can be enhanced by publishing responses before the consultation period closes. In particular, this can help those individuals and organisations with limited resources or familiarity with the issues to respond in a more informed way. Therefore Ofcom would encourage respondents to complete their coversheet in a way that allows Ofcom to publish their responses upon receipt, rather than waiting until the consultation period has ended.
- A3.4 We strongly prefer to receive responses via the online web form which incorporates the coversheet. If you are responding via email, post or fax you can download an electronic copy of this coversheet in Word or RTF format from the 'Consultations' section of our website at www.ofcom.org.uk/consult/.
- A3.5 Please put any parts of your response you consider should be kept confidential in a separate annex to your response and include your reasons why this part of your response should not be published. This can include information such as your personal background and experience. If you want your name, address, other contact details, or job title to remain confidential, please provide them in your cover sheet only, so that we don't have to edit your response.

Cover sheet for response to an Ofcom consultation

BASIC DETAILS

Consultation title:

To (Ofcom contact):

Name of respondent:

Representing (self or organisation/s):

Address (if not received by email):

CONFIDENTIALITY

Please tick below what part of your response you consider is confidential, giving your reasons why

Nothing

☐

Name/contact details/job title

☐

Whole response

☐

Organisation

☐

Part of the response

☐

If there is no separate annex, which parts?

If you want part of your response, your name or your organisation not to be published, can Ofcom still publish a reference to the contents of your response (including, for any confidential parts, a general summary that does not disclose the specific information or enable you to be identified)?

DECLARATION

I confirm that the correspondence supplied with this cover sheet is a formal consultation response that Ofcom can publish. However, in supplying this response, I understand that Ofcom may need to publish all responses, including those which are marked as confidential, in order to meet legal obligations. If I have sent my response by email, Ofcom can disregard any standard e-mail text about not disclosing email contents and attachments.

Ofcom seeks to publish responses on receipt. If your response is non-confidential (in whole or in part), and you would prefer us to publish your response only once the consultation has ended, please tick here.

☐

Name

Signed (if hard copy)

Annex 4

Consultation questions

Question 1. Do you agree with the approach that we propose to deriving a lump sum estimate of full market value for licences for 900 MHz spectrum and for 1800 MHz spectrum?

Question 2. Do you have any comments on our assessment of the lump sum value of (a) a licence for 900 MHz spectrum; or (b) a licence for 1800 MHz spectrum?

Question 3. Do you agree with our approach to annualising the proposed lump sum value, including the cost of capital which we propose to use?

Question 4. Do you agree that fees should be specified in constant real terms and should be adjusted annually in the light of changes to the Retail Prices Index (RPI)?

Question 5. Do you agree that revised fees should be implemented in a manner which has an effect such that all licensees are charged higher fees simultaneously, even though payment dates of individual licensees may vary?

Question 6. Do you agree it is appropriate that revised fees should be payable in full as soon as practicable after revised fee regulations are made.

Question 7. Do you have any views about the minimum period that should elapse before we should consider revising fees again?

Assessment of the competitiveness of the UK Combined Award

Introduction

- A5.1 At paragraph A13.76 (i) of the Second Competition Assessment we stated that for the purposes of revising ALF we would use “the bids made and licence fees paid in the combined award, using the linear reference price methodology described in the First Competition Assessment, provided the auction is sufficiently competitive.”
- A5.2 At the subsequent paragraph A13.77 we proposed to determine the precise approach to revising ALF following a further consultation after the auction. The purpose of this annex is to assess the competitiveness of the UK 4G Auction in order to determine what weight we should place on price information from the auction as part of our evidence for the purpose of revising ALF.

Assessment of the degree of competition in the auction

- A5.3 In the First Competition Assessment (paragraph A11.17) we acknowledged that there is no unique methodology to assess the degree of competition in an auction and this will be to a significant degree a matter of our judgement. We stated that to help in forming our judgement we expected to look at several indicators, which we will address in turn in the rest of this subsection:
- Initial eligibility ratio
 - Number of rounds
 - Rate of decrease of activity
 - International benchmarking
- A5.4 We consider each of these simple indicators in turn below. In addition to the above indicators, we take into account prices paid by the winning bidders, which were determined in the UK 4G Auction as second prices (highest losing bids). These (base) prices were materially above reserve prices by 72% on average (and by between 55% and 311% depending on the bidder). A similar comparison using the linear reference prices (LRPs) shows that the LRPs were larger than reserve prices by 19% for lot category A1 (800 MHz without coverage obligation), 102% for A2 (800 MHz with coverage obligation) and 230% for C (paired 2.6 GHz).

Initial eligibility ratio

- A5.5 The eligibility ratio is the ratio of the total eligibility demanded at the start of the auction to the eligibility of the total supply on offer. Eligibility points are a measure of spectrum quantity weighted by the relative value of lots.
- A5.6 They are a means to enforce rules on bidding in the auction, and to help with efficient price discovery. With a fixed supply of spectrum, the total eligibility associated with that supply is also fixed and known at the start of the auction. In the

first round of the auction, the sum of the eligibility associated with all bids made is a measure of demand from all bidders in that round. The ratio of eligibility of all bids in the first round and the total eligibility for the supply is a simple measure of excess demand and by extension provide some simple information on competition in the auction.

- A5.7 In the First Competition Assessment (paragraph A11.17) we considered that auctions with a ratio above 3 are typically viewed as likely to be highly competitive since bidders reveal a strong demand for a relatively scarce supply. On the other hand auctions with a ratio below 2 may indicate that competition is weak. However, we also noted that this ratio is only a snapshot of excess demand in the first round.
- A5.8 In the Combined award the eligibility points of all bids in the first round totalled 30,549; the total eligibility for the supply was 15,609.⁷⁰ While a ratio just below 2 at first sight may suggest that competition was weak, one has to consider that demand from the incumbents was constrained by spectrum caps: in fact, the four incumbents could at most have generated 36,900 eligibility points in total (ignoring the points for lot category E for unpaired 2.6GHz spectrum), or a ratio to supply of only 2.364.⁷¹ More specifically:
- EE's bidding was constrained by the overall spectrum cap set at 2x105 MHz. Its largest possible eligibility total was for 2x25 MHz of 800 MHz spectrum⁷² and 2x15 MHz of paired 2.6 GHz, for a total of 11,700 eligibility point. In the first round, EE's activity was for 2x20 MHz of A1 spectrum and 2x20 MHz of C spectrum for a total of 9,600 eligibility points.
 - Telefonica's and Vodafone's bids in the first round were constrained by both the sub-1GHz cap set at 2x27.5 MHz, which only enabled them to express demand for 2x10 MHz of 800 MHz spectrum.⁷³ As a result, their maximum potential eligibility was respectively 6,300 and 6,150 points, which is not much higher than the points implied in their first round bid, respectively 6,300 and 5,700 (again, excluding lot category E for simplicity).
 - Also H3G bid in the first round up to the overall spectrum cap of 2x105 MHz, with a bid for a large lot that totalled 10,751 points out of a potential maximum of 12,750.
- A5.9 An alternative way to look at this ratio is to consider the extent of bidding that would have been required to achieve a ratio above 3, which we previously indicated as likely indicative of strong competition. This would have required the new entrant bidders to place bids on at least 2x20 MHz of 800 MHz and 2x35 of paired 2.6 GHz spectrum, or alternatively would have required at least 5 new entrant bidders to express a total demand for 67 lots of 2.6 GHz spectrum.

⁷⁰ Please note that we are here comparing the eligibility points implied by the actual bids made in the first round, rather than the eligibility points "bought" via the deposit paid to Ofcom in advance of the auction. While some bidders did not make use of their full eligibility allowance, we consider that looking at the actual bid made is more relevant to assessing the competitiveness of the auction.

⁷¹ Since eligibility was heavily concentrated in the 800 MHz band, we are not considering the maximum potential demand from bidders which did not show any interest in this band.

⁷² Due to the cap on sub-1 GHz spectrum.

⁷³ Telefonica also bid up to the overall cap, for an additional 2x60 MHz of paired 2.6 GHz spectrum. Vodafone instead limited its demand below the overall cap, to 2x40 MHz of paired 2.6 GHz spectrum but also bid for 35 MHz of unpaired 2.6 GHz spectrum.

- A5.10 Overall, we consider that spectrum caps have had a significant impact on the ratio of demand eligibility to supply eligibility, and given this the resulting ratio just below 2 is consistent with significant competition in the auction.

Number of rounds

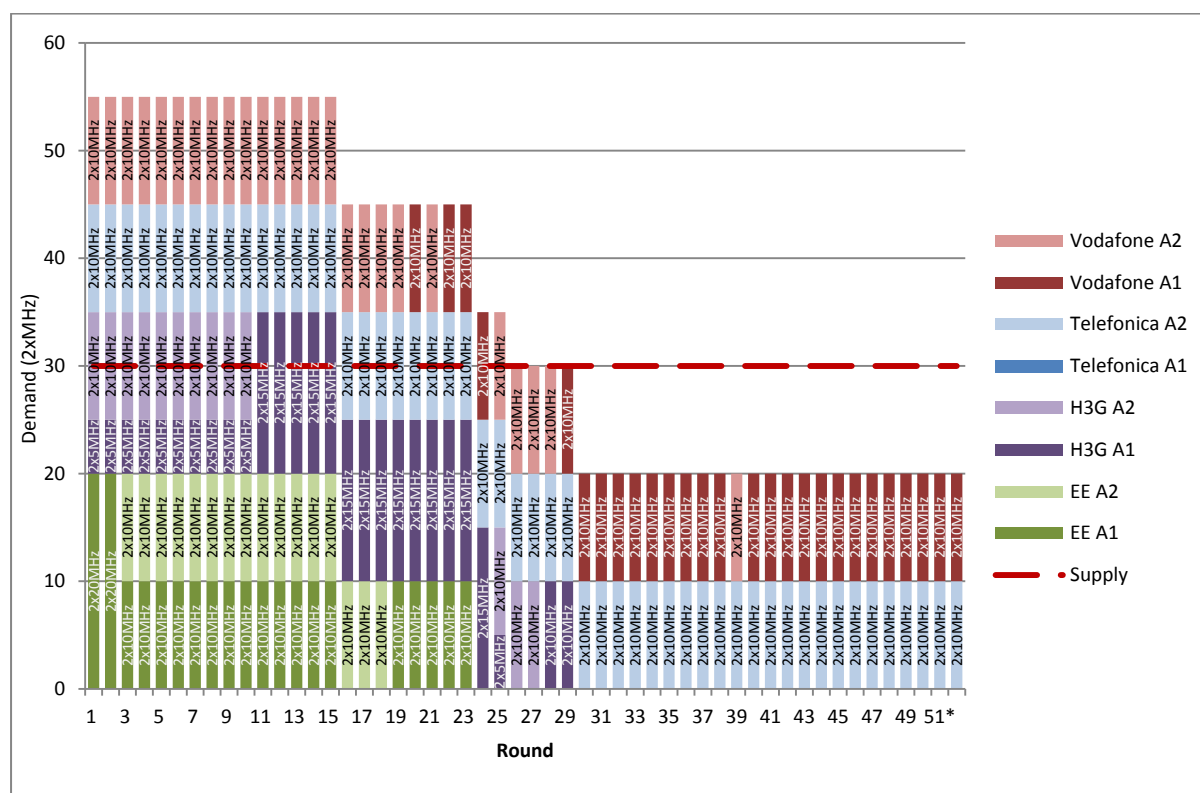
- A5.11 It is generally considered that if the clock phase closes quickly, this could be an indicator of low demand or of weak competition.
- A5.12 There were 52 clock rounds in the Combined Award, generally with 5% price increments between clock rounds for spectrum categories with excess demand.⁷⁴
- A5.13 We hence consider that this indicator suggests that the auction was sufficiently competitive for the purposes of this consultation.

Rate of decrease of activity

- A5.14 In the First Competition Assessment we considered that if the auction has a long tail of activity on just a few lots, a high number of rounds may not indicate that competition is spread evenly throughout the auction. In the following we assess whether activity was unevenly spread over different lot categories and we will take into account this dimension to evaluate the competitiveness of the UK 4G Auction.
- A5.15 With respect to lot categories A1 and A2 for 800 MHz spectrum, the extent of excess demand in the first round was 2x25 MHz, but dropped as the two incumbents not constrained by the sub-1GHz cap reduced their initial demands round after round. Competition for the A2 lot subject to coverage obligation appeared to be particularly intense, with three bidders consistently bidding for it in the first 27 rounds. Overall, there was excess demand for 800 MHz lots until round 25, with bidders substituting demand between A1 and A2 according to the relative level of prices as the rounds progressed.

⁷⁴ Larger price increments (up to 25%) were adopted for unpaired 2.6 GHz spectrum (which had a very low reserve price).

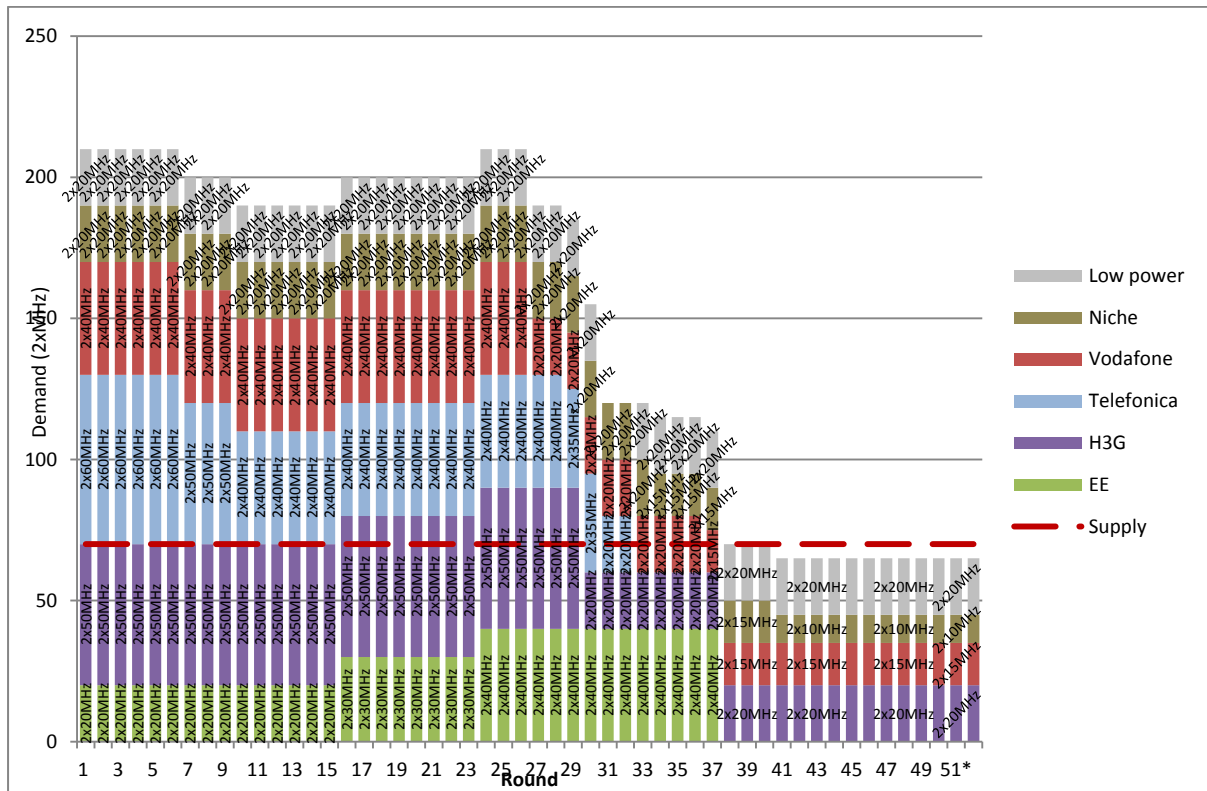
Figure A5.1: Bids for 800MHz: A1 (no coverage obligation) & A2 (with coverage obligation)



A5.16 With respect to lot categories C and D demand had exceeded supply by a ratio of four or more for the first 26 rounds. At that point, Vodafone halved its demand to 2x20 MHz, while shortly after both H3G and Telefonica substantially dropped their demand to 2x20 MHz, respectively at round 30 and 31. By round 37 demand and matched supply of C and D lots. It is not surprising that demand exceeded supply of for C lots for a higher number of rounds than for A lots, as bidders substituted their demand of higher value 800 MHz spectrum for lower value 2.6 GHz spectrum.⁷⁵

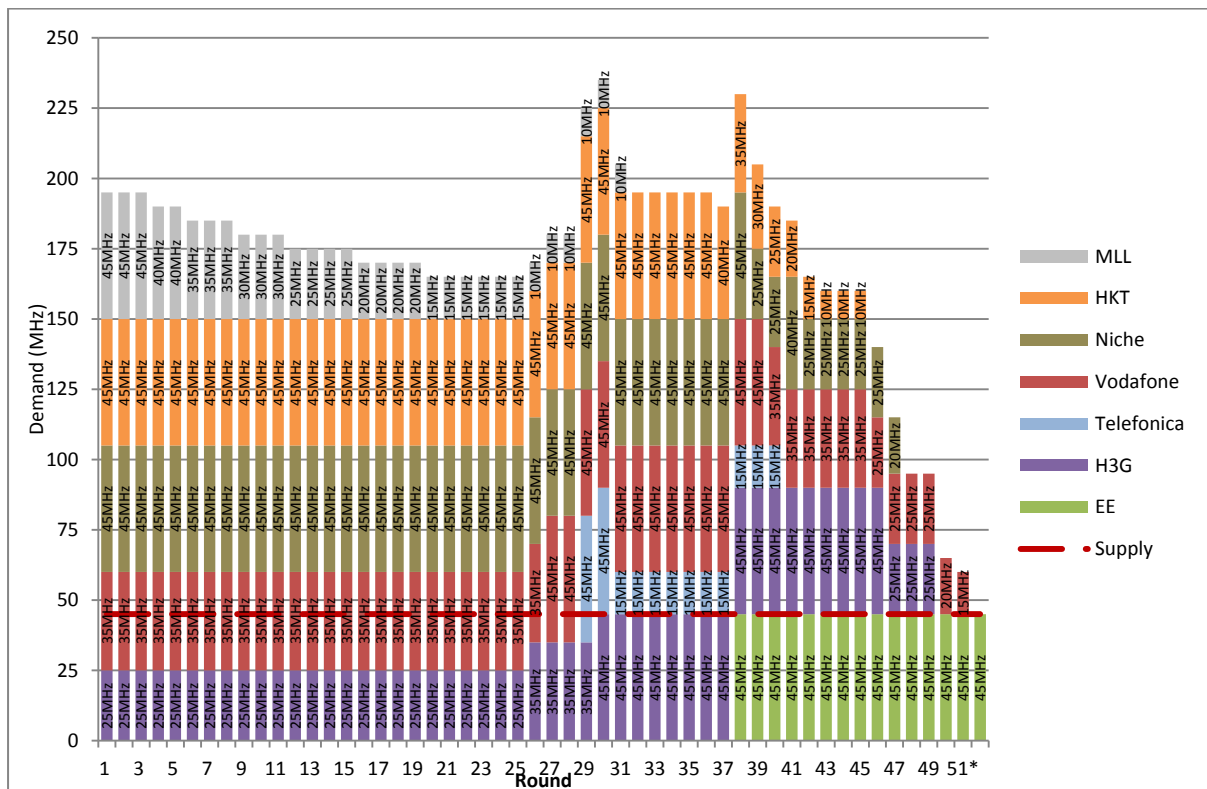
⁷⁵ The rules in the auction allowed bidders to switch demand from 800 MHz to 2.6 GHz but not in the other direction.

Figure A5.2: Bids for 2.6GHz paired: C (standard power) & D (low power)



A5.17 Unpaired 2.6 GHz spectrum was the last remaining lot category to experience excess demand, until round 51.

Figure A5.3 Bids for 2.6GHz unpaired: E



- A5.18 Overall, there was excess demand for a significant number of rounds for both the 800 MHz and 2.6 GHz bands.

International benchmarking

- A5.19 Finally, using benchmarks from other countries may provide a useful indicator of whether the outcome of the auction is competitive, although we need to recognize that there are likely differences between UK and other countries' mobile markets and award processes.
- A5.20 As demonstrated in DotEcon's report on international benchmarks published alongside this consultation document, the results of the UK 4G Auction are broadly consistent with international benchmarks. While the auction only generated package prices, the estimated linear reference prices per band were within the range of outcomes in other recent European auctions.

Provisional conclusions

- A5.21 The analysis above indicates that the UK 4G Auction was sufficiently competitive for us to use price information from the auction as relevant evidence for the purpose of revising ALF.

Annex 6

Network cost modelling and other technical evidence

Introduction

- A6.1 This annex discusses the potential use of network cost modelling and other technical evidence in estimating the market value of 900 MHz and 1800 MHz spectrum, in the context of revising ALF.
- A6.2 In general, we consider that network cost modelling can be a valid tool for informing the valuation of spectrum for the purpose of setting spectrum prices. However, the relevant question in the present context is whether network cost modelling and other technical evidence can provide additional guidance on the assessment of ALF, over and above the evidence that is available to us on the market value of 900 MHz and 1800 MHz spectrum (particularly from UK and international benchmarks). We have considered this question at two levels:
- Whether it is appropriate to use network cost modelling to generate specific estimates of the absolute or relative value of spectrum in the context of revising ALF; and
 - Whether, if it is not appropriate to do so, our interpretation of network cost modelling and other technical evidence can, nevertheless, inform us as to the ranking of bands (e.g. by indicating that one band has a higher value than another).
- A6.3 For the reasons set out in this annex, we are not proposing to use network cost modelling to generate specific estimates of the absolute or relative value of spectrum in the context of revising ALF. As regards the ranking of different spectrum bands, we provisionally conclude that technical evidence supports the view that 1800 MHz spectrum has a greater value than paired 2.6 GHz spectrum, but that the technical evidence does not, in itself, allow a clear conclusion to be drawn as to whether 900 MHz has greater value, or less value, than 800 MHz spectrum.
- A6.4 We welcome views on our provisional conclusions and invite any stakeholders who consider there is a case for making greater use of network cost modelling to submit detailed suggestions on how to overcome the limitations which we have identified in the context of revising ALF.

Potential for network cost modelling to derive absolute or relative spectrum values for setting ALF

- A6.5 We begin this section by considering whether there is a role for using network cost modelling to generate specific estimates for the absolute or relative values of spectrum bands in the context of revising ALF:
- We set out licence holders' views on this subject;

- We summarise relevant network cost modelling work that has been carried out to date;
- We consider the appropriateness of using network cost modelling to generate absolute or relative values for ALF;
- We set out our provisional conclusion on this point.

Licence holders' views

A6.6 In their responses to the First and Second Competition Assessments, Vodafone considered that there were a number of advantages to using technical modelling to estimate the value of 900 MHz spectrum. It considered the reasons we gave for suggesting we might not use technical modelling, and rejected those reasons:

- Vodafone considered that the allegedly considerable margin of error involved had not prevented Ofcom from using network cost modelling for estimating AIP in the past. Vodafone considered that using the price paid for 800 MHz spectrum to estimate the value of 900 MHz spectrum would also be subject to potentially larger errors because it considered that 900 MHz spectrum was not a good substitute for 800 MHz spectrum, and the price of the latter could reflect 'distorted' bidding intended to drive up the cost of the former. Vodafone argued that technical and cost modelling would use more robust and widely available data on 3G costs.
- Vodafone argued that, because the price paid for 800 MHz spectrum in the Auction might not be a good proxy for the market value of 900 MHz, network cost modelling would be an additional source of information, which would have advantages over auction-based prices.
- Vodafone considered that modelling results which appeared out of line with full market value as inferred from the Auction were potentially very useful information, indicating that the value inferred from the Auction was overestimating the market value of 900MHz spectrum.

A6.7 In May 2013 Vodafone submitted a report to us which it had commissioned from Frontier Economics, which argued that:

The relationship between market value and frequency is unlikely to be linear, except co-incidentally. A more accurate estimation of the relationship should be possible through network cost modelling of the potential incremental cost savings for deploying LTE networks given incremental blocks of 800 MHz, 1800 MHz and 2.6 GHz spectrum and under varying demand. Given that this modelling would only need to provide relative valuations, such an approach could be reasonably robust.

A6.8 Vodafone also called our attention to its response to Ofcom's March 2013 consultation on "Spectrum Pricing for Terrestrial Broadcasting",⁷⁶ commenting to us that "...if a network modelling approach is appropriate for DTT spectrum it is equally appropriate for 900 and 1800 MHz mobile spectrum". In its consultation response, Vodafone commented:

⁷⁶ <http://stakeholders.ofcom.org.uk/consultations/aip13/>

We [also] agree with Ofcom's use of an opportunity cost/network build approach to identify the alternative values in use of two potentially competing uses, and hence to secure the optimal use of spectrum. It follows from this that if Ofcom is using this method to both determine the best use of the spectrum and to calculate a spectrum fee charge for DTT, then it must establish why it would be appropriate to adopt a different methodology for charges relating to any spectrum used by mobile operators. To adopt a different approach in the absence of a compelling justification would be inequitable and as such place Ofcom in clear breach of its obligations to ensure that any regulation operates in a consistent and non-discriminatory way.

A6.9 Vodafone's submission goes on to say that "even the limited scenario sensitivities that Analysys Mason provides give a very broad range of possible outputs in terms of opportunity cost per MHz". Vodafone illustrates this with a set of scenario sensitivities in which the opportunity cost ranges from slightly less than half than the base case, to around 50%-75% above the base case.

A6.10 Vodafone concludes that the model is sufficiently robust to establish that the band in question (700 MHz) has a higher value in mobile use than in its current DTT use, but adds:

...it is equally quite obvious from our review that the model is not sufficiently accurate or robust to reliably identify the absolute value of the spectrum in mobile use for mobile spectrum fee setting (nor clearly is it intended to be by Analysys Mason). The calculated output cost avoided is significantly too high even in the base case.

Relevant network cost modelling that has been carried out to date:

For Ofcom in the context of recent projects

A6.11 Ofcom has modelled, or commissioned models of, mobile network costs in some recent projects, including the following:

- In our 2009 consultation on spectrum liberalisation in the mobile sector,⁷⁷ we modelled the differences between operators with different spectrum holdings that might arise after liberalisation, in costs incurred and/or quality of service (data rate and coverage), if liberalised spectrum were used for UMTS (3G) services.
- In our Second Competition Assessment on the Combined Award and in the July 2012 Statement,⁷⁸ we modelled network performance for the 800 MHz, 1800 MHz and 2.6 GHz bands, to assess whether an operator without sub-1 GHz spectrum would be able to match the performance of an operator holding sub-1 GHz spectrum (so that the former would be a credible national wholesaler).

⁷⁷ Application of spectrum liberalisation and trading to the mobile sector, February 2009

<http://stakeholders.ofcom.org.uk/consultations/spectrumlib/>

⁷⁸ *Second consultation on the Assessment of future mobile competition and proposals for the award of 800 MHz and 2.6 GHz spectrum and related issues*, Annex 7, January 2012, available at:

http://stakeholders.ofcom.org.uk/binaries/consultations/award-800mhz/annexes/2nd_Condoc_Annex_7.pdf

Assessment of future mobile competition and proposals for the award of 800 MHz and 2.6 GHz, Annexes 7-12, July 2012, available at:

<http://stakeholders.ofcom.org.uk/binaries/consultations/award-800mhz/statement/Annexes7-12.pdf>

Ofcom considered coverage, speed and capacity as metrics of performance in urban and rural areas respectively, and examined:

- Coverage as a function of number of sites; that is the percentage of locations⁷⁹ at which it is possible to receive the specified minimum data-rate on the y-axis versus number of sites on the x-axis
 - Coverage as a function of depth in building; that is, the percentage of locations at which it is possible to receive the specified minimum data-rate on the y-axis (see A7.48) versus depth in building on the x-axis.
 - Single-user throughput as a function of location; that is, the percentage of locations at which it is possible to receive the specified minimum data-rate on the y-axis (see A7.48) versus depth in building on the x-axis.
 - Capacity as a function of locations served; that is the capacity on the y-axis versus percentage of locations on the x-axis.
- As mentioned by Vodafone, in the context of our recent review of spectrum pricing for terrestrial broadcasting, we commissioned a study by Analysys Mason and Aegis Systems, which included modelling of the network cost savings that could be achieved if 700 MHz spectrum were made available for mobile broadband.⁸⁰ Ofcom has recently commissioned Analysys Mason to conduct a further study on the value of 700 MHz spectrum for mobile broadband building on Analysys Mason's previous work and other technical studies of relevance to this question.

A6.12 In summary, Ofcom has used network cost modelling to assess the relative or absolute value of spectrum in a number of contexts, including, in the case of terrestrial broadcasting, for the purpose of setting spectrum prices.

By Analysys Mason for H3G in the context of the Combined Award

A6.13 Analysys Mason, on behalf of H3G,⁸¹ attempted to quantify the relative advantage of 900 MHz over 800 MHz. HSPA+900 has an already developed customer base, hence providing holders of 900 MHz licences with a first mover advantage, in terms of building up market shares and obtaining positive cash flows earlier. Analysys Mason estimates that the net present value of such an advantage over the next ten years would be around £0.27/MHz/Pop, or £17m per MHz.

By DotEcon for Ofcom in the context of ALF

A6.14 As part of our ALF review project, we appointed DotEcon to carry out an international benchmarking exercise (see paragraph 4.8 above). This included a review of third parties' technical cost modelling and business modelling. DotEcon found that:

⁷⁹ In this context, the term "Locations" refers to domestic delivery points within the simulation area. Each postcode unit has associated with it a number of domestic delivery points: each delivery point will generally correspond to one residential address.

⁸⁰ Opportunity cost of the spectrum used by digital terrestrial TV and digital audio broadcasting, 12 March 2012, <http://stakeholders.ofcom.org.uk/binaries/consultations/aip13/annexes/report.pdf>

⁸¹ Analysys Mason, *Relative value of 800MHz and 900MHz spectrum in the UK*, submitted as part of H3G's confidential response to the Second Competition Assessment, section 4.2. page 17.

- **Cell radii:** “There are some discrepancies across the studies in terms of relative cell radii for the same band.” (paragraph 279). However, DotEcon also recognises that there was broad agreement that sub-1 GHz spectrum has larger radii and that the propagation characteristics of 800 MHz and 900 MHz are comparable.
- **Cell areas:** “There is less agreement across various sources on relative cell areas for different bands.” (paragraph 282).
- **Number of sites required for coverage and network cost:** “the technical studies we have reviewed differ in their views on the reduction in the number of sites required to achieve a given level of coverage. In particular, the PA Consulting work for MEZ would seem to produce rather different estimates of the impact on cell site requirements from much of the other technical work. Some of the differences across the technical studies may be explained by differences in network topography, available capacity, services modelled and other modelling specifics. However, despite the differences in the estimated magnitude of the effect, it is clear that sub 1GHz spectrum is better for achieving coverage than spectrum above 1GHz” (paragraph 289).
- Not surprisingly, differences in the estimated number of sites required for a certain level of coverage generate wide discrepancies in the estimates of the impact on network costs: For example, PA Consulting found that network deployment costs using 900MHz were only 14% of costs using 1800 MHz, whereas Vilicom in their work for ComReg found the cost with 900 MHz was 76% of that with 1800 MHz (See Table 28 of DotEcon’s report).
- Substantial uncertainty remains as to the absolute value and specific relative value of different bands, with consensus among different modelling studies only in relation to sub-1 GHz spectrum being more valuable than supra-1 GHz spectrum (although the extent of such an advantage was quite differentiated), and to 800 MHz and 900 MHz to be closely comparable.⁸²

Appropriateness of using network cost modelling to generate absolute or relative values for ALF

A6.15 In light of the above, we have considered whether it is appropriate to use network cost modelling to generate specific estimates of the absolute or relative value of spectrum in the context of revising ALF, given the evidence that is available to us on the market value of 900 MHz and 1800 MHz spectrum (particularly from UK and international benchmarks). In discussing these points, we will refer to some of the above mentioned modelling exercises.

Limitations of single-frequency network cost modelling in the context of 4G services

- A6.16 Since multi-frequency networks are very difficult to model, network cost modelling is often carried out for a single-frequency network, so that it provides an estimate of the value of a spectrum band considered in isolation.
- A6.17 However, following the Combined Award all mobile operators have holdings of liberalised spectrum in more than one frequency band. An MNO might decide to operate multi-frequency 4G networks, with lower frequency spectrum used to provide coverage and higher frequency spectrum used to provide capacity to

⁸² This latter point is in contrast to the differing views of MNOs on the subject.

consumers in easy-to-reach locations.⁸³ In this case, modelling single-band networks would not necessarily capture the value that can be created from such complementary ways of using multiple spectrum bands, or conversely the diminishing returns that can be achieved with additional spectrum holdings.

- A6.18 Another potentially relevant factor in the valuation of spectrum is the existing site portfolio of an operator: for example, an operator with a large number of existing sites optimised for the current holdings of higher frequencies may not value low frequency spectrum as much as one with fewer as they do not need the coverage advantage as much (albeit a rational operator would still consider the opportunity cost of disposing of the sites that sub-1GHz spectrum would render non-necessary).

Dependence on assumptions

- A6.19 Network cost modelling requires assumptions about the value of a range of relevant parameters. As a result, network cost modelling usually involves running several scenarios and sensitivity analysis with variations from a base case. As in the case of the Combined Award, it can be particularly useful for assessing the effect on network costs or performance of changing one parameter (keeping others constant). However, it can be difficult to assess which scenario(s) will be more likely to materialise and hence how results from different scenarios should be weighted.
- A6.20 Network cost modelling is typically forward-looking: based on projections of the relevant variables, it provides a snapshot of the estimated value of the spectrum based on the knowledge available to Ofcom at the time of the exercise. When the model extends well into the future, forecasts of market trends (e.g. mobile take up, average revenue per user) and technological developments (e.g. improvements in spectral efficiency) naturally tend to become less reliable.⁸⁴ This is exacerbated by the presence of other uncertainties which are not reflected in theoretical cost modelling, such as demand for specific mobile devices, which may differ in the spectrum bands which they support.
- A6.21 Because the results of network cost modelling are highly sensitive to the assumptions made and the value of parameters chosen in each scenario, the results may present a substantial degree of variability. The degree of caution needed in interpreting these results may reflect the specific needs of each project. In general this uncertainty can be material. For example:
- The consultation on spectrum liberalisation mentioned above estimated the additional sites required in densely populated areas to achieve a certain performance level, using only UMTS 2100 (rather than also deploying UMTS 900). As Figure A6.1 below shows, the model found that the results varied greatly depending on demand assumptions, ranging at the extremes from 5,700 sites in a “lower demand” scenario (8,600 minus 2,900) to 13,800 (21,100 minus 7,300) in a “higher demand” scenario.⁸⁵

⁸³ This is not the only deployment strategy available to MNOs: for example, a mix of macro-cells and small cells operating on a single frequency band might be used to provide capacity in what would otherwise be hard to serve locations, potentially using a high frequency.

⁸⁴ Auction bids and prices reflect operators' assessment of future events, which are subject to similar uncertainty. However, we are inclined to put more weight on evidence which reflects market participants' view of the future of the market, rather than Ofcom's view.

⁸⁵ See table 4 (page 13) in Annex 10 to the February 2009 consultation document, available here: <http://stakeholders.ofcom.org.uk/binaries/consultations/spectrumlib/annexes/annex10.pdf>

- The variance in cost was an order of magnitude between the extremes of the range of demand scenarios, “lower demand” and the “higher demand”.⁸⁶ For example, as shown in Figure A6.2, for a Single (i.e. non network sharing) UMTS2100 operator (who acquires 800 MHz) the present value of cost savings (discounted at the social rate of 3.5%) was £50m in the lower demand scenario and £1.6bn in the higher demand scenario, a 30-fold difference.⁸⁷ The variance in cost was still substantial when cost savings were discounted at the commercial rate of 11.5%: for example the cost for a single UMTS2100 operator was £30m in the lower demand scenario and £1.0bn in the higher demand scenario.
- In the July 2012 Statement⁸⁸, we considered several technical dimensions which might make a frequency band more or less valuable, in absolute terms or relative to other bands. In the following we focus our attention on the modelling of single-user throughput as a function of location, which illustrates the maximum coverage that it is possible to provide with a given network: the results in Figure A6.3 below represent the maximum proportion of locations to which it is possible to deliver a minimum level of service in the simulation areas considered.⁸⁹ The figures shows that the relative coverage performance of different bands can vary significantly across frequencies for a certain scenario, and degrades in all cases (but at different rates, with higher frequencies degrading faster than lower frequencies) when moving from shallow to a deep scenario or when moving to lower different levels of population density.⁹⁰ The final two rows are calculated as a weighted sum from the rows above - they give the total coverage (for basic connectivity) that our model predicts for each frequency at each depth for the combined 0-80% and 0-90% areas.
- DotEcon’s survey of recent modelling work in the context of ALF illustrates that differences in the estimated number of sites required for a certain level of coverage can generate wide discrepancies in the estimates of the impact of different spectrum holdings on network costs.

⁸⁶ See table 5 in the same Annex 10 linked above.

⁸⁷ Annex 15 to the February 2009 Consultation document on spectrum Liberalisation provides details about the cost modelling. Available here:

<http://stakeholders.ofcom.org.uk/binaries/consultations/spectrumlib/annexes/annex15.pdf>

⁸⁸ See <http://stakeholders.ofcom.org.uk/binaries/consultations/award-800mhz/statement/Annexes7-12.pdf>

⁸⁹ These areas are defined on the basis of local authority district boundaries but they exclude Northern Ireland due to lack of appropriate data. For example, the “0-50%” area is comprised of the most densely populated local authority districts in England, Scotland and Wales where 50% of the population live (from the 2001 census).

⁹⁰ We acknowledge however that these figures are based on the “max var” scenario, that is *the group the parameter values that tend, in most circumstances, to maximise the relative performance variation* (‘Max var’). We recognise that the set of parameters which is appropriate for the review of ALD may be less extreme than “maxvar”.

Figure A6.1 Number of sites required in densely populated areas

	Lower demand	Higher demand
Services provided:	<ul style="list-style-type: none"> •Minimum of 384 kbps •Shallower indoor coverage •1 MB / subscriber / day 	<ul style="list-style-type: none"> •Minimum of 2.4 Mbps •Deeper indoor coverage •30 MB / subscriber / day
Operator with 900 MHz spectrum deploying UMTS 900	2,900	7,300
Operator using only UMTS 2100	8,600	21,100

Source: Table 4 of the February 2009 Consultation Document on Spectrum Liberalisation

Figure A6.2 Additional costs for an operator using only UMTS2100 compared to an operator deploying UMTS900 (assuming the same service is provided) (NPV at 3.5%)

	Lower demand	Higher demand
<i>Services provided</i>	<ul style="list-style-type: none"> •384 kbps •Shallower indoor penetration •1 MB / subscriber / day 	<ul style="list-style-type: none"> •2.4 Mbps •Deeper indoor penetration •30 MB / subscriber / day
Single UMTS 2100 operator - who acquires 800 MHz	£50m	£1.6bn
Network sharing UMTS 2100 operator - who acquires 800 MHz	No cost advantage for 900MHz operator arising from liberalisation	£1.0bn
Single UMTS 2100 operator - who does not acquire 800 MHz	£250m	£2.2bn
Network sharing UMTS 2100 operator -who does not acquire 800 MHz	£50m	£1.4bn

Source: Table 5 of Annex 10 to the February 2009 Consultation Document

Figure A6.3 Coverage performance (based on 12,000 sites) by band and service level

Area	Pop.	Shallow			Deep		
Area	Pop.	800 MHz	1800 MHz	2.6 GHz	800 MHz	1800 MHz	2.6 GHz
0-50%	50%	98%	93%	89%	96%	86%	78%
50-80%	30%	96%	83%	76%	91%	73%	62%
80-90%	10%	94%	80%	71%	87%	67%	58%
0-80%	80%	97%	89%	84%	94%	81%	72%
0-90%	90%	96%	88%	82%	94%	80%	71%

Source: Table 7.4 in Annex 7 to the July 2012 Statement

A6.22 Network cost modelling which focuses on the trade-off between spectrum and number of sites to achieve a level of performance and coverage does not capture the "commercial" value of spectrum, i.e. additional cash flow from the ability to offer additional services or a higher quality service. It is possible to model this value too, and the work mentioned above by Analysys Mason is an example of such modelling, but this requires additional assumptions such as about rate of migration towards new services, willingness to pay, traffic levels, and cannibalisation of existing services.

A6.23 In particular, we note that Analysys Mason's assessment is predicated on the assumption that HSPA+900 is a close substitute to LTE800 from a technical point of view, which is not so clear cut. In addition, the results are inevitably dependent on the specific assumptions and parameters used to model the first-mover advantage. For example, we consider that Analysys Mason has not demonstrated that the use of the relative size of the ecosystem available for each band (in terms of number of devices available and level of existing stock) is a good indicator of the first mover advantage enjoyed by 900 MHz spectrum over the next ten years.⁹¹

Provisional conclusion

A6.24 In our previous consultations we accepted that to the extent 800 MHz and 900 MHz spectrum were not close substitutes, or if the likely relativities were very uncertain, then the auction results for 800 MHz spectrum might be less informative for determining the value of the 900 MHz spectrum. In this case, we said there was likely to be more benefit in undertaking technical modelling.

A6.25 We were therefore not ruling out using network cost modelling to inform ALF, but we considered that if international benchmarking and the bids in the UK Auction involving 800 MHz spectrum could inform the price of 900 MHz spectrum they were likely to give a better indication of full market value than such modelling, due to the considerable margin of error involved in the latter. In this case, undertaking network

⁹¹ For example, if many 3G customers on 12 to 24 month contracts interested in upgrading their handset at the end of the contract, the stock of LTE handsets may grow considerably quickly.

cost modelling might be of limited benefit. We therefore did not envisage relying on technical modelling, but said we would review this position after the Auction if there were reasons for considering it likely to be more reliable than other sources of information.

- A6.26 We recognise that, in the event, there is some uncertainty as to the relative values of 900 MHz and 1800 MHz spectrum compared to the spectrum in the auction, 800 MHz and 2.6 GHz. However, we consider that the range of evidence on this matter from UK and international benchmarks has enabled us to take a balanced view of the market value of spectrum in the 900 MHz and 1800 MHz bands. It is far from clear that generating additional estimates of spectrum value based on network cost modelling would allow us to reach a better-informed view, particularly because of the complexity of the modelling, the sensitivity of any such estimates to assumptions about the underlying parameters, and because the intrinsic value of spectrum may not be fully captured by such modelling, which typically focuses on the scope for reductions in infrastructure costs.
- A6.27 As regards Vodafone's comments about the Analysys Mason model in the context of spectrum pricing for broadcasting, we note that the Direction requires us, in revising ALF for the 900 MHz and 1800 MHz bands, to have particular regard to the sums bid for licences in the Auction. For other spectrum, in principle we would not rule out using evidence such as auction bids/prices in assessing the opportunity cost of spectrum in order to determine AIP. In any case of spectrum pricing we would seek to have regard to all relevant evidence.

Role of technical evidence in informing our view of the ranking of spectrum bands

- A6.28 In light of our view that it is not appropriate to use network cost modelling to generate absolute or relative values of spectrum bands for ALF, we now consider whether network cost modelling, or other technical evidence, can be used to inform our view of the ranking of different spectrum bands in the context of ALF.

Licence-holders' views

Ranking of 900 MHz and 800 MHz

- A6.29 Licence holders have made a number of qualitative arguments in relation to whether 900 MHz spectrum has a higher or lower value than 800 MHz spectrum.
- A6.30 Some factors were suggested for why 800 MHz spectrum may have some technical advantages over 900 MHz and may hence be more valuable. For example:
- 800 MHz spectrum is less fragmented, thus enabling wider carriers;
 - LTE800 has a superior performance to HSPA+900, with LTE900 only becoming available in the distant future;
 - Holders of 900 MHz spectrum would incur clearance cost to transition existing customers to other frequencies.
- A6.31 Other factors were suggested for why 900 MHz may enjoy some commercial advantages over 800 MHz, which may make 900 MHz spectrum more valuable than

800 MHz on the assumption that, from, a technical point of view HSPA+900 is a good substitute for LTE800:

- The available ecosystem for HSPA+900 is currently more developed than for LTE800;
- As noted above, Analysys Mason, on behalf of H3G, argued that HSPA+900 has an established customer base, providing holders of 900 MHz licences with a first mover advantage.
- Licences of 900 MHz spectrum have an option value compared to auctioned licences for 800 MHz spectrum, in that holders of the former could relinquish them at no loss if the value of spectrum decreased materially in the future.

Ranking of 1800 MHz against other bands

A6.32 As regards the value of 1800 MHz relative to 800 MHz, 900 MHz and 2.6 GHz spectrum, Telefonica has noted that 1800 MHz spectrum can support wider carriers than these other bands, which can improve network performance. H3G said that 1800 MHz spectrum would have a time advantage in delivery of LTE compared to the other bands. On the other hand, EE has argued (in its response to our First Competition Assessment) that the coverage characteristics of 1800 MHz spectrum were closer to 2.6 GHz spectrum than 800 MHz spectrum, and that LTE in 1800 MHz would be rolled out after other networks. In summary, there is a divergence of views as to the technical and commercial value of 1800 MHz relative to these other bands.

Assessment and provisional conclusion

A6.33 As shown above, arguments can be made on both sides as to whether 900 MHz has a higher or lower value than 900 MHz spectrum. In addition, future releases of HSPA+900 and LTE800 (including LTE Advanced) may change the balance of relative technical performance between the bands, and the alleged commercial first-mover advantages of 900 MHz are equally difficult to estimate with certainty. It is also very difficult to estimate how important any present or future technical advantage will prove with consumers, and hence the extent to which this could translate into a commercial advantage in the short and long term.

A6.34 In our view the qualitative and quantitative technical modelling submitted is not sufficiently clear-cut or robust to derive a reliable inference about the relative value of 900 MHz and 800 MHz.

A6.35 As set out in Section 4 (paragraphs 4.43 to 4.45), we concluded in our July 2012 Statement that the propagation characteristics of 1800 MHz, and its consequent ability to support UK-wide LTE rollout, were substantially better than 2.6 GHz spectrum. In light of this, and the outcome of the UK 4G Auction, we do not consider it credible that 1800 MHz spectrum has a lower value than 2.6 GHz spectrum in the UK.

Annex 7

European auction evidence

- A7.1 In this annex we summarise the outcomes of 4G Auctions in Europe from 2010 onwards, and provisionally categorise the resulting evidential points as more important or less important evidence for the derivation of ALFs. Figure A7.1 below summarises our provisional conclusions.
- A7.2 In assessing the evidence and provisionally concluding on its relevance in determining ALFs on 900 MHz and 1800 MHz spectrum we have adopted a number of general principles which are as follows:
- Evidential points are:
 - UK prices of 800 MHz and 2.6 GHz spectrum⁹² (not considered in this annex).
 - Absolute values of 900 MHz and 1800 MHz spectrum from international benchmarks.
 - Absolute values of 800 MHz and 2.6 GHz spectrum from international benchmarks.
 - Relative values (within countries – i.e. comparing results from (b) and (c) above) of: 800 MHz to 900 MHz; 800 MHz to 1800 MHz; and 1800 MHz to 2.6 GHz.⁹³
 - Implied values of 1800 MHz spectrum based on combinations (simple average, linear interpolation, inverse exponential) of 800 MHz and 2.6 GHz spectrum values (not considered in this annex).
 - We distinguish between evidence to which we think more weight should be given (“more important evidence”) and evidence to which we think less weight should be given (“less important evidence”): We denote the base case estimates of (a) above as more important evidence. The analysis in the following pages is focused on whether specific benchmarks in categories (b) and (d) above are more important or less important evidence. If we consider that absolute values of 900 MHz and 1800 MHz (b) are less important evidence, we do not go on to evaluate these values relative to other bands (i.e. (d) above). We denote benchmarks (c) above as less important evidence – because we have direct measures of the UK value of these bands, their importance is limited to deriving relative measures in category (d). As regards category (e), we take the simple average as more important evidence, and the other two combinations as less important evidence.
 - Our international benchmarks are generally *realised auction prices*, with the exceptions of:

⁹² References to 2.6 GHz spectrum are to paired spectrum unless otherwise specified.

⁹³ We do not separately consider the ratio of 900 MHz to 1800 MHz spectrum: there was only one country (Greece) in which both of these bands were auctioned and the 800 MHz band was not auctioned, and we do not consider that the results of the auction in Greece stand as key evidence..

- Romania: In this case the auction was CCA so band-specific prices were not generated, but the package prices were very close to the sum of reserve prices of the lots in each package. Because of this we have taken the reserve prices as a proxy for the auction prices.
- Netherlands: as band prices are not known, we considered whether reserve prices might provide some indication of market value, however we considered these reserve prices to be less important evidence. We have also considered estimated prices by a market analyst as less important evidence.
- If spectrum was sold above the reserve price then we consider there was excess demand for this spectrum indicating a degree of competition in the award.
- In cases where all spectrum in a band was sold at, or close to, reserve prices, we have noted the risk that this understates the value of spectrum in the band (as bidders might have been willing to pay above reserve price if there had been stronger competition for the spectrum).
- The value of 1800 MHz spectrum is likely to be greater than that of 2.6 GHz spectrum. This is consistent with our analysis in the July 2012 Statement. We therefore consider that any international benchmark evidence – absolute or relative – which implies a UK value for 1800 MHz spectrum below the observed UK value of 2.6 GHz spectrum should be treated as less important evidence.⁹⁴
- Coverage/access obligations tend to reduce the value of spectrum to bidders as they involve a cost commitment to meet said obligation. In practice the scale of the effect depends on whether the obligations are seen as onerous.
- Where different bands were awarded at different times, this tends to make them less informative as to relative valuations.

A7.3 Note that package prices are displayed in this annex as background information. Elsewhere in this consultation we have used UK-equivalent prices which account for differences in currency, purchasing power, country population, and licence duration.

⁹⁴ On balance, we also consider that the value of 900 MHz spectrum in the UK is unlikely to be greater than that of 800 MHz spectrum. However, this is informed in part by the general pattern of international benchmarks. For reasons discussed below, we do not consider that the single exception to this – Romania – is sufficient to overturn this view.

Figure A7.1 Provisional conclusions on international benchmarks

		800 MHz	900 MHz	1800 MHz	2.6 GHz	900 MHz / 800 MHz	1800 MHz / 800 MHz	1800 MHz / 2.6 GHz
Austria	Oct-10				<i>Less important evidence</i>			
Belgium	Nov-11				<i>Less important evidence</i>			
Denmark	May-10				<i>Less important evidence</i>			
Denmark	Sep-10		Three largest bidders excluded; Very low price; <i>Less important evidence</i>	Three largest operators excluded; Implied UK price below 2.6 GHz; <i>Less important evidence</i>				
Denmark	Jun-12	<i>Less important evidence</i>						
France	Dec-11	<i>Less important evidence</i>						
France	Sep-11				<i>Less important evidence</i>			
Germany	May-10	<i>Less important evidence</i>		Lack of competition; Implied UK price below 2.6 GHz; <i>Less important evidence</i>	<i>Less important evidence</i>			
Greece	Nov-11		All sold at reserve price; RP based on Comreg (market value); More important evidence (risk of understating)	All sold at reserve price; [RP based on Comreg (market value)] More important evidence (risk of understating)				
Ireland	Nov-12	<i>Less important evidence</i>	More important evidence	More important evidence		More important evidence	More important evidence	
Italy	Sep-11	<i>Less important evidence</i>		More important evidence	<i>Less important evidence</i>		More important evidence	More important evidence
Netherlands	Apr-10				<i>Less important evidence</i>			

		800 MHz	900 MHz	1800 MHz	2.6 GHz	900 MHz / 800 MHz	1800 MHz / 800 MHz
Netherlands	Dec-12	Not known; Reserve prices are <i>less important evidence</i>	Not known; Reserve prices and analyst's estimates are <i>less important evidence</i>	Not known; Reserve prices and analyst's estimates are <i>less important evidence</i>	Not known; Reserve prices are <i>less important evidence</i>		
Norway	2011		Lowest winning bid was trivial; <i>Less important evidence</i>				
Portugal	Nov-11	<i>Less important evidence</i>	Some spectrum unsold, may be due to country-/auction-specific factors; <i>Less important evidence</i>	Some spectrum unsold due to caps; Implies price below 2.6 GHz in UK; <i>Less important evidence</i>	<i>Less important evidence</i>		
Romania	Sep-12	<i>Less important evidence</i>	At or close to reserve price; RP reflected market evidence; More important evidence (risk of understating)	At or close to reserve price; [RP reflected market evidence;] More important evidence (risk of understating)	<i>Less important evidence</i>	Some 800 MHz unsold; More important evidence (risk of understating)	Some 800 MHz unsold; More important evidence (risk of understating)
Spain	May-11		Beauty contest; Two largest could not bid; <i>Less important evidence</i>	Beauty contest; Three largest could not bid; <i>Less important evidence</i>			
Spain	Jul 11 / Nov-11	<i>Less important evidence</i>	2x5 MHz sold at reserve in Jul-11; unsold 2x5 MHz from Jul-11 was re-auctioned in Nov-11 with relaxed spectrum caps; More important evidence (risk of understating)		Some spectrum unsold; <i>Less important evidence</i>	More important evidence	
Sweden	Mar-11	<i>Less important evidence</i>		More important evidence			More important evidence
Switzerland	Feb-12	Not known	Not known	Not known	Not known		

Austria

October 2010 2.6 GHz award

Description: CCA auction format⁹⁵ including 2x70 MHz of paired 2.6 GHz and 50 MHz of unpaired 2.6 GHz spectrum.

Context: Prior to this auction, Austria had four MNOs: Telekom Austria, T-Mobile, Orange and 3G Austria.⁹⁶

	2.6 GHz	Unpaired 2.6 GHz	Price Paid ⁹⁷
Total Available	2x70	50	-
Telekom Austria	2x20	25	€13.2m
T-Mobile	2x20	-	€11.2m
Orange	2x10	-	€4m
Hi3G	2x20	25	€11m
Unsold	-	-	-

	Description	Implications
Number of bidders > number of lots?	4 bidders. Spectrum was available in lots of 2x5 MHz paired and 5 MHz unpaired. ⁹⁸	Given the spectrum was available in relatively small lots (2x5 MHz paired, 5 MHz unpaired) it was possible for all bidders to win at least one licence in the auction.
Spectrum caps / Restrictions	Cap of 2x30 MHz on wholesalers who already held spectrum in the 900 MHz or 1800 MHz bands (Telekom Austria, T-Mobile and Orange)	This cap was not binding for any of the wholesalers it applied to. Hence they did not constrain competition to any extent, or prevent the auction from producing bid amounts at full market value.
Unsold spectrum?	No	N/A
Reserve prices	All spectrum was sold above reserve prices	
Obligations	Obligation on all winners of spectrum to provide at least 25% population coverage by December 31 2013. In the areas covered, a bearer service must be offered with a data transmission rate of at least 1 MBit/s on the downlink and at least 256 kBit/s on the uplink. ⁹⁹	

Provisional conclusion

As this auction only included 2.6 GHz spectrum, we provisionally conclude that it provides **less important evidence** when deriving ALFs for 900 MHz and 1800 MHz licences in the UK.

⁹⁵ See: <http://www.dotecon.com/assets/images/dp1001.pdf>

⁹⁶ In January 2013 a merger was completed between 3G Austria and Orange, leaving only three national wholesalers in the Austrian market.

⁹⁷ See: https://www.rtr.at/en/tk/FRQ_2600MHz_2010_AE

⁹⁸ See page 30: <http://www.dotecon.com/assets/images/dp1001.pdf>

⁹⁹ See: https://www.rtr.at/en/tk/FRQ_2600MHz_2010_AU/F4_08_TenderDocumentation_2_6_GHz.pdf

Belgium

November 2011 2.6 GHz award

Description: Auction for 2x70 MHz of paired 2.6 GHz and 45 MHz of unpaired 2.6 GHz spectrum.

Context: Prior to this auction there were three MNOs (Belgacom, Mobistar and KPN Group (Base), with a fourth operator granted a 3G licence in June 2011 (Telenet Tecteo Bidco).¹⁰⁰

	2.6 GHz	Unpaired 2.6 GHz	Price Paid ¹⁰¹
Total Available	2x70	45	-
Belgacom	2x20		€20.2m
Mobistar	2x20		€20m
BASE	2x15		€15m
BUCD BUVA	-	45	€22.5m
Unsold	2x15	-	-

	Description	Implications
Number of bidders > number of lots?	5 bidders participated in the auction, ¹⁰² including Craig Wireless, who did not win any spectrum. Telenet Tecteo did not participate. Lot size was dependent on the number of bidders. With 4 or more bidders there were 4 lots of 2x15 MHz and 2 lots of 2x5 MHz. ¹⁰³	There were 5 bidders participating in the auction with 6 lots of spectrum available.
Spectrum caps / Restrictions	2x20 MHz applicable to all bidders.	These caps and the lot sizes may have contributed to the unsold spectrum.
Unsold spectrum?	2x15 MHz	See above.
Reserve prices	Spectrum was sold at reserve prices.	
Obligations	None.	

Provisional conclusion

As this auction only included 2.6 GHz spectrum, we provisionally conclude that it provides **less important evidence** when deriving ALFs for 900 MHz and 1800 MHz licences in the UK.

¹⁰⁰ Telenet Tecteo Bidco has to date failed to make use of this spectrum and faces revocation if it does not launch services over it. See:

<http://www.telegeography.com/products/commsupdate/articles/2013/04/26/tecteo-telenet-bidco-facing-licence-revocation-for-failure-to-use-spectrum/>

¹⁰¹ <http://www.dotecon.com/news/belgian-4g-auction-finished-after-four-rounds-of-bidding/>

¹⁰² <http://www.dotecon.com/news/belgian-4g-auction-finished-after-four-rounds-of-bidding/>

¹⁰³ See page 15: <http://www.dotecon.com/assets/images/dp1001.pdf>

Denmark

May 2010 2.6 GHz award

Description: Award of the 2.6 GHz spectrum using a CCA auction format.¹⁰⁴

Context: Denmark has four MNOs; TDC Telenor, Telia and Hi3G.

	2.6 GHz	Unpaired 2.6 GHz	Price Paid
Total Available	2x70	50	-
TDC	2x20	-	€44.8m
Telenor	2x20	10	€44.8m
Telia	2x20	15	€45.2m
Hi3G	2x10	25	€953k
Unsold	-	-	-

	Description	Implications
Number of bidders > number of lots?	4 bidders. FDD spectrum sold in 2x5 MHz lots, TDD spectrum sold in 5 MHz lots. ¹⁰⁵	Spectrum was available in relatively small lots (2x5 MHz paired, 5 MHz unpaired) it was possible for all bidders to win at least one licence in the auction.
Spectrum caps / Restrictions	2x20 MHz applicable to all bidders.	This was binding for the 3 largest incumbents, allowing Hi3G to secure the remaining 2x10 MHz below market value.
Unsold spectrum?	No	N/A
Reserve prices	Most spectrum was sold above reserve price.	
Obligations	No coverage obligations. ¹⁰⁶	

¹⁰⁴ See page 14: <http://www.dotecon.com/assets/images/dp1001.pdf>

¹⁰⁵ See: <http://www.dotecon.com/assets/images/dp1001.pdf>

¹⁰⁶ See: <http://m.policytracker.com/headlines/danish-2.6-ghz-auction-raises-50-times-more-than-dutch-auction>

September 2010 900 MHz and 1800 MHz award

Description: 900 MHz and 1800 MHz spectrum was refarmed and offered for sale in an auction where the three largest incumbents were not allowed to participate. This was intended to improve competition in the market by encouraging new entry.¹⁰⁷

	900 MHz	1800 MHz	Price Paid 900 MHz	Price Paid 1800 MHz
Total Available	2x5	2x10	-	-
TDC	-	-	-	-
Telenor	-	-	-	-
Telia	-	-	-	-
Hi3G	2x5	2x10	DKK 4m	DKK 8m
Unsold	-	-	-	-

	Description	Implications
Number of bidders > number of lots?	1 bidder entered the auction, 1 lot available in each band.	No excess demand.
Spectrum caps / Restrictions	No caps.	N/A
Unsold spectrum?	No	N/A
Reserve prices	Licences were sold at the reserve price.	
Obligations	No coverage obligations.	

¹⁰⁷ See: <http://dba.erhvervsstyrelsen.dk/900-1800-mhz-auction>

June 2012 800 MHz award

Description: Award of the 800 MHz spectrum using a CCA auction format.¹⁰⁸

	800 MHz	Price Paid ¹⁰⁹
Total Available	2x30	-
TDC	2x20	DKK627.8m
Telenor	2x10	DKK111.5m
Telia		
Hi3G	-	-
Unsold	-	-

Note: 2x10 MHz was won by TT-Netvaerket which is a joint venture between Telenor and Teliasonera.

	Description	Implications
Number of bidders > number of lots?	3 bidders (TDC, TT (JV), Hi3G). ¹¹⁰ The spectrum was packaged in 1 2x10 MHz lot (subject to usage restrictions to protect DTT users) and 4 2x5 MHz lots. ¹¹¹	There were only 3 bidders participating in the auction, with 5 lots available. Telenor and Telia participated in the auction as a joint venture (TT).
Spectrum caps / Restrictions	2x20 MHz applicable to all bidders.	Binding for TDC.
Unsold spectrum?	No	N/A
Reserve prices	Overall the 800 MHz spectrum was sold above reserve prices.	
Obligations	Obligation to ensure average download access speed of at least 10 Mbit/s outdoors across 207 post code areas. Winners were not explicitly required to use the 800 MHz spectrum to meet this. ¹¹² Innovative component allowed bidders to bid for regional exemptions from the coverage obligation imposed on the 800MHz licences. ¹¹³ Strict coexistence restrictions on 800 MHz band.	
Other	Sub 1 GHz spectrum not considered essential in Denmark due to population density and topography.	Tends to reduce the value of sub 1 GHz spectrum.

Provisional conclusion

1800 MHz spectrum sold at a price which would, in UK terms, be well below the price of 2.6 GHz spectrum. 900 MHz spectrum also sold at a very low price. Neither of these outcomes is surprising given that the three largest operators were not allowed to bid. We provisionally conclude that the Denmark auctions provide **less important evidence** when deriving ALFs for 900 MHz and 1800 MHz licences in the UK.

¹⁰⁸ See: <http://www.dotecon.com/news/danish-800mhz-auction-completed/>

¹⁰⁹ See: <http://dba.erhvervsstyrelsen.dk/800-mhz-auction>

¹¹⁰ See: <http://dba.erhvervsstyrelsen.dk/800-mhz-auction>

¹¹¹ See page 2: <http://erhvervsstyrelsen.dk/file/251159/information-memorandum-800mhz-auction.pdf>

¹¹² See pages 10-11: <http://erhvervsstyrelsen.dk/file/251159/information-memorandum-800mhz-auction.pdf>

¹¹³ See: <http://www.dotecon.com/news/danish-800mhz-auction-completed/>

France

December 2011 800 MHz and September 2011 2.6 GHz awards

Description: The awards were undertaken separately. The 2.6 GHz award was in the form of a beauty contest, with the 800 MHz licences awarded subsequently through a hybrid tender which included commitments to host MVNOs as well as a financial bid.

Context: There are four MNOs in France: Orange (France Telecom), SFR, Bouygues and Iliad (Free Mobile).

	800 MHz	2.6 GHz	Price Paid (800 MHz) ¹¹⁴	Price Paid (2.6 GHz) ¹¹⁵
Total Available	2x30	2x70	-	-
Orange	2x10	2x20	€891m	€287m
SFR	2x10	2x15	€1bn	€150m
Bouygues	2x10	2x15	€683m	€228m
Iliad	-	2x20	-	€271m
Unsold	-	-	-	-

	Description	Implications
Number of bidders > number of lots?	4 submissions for licences in the 2.6 GHz award ¹¹⁶ and 4 participants in the auction for 800 MHz licences. ¹¹⁷ 800 MHz spectrum was awarded as 2 lots of 2x10 MHz and 2 lots of 2x5 MHz.	Licences for the 2.6 GHz spectrum seemed to be uncontested, with those submissions for licences by the four operators being accepted by ARCEP. The 800 MHz award was contested by 4 bidders, with relatively high prices paid for the spectrum awarded.
Spectrum caps / Restrictions	2x15 MHz on 800 MHz spectrum and 2x30 MHz on 2.6 GHz spectrum.	Neither of the caps were binding for any of the national wholesalers.
Unsold spectrum?	No	N/A
Reserve prices	800 MHz spectrum sold above reserve prices.	
Obligations	The winner of the two middle blocks of the 800 MHz band is obliged to allow wholesale access to any winner of 2.6 GHz which failed to win 800 MHz.	SFR was the winner of the two middle blocks. However the price indicates these blocks may be more valuable than adjacent blocks, even with the obligation.

¹¹⁴ See:

[http://www.arcep.fr/index.php?id=8571&tx_gsactualite_pi1\[uid\]=1470&tx_gsactualite_pi1\[backID\]=1&cHash=80abfa005c](http://www.arcep.fr/index.php?id=8571&tx_gsactualite_pi1[uid]=1470&tx_gsactualite_pi1[backID]=1&cHash=80abfa005c)

¹¹⁵ See:

http://www.arcep.fr/index.php?id=8571&tx_gsactualite_pi1%5Buid%5D=1431&tx_gsactualite_pi1%5BbackID%5D=1&cHash=136860fe4e&L=1

¹¹⁶ See: http://www.arcep.fr/uploads/tx_gsavis/11-1080.pdf

¹¹⁷ See:

http://www.arcep.fr/index.php?id=8571&tx_gsactualite_pi1%5Buid%5D=1463&tx_gsactualite_pi1%5BbackID%5D=1&cHash=377b4c6bf9&L=1

Provisional conclusion

As these awards only included 800 MHz and 2.6 GHz spectrum, we provisionally conclude that they provide **less important evidence** when deriving ALFs for 900 MHz and 1800 MHz licences in the UK.

Germany

May 2010 multiband auction

Description: Germany's large multiband auction awarded a large proportion of the spectrum for mobile use.

Context: Germany has four MNOs: T-Mobile (Deutsche Telekom), Vodafone, Telefonica and E-Plus. In contrast to other European countries, the fourth largest operator has similar spectrum holdings to the other incumbents. Telefonica has a slightly smaller subscriber share than E-Plus, but E-Plus only has access to a small amount of sub 1 GHz spectrum.

	800 MHz	1800 MHz	2.1 GHz	2.1 GHz unpaired	2.6 GHz	2.6 GHz unpaired	Price Paid
Total Available	2x30	2x25	2x20	19.2	2x70	50	-
T-Mobile	2x10	2x15	-	-	2x20	5	€1.3bn
Vodafone	2x10	-	2x5	-	2x20	25	€1.4bn
Telefonica	2x10	-	2x5	19.2	2x20	10	€1.4bn
E-Plus	-	2x10	2x10	-	2x10	10	€284m
Unsold	-	-	-	-	-	-	-

	Description	Implications
Number of bidders > number of lots?	<p>There were 4 incumbent operators in the market prior to the multiband auction, and in contrast to much of the rest of Europe, in Germany the 4th operator (E-Plus) has similar pre-auction spectrum holdings to the other 3 operators.</p> <p>All lots in the auction were sold in 2x5 MHz with the exception of the unpaired 2.1 GHz which was sold as a single 1x5 MHz lot and a single 1x14.2 MHz lot.</p>	Spectrum was available across a number of bands in this auction, and because it was largely packaged in 2x5 MHz lots there was potential for all operators to win something from each band with the exception of the unpaired 2.1 GHz.
Spectrum caps / Restrictions	<p>Asymmetric spectrum caps: T-Mobile and Vodafone were subject to a cap of 2x10 MHz of 800 MHz, E-Plus and Telefonica were subject to a cap of 2x15 MHz of 800 MHz and any new entrants were limited to 2x20 MHz of 800 MHz.</p> <p>There were no caps on spectrum above 1 GHz.</p>	Both T-Mobile and Vodafone reached the cap imposed on them with respect to 800 MHz spectrum. There is a possibility that they would have bid for more absent the spectrum caps. If so, the presence of the caps is likely to have reduced the overall winning bids. Telefonica did not win the maximum allowed under its cap.
Unsold spectrum?	No	N/A
Reserve prices	Spectrum sold above reserve prices	

Obligations	Obligation on winners of licences in the 800 MHz band to roll-out mobile broadband to low density areas first.

Provisional conclusion

1800 MHz spectrum was sold above reserve price, and there was no unsold spectrum. However the existing frequency holdings in the 1800 MHz band split the available blocks in such a manner that there were obvious contenders for the available spectrum among the incumbent operators who were the only participants in the auction.

Moreover, the price of 1800 MHz spectrum implies a UK value below that of 2.6 GHz spectrum.

We provisionally conclude that Germany provides **less important evidence** when deriving ALFs for 1800 MHz licences in the UK.

Greece

November 2011 multiband auction

Description: Greece's National Telecommunications & Post Commission (EETT) auctioned mobile operating frequencies in the 900MHz and 1800MHz bands.

Context: There are three MNOs in the Greek mobile market; Cosmote, Vodafone and Wind Hellas. EETT used a mixed system of granting of rights, organized in two stages: In the first stage, a minimum spectrum is reserved for the existing network providers in order to secure continuity and future enhancement of their broadband services. In the second stage, the remainder of the spectrum is administered through a multiple rounds auction process with increasing price.¹¹⁸

	900 MHz	1800 MHz	Price Paid ¹¹⁹
Total Available	2x35	2x20	-
Cosmote	2x10	2x10	€118.8m
Vodafone	2x15	2x10	€168.5m
Wind Hellas	2x10	-	€93.2m
Unsold		-	-

A portion of 900MHz spectrum was pre-assigned to each operator and cost them a total EUR181.7 million – this is included in the allocations of 900 MHz spectrum above, but not in the total price paid.

	Description	Implications
Number of bidders > number of lots?	3 bidders and 3 winners. ¹²⁰ 900 MHz spectrum was sold in 14 blocks of 2x2.5 MHz 1800 MHz spectrum was sold in 4 blocks of 2x5 MHz.	The number of lots exceeded the number of bidders, although lot sizes were small. All spectrum sold at reserve prices indicating that there was not strong excess demand.
Spectrum caps / Restrictions	The spectrum cap on 900 MHz spectrum was dependent on the number of bidders; 2 × 12.5 MHz if there were four bidders, otherwise a 2 × 15 MHz cap. The 1800 MHz spectrum cap was 2 × 35 MHz. A spectrum floor of 2 × 5 MHz in the 900 MHz band would have been applied if	The 900 MHz cap was binding for Vodafone but not on the other two bidders.

¹¹⁸ See: http://www.eett.gr/opencms/opencms/admin_EN/News/news_0126.html

¹¹⁹ See: <http://www.telegeography.com/products/commsupdate/articles/2011/11/15/three-cellcos-pay-eur380-5m-for-900mhz-1800mhz-frequencies/>

¹²⁰ <http://www.telegeography.com/products/commsupdate/articles/2011/10/24/no-outside-interest-in-greek-900mhz1800mhz-auction/>

	there were four or more bidders. ¹²¹	
Unsold spectrum?	No	N/A
Reserve prices	Spectrum was sold at reserve prices. Reserve prices were effectively set based on benchmarking for the Irish regulator, and then adjusted for the Greek population. ¹²²	

Provisional conclusion

Both 900 MHz and 1800 MHz spectrum in this auction was sold at, but did not exceed, reserve prices.

We provisionally conclude that the absolute value of 900 MHz spectrum, and the absolute value of 1800 MHz spectrum in Greece provides **more important evidence** in deriving ALFs for 900 MHz and 1800 MHz licences in the UK. However, because auction prices did not exceed reserve prices, we consider there is risk of these results **understating** the value of 900 MHz and 1800 MHz spectrum in Greece.

¹²¹ See page 351: http://www.comreg.ie/_fileupload/publications/ComReg1225a.pdf

¹²² See page 5: http://www.eett.gr/opencms/export/sites/default/admin/downloads/Consultations/RadioCommunications/dikaionmata_xrasis_radiosyxnotiton/900-1800MHz_Consultation_ENG.pdf

Ireland

November 2012 multiband auction

Description: The Multi-Band Spectrum Award Process concluded on the 5th of December 2012. The Multi-Band Spectrum Award Process offered spectrum rights of use across three spectrum bands, namely the 800 MHz, the 900 MHz and the 1800 MHz bands, for the period 2013 to 2030.¹²³

Context: The auction was of the form of a combinatorial clock auction (CCA) and, to accommodate the current expiry dates of GSM licence assignments, spectrum rights of use were auctioned across two time periods, applicable to each of the three bands being auctioned. The results presented below, and corresponding prices, cover the second time period only (beyond 2015).¹²⁴ Ireland currently has 4 MNOs; Meteor Mobile, Vodafone, Telefonica and H3G.

	800 MHz	900 MHz	1800 MHz	Price Paid ¹²⁵
Total Available	2x30	2x35	2x75	-
Meteor Mobile	2x10	2x10	2x15	€145m
Vodafone	2x10	2x10	2x25	€125m
Telefonica	2x10	2x10	2x15	€161m
H3G	-	2x5	2x20	€51m
Unsold	-		-	-

	Description	Implications
Number of bidders > number of lots?	4 bidders All spectrum was available in the auction in lots of 2x5 MHz. ¹²⁶	The overall number of lots exceeded the number of potential bidders.
Spectrum caps / Restrictions	2x20 MHz of sub 1 GHz spectrum. 2x50 MHz of total spectrum across the three bands. ¹²⁷	The sub 1 GHz cap was binding for 3 of the 4 national wholesalers. The overall spectrum cap was not binding for any national wholesaler.
Unsold spectrum?	No	N/A
Reserve prices	All spectrum was sold above reserve prices. ComReg determined the reserve prices using an independent benchmarking study which estimated reserve prices on what it considered to be a lower bound of full market value for the spectrum.	
Obligations	All licence holders must attain and maintain a minimum coverage of 70%	70% population coverage is not particularly onerous over 3 years.

¹²³ Spectrum in the Irish Auction was awarded on two different time periods: "Time Slice 1" between 2013 and 2015, and "Time Slice 2" between 2015 and 2030.

¹²⁴ <http://www.dotecon.com/news/irelands-telecoms-regulator-publishes-its-decision-on-multi-band-spectrum-auction/>

¹²⁵ <http://www.comreg.ie/fileupload/publications/PR15112012.pdf>

¹²⁶ See page 10: <http://www.comreg.ie/fileupload/publications/ComReg12123.pdf>

¹²⁷ See page 10: <http://www.comreg.ie/fileupload/publications/ComReg12123.pdf>

	<p>of the population and to attain this coverage obligation within 3 years.</p> <p>Licence holders may use spectrum rights in multiple bands to achieve the coverage targets, but at least 50% of the coverage requirement (i.e. 35% of the population) must be met using spectrum rights in the 800 MHz, 900 MHz and/or 1800 MHz bands.</p>	
--	--	--

Ofcom's estimate of spectrum values by frequency band

Because of the combinatorial nature of the Multi-Band Spectrum Award and the confidentiality of bidding information, we cannot directly observe prices by band for this auction. However, we have derived estimates of band prices, based on publicly available information and evidence from Vodafone which we have discussed with ComReg.

In order to derive an estimate of the absolute and relative values of different frequency bands in the Irish auction we have used the following pieces of information:

- The total amounts paid in the auction for each winning package, as published by Comreg.¹²⁸ We used figures for upfront fees paid for the licences, which cover both time periods on auction, as well as payments for early liberalisation of the spectrum.¹²⁹
- An estimate of relative prices of different spectrum bands, based on the ratios of clock prices in the rounds in which supply matched demand for each band which we have taken as 45% and 35% for 900MHz and 1800MHz respectively, relative to 800MHz spectrum.¹³⁰
- The annual Spectrum Usage Fee (SUF) attaching to the frequency bands that were auctioned, as published by Comreg are:
 - Euros 1.08m per 2x5 MHz lot for both 800 MHz and 900 MHz; and
 - Euros 0.54m per 2x5MHz lot for 1800 MHz spectrum.

¹²⁸ See Comreg 12/123, page 5: <http://www.comreg.ie/fileupload/publications/ComReg12123.pdf>

¹²⁹ Bidding in Time Slice 1 reflect short term considerations about keeping hold of spectrum already in the hands of bidders, while bidding in Time Slice 2 was likely to reflect longer-term considerations.

¹³⁰ Vodafone submitted a confidential note to us (having obtained permission from Comreg to do so) which included a bar chart showing its best estimate of the price ratios for 800MHz, 900MHz and 1800MHz spectrum, based on the prices in the clock rounds of the auction in which supply matched demand for each frequency band. Comreg have not been able to provide the actual data on the auction clock prices to us for reasons of confidentiality: however, Comreg has confirmed to us that the estimated prices ratios of 45% and 35% (that we put to Comreg, based on the Vodafone bar chart) were reasonable indications of the ratios of, respectively, the final clock price for 900MHz relative to 800MHz spectrum and of the final clock price of 1800Mhz relative to 800MHz spectrum ("within a couple of percentage points").

In order to derive an estimate of the total PV of each spectrum band in the Irish auction we have gone through two steps:

- First, we used the relative values described above and the publicly available information on the up-front auction payments in order to derive the absolute value of each band, before taking account of SUF.
- Second, we added the present value of SUF to derive the total value (that is, upfront fees and present value of SUF) of each band auctioned in Ireland.

Finally we have derived the ratios of value between bands (based on total value).

To estimate the upfront sums by band, we used the estimated price ratios for 800MHz, 900MHz and 1800MHz spectrum, based on the prices in the final clock rounds (and subject to the qualifying comments above) to apportion the total €482m paid in the auction across the 3 frequency bands. In particular, if the value of 2x5MHz of 800MHz spectrum is “v”, then we have solved the equation $6 \times v + 7 \times 0.45v + 15 \times 0.35v = €482m$

The estimated upfront prices include payments for both time slices and bidder-specific liberalisation payments whereas the relativities of final clock prices only refer to time slice 2. Although Comreg has told us that the relativities were different across the two time slices, we believe that the use of the relative prices from time slice 2 is a pragmatic and reasonable approach given that time slice 2 represents a large proportion of the total licensed period (15 years out of the total of 17 years) and given the limited information available to us.

In order to derive an estimate of the total present value of the spectrum we have to add in the present value of the SUFs for 17 years. We have estimated the present value of these SUF as an annuity due over the 17 years of the overall licence period (time slices 1 and 2) at a discount rate of 4.1%.¹³¹ The table below summarises the resulting total present values expressed as UK equivalent figures, that is adjusted for differences in the length of the licence term, population and purchasing power:

Total value by band (£m per MHz)	800 MHz	900 MHz	1800 MHz
Upfront fees	41.7	18.8	14.6
PV of SUF	16.9	16.9	8.5
Total value	58.6	35.7	23.1
<i>Ratio to 800 MHz (total value)</i>	<i>100%</i>	<i>61%</i>	<i>39%</i>

Provisional conclusion

There was no unsold spectrum in this auction, and all the spectrum available was sold above reserve prices.

¹³¹ The discount rate 4.1% is the real post-tax WACC from the MCT 2011 Statement. It informs our derivation of lump-sum values in relation to other international benchmarks, for example when an adjustment for different licence-length is required or annual licence fees may be paid. We recognise that we are using a slightly different rate in the annualisation of these lump-sum values, but we expect the difference in results to be small.

The sub 1 GHz cap was binding for three of the four operators, which may have constrained bidding on the 800 MHz and 900 MHz lots to some extent.

We provisionally conclude that our estimated absolute values of 900 MHz and 1800 MHz in the Irish auction are **more important evidence**, and the implied relative values of 900 MHz to 800 MHz and 1800 MHz to 800 MHz are also **more important evidence**, in deriving ALFs for 900 MHz and 1800 MHz licences in the UK.

Italy

September 2011 multiband auction

Description: Italy's multiband auction awarded licences in the 800 MHz, 1800 MHz, 2.1 GHz and 2.6 GHz bands.

Context: Italy has four MNOs: Telecom Italia, Vodafone, Wind and 3 Italia.

	800 MHz	1800 MHz	2.1 GHz unpaired	2.6 GHz	2.6 GHz unpaired	Price Paid ¹³²
Total Available	2x30	2x15	15	2x60	30	-
Telecom Italia	2x10	-	-	2x15	-	€1.3bn
Vodafone	2x10	2x5	-	2x15	-	€1.3bn
Wind	2x10	2x5	-	2x20	-	€1.1bn
3 Italia	-	2x5	-	2x10	30	€305m
Unsold	-	-	15	-	-	-

Note: Prices for lots in individual bands are available here: <http://frankrayal.com/2011/10/17/the-italian-4g-spectrum-auction-an-analysis/>

	Description	Implications
Number of bidders > number of lots?	4 bidders. All spectrum was made available in lots of 2x5 MHz. ¹³³	The overall number of lots exceeded the number of potential bidders, but lot sizes were relatively small.
Spectrum caps / Restrictions	2x20 MHz on sub 1 GHz frequencies, and 55 MHz on joint paired and unpaired 2.6 GHz spectrum. Applicable to all bidders.	Neither of the caps was binding for any of the bidders, i.e. no bidder was restricted from bidding on additional spectrum over what it eventually won.
Unsold spectrum?	15 MHz of unpaired 2.1 GHz.	This was not as a result of the spectrum caps, therefore it is likely there was insufficient demand to meet the reserve price for this spectrum.
Reserve prices	Spectrum was sold above reserve prices.	
Obligations	800 MHz: 30% coverage in 36 months, 70% in 60 months. 2.6 GHz: 20% in 24 months, 40% in 48 months. Coverage refers to land covers of a list of municipalities. ¹³⁴	The Italian obligations do not seem particularly onerous. However they do refer to land coverage rather than population coverage, which tends to make them more costly.

¹³² See: <http://frankrayal.com/2011/10/17/the-italian-4g-spectrum-auction-an-analysis/>

¹³³ See: <http://www.sviluppoeconomico.gov.it/images/stories/documenti/Disciplinarevesrionedefinitiva.pdf>

¹³⁴ See page 69:

<http://www.agcom.it/Default.aspx?message=visualizzadocument&DocID=6447>

Provisional conclusion

There was no unsold spectrum in the bands we are particularly interested in, and all the spectrum in these bands was sold above reserve prices. None of the spectrum caps in the auction were binding.

We provisionally conclude that the the absolute value of 1800 MHz spectrum, and the value of 1800 MHz relative to 800 MHz spectrum and to 2.6 GHz spectrum respectively are **more important evidence** in deriving ALFs for 1800 MHz licences in the UK.

The Netherlands

April 2010 2.6 GHz award

Description: Award of the 2.6 GHz spectrum using CCA auction format.

Context: Prior to the award of 2.6 GHz spectrum there were three MNOs; KPN, Vodafone and T-Mobile. The Dutch Parliament decided that the auction should limit the amount of spectrum that the three existing mobile operators could win, in order to ensure that new entrants could participate in the auction.

	2.6 GHz	Unpaired 2.6 GHz	Price Paid ¹³⁵
Total Available	2x65	55	-
KPN	2x10	-	€909k
Vodafone	2x10	-	€200k
T-Mobile	2x5	-	€109k
Tele2	2x20	-	€400k
Ziggo	2x20	-	€1m
Unsold	-	55	-

	Description	Implications
Number of bidders > number of lots?	5 bidders. Spectrum was available in 2x5 MHz lots. KPN, Vodafone and T-Mobile were limited to winning 2x25MHz of paired spectrum in total. This left 2x40MHz of paired spectrum plus 60MHz of unpaired spectrum – sufficient for at least three new entrants. In the end, only two new entrants (Ziggo/UPC and Tele2) participated in the auction, each demanding 2x20MHz of paired spectrum.	There were 13 lots of spectrum available, although there may be little demand for block sizes smaller than 2x10 MHz, and if so there were effectively 6 2x10 MHz lots. This is still in excess of the number of bidders. The result of these caps and only 2 new entrants was twofold: no interest in the unpaired spectrum, and demand equalling supply for the paired spectrum, meaning that it was sold just above the reserve price
Spectrum caps / Restrictions	KPN – 2x10 MHz, T-Mobile – 2x5 MHz, Vodafone – 2x10 MHz.	See above.
Unsold spectrum?	55 MHz unpaired.	
Reserve prices	Spectrum sold above reserve prices	
ObligationsCoverage obligations	Network coverage of 80 square kilometres by May 2012.	This is a fairly small area to cover, and was met by all operators. It is unlikely to have reduced bids to a significant extent.

¹³⁵ <http://www.analysysmason.com/About-Us/News/Newsletter/Dutch-26GHz-auction-raises-just-EUR26m/>

December 2012 multiband auction¹³⁶

Description: Award of various bands using CCA auction format.

Context: Following the 2010 2.6 GHz award the Dutch mobile market had 5 operators. One of the entrants, Tele2, won 2x10MHz of 800MHz spectrum reserved for a newcomer at a price of €161m. The other entrant in 2010, Ziggo, entered the auction as part of a joint venture with UPC, but did not win any spectrum.

	800 MHz	900 MHz	1800 MHz	Unpaired 1900 MHz	2.1 GHz	Unpaired 2.6 GHz	Price Paid ¹³⁷
Total Available	2x30	2x35	2x70	4.9+9.7	2x10	55	-
KPN	2x10	2x10	2x20	-	2x5	30	€1.35bn
Vodafone	2x10	2x10	2x20	-	2x5	-	€1.38bn
T-Mobile	-	2x15	2x30	4.9+9.7	-	25	€911m
Tele2	2x10	-	-	-	-	-	€161m
Ziggo	-	-	-	-	-	-	-
Unsold	-	-	-	-	-	-	-

	Description	Implications
Number of bidders > number of lots?	5 bidders. All paired spectrum was available in 2x5 MHz lots. ¹³⁸	There was a large amount of spectrum available in this auction across a number of different bands.
Spectrum caps / Restrictions	2x10 MHz of 800 MHz and 2x5 MHz of 900 MHz were reserved for new entrants (including those who were new entrants in the 2.6 GHz award). This reduced the amount available for incumbent operators. No spectrum caps. ¹³⁹	Despite the absence of spectrum caps, the reservation in place for new entrants (exercised only by Tele2) restricted the 800 MHz spectrum available, meaning only 2 of the incumbent operators were able to win 2x10 MHz of 800 MHz.
Unsold spectrum?	No	N/A
Reserve prices	Spectrum sold above reserve prices.	
Obligations	800 MHz: coverage of 308 square km after two years, increasing to 3080 square km after five years. 900 MHz: coverage of 256.7 square km within two years increasing to 2567 square kilometres after five years.	The land area of the Netherlands is over 41,000 square kilometres, so the coverage obligations tied to these spectrum licences do not seem to be particularly onerous.

¹³⁶ Results source: <http://www.telecompaper.com/news/dutch-multiband-spectrum-auction-ends-with-four-winners--914279>

¹³⁷ <http://www.accessmylibrary.com/article-1G1-312372403/netherlands-dutch-multiband-spectrum.html>

¹³⁸ See slide 8: [http://tst.acgea.com/86/text/169/files/Dutch%20Multi-Band%20Spectrum%20Auction%20040612%20AGA%20\[Compatibility%20Mode\].pdf](http://tst.acgea.com/86/text/169/files/Dutch%20Multi-Band%20Spectrum%20Auction%20040612%20AGA%20[Compatibility%20Mode].pdf)

¹³⁹ See: <http://www.telegeography.com/products/commsupdate/articles/2010/12/10/netherlands-to-auction-spectrum-in-late-2011early-2012-paper-says/>

Provisional conclusions

We consider that the prices obtained in this auction could potentially have offered valuable evidence for deriving ALFs. However, given the CCA auction format we have not been able to determine band-specific prices.

Vodafone referred us to estimates by New Street Research (NSR), an analyst, of band-specific prices.¹⁴⁰ However, in its report, NSR comments that “we emphasise that our breakdown is only one of many mathematically plausible solutions”. We do not have evidence to suggest that NSR’s band-specific prices are sufficiently reliable or representative for us to place significant weight on them for the purpose of revising ALF in the UK. We provisionally conclude that it is appropriate to categorise these estimates and the implied relative values as **less important evidence**.

We also note that the reserve prices were significantly exceeded in the auction. We provisionally conclude that it is appropriate to categorise these reserve prices as **less important evidence** (with a significant risk of understating market value).

¹⁴⁰ New Street Research, “Dutch Spectrum Auction”, 17 December 2012

Portugal

November 2011 multiband award

Description: The auction format used was SMRA

Context: The Portuguese market has 3 MNOs; Vodafone, TMN and Optimus.

	450 MHz	800 MHz	900 MHz	1800 MHz	Unpaired 2.1 GHz	2.6 GHz	Unpaired 2.6 GHz	Price Paid ¹⁴¹
Total Available	2x1.25	2x30	2x10	2x57	10	2x70	50	-
Vodafone	-	2x10	2x5	2x14	-	2x20	25	€146m
TMN	-	2x10	-	2x14	-	2x20	-	€113m
Optimus	-	2x10	-	2x14	-	2x20	-	€113m
Unsold	2x1.25	-	2x5	2x15	10	2x10	25	-

	Description	Implications
Number of bidders > number of lots?	4 bidders – Zon III also participated in the auction, but did not win any spectrum. ¹⁴² The 800 MHz and 900 MHz bands were made available in 2x5 MHz lots. The 1800 MHz band was packaged as 9 lots of 2x5 MHz and 3 lots of 2x4 MHz. The 2.1 GHz spectrum was in lots of 5 MHz, paired 2.6 GHz in lots of 2x5 MHz and the unpaired 2.6 GHz in 2 lots of 25 MHz.	Lot sizes were mainly 2x5 MHz meaning that the number of lots exceeded the number of bidders, allowing each of the 3 incumbents to win spectrum in the core bands available (800/1800/2.6).
Spectrum caps / Restrictions	<p>800 MHz: 2x10 MHz</p> <p>900 MHz: 2x5 MHz, or 2x10 MHz for new entrants</p> <p>A deferred sub 1 GHz spectrum cap of 2 x 20 MHz between existing holdings and holdings won in the auction, with excess spectrum handed back from 30 June 2015.</p> <p>1800 MHz: Cap of 2x20 MHz, including existing holdings. All 3 incumbents already held 2x6 MHz.</p>	<p>Spectrum caps were relatively tight on the sub 1 GHz spectrum, and may have contributed to the low revenues in this auction, combined with only having 3 incumbent operators.</p> <p>The 1800 MHz cap appears to have been binding for all three incumbents, and is likely to have contributed to the unsold spectrum in this band.</p>

¹⁴¹ See: <http://www.anacom.pt/render.jsp?categoryId=344704>

¹⁴² See: <http://www.anacom.pt/render.jsp?categoryId=344702>

	2.6 GHz: 2x25 MHz	
Unsold spectrum	450 MHz: 2x1.25 MHz 900 MHz: 2x5 MHz 1800 MHz: 2x15 MHz Unpaired 2.1 GHz: 10 MHz 2.6 GHz: 2x10 MHz Unpaired 2.6 GHz: 25 MHz	There was a significant amount of unsold spectrum.
Reserve prices	All spectrum sold was at reserve price. DotEcon notes in their report that no indication is given to suggest that the reserve prices were set to reflect market value. ¹⁴³	

Provisional conclusion

Some spectrum remained unsold in each of the relevant bands with the exception of 800 MHz.

In the case of 900 MHz spectrum we consider that country-specific or auction-specific factors may have led to spectrum being unsold. Of the awards considered, this is the only case in which 900 MHz spectrum was unsold, other than as a result of a spectrum cap. DotEcon has noted that the non-contiguity of the unsold lot to operators' existing lots may have been a factor in this outcome. We provisionally conclude that Portugal provides **less important evidence** in deriving ALFs for 900 MHz licences in the UK.

In the case of 1800 MHz, we note that each of the incumbent operators acquired spectrum in this band up to its spectrum cap, leaving 2x15 MHz unsold, and paid the reserve price. We note that this price implies a value of 1800 MHz spectrum in the UK which would be below that of 2.6 GHz spectrum, and we do not consider this credible. We provisionally conclude that Portugal provides **less important evidence** in deriving ALFs for 1800 MHz licences in the UK.

¹⁴³ DotEcon May 2013 report, paragraph 105.

Romania

September 2012 Multiband award

Description: Award for spectrum in the 800 MHz, 900 MHz, 1800 MHz and 2.6 GHz bands using a CCA auction format.

Context: Prior to the auction there were four MNOs, with 2K Telecom being a new entrant into the market as a result of winning spectrum in the auction. ANCOM said the amount of spectrum available for mobile communications has increased by 77% as a result of the award.

	800 MHz	900 MHz	1800 MHz	2.6 GHz	Unpaired 2.6 GHz	Total Paid ¹⁴⁴
Total Available	2x30	2x35	2x75	2x70	45	-
Cosmote RMT	2x5	2x10	2x25	2x10	-	€179.9m
Orange	2x10	2x10	2x20	2x20	-	€227.1m
RCS & RDS	-	2x5	-	-	-	€40m
Vodafone	2x10	2x10	2x30	-	15	€228.5m
2K Telecom	-	-	-	-	30	€6.6m
Unsold	2x5	-	-	2x40	-	-

	Description	Implications
Number of bidders > number of lots?	5 bidders. Substantial spectrum available.	Large amount of spectrum available may have reduced likelihood of excess demand.
Spectrum caps / Restrictions	800 MHz: 2x15 MHz 900 MHz: 2x15 MHz Cumulative 800 MHz/900 MHz: 2x20 MHz. ¹⁴⁵	Only the combined 800 MHz/900 MHz cap was binding, and only for Orange and Vodafone.
Unsold spectrum?	2x5 MHz of 800 MHz and 2x40 MHz of 2.6 GHz.	3 bidders still had sufficiently eligibility to bid for the 800 MHz, and all bidders could have bid for more 2.6 GHz.
Obligations	Holders of spectrum below 1 GHz (800 MHz and/or 900 MHz) are required to ensure: i) Priority coverage of 90% percent of the population from certain areas by 5 th April 2015. ii) Coverage of certain areas inhabited by 60% of the population, by April	The coverage obligations tied to these spectrum licences do not seem to be particularly onerous.

¹⁴⁴ http://www.ancom.org.ro/en/uploads/links_files/Rezultate_licitatie_-_final_EN.pdf

¹⁴⁵ See page 60 :

http://www.ancom.org.ro/en/uploads/forms_files/terms_of_reference1331893175.pdf

	2019. Holders of spectrum over 1 GHz (1800 MHz and/or 2600 MHz FDD) to ensure coverage of certain areas inhabited by 30% of the population, until April 2019. ¹⁴⁶	
--	---	--

Provisional conclusion

Romania held a combinatorial clock auction, so band-specific prices are not available. However, all packages sold for prices which were very close to the sum of the reserve prices for lots within the package. We therefore take reserve prices as a close proxy for band-specific auction prices in this case.

All 900 MHz and 1800 MHz spectrum was sold. The large amount of spectrum available in the auction, and moreover the fact that package prices did not significantly exceed the sum of reserve prices, indicate that auction prices may not have fully reflected the market value of the spectrum.

We provisionally conclude that the absolute value of 900 MHz and 1800 MHz spectrum in Romania provides **more important evidence** in deriving ALFs for 900 MHz and 1800 MHz licences in the UK. Because auction prices did not exceed reserve prices, we consider there is risk of these results **understating** the value of 900 MHz and 1800 MHz spectrum, although we recognise that the resulting prices are not low compared to other benchmarks we are considering.

As regards relative prices, the fact that some 800 MHz and 2.6 GHz spectrum was unsold suggests the reserve prices for these bands risk overstating their value. We provisionally conclude that the relative values of 900 MHz to 800 MHz, and 1800 MHz to 800 MHz spectrum provide **more important evidence** in deriving ALFs for 900 MHz and 1800 MHz licences in the UK, but that there is a risk of **understating** the value of each band relative to 800 MHz, because the relative reserve prices may understate the value of the 900 MHz and 1800 MHz bands, and overstate the value of the 800 MHz band.

¹⁴⁶ See pages 26-27:

http://www.ancom.org.ro/en/uploads/forms_files/terms_of_reference1331893175.pdf

Spain

May 2011 Award

Description: Beauty contest under which applicants set out their cases for being awarded licences on the basis of the criteria set out in the invitation to bid, and the spectrum was then awarded to the applicant who was best able to satisfy that criteria.

Context: The Spanish market features 4 MNOs, with several regional operators which serve only particular parts of the country. The national mobile operators are Movistar, Vodafone, Orange and Yoigo.

	900 MHz	1800 MHz	Total Paid ¹⁴⁷
Total Available	2x5	2x15	-
Orange	2x5	-	€126m
Yoigo	-	2x15	€42m
Unsold	-	-	-

Note: As part of the bids Orange committed to €433m of investment over the next 3 years, and Yoigo made a €300m capex commitment. See: <http://www.ihs.com/products/global-insight/industry-economic-report.aspx?id=1065929783>

	Description	Implications
Number of bidders > number of lots?	<p>In the award of 900 MHz only 1 lot was available, with 2 potential bidders.</p> <p>In the award of 1800 MHz 3 lots of 2x5 MHz were available, but only 1 potential bidder.</p>	<p>Some scope for competition in the award of 900 MHz, but somewhat limited due to restrictions (see below).</p> <p>No apparent scope for competition in the award of 1800 MHz and therefore the price paid is unlikely fully to reflect market value for this spectrum.</p>
Spectrum caps / Restrictions	<p>Movistar and Vodafone prevented from participating in the award of 900 MHz spectrum.</p> <p>Orange, Movistar and Vodafone prevented from participating in the award of 1800 MHz as they already held 1800 MHz spectrum.</p>	<p>Two largest operators prevented from bidding for 900 MHz spectrum, leaving only Orange, Yoigo or an entrant to bid for the licence. Three largest operators were prevented from bidding on 1800 MHz spectrum, leaving only Yoigo or an entrant to bid for the licences.</p> <p>These restrictions limited competition, and bids therefore may tend to underestimate the true value of this spectrum. Also, they were awarded through a beauty contest which takes into account commitments by the winning bidders in addition to the monetary value of their bid.</p>
Unsold spectrum?	No	N/A

¹⁴⁷ <http://www.gsma.com/spectrum/wp-content/uploads/DigitalDividend/DDtoolkit/auctions-summary.html>

July 2011 Multiband Auction

Description: Multiband auction using an SMRA format.

	800 MHz	900 MHz	2.6 GHz	2.6 GHz unpaired	Total Paid ¹⁴⁸
Total Available	2x30	2x10	2x70	50	-
Movistar	2x10	-	2x20		€668.3m
Vodafone	2x10	-	2x20		€517.6m
Orange	2x10	2x5	2x20		€437m
Regional Wholesalers	-	-	2x10		-
Unsold	-	2x5	See table	50	-

	Description	Implications
Number of bidders > number of lots?	<p>4 incumbent bidders in the auction with 2 other bidders also allowed to bid.</p> <p>The licences for 800 MHz and 900 MHz spectrum were in 2x5 MHz lots, the national licences for 2.6 GHz spectrum were available in a mix of 2x5 MHz and 2x10 MHz lots, the unpaired 2.6 GHz spectrum was sold in 10 MHz blocks.</p>	A total of 6 potential bidders meant there was potential for strong competition in all bands available.
Spectrum caps / Restrictions	<p>2x20 MHz cap on sub-1 GHz spectrum</p> <p>Limit of 115 MHz on joint 1800 MHz, 2.1 GHz and 2.6 GHz spectrum</p>	Spain's ministry of communications indicated that the top three operators reached their sub- 1 GHz caps, reducing the competition in the remaining spectrum – the 900 MHz going unsold.
Unsold spectrum?	1 regional licence for a 2x10 MHz block of 2.6 GHz went unsold, along with 2x5 MHz of 900 MHz and the entire 50 MHz of unpaired 2.6 GHz.	It was suspected the spectrum caps in place in the auction led to the unsold spectrum. As a result this was later re-auctioned with the caps raised (see below).
Obligations	Joint obligation on the 800MHz licensees who win 2x10MHz to provide broadband access with access speeds of "at least 30 mpps" to towns with less than 5000 inhabitants. ¹⁴⁹	

¹⁴⁸ http://www.minetur.gob.es/telecomunicaciones/es-ES/ResultadosSubasta/Informe_Web_29072011_fin_de_subasta.pdf

¹⁴⁹ Footnote 17 of DotEcon report for ComReg:
<http://www.comreg.ie/fileupload/publications/comreg1223.pdf>

November 2011 Re-auction of unsold spectrum

Description: Re-auction of the spectrum licences which went unsold in the July 2011 multiband auction.¹⁵⁰

	900 MHz	2.6 GHz unpaired	Price Paid ¹⁵¹
Total Available	2x5	50	-
Movistar	2x5	-	€169m
Vodafone	-	20	€10.4m
Orange	-	10	€5.2m
Regional Wholesalers	-	10	€0.8m
Unsold	-	10	-

	Description	Implications
Number of bidders > number of lots?	All 4 operators could bid for the spectrum available in this auction which included 1 lot of 900 MHz and 5 lots of unpaired 2.6 GHz. However despite this the 900 MHz spectrum was sold at the reserve price. ¹⁵²	There was potential for competition for 900 MHz with only 1 lot available. The fact that it did not exceed reserve price suggests limited demand.
Spectrum caps / Restrictions	Spectrum caps raised to 2x25 MHz for the sub-1 GHz spectrum and to 135 MHz for higher frequencies so as to allow Telefónica, Vodafone and Orange to participate in the auction.	The spectrum available in this auction was as a result of it not selling in the previous multiband award where the spectrum caps were deemed to be too tight, and hence prevented its sale there. The caps were raised allowing all operators to bid; hence there was potential for a degree of competition for this spectrum.
Unsold spectrum?	Some regional licences for 10 MHz of the unpaired spectrum went unsold, as did a regional licence for 2x10 MHz of 2.6GHz. ¹⁵³	
Reserve prices	900 MHz was sold at reserve price.	This may indicate limited competition for 900MHz.

¹⁵⁰ <http://www.dotecon.com/news/spanish-auction-for-the-award-of-licences-in-the-900mhz-and-2-6ghz-bands-ended/>

¹⁵¹ http://www.minetur.gob.es/telecomunicaciones/es-ES/ResultadosSubasta2/Resultados_segunda_subasta_10112011.pdf

¹⁵² International benchmarking of 900MHz and 1800MHz spectrum value, DotEcon, May 2013.

¹⁵³ <http://www.dotecon.com/news/spanish-auction-for-the-award-of-licences-in-the-900mhz-and-2-6ghz-bands-ended/>

Provisional conclusion

In the July 2011 auction all spectrum in the 800 MHz and 2.6 GHz bands was sold above reserve price with the exception of a regional 2.6 GHz licence. One 2x5 lot of 900 MHz was unsold, but the three leading operators were bound by spectrum caps and could not have acquired this lot without foregoing some 800 MHz spectrum – i.e. all three preferred to acquire 800 MHz spectrum at the realised auction price rather than this lot of 900 MHz spectrum at its reserve price.

In November 2011 the caps were raised potentially allowing competition for this 2x5 MHz lot of 900 MHz spectrum, but it sold at reserve price. We provisionally conclude that the absolute value of 900 MHz spectrum in November 2011 provides **more important evidence** in deriving ALFs for 900 MHz licences in the UK. but because it was sold at the reserve price there is a risk of **understating** the value of 900 MHz.

We consider that the value of 900 MHz in November 2011, relative to the value of 800 MHz in July 2011, represents **more important evidence** for the relative values of these respective bands.

Sweden

March 2011 800 MHz auction

Description: Award of 800 MHz spectrum through auction.

Context: Sweden's mobile market is characterised by 4 MNOs; Teliasonera, Tele2, Telenor and Hi3G.

	800 MHz	Price Paid (800 MHz) ¹⁵⁴
Total Available	2x30	-
Teliasonera	2x10	SEK 854m
Tele2	2x10	SEK 469m
Telenor		
Hi3G	2x10	SEK 431m
Unsold	-	-

Note: Net4Mobility, a joint venture between Tele2 and Telenor, won 2x10 MHz of 800 MHz in the auction.

	Description	Implications
Number of bidders > number of lots?	5 bidders for 800 MHz - Com Hem AB and Netett Sverige AB also participated in the auction but did not win any licences. ¹⁵⁵ Lots available in 2x5 MHz.	5 bidders for 800 MHz in an auction where there are only 6 licences available. Tele2 and Telenor bidding as a joint venture rather than as separate entities may have reduced competitive pressure in the auction.
Spectrum caps / Restrictions	2x10 MHz of 800 MHz applicable to all bidders. ¹⁵⁶	The spectrum cap is likely to have reduced the level of competition to some extent.
Unsold spectrum?	No	N/A
Obligations	Coverage and rollout obligations only apply to FDD6 which was won by Hi3G and included a commitment of up to SEK 300m to meet the obligation. ¹⁵⁷ The two bottom blocks of 800 MHz were also subject to stricter usage restrictions related to DTT coexistence.	The licence for block FDD6 is likely to be valued less than others in the band due to the coverage obligation commitment. The stricter usage restrictions on particular blocks are also likely to have reduced the value of these to bidders. In fact the lowest block sold for almost two thirds of the value for the rest of the band. ¹⁵⁸

¹⁵⁴ See: <http://www.pts.se/en-GB/News/Press-releases/2011/Press-release/>

¹⁵⁵ See: <http://www.pts.se/en-GB/News/Press-releases/2011/Press-release/>

¹⁵⁶ See: <http://www.pts.se/en-GB/News/Press-releases/2010/PTSs-invitation-to-auction-of-the-800-MHz-band/>

¹⁵⁷ Full details at paras 18-21: <http://www.pts.se/upload/Beslut/Radio/2011/10-10534-appendix-a-to-decision-800mhz.pdf>

¹⁵⁸ See paragraph 72, DotEcon 2012 Reserve price benchmarking report.

October 2011 1800 MHz auction

Description: Award of 1800 MHz spectrum through auction.

Context: Sweden's mobile market is characterised by 4 MNOs; Teliasonera, Tele2, Telenor and Hi3G.

	1800 MHz	Price Paid (1800 MHz) ¹⁵⁹
Total Available	2x35	-
Teliasonera	2x25	SEK 920m
Tele2	2x10	SEK 430m
Telenor		
Hi3G	-	-
Unsold	-	-

Note: Net4Mobility, a joint venture between Tele2 and Telenor, won 2x10 MHz 1800 MHz in the auction.

	Description	Implications
Number of bidders > number of lots?	3 bidders for 1800 MHz, Hi3G did not win any spectrum. Spectrum available in 2x5 MHz.	Only 3 bidders, with 7 2x5 MHz licences available.
Spectrum caps / Restrictions	No spectrum cap on 1800 MHz spectrum. ¹⁶⁰	N/A
Unsold spectrum?	No	N/A
Obligations	None ¹⁶¹	N/A

Provisional conclusion

All 800 MHz and 1800 MHz spectrum was sold, and at a price in excess of the reserve price. Therefore we provisionally conclude the absolute value of 1800 MHz **provides more important evidence** in deriving ALFs for 1800 MHz licences in the UK, but with a risk of understating this value. The reason for this risk is that 2 operators bid jointly in the auction, and the 1800 MHz auction was limited to 2x35 MHz as the remaining licences in this band were renewed for their existing holders.

The relative value of 1800 MHz to 800 MHz provides **more important evidence** in deriving ALFs for 1800 MHz licences in the UK, but with a risk of either understating or overstating this value. The reason it potentially understates this value is because, as noted above, the absolute value of 1800 MHz licences may be understated. The reason it potentially overstates this value is due to a risk that the value of 800 MHz understates market value for the purpose of ALF in the UK because of joint bidding by 2 incumbents, and a cap of 2x10 MHz on the incumbents in this auction.

¹⁵⁹ See: <http://www.pts.se/en-GB/News/Press-releases/2011/Auction-concluded/>

¹⁶⁰ See: <http://www.pts.se/en-GB/News/Press-releases/2011/PTS-invites-interested-parties-to-the-spectrum-auction-for-the-1800-MHz-band/>

¹⁶¹ See page 17: <http://www.gsma.com/spectrum/wp-content/uploads/2012/07/refarmingcasestudysweden1800mhz20111129.pdf>

Switzerland

February 2012 multiband award¹⁶²

Description: The auction of spectrum in the 800MHz, 900MHz, 1800MHz, 2.1GHz and 2.6GHz bands using a CCA format was completed after 13 days of bidding. All spectrum suitable for mobile telecommunications services was offered in one combined award, allowing participants to bid on comprehensive spectrum packages across all bands that best suit their long-term spectrum needs.

Context: The Swiss mobile market was characterised by 3 MNOs, with a fourth operator, In&Phone, also holding some spectrum, but it failed to meet the entry criteria for the auction and subsequently ceased operating in the market.

	800 MHz	900 MHz	1800 MHz	2.1 GHz	Unpaired 2.1 GHz	2.6 GHz	Unpaired 2.6 GHz	Price Paid
Total Available	2x30	2x35	2x75	2x60	2x10	2x70	45	-
Orange	2x10	2x5	2x25	2x20	-	2x20	-	€154.7m
Sunrise	2x10	2x15	2x20	2x10	-	2x25	-	€481.7m
Swisscom	2x10	2x15	2x30	2x30	-	2x20	45	€359.8m
Unsold	-	-	-	-	2x10	2x5	-	-

	Description	Implications
Number of bidders > number of lots?	3 bidders. A fourth company applied to enter the auction, but failed to satisfy the entry requirements. ¹⁶³	There was a substantial amount of spectrum available in this auction, and with only 3 bidders each should not have had difficulty in obtaining some spectrum.
Spectrum caps / Restrictions	<p>Spectrum caps of:</p> <p>2 × 135 MHz of the total available FDD spectrum (duplex frequencies).</p> <p>2 × 25 MHz between 800 MHz and 900 MHz bands;</p> <p>2 × 20 MHz for the 900 MHz band;</p> <p>2 × 35 MHz for the 1800 MHz band; and</p> <p>2 × 30 MHz for the 2.1 GHz band.¹⁶⁴</p>	The sub 1 GHz cap was binding for 2 of the operators, and the cap on 2.1GHz for 1 operator. The 3 bidders each won 2x10 MHz of 800MHz.

¹⁶² Results source: <http://www.news.admin.ch/NSBSubscriber/message/attachments/26004.pdf>

¹⁶³ See page 369: <http://www.comreg.ie/fileupload/publications/ComReg1225a.pdf>

¹⁶⁴ See page 368: <http://www.comreg.ie/fileupload/publications/ComReg1225a.pdf>

Unsold spectrum?	No	N/A
Obligations	Licensees who have the right to use frequencies below 1 GHz are obliged to ensure coverage of 50% of the population of Switzerland with mobile radio services via their own infrastructure by 31 December 2018 (800 MHz) and 31 December 2020 (900 MHz), licensees for 1800 MHz have until 31 December 2020 to achieve 25% coverage, whereas licensees of 2.1 GHz spectrum have to achieve 25% coverage by 31 December 2021. ¹⁶⁵	These particular coverage obligations do not seem particularly onerous, so are not likely to have reduced bid amounts to a huge extent.

Provisional conclusion

We consider that the prices obtained in this auction could potentially have offered relevant evidence for deriving ALFs. However, given the CCA auction format we have not been able to determine band-specific prices.

¹⁶⁵ See page 369: <http://www.comreg.ie/fileupload/publications/ComReg1225a.pdf>

Sensitivity analysis

Introduction

- A8.1 DotEcon has estimated the linear reference price (LRP) for 800 MHz spectrum at £26.85m per MHz for lot category A1 (800MHz without coverage obligation), and for paired 2.6 GHz spectrum at £4.95m per MHz (lot category C). Acquirers of 800 MHz spectrum faced a £3m per MHz liability for DTT co-existence costs, suggesting a higher figure of £29.85m per MHz.
- A8.2 We have taken these figures as the base case for the prices of 4G auctioned spectrum licences, but we considered several possible variations, which can be categorised as:
- Basic adjustments to these LRPs based on the treatment of coverage obligations, coexistence costs, and assignment-stage bids;
 - Alternative methods of calculating 4G spectrum prices;
 - Hypothetical changes to the auction rules, licences available, and participation.
- A8.3 In practice the distinction between (b) and (c) is not clear-cut,¹⁶⁶ but broadly speaking the alternative methods to the LRP are the Additional Spectrum Methodology (ASM) and the decomposition approach suggested by Vodafone (discussed below), while the hypothetical changes are the absence of a competition constraint, the absence of H3G from the Auction, and a nominal reserve price for 800 MHz licences. In considering these hypothetical changes it should be borne in mind that the evidence we have is of the actual bids that were made in response to the auction rules. Estimates of what would have happened in different circumstances are necessarily speculative, for example because changes to the auction rules could well have changed the bids made in unpredictable ways.¹⁶⁷
- A8.4 In the following discussion we set out the base case and each of the sensitivities we have considered. For the reasons set out below, whilst we have taken these sensitivities into account, we do not consider it appropriate to place significant weight on most of them compared to the base case. A partial exception is the treatment of co-existence costs for 800 MHz. We consider that we should put more weight on the base case valuation than on a valuation which does not include these co-existence costs. However, we have considered what the effect would be on our assessment of the lump-sum value of ALF licences if we were to assume that

¹⁶⁶ For example, the ASM is based on a hypothetical change in the spectrum licences available.

¹⁶⁷ Vodafone has previously commented, in the context of ASM, that bidders would be making bids assuming 2x30 MHz of 800 MHz spectrum, and it was unreasonable to assume they would have made the same bids if, hypothetically, there were additional 800 MHz spectrum (paragraph 87 of Vodafone's response to our Second Competition Assessment). Our view in the July 2012 Statement was that this ought to make little difference, as long as firms' private values were driven to a significant degree by their existing holdings of spectrum. We now recognise that in saying this we may have understated the potential effect of assuming that the same bids would have been made if different amounts of spectrum had been available, particularly in light of the small number of supplementary bids that were made by some bidders (suggesting that they did not express the full extent of their demand functions in their bids).

auction bids were based on the expectation of a rebate of these costs in full or in part.

- A8.5 This sensitivity analysis focuses on variations in the estimated value of 800 MHz and 2.6 GHz in the UK, and how these variations change our benchmarks for informing the value of 900 MHz and 1800 MHz spectrum. In principle, it might be possible to devise other sensitivities centering on the international benchmarks we have used. However, it is not clear that doing so would be particularly informative in the absence of clear evidence of a systematic bias in this evidence. The international benchmarks already generate a wide range of values and we have had regard to the distribution of these values in considering lump-sum values for ALF.

Sensitivities

Base case

- A8.6 As noted, our base case is the LRP in the principal stage for the A1 (800 MHz spectrum unencumbered by coverage obligation, but including coexistence costs) and C lots (paired 2.6 GHz spectrum).
- A8.7 For the purpose of deriving ALF we are most interested in auction prices by band that are linear, in that the prices per MHz do not differ between winning bidders or between different amounts of spectrum of the same type. As DotEcon notes in its report, given the nature of pricing rules in the 4G Auction (which yield prices that are non-linear) any linear pricing methodology involves choices and approximations, because no constructed linear prices for individual lots are guaranteed to support the observed auction outcome, in the sense that bidders would choose their winning packages if faced by those prices. The LRP methodology was specifically designed as a method to analyse the auction bids to yield appropriate linear prices, i.e. the closest to market clearing prices, taking account of competitive pressure for spectrum bands by incorporating information from losing bids. As DotEcon explains (page 8), it generates “linear prices that *best* support the outcome given the revenue condition, in that overall incentives for bidders to prefer some other outcome are minimised.”
- A8.8 We have considered some basic adjustments to the LRP methodology. However, for the reasons we discuss below, we consider that we should give more weight to our base case than to any of these adjustments in informing ALF.

Basic adjustments to the base case LRPs

Coexistence

- A8.9 For 800 MHz spectrum (lot categories A1 and A2), in addition to the auction price, winners had to pay £30m per 2x5 MHz lot for funding DTT co-existence mitigation actions through At800. Since bidders knew that they would have to pay this additional amount if they won 800 MHz spectrum, we would expect them to have subtracted it from their values when deciding their auction bids. Accordingly we have included this payment in our base case linear price of 800 MHz spectrum, increasing the linear price derived from the auction bids by £3m per MHz.
- A8.10 Bidders could potentially have expected that the overall cost of mitigation actions would be less than the sum of these commitments, possibly leading to a future rebate when At800 is dissolved. If so, it might be appropriate to increase the linear price by less than the full £3m per MHz. Therefore we have also considered as a

sensitivity the possibility that bidders expected co-existence costs to be lower. For simplicity, Figures A8.11 and A8.12 below consider the cases in which either the £3m is included in full (our base case of £29.85m), or none of the £3m per MHz is included in the linear price (i.e. £26.85m per MHz for lot category A1).¹⁶⁸

- A8.11 Our provisional view is that there is a stronger case for assuming the inclusion of all of the co-existence costs than for excluding or partially excluding them, as a prudent bidder would be likely to take account of the liability of £3m per MHz.
- A8.12 However, for illustration Figure A8.1 below sets out our more important evidence based on an in-between scenario in which bidders expected to pay half the co-existence cost. This would reduce the 800 MHz base case from £29.85m per MHz to £28.35m:
- In the case of 900 MHz spectrum, three of the seven more important evidence points would reduce in value, while the other four would remain unchanged. Our best estimate of market value, £25m per MHz, would continue to be supported by similar absolute values in Spain and Romania, although the relative value in Spain would be reduced from £23.5m per MHz to £22.4m per MHz. As before, three of the other evidence points would be substantially above this value, and one would be substantially below it.
 - In the case of 1800 MHz, five out of the eleven more important evidence points would be affected by this change, although the scale of the effect is less as 1800 MHz relative benchmarks tended to be a smaller proportion of the value of 800 MHz spectrum. In addition to the simple average, the values relative to 800 MHz for Sweden, Ireland, Italy and Romania would all be reduced. However, our best estimate of the UK value, of £15m per MHz, would continue to be supported by similar absolute values in Italy and Greece, with the remaining more important evidence points divided between those which are above and below this level.

¹⁶⁸ We recognise this sensitivity involves an extreme assumption which we expect clearly to understate the reality. It seems implausible that bidders would have expected there to be no co-existence costs and a full rebate of £3m per MHz. Furthermore even in this implausible case in which bidders expected co-existence costs to be negligible, the rebate would be in the future when At800 is dissolved and accordingly should have been appropriately discounted by bidders taking into account the time value of money.

Figure A8.1 Effect of assuming co-existence costs of £1.5m per MHz

	900 MHz; UK LRP at £28.35m per MHz	1800 MHz; UK LRP at £28.35m per MHz
	900 MHz base case	1800 MHz base case
Ireland	35.7	23.1
Romania (Relative)	34.0	21.7
Greece	31.4	17.4
Romania	24.9	17.3
Spain	24.9	15.5
Spain (Relative)	23.6	13.9
Ireland (Relative)	18.2	11.7
		9.6
		9.1
		8.5
		6.2

A8.13 We provisionally conclude that we should put some weight on the possibility that the expectation of at least a partial rebate of co-existence costs may have informed bids for 800 MHz spectrum. However, we remain of the view that our base case should include these co-existence costs in full.

Coverage obligation

A8.14 Lot A2 was for 800 MHz spectrum with a coverage obligation. The bidding pattern of the winner of the A2 lot (Telefonica) suggests it placed no premium on 2xA1 lots above the A2 lot (or, equivalently, no discount because of the coverage obligation). However, this was not consistently the case for other bidders for A2. Reflecting this, the LRP of lot A2 was around £1.5m/MHz lower than the LRP for lot A1. On the basis that the LRP of A2 might provide further information on the value of 800 MHz spectrum, we consider the sensitivity of averaging the LRP of A1 and A2 lots.

A8.15 This implies an LRP for 800 MHz of £26.34m per MHz or £29.34m if the maximum co-existence cost is included (compared to the base case figure for lot category A1 of £29.85m). This sensitivity therefore only involves a small impact on the LRP.

A8.16 However, as coverage obligations are not specified in 900 MHz or 1800 MHz licences, we consider that there is a stronger case to focus on the LRP of the A1 lots as our base case.

Assignment stage bids

A8.17 In the principal stage of the auction, bids were made for generic lots whose specific frequencies were determined in a follow-up assignment stage. We have used prices based on principal-stage bids in the base case, on the basis that assignment-stage bids reflected competition for specific blocks within the 800 MHz and 2.6 GHz bands, which may not be informative of the value of ALF spectrum. However a possible alternative view is that assignment stage bids reflect part of the overall value of the spectrum. In the UK auction these bids were not very material compared to the total revenue. For simplicity we have considered a sensitivity in which the assignment stage revenue is spread uniformly over the available lots.

This sensitivity only involves a small change in the LRPs to £29.98m per MHz for 800 MHz (lot category A1) and £5.09m for 2.6 GHz (lot category C).

Alternative methods of calculating realised auction prices

ASM

- A8.18 The ASM was set out in our Second Competition Assessment¹⁶⁹ (paragraphs A13.66 to A13.75). As described there, the objective of this approach is to obtain an estimate of the opportunity cost of each holder of 900 MHz and 1800 MHz spectrum licences retaining its holding of these licences, in light of the bids made in the auction, but in a way that is not directly influenced by the bids of the licensee whose spectrum value we are assessing.
- A8.19 ASM is based on calculating what bidders would have been willing to pay for additional 800 MHz and 2.6 GHz spectrum, based on the bids actually made in the auction, if such spectrum had hypothetically been available in the auction. This is effectively a proxy for the hypothetical inclusion of 900 MHz and 1800 MHz spectrum in the auction. The amount of additional spectrum added in the ASM can be varied to correspond to existing holdings or other amounts.
- A8.20 For 1800 MHz spectrum we consider as proxies both hypothetical additional 800 MHz and 2.6 GHz spectrum as 1800 MHz lies in between these frequency bands (whereas 900 MHz is close in frequency to 800 MHz).
- A8.21 To take an example of the ASM approach, suppose that some of Telefónica's current holdings of 900 MHz spectrum had hypothetically been included in the auction. Based on the bids they made in the auction (in which this spectrum was not on offer), what would bidders other than Telefónica have been willing to pay for this spectrum? To address this question, the ASM first identifies a "baseline" set of spectrum rights, comprising all the spectrum in the auction which was *not* won by Telefónica, and adds the hypothetical additional block of spectrum to this baseline. It also identifies the total amount bid for this baseline set of rights, excluding bids by Telefónica (hence we refer to Telefónica as the "excluded" bidder in this scenario).
- A8.22 The next step is to identify what the total value of those winning bids would have been, taking account of the bids actually observed in the auction (from bidders other than Telefónica) which would have made up the winning set of bids if this larger total amount of spectrum had been on offer in the auction. Importantly, this calculation only counts bids made by bidders during the auction itself. In other words, the ASM makes the potentially artificial assumption of no additional (or different) bids than those actually observed, while assuming in some scenarios substantial additional spectrum available in the auction. The larger the amount of spectrum hypothetically added in the ASM calculations, the more artificial this assumption is likely to be.
- A8.23 The value of the additional spectrum is measured as the difference between the total amount of the winning bids in this hypothetical scenario, and the original baseline total winning bid amount. This is taken to represent the additional amount that bidders other than Telefónica would be willing to pay for the additional spectrum hypothetically on offer.

¹⁶⁹ http://stakeholders.ofcom.org.uk/binaries/consultations/award-800mhz/annexes/2nd_condoc_Annexes_8-15.pdf

A8.24 DotEcon applied the ASM in its report. In the results, the value per block implied by adding spectrum depends on the amount of spectrum added and the identity of the operator whose spectrum holding is being considered (and so being excluded from the calculations, as described above). For example, Figure A8.2 shows the change in value per block from hypothetically adding 2x5, 2x10, 2x15 or 2x20 MHz of 800 MHz spectrum as a proxy for the current holdings of 900 MHz of Vodafone and Telefónica (2 x 17.4 MHz). Figure A8.3 shows the change for similar amounts of additional 800 MHz as a proxy for the current holdings of 1800 MHz of Vodafone and Telefónica (2 x 5.8 MHz), EE (2 x 45 MHz)¹⁷⁰ and H3G (2 x 15 MHz). Figure A8.4 shows the ASM results for hypothetical additional amounts of 2.6 GHz as a proxy for 1800 MHz holdings.

Figure A8.2 ASM results for hypothetical additional 800 MHz spectrum as a proxy for 900 MHz spectrum

Excluded operator:	Vodafone (£m/MHz)	Telefónica (£m/MHz)	EE (£m/MHz)	H3G (£m/MHz)
2 x 5 MHz	38.4	35.6	-	-
2 x 10 MHz	26.4	26.5	-	-
2 x 15 MHz	30.7	29.5	-	-
2 x 20 MHz	23.7	22.7	-	-

Figure A8.3 ASM results for hypothetical additional 800 MHz as a proxy for 1800 MHz spectrum

Excluded operator:	Vodafone (£m/MHz)	Telefónica (£m/MHz)	EE (£m/MHz)	H3G (£m/MHz)
2 x 5 MHz	38.4	35.6	2.5	38.4
2 x 10 MHz	-	-	1.3	19.2
2 x 15 MHz	-	-	0.8	30.2
2 x 20 MHz	-	-	0.6	-

¹⁷⁰ However, ASM results were not derived for hypothetical additional amounts of 800 MHz spectrum beyond 2 x 20 MHz.

Figure A8.4 **ASM results for hypothetical additional 2.6 GHz spectrum as proxy for 1800 MHz**

Excluded operator:	Vodafone (£m/MHz)	Telefónica (£m/MHz)	EE (£m/MHz)	H3G (£m/MHz)
2 x 5 MHz	7.3	4.5	7.3	7.3
2 x 10 MHz	-	-	6.4	6.4
2 x 15 MHz	-	-	5.8	5.2
2 x 20 MHz	-	-	5.7	-
2 x 25 MHz	-	-	5.3	-
2 x 30 MHz	-	-	5.2	-
2 x 35 MHz	-	-	5.2	-
2 x 40 MHz	-	-	4.9	-
2 x 45 MHz	-	-	4.4	-

A8.25 The ASM results for hypothetical additional 800 MHz spectrum are highly asymmetric across excluded operators. This is mainly because Vodafone and Telefónica were each restricted from bidding for more than the 2x10 MHz of 800 MHz spectrum which each of them acquired, while H3G did not compete strongly for more 800 MHz spectrum than it won, with the result that there is no demand for hypothetically added 800 MHz spectrum as a proxy for EE's 1800 MHz spectrum. In the other scenarios, where EE is present as a bidder, more spectrum creates additional value because EE expressed demand for more 800 MHz spectrum than it won.¹⁷¹

A8.26 Focusing on the results intended to proxy for Vodafone and Telefónica's existing 900 MHz and 1800 MHz spectrum (with Vodafone and Telefónica as excluded bidders), we note that as the amount of additional 800 MHz spectrum goes from 2x5 to 2x10 MHz, the value per MHz falls, but it rises again as a further 2x5 MHz is added (and then falls again when the amount reaches 2x20 MHz). This variation depending on the amount of hypothetically additional spectrum complicates the interpretation of the ASM results. The results include both figures above and below the LRP of 800 MHz (£26.85m on a comparable basis, i.e. excluding co-existence costs). There is also the question of whether the results for a larger or smaller amount of additional spectrum are more meaningful. The larger the amount of additional spectrum considered, the more hypothetical the situation considered, i.e. the further the deviation from the spectrum actually on offer in the auction.

A8.27 In the case of additional 2.6 GHz spectrum we also see differences in the results as between different excluded bidders, for example adding 2x5 MHz generates additional value of £4.5m in the case of Telefonica, but around £7.3m in the case of

¹⁷¹ As described above, the ASM attempts to use hypothetical additional 800 MHz spectrum as a proxy for a current licence holder's 900 MHz or 1800 MHz spectrum. Since neither EE nor H3G hold 900 MHz spectrum, the ASM results for hypothetical additional 800 MHz with these as the excluded bidders are only relevant as proxies for values of 1800 MHz.

the other three. However, there is a consistent decline in the average value of spectrum as more hypothetical lots are added. The ASM results are generally above the LRP of 2.6 GHz (£5m in the base case), although there are some results below that level.

- A8.28 Given the hypothetical nature of the ASM approach and the variation in the ASM results, including figures both above and below the LRPs for 800 MHz and 2.6 GHz, we provisionally conclude that the ASM results do not provide a strong basis for deviating from the base case figures.

Decomposition approach

- A8.29 Vodafone argues that LRP produces a poor fit to auction prices, and notes the difference between bidders in prices apparently paid for 800 MHz spectrum. Instead it proposes an alternative ‘decomposition’ approach. This approach is based on, first, decomposing total prices into the incremental cost to bidders of obtaining the spectrum won in each spectrum band in succession. Vodafone calculates this by constructing hypothetical smaller packages and deriving incremental prices for the additional spectrum in the larger package. Second, for each category of lot, it then takes a simple average across the various possible incremental prices of all bidders. The results are illustrated in Figure A8.5 below. As illustrated, the resulting average values are slightly lower than LRP for 800 MHz, and slightly higher for 2.6 GHz licences.

Figure A8.5 Vodafone’s decomposition approach

£m per MHz	800 MHz	2.6 GHz
Vodafone	27.4	5.3
Telefónica	27.5	
EE	22.5	5.2
H3G	22.5	
Niche		5.3
Average (per lot)	25.8	5.3
LRP	26.9	5.0

Source: Vodafone

- A8.30 This approach offers a slightly improved “fit” to observed prices compared to the LRP methodology. Vodafone comments that the decomposition approach shifts revenue from 800 MHz towards 2.6 GHz (compared to LRP), which Vodafone says gives “a better reflection of actual auction activity” because 800 MHz was “relatively lightly contested”.
- A8.31 In assessing the benefits of the decomposition approach, we begin by recalling that the LRP methodology estimates the linear prices that are closest to market clearing prices given the bids made. In particular, it is designed to generate linear prices which minimize the incentive for bidders to switch from winning packages. In our view, this gives a clear conceptual basis for LRP, which we consider appropriate given that the outputs are being used to inform ALFs which (also in our view) should be linear and as close as possible to market clearing prices.

- A8.32 Vodafone notes that prices generated by the LRP methodology are a poor fit to the auction outcome. Essentially this is because LRP converts a non-linear set of prices into a single linear price for each band. In the first stage of Vodafone's decomposition approach the prices derived by band retain the feature of non-linear prices. However, in the second stage Vodafone averages these prices together to yield the linear price results it proposes should be used to inform ALF.
- A8.33 Our current view is that the decomposition approach is a broadly sensible alternative way of deriving auction prices by band (and other such alternatives may exist), but we have not seen evidence that it has a significant advantage over LRP. It is not clear that there is a conceptual basis for favouring Vodafone's decomposition approach over the LRP methodology. In contrast, LRP has the advantage of a clearer rationale. The objective is to derive linear prices by band and the LRP methodology identifies the linear prices that are closest to market clearing, given the bids made. In contrast, Vodafone's decomposition approach involves averaging together non-linear prices by band to estimate the linear prices. This is a less direct method to derive linear prices and such prices are not designed to be closest to market-clearing linear prices.
- A8.34 While our sensitivity analysis considers what the impact would be of adopting the decomposition approach, our current view is that there is a stronger case for the base case approach, because the conceptual basis of LRP gives it an advantage in the context of setting ALFs.

Adjustments based on hypothetical changes to the auction

- A8.35 We consider below a number of possible hypothetical changes to the auction and their implications for linear prices. In all cases, despite these hypothetical changes, the results rely on the auction bids that were actually made in the real auction in which such hypothetical changes did not apply. We are also aware that other hypothetical changes could be considered (such as relaxation of spectrum caps). Although we assess below the merits of each hypothetical change discussed, we are mindful of the general point that it may be dangerous to rely on results that involve hypothetical departures from the real auction (similar concerns also apply to the ASM results discussed above).

Nominal reserve prices

- A8.36 Vodafone commented that Ofcom's decisions on reserve prices had a very significant impact on the prices paid, such that one could not read these prices as a simple indication of market value. It proposed using "the auction payments that would have occurred in the absence of such distortionary conditions". It therefore derived the hypothetical winning prices with all reserve prices set to a nominal £1,000 and re-ran the LRP and decomposition algorithms, but taking as the overall revenue constraint the sum of the hypothetical winning prices (instead of the sum of the actual auction prices). The results with the decomposition method are illustrated in Figure A8.6 and the LRP results are in Figure A8.7 and A8.8 below. In this case, the resulting value of 800 MHz spectrum is substantially lower than that implied by the LRP, while that of 2.6 GHz is slightly higher than the LRP figure.

Figure A8.6 Vodafone's decomposition approach with nominal reserve prices

£m per MHz	800 MHz	2.6 GHz
Vodafone	26.1	5.3
Telefónica	26.3	
EE	2.5	5.2
H3G	13.7	
Niche		5.3
Average (per lot)	20.2	5.3
LRP	26.9	5.0

Source: Vodafone

- A8.37 We recognise that reserve prices had the potential to influence the auction outcome (and indeed to some extent were intended to do so, at least to guard against some possibly inefficient outcomes), and that they were set by Ofcom rather than determined by the market. However, Ofcom sought to ensure that reserve prices did not have an unduly distortionary effect. Reserve prices were based on the evidence of prices paid in auctions in other countries for the same or similar spectrum, but we also had regard to a range of considerations including the risk that setting them too high could prevent a fourth national wholesaler from acquiring spectrum where this would benefit consumers, or that spectrum could remain unsold. Reserve price levels were also informed by the risk that bidders could engage in behaviours such as tacitly colluding or artificially reducing their demand – i.e. by their potential role in correcting a potential market distortion and avoiding artificially low auction prices.¹⁷²
- A8.38 We note that the reserve prices for 800 MHz and 2.6 GHz spectrum did not prevent an outcome in which all spectrum in these categories were sold. We consider that this outcome supports the view that the reserve prices were not substantially out of line with market value.
- A8.39 In addition, we note that Vodafone's method of reducing the reserve price to a nominal amount assumes that the same bids would have been observed in the auction as were actually observed even with nominal reserve prices which are very different from the reserve prices that actually applied. However, when reserve prices are set, any (incremental) bids on a lot at a value below the reserve price cannot win and bidders have no reason to make them¹⁷³. For example, if bidders for 800 MHz had valued an additional A1 Lot at £220 million, they would have no reason to make such a bid given the reserve price of £225 million, whereas with a nominal reserve price of £1000 they would have an incentive to bid up to £220 million.¹⁷⁴ Similarly other bidders might have entered the bidding for an A1 lot if it had a lower reserve price. The potential for such additional bids given much lower reserve prices suggests that this sensitivity is likely to understate market value.
- A8.40 The treatment of reserved spectrum won by H3G at the reserve price provides a further complication for the hypothetical scenario of deriving linear prices at nominal

¹⁷² July Statement, paragraphs 1.33 and 1.34.

¹⁷³ In fact, some bids with an incremental value below reserve price were observed in the auction, although they could not have won. It is unclear why these were made.

¹⁷⁴ To take an extreme case, if the entire spectrum had been sold at the reserve price (as was the case in some other countries), Vodafone's approach of relying solely on the bids actually made (at much higher reserve prices) would suggest a market value of the spectrum close to zero.

reserve prices. H3G's bids in the auction had the effect of guaranteeing that the reserved spectrum portfolio it won would be at the reserve price. This makes the assumption of no change in bids especially artificial for H3G. In Figures A8.7 and A8.8 below we therefore present results for two cases when making the hypothetical change to nominal reserve prices: (a) allowing all prices for the winning bidders to change; and (b) assuming no change in H3G's price of £225m for 2x5MHz of 800MHz (but allowing the prices for other winning bidders to change). In both cases, the resulting prices for 800 MHz spectrum (A1)¹⁷⁵ are below that indicated by LRP, but higher than the prices presented by Vodafone when the assumption of nominal reserve prices is used alongside its decomposition approach. Where no impact on H3G's price is assumed, the resulting value is only 10% below the LRP.

Figure A8.7 Nominal reserve price allowing all prices to change

Bidder	A1	A2	C	E	Price paid (£k)	Difference from actual £	Difference from actual %
Vodafone	2	0	4	5	£ 770,261	-£ 20,500	-3%
Telefonica	0	1	0	0	£ 526,338	-£ 23,662	-4%
EE	1	0	7	0	£ 388,875	-£ 200,001	-34%
H3G	1	0	0	0	£ 136,666	-£ 88,334	-39%
Niche	0	0	0	4	£ 186,476	£ -	0%
Totals	4	1	14	9	£2,008,616	-£ 332,497	-14%
Implied LRP (£m/MHz)	22.43	20.88	4.59	1.15			
Difference from base case £m	-4.42	-4.42	-0.37	-0.35			
Difference from base case %	-16%	-17%	-7%	-23%			

Source: Vodafone

Figure A8.8 Nominal reserve price assuming no change in H3G's price

Bidder	A1	A2	C	E	Price paid (£k)	Difference from actual £	Difference from actual %
Vodafone	2	0	4	5	£ 770,261	-£ 20,500	-3%
Telefonica	0	1	0	0	£ 498,000	-£ 52,000	-9%
EE	1	0	7	0	£ 388,875	-£ 200,001	-34%
H3G	1	0	0	0	£ 225,000	£ -	0%
Niche	0	0	0	4	£ 186,476	£ -	0%
Totals	4	1	14	9	£2,068,612	-£ 272,501	-12%
Implied LRP (£m/MHz)	24.18	22.63	4.21	1.32			
Difference from base case £m	-2.67	-2.67	-0.74	-0.18			
Difference from base case %	-10%	-11%	-15%	-12%			

Source: DotEcon

¹⁷⁵ Spectrum in the 800MHz band was offered in two categories: four lots of 2x5MHz in category A1; and one lot of 2x10MHz in category A2. The winner of the A2 lot is required to serve roll-out obligations. Fourteen lots of 2x5 MHz of paired 2.6 GHz spectrum were offered in category C, while category E was for unpaired 2.6 GHz spectrum.

A8.41 Figure A8.11 below sets out the impact of assuming nominal reserve prices, alongside other hypothetical adjustments to the auction process. However our current view is that it is not appropriate to estimate LRPs on the basis of hypothetical nominal, or indeed lower, reserve prices compared to the base case derived from the actual reserve prices.

Removal of revenue constraint

A8.42 The LRP methodology identifies a set of prices that minimises the incentive to deviate from winning bids, subject to the overall revenue constraint of the sum of the winning prices, and the constraint that LRPs are no lower than respective reserve prices. DotEcon has commented that an alternative way of entirely removing the impact of reserve prices would be to drop the revenue constraint from the LRP determination, which would yield the linear prices that are as close as possible to separating the winning and losing bids. We have therefore considered this as an alternative way of assessing the sensitivity of our results to the reserve price. The result of this change is a 15% higher valuation for 800 MHz spectrum (lot A1) compared to our base case, and a 10% higher valuation for paired 2.6 GHz spectrum (lot C).

Figure A8.9 LRP results without revenue constraint

Bidder	A1	A2	C	E
Vodafone	2	0	4	5
Telefonica	0	1	0	0
EE	1	0	7	0
H3G	1	0	0	0
Niche	0	0	0	4
Totals	4	1	14	9
Implied LRP (£m/MHz)	30.93	29.38	5.43	1.33
Difference from base case £m	4.08	4.08	0.48	-0.17
Difference from base case %	15%	16%	10%	-11%

Source: DotEcon

A8.43 In the context of exploring the impact of reserve prices, this approach has the advantage of entirely removing it. Furthermore it could be argued that it yields linear prices which are closer to market clearing prices, in the sense of better separating the winning bids from the losing bids compared to linear prices with the revenue constraint. However, the linear prices derived without the revenue constraint are higher overall than the prices actually paid in the auction, which raises a question of whether substantial weight should be placed on them for the purpose of revising annual licence fees. On balance we do not consider there is a stronger case for this approach compared to the base case.

LRP without competition constraint

A8.44 The interaction of the competition constraint (i.e. spectrum reservation) and the second price rule, given the bids made by H3G, meant that it paid the reserve price for its winning package of reserved spectrum rather than the full opportunity cost resulting from not allocating this spectrum to other bidders. Therefore we consider a sensitivity in which the auction prices are revised under the hypothetical change of assuming no spectrum reservation in the auction and the LRPs are re-computed (at the different overall revenue constraint). This sensitivity assumes that in the absence of the competition constraint the same bids would have been made. On that basis, H3G's price and the LRPs would be higher. In particular, the value for 800 MHz (lot A1) would be 4% higher than our base case while the value of paired 2.6 GHz spectrum (lot C) would be 14% higher.

Figure A8.10 Nominal reserve price assuming no competition constraint

Bidder	A1	A2	C	E	Price paid (£k)	Difference from actual £	Difference from actual %
Vodafone	2	0	4	5	£ 821,777	£ 31,016	4%
Telefonica	0	1	0	0	£ 525,058	-£ 24,942	-5%
EE	1	0	7	0	£ 673,988	£ 85,112	14%
H3G	1	0	0	0	£ 278,029	£ 53,029	24%
Niche	0	0	0	4	£ 201,262	£ 14,786	8%
Totals	4	1	14	9	£1,153,279	-£1,187,834	-51%
Implied LRP (£m/MHz)	27.80	26.25	5.66	1.58			
Difference from base case £m	0.95	0.95	0.70	0.08			
Difference from base case %	4%	4%	14%	5%			

Source: DotEcon

A8.45 However, with this hypothetical change of no competition constraint, the assumption of no change in bids is especially artificial for H3G, for the reason noted above.

A8.46 We do not consider that it is appropriate to adopt the approach of hypothetically removing the competition constraint, as it is based on a hypothetical situation which departs substantially from the facts of the real auction.

Removal of H3G from the auction

A8.47 As the only opted-in bidder for reserved spectrum, H3G was only permitted to bid for packages that included, alongside any additional lots, at least one of its opt-in packages of reserved spectrum, and it was guaranteed to win one of these packages if it bid at least the reserve price. The differences in the bid amounts submitted by H3G for its opt-in packages were equal to the differences between the reserve prices for these packages. The incremental sum H3G bid for any given additional lot was identical across each of the opt-in packages. For example H3G submitted bids which added two C lots (2.6 GHz) to any of its opt-in packages, and the incremental value of these two C blocks was always £100 million (or £5m per MHz).

A8.48 As both Vodafone and DotEcon note, unless H3G's relative valuation in packages happened to be the same as the difference in reserve prices, its bidding is consistent with an aim of winning an opt-in package whilst paying no more than

reserve price. We have taken this into account in our discussion of some of the sensitivities above.

A8.49 However, Vodafone also argues that all bids by H3G for larger (than opt-in) packages were unlikely to be successful, and that their aim was to raise the price for other bidders. It comments that H3G's primary round bids for packages with A1 and A2 lots also included huge amounts of 2.6MHz (10 C lots and the D2 lot), and that it was virtually impossible for those bids to have won because that would have prevented everyone else from winning paired 2.6MHz spectrum. Vodafone further comments that H3G's bids for additional lots in the supplementary bids round had an incremental value well below final primary round prices. Vodafone concludes that:

This all suggests H3G's objective: "Win spectrum at the reserve price and make everyone else pay more". If that was indeed the H3G bid team's objective, then they achieved it. However, we must observe that such an objective contains no inherent concept of the underlying value of the spectrum.

A8.50 Vodafone considers that H3G's involvement in the auction distorted the outcome, and proposes to exclude H3G's bids and the A1 lot it won from the calculation of ALF lump-sum values.

A8.51 Our view is that there is not a sound basis for making the hypothetical adjustment which Vodafone proposes, for the following reasons:

- We disagree with Vodafone that H3G's bids for packages larger than its opt-in packages had the effect of distorting the prices paid by other winning bidders. The specific very large package bids made by H3G in primary rounds to which Vodafone refers did not affect the outcome of the auction or the prices. For H3G's other bids, the fact that they included incremental values below final primary round prices does not demonstrate either that H3G was solely seeking to distort the auction outcome or to raise the prices paid by others. This is especially so given that there was excess supply at the prices in the final primary round and that the base prices determined at the end of the principal stage turned out to be materially lower than the prices in the final primary round (e.g. the base case LRP for 2.6 GHz is £5m per MHz compared to the final primary round price of £9.2m per MHz).
- H3G could not be certain that its bids for additional lots would be unsuccessful (and Vodafone has not claimed that it could be certain). It is possible to construct scenarios in which H3G's supplementary bid for additional C lots could have succeeded if there had been different bids by other bidders. In our view, it is not safe to conclude that H3G only made these bids in order to drive up prices for others.
- The approach proposed by Vodafone involves removing a major component from the auction (i.e. H3G's participation) and assuming that all other bids would have been as they were in the actual auction.

A8.52 We therefore reject the scenario proposed by Vodafone of hypothetically removing H3G from the auction and have not considered it as one of our sensitivities. For the reasons set out above, we consider that the results of such an exercise are highly artificial and unlikely to be informative.

Summary of results of sensitivities

A8.53 Figure A8.11 shows the base case (highlighted) and the sensitivities discussed above, while Figure A8.12 shows the same results as percentage deviations from the base cases for 800 MHz and 2.6 GHz respectively. Following the broad distinction set out above between basic adjustments to the LRP and alternative calculations based on different approaches or assumptions, the figures show the adjustments on the side, while the alternative calculations are set out across the top of the tables. Figure A8.13 shows the sensitivities graphically compared to the base case LRPs (and the lump sum values discussed in Section 4).

A8.54 Beginning with 800 MHz licences. Figure A8.12 shows that the possible adjustments to the base case LRP can reduce it by as much as 12% (i.e. where the coverage obligation lot is included, and the DTT coexistence liability is set at zero). The range of alternative calculations has a somewhat wider variation, from an increase of 39% based on the ASM assuming an additional 2x5 MHz of spectrum, to a decrease of 32% for the combined effect of a number of sensitivities: Vodafone's decomposition approach, nominal reserve prices, and excluding co-existence and coverage obligation costs.

A8.55 As Figures A8.11 to A8.13 illustrate:

- The assumption of no co-existence costs generates a number below the base case, while other basic adjustments make little difference;
- The decomposition approach implies a modest reduction relative to the base case;
- The ASM generates numbers above, close to, or below the base case, depending on the assumptions made about the amount of additional spectrum;
- Assuming a nominal reserve price or removing the impact of reserve prices (with no revenue constraint) can generate higher or lower numbers, depending on the other assumptions made (and whether the LRP or decomposition approach is used). Of the four versions we have presented, three are below the base case, and one is above the base case.
- Removal of the competition constraint implies a modest increase relative to the base case.

A8.56 Under these variations, the value of 2.6 GHz ranges from an increase of about 50% to a decrease of 15%. Again, the highest figures are driven by using the ASM approach, while the lowest figures are from combining the decomposition approach and assuming nominal reserve prices. Most of the variations lead to an increase relative to the base case. This is for a number of reasons, including: (a) the irrelevance of co-existence costs to 2.6 GHz; (b) the greater stability of ASM results (compared to 800 MHz) as more additional spectrum is assumed; and (c) the tendency of the decomposition approach to shift revenue from 800 MHz to 2.6 GHz.

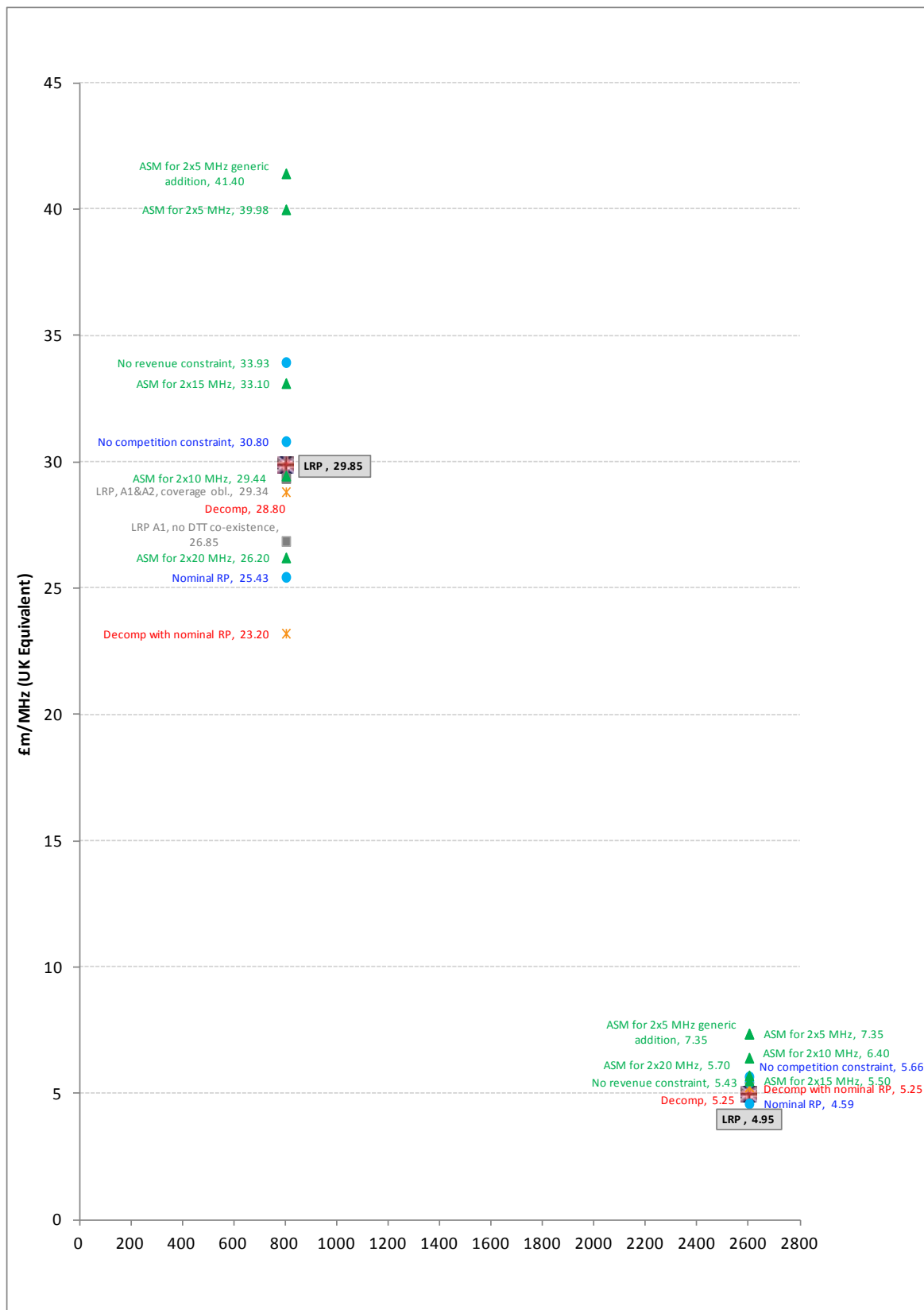
Figure A8.11 Sensitivities, £m per MHz

<i>£m per MHz</i>	LRP	Decomp	ASM for generic addition 2x5 MHz	ASM for 2x5 MHz	ASM for 2x10 MHz	ASM for 2x15 MHz	ASM for 2x20 MHz	Nominal reserve price; impact on H3G	Nominal reserve price; no impact on H3G	Removing impact of reserve price: no revenue constraint	Decomp; nominal reserve price	No competition constraint
800 MHz:												
Category A1 (no coverage obligation)	26.85	25.80	38.40	36.98	26.44	30.10	23.20	22.43	24.18	30.93	20.20	27.80
Category A1+A2 (coverage obligation)	26.34	-	-		-			21.92	23.67	30.41	-	27.29
Category A1 with DTT coexistence	29.85	28.80	41.40	39.98	29.44	33.10	26.20	25.43	27.18	33.93	23.20	30.80
Category A1, with DTT coexistence, and assignment	29.98	28.93	41.53	40.11	29.57	33.23	26.33	25.57	27.32	34.06	23.33	30.93
2.6 GHz												
Category C	4.95	5.25	7.35	7.35	6.40	5.50	5.70	4.59	4.21	5.43	5.25	5.66
Category C with assignment	5.09	5.39	7.49	7.49	6.54	5.64	5.84	4.72	4.35	5.57	5.39	5.80

Figure A8.12 Sensitivities, relative to base case

<i>%age terns, relative to the base case</i>	LRP	Decomp	ASM for generic addition 2x5 MHz	ASM for 2x5 MHz	ASM for 2x10 MHz	ASM for 2x15 MHz	ASM for 2x20 MHz	Nominal reserve price; impact on H3G	Nominal reserve price; no impact on H3G	Removing impact of reserve price: no revenue constraint	Decomp; nominal reserve price	No competition constraint
800 MHz:												
Category A1 (no coverage obligation)	-10%	-14%	29%	24%	-11%	1%	-22%	-25%	-19%	4%	-32%	-7%
Category A1+A2 (coverage obligation)	-12%	-	-	-	-	-	-	-27%	-21%	2%	-	-9%
Category A1 with DTT coexistence	0%	-4%	39%	34%	-1%	11%	-12%	-15%	-9%	14%	-22%	3%
Category A1, with DTT coexistence, and assignment	0%	-3%	39%	34%	-1%	11%	-12%	-14%	-8%	14%	-22%	4%
2.6 GHz												
Category C	0%	6%	48%	48%	29%	11%	15%	-7%	-15%	10%	6%	14%
Category C with assignment	3%	9%	51%	51%	32%	14%	18%	-5%	-12%	12%	9%	17%

Figure A8.13 Sensitivities



Annex 9

Whether there is an asymmetric risk of inefficient use of spectrum from setting ALFs too high or too low

Introduction

- A9.1 Some of the current licence holders have put to us a number of ways in which setting ALFs above market value could, in their view, lead to inefficient use of spectrum. In addition they have argued that the risks of setting ALF too high and setting ALF too low are asymmetric, with the risks of setting ALF too high being greater. They argue that, in light of the uncertainty over the true market value of spectrum, we should set ALF more conservatively as a consequence of this asymmetry.
- A9.2 We recognise that there is uncertainty about the market value of 900 MHz and 1800 MHz spectrum. We have therefore considered whether there is a material risk that (inadvertently) setting ALFs above true market value, or (inadvertently) setting ALFs below true market value, could lead to a significant welfare loss arising from the inefficient use of spectrum.
- A9.3 In this Annex:
- We set out the arguments put forward by the licence holders;
 - We assess whether setting ALFs too low or too high could lead to inefficient allocation of spectrum;
 - We then consider whether there is an asymmetry as between setting ALFs too low or too high in respect of the efficiency with which spectrum is used by existing licence holders.
- A9.4 Our provisional conclusion is that, on balance it is not appropriate to set ALFs either below or above the levels implied by our best estimates of market value for reasons of spectrum efficiency for the following reasons:
- We consider that there may be a risk that setting ALF too high will trigger a return of spectrum, with a consequent fallow period over which the spectrum concerned is not used efficiently. However, there are also risks of inefficient use of spectrum from setting ALF too low if, as a result, the spectrum is not transferred to the highest-value user. We recognise there may be an asymmetry – i.e. the risk to inefficient use of spectrum may be greater from setting ALFs too high than from setting them too low, in particular if ALF were to be set at a level above the valuation of the highest-value user. However, our approach to setting ALF is based on auction prices rather than the private valuations of winning bidders; hence, the private valuations associated with the licences to which we are applying ALF are likely to be considerably higher than the level of ALFs that we are proposing. Moreover, to the extent that there is some value associated with sunk investment in the existing licences, the point at which ALF would trigger a return of spectrum should be that much higher

still. These considerations significantly reduce the chances of the ALFs we propose being set (inadvertently) so much higher than the actual market value that they trigger a return of spectrum. In our judgement, this significantly mitigates the asymmetric risk concern.

- In the case of efficiency of use by existing licensees, there is some risk that setting ALFs either below or above our best estimate could lead to a failure to incentivise efficient use and efficient investment decisions. There is no clear reason to expect that the risk of setting ALFs too high or too low is asymmetric.

- A9.5 It has been argued that lower ALFs could benefit consumers through lower prices. However, we consider that, to the extent that the level of ALF affects consumer prices, there is a risk of distorting downstream market signals by setting ALFs too low as well as too high. We have not identified an asymmetry from one risk being greater than the other.
- A9.6 ALFs could also affect operators' choices when making trade-offs between spectrum and network investment. It is not clear in this case that there are material sources of asymmetry between the effects of ALFs being set too high or too low.
- A9.7 We also reach a provisional conclusion that it is not appropriate to set ALFs below our best estimate of market value to allow for the possibility of falling spectrum values over the coming years.

Submissions by licence holders

- A9.8 Frontier Economics, in a report on behalf of Vodafone, argues that where the market value of spectrum is uncertain, there is a "strong asymmetry" between the welfare loss from setting ALF above the market value, which the Frontier Economics report considers will be significant, and the welfare loss from setting ALF below the market value, which the Frontier Economics report considers may be small, or zero if spectrum is currently optimally allocated. The Frontier Economics report argues that the current allocation of spectrum is likely to be optimal, due to sunk investments in spectrum holdings, and given the ability of operators to trade spectrum.
- A9.9 The Frontier Economics report argues that:
- Setting ALFs to reflect the market value of spectrum is consistent with an optimal allocation of spectrum if the market value is known with certainty. However, where the market value is uncertain, there is a strong asymmetry in the welfare losses associated with different outcomes: setting an ALF above the true market value will lead to significant welfare losses compared to setting ALFs conservatively, where the welfare loss may be small, or zero if spectrum is currently optimally located.
- This is because, where spectrum is returned and lies fallow (following the imposition of an ALF that is in excess of the true market value), even for a small period, there will be a significant and persistent impact on society's welfare.
- A9.10 The report adds that the spectrum is likely to be under-used for a time before it is handed back, and for a time after it is re-awarded. It cites a report for DCMS

stating that public mobile communications were worth £30.2 billion in 2011, and that 80% of this value derived from consumer surplus.

A9.11 The Frontier Economics report comments that:

If ALFs are to be set at a constant level, then they should be set to reflect the long-term value of the spectrum, which may be lower than implied by current valuations due to expected increases in the supply and fungibility of spectrum in the medium and long term.

A9.12 In addition to this risk of static inefficiency due to spectrum lying fallow, the Frontier Economics report identifies a risk of dynamic inefficiency if ALF is set above market value (but below the licence-holder's private value):

...[O]nce an operator has sunk costs in network equipment which is reliant on a given spectrum band, it may continue to pay ALFs even if they were raised considerably above the market value.

[...]

An increase in ALFs above the market value would effectively be a partial transfer of the value of the sunk investments from the operator to the government, and could result in the operator not fully recovering its initial investments in these assets. This partial expropriation of the value of operators' assets would set a regulatory precedent, and could lead to operators foregoing future investments due to the perceived regulatory risk.

A9.13 The same broad points were made to us by EE. In addition, the following points have been put to us as to why the ALFs should be set conservatively:

- a) If innovation by licence holders led to an increased market value for their spectrum, and this was reflected in upwards revision of ALFs, this could reduce the incentive to innovate. This effect would be greater for higher ALFs than for lower ALFs;
- b) ALF reduces buyer and seller's net value, reducing the scope to overcome transaction costs;
- c) On the presumption that Ofcom intended to revise ALFs infrequently to minimise uncertainty, ALF should be conservative to allow for the possibility of falling spectrum values over the coming years.

Assessment

A9.14 In the remainder of this annex we consider the above points, together with other factors that may have a bearing on whether there is a (greater) risk of setting ALFs too high or too low. In this context it is important to distinguish between the different roles that ALF could potentially play in relation to spectrum efficiency. In terms of the price signals it provides to current and potential users of the spectrum, ALF could affect efficiency by incentivising:

- a) Allocation of the spectrum to the most efficient user, which could involve a change in the operator holding the licence; and

- b) Efficient use of spectrum by the licence holder (such as in the licence holder's choices when making trade-offs between spectrum and network investment).

A9.15 Accordingly, the remainder of this annex considers the following issues in turn:

- The potential risks associated with inefficient spectrum allocation, covering:
 - Reduced gains from trade, relative to transaction costs; and
 - The cost to society of returned spectrum lying fallow.
- The potential risks associated with inefficient use of spectrum when held by the current licencees:
 - Regulatory risk associated with perceived asset expropriation;
 - The disincentive to innovate in ways that increase the value of spectrum.
 - The impact on efficient investment and use of spectrum by operators; and
 - The risks relating to price signals in downstream markets.

Risks of inefficient spectrum allocation

Reduced gains from trade, relative to transaction costs

A9.16 It has been put to us that a higher ALF reduces buyers' and sellers' net value of holding spectrum, hence reducing the scope to overcome transaction costs. Detailed arguments were not provided to support this suggestion. In the absence of these, our perspective is that, whilst a higher ALF would reduce the buyer's willingness to pay for spectrum, it would also reduce the price at which the seller was willing to sell by the same amount; accordingly, it would not alter the potential gain from trade.

The cost to society of returned spectrum lying fallow

A9.17 The scenario put forward by Vodafone EE is that a licence holder returns a spectrum licence as a result of high ALF, leading to a situation in which spectrum is unused or under-used for a period of time before it is re-assigned to a new operator. For this to occur, we note that the ALF would have to be higher than the private value of the licence to the operator *including* any additional value derived from sunk investment in licence-specific assets (an issue to which we return below).

A9.18 Potential outcomes are set out in Figure A9.1 below, in which we assume for simplicity that either the current user or a specific alternative user, Firm X, is the highest-value user. Note that in the second column, covering outcomes [I] and [IV], this means that ALF is set below full market value¹⁷⁶; and in the third and fourth columns, covering outcomes [II], [III], [V] and [VI], this means that ALF is set above full market value.

A9.19 In the first row, outcomes [I] to [III], the current user is the highest-value user.

¹⁷⁶ For the purpose of this discussion, we take full market value to be the value of the second-highest-value user of the spectrum.

- In the first two of these outcomes (one where ALF is below full market value and one where it is above full market value) there is no effect on spectrum holdings or user, and so the ALF cannot lead to a “fallow period” inefficiency.
- In outcome [III] (where ALF is above full market value) the current user returns the spectrum and then wins it back at a lower price. In this case, there is a fallow period inefficiency of the kind described by the licencees,¹⁷⁷ with no offsetting efficiency gain.

A9.20 In the second row, outcomes [IV] to [VI], Firm X is the highest-value user.

- In outcome [IV] (where ALF is below full market value), the ALF is too low to prompt a change of use, even though the current user is not the highest-value user.
- A change of use occurs in outcome [V] (where ALF is above full market value) leading to some inefficiency from spectrum lying fallow, but an increase in efficiency from a switch to the highest-value user. The net effect on efficiency is uncertain. However, as the illustrative example in Figure A9.2 shows, it is quite possible that an increase in efficiency from a change in spectrum use could outweigh the loss of efficiency from spectrum lying fallow.
- Outcome [VI] (where ALF is above full market value) is similar to outcome [V], except there is a need to reduce the spectrum price, whether by setting a lower ALF or realising a market price through an auction.

¹⁷⁷ For simplicity, we are not distinguishing between the fallow period when re-acquired by the same licence holder, and the fallow period when acquired by a new user, though there could be potential for the two to have different durations.

Figure A9.1 Potential for ALF spectrum to lie fallow

	•	ALF is below current user's value and below Firm X's value (and so is below full market value)	ALF is below highest-value user's value, but above second-highest-value user's value	ALF is above highest-value user's value
Current user is highest-value user		[I] No change in user. The "fallow period" inefficiency does not arise. No potential gain from spectrum moving to a higher-value user.	[II] No change in user. The "fallow period" inefficiency does not arise. No potential gain from spectrum moving to a higher-value user.	[III] Current user returns spectrum and acquires it again at a lower price when it is re-awarded; there is a "fallow period" inefficiency with no offsetting efficiency gain (that would arise if the spectrum were passing to higher value user).
Firm X is highest-value user		[IV] No change in user occurs, the "fallow period" inefficiency is avoided but a potential gain from spectrum moving to a higher value user is foregone.	[V] Change in user occurs, but the "fallow period" inefficiency is offset by a gain from spectrum moving to a higher value user.	[VI] Current user returns spectrum and new, higher value user acquires it (with lower ALF level than previously); but the "fallow period" inefficiency is offset by a gain from spectrum moving to a higher value user

Figure A9.2 Illustrative example

The following example illustrates the incremental value of moving spectrum to a higher value use, and compares this with the transitional cost of the spectrum lying fallow for a period (both effects happening as a result of ALF being set above the value to the incumbent user). Suppose that a spectrum licence has a social value of £500 million per annum in the hands of the incumbent,⁽¹⁾ that a higher-value user would generate 20% greater social value than the existing user, and that the time for which the spectrum would lie fallow is three years (e.g. one year of lost welfare as the incumbent clears the spectrum, one year for Ofcom to re-allocate the spectrum, and one year for the new operator to reconfigure its network). The impact on social value would be as follows:

Social value per annum of current user	£500m
NPV of this social value in perpetuity ²⁾	£14.3bn
NPV of current user from year 4 onwards	£12.9bn
Implied cost of 3 year fallow period	£1.4bn
Social value per annum of new user:	£600m
NPV of new user from year 4 onwards:	£15.5bn
Efficiency gain associated with new user from year 4	£2.6bn
Overall change in social welfare:	£1.2bn

The NPV in new use deferred for three years (£15.5bn) is higher than the original NPV (£14.3bn). The increase in PV associated with the switch to the higher value user (of £2.6bn) is greater than the cost of the 3 year fallow period (£1.4bn). If the fallow period were two years rather than three⁽³⁾ the overall social welfare gain would be larger. On the other hand, the overall welfare effect could be negative if there were a smaller efficiency gain from the new user or the fallow period were longer.

Notes:

⁽¹⁾ This is broadly consistent with the Analysys Mason report cited by Frontier Economics, which estimates a social value of £30 billion from mobile communications, using 580 MHz of spectrum, and assuming the licence is for 2x5 MHz of spectrum. However the results in this illustrative example do not depend on the assumed absolute value of spectrum.

⁽²⁾ As this is predominantly consumer surplus, the social discount rate of 3.5% is assumed.

⁽³⁾ Or similarly, if only half the welfare were lost in the first and third years (as indicated by Frontier Economics (Figure 6)).

A9.21 In summary, where the current licence holder is the highest-value user, then setting ALF below this licence-holder's valuation will have no effect, while setting ALF above this licence holder's valuation will lead to an inefficient outcome. If another user is the highest-value user, then there is a risk of inefficiency in setting ALF too low – i.e. setting it below the current user's valuation (which, by definition, is either

at or below the market price). In this case, whether there is, in fact, a net inefficiency will depend on the relative importance of the efficiency benefit from a change of user compared to the efficiency loss from fallow spectrum – see the illustrative example in Figure A9.2.

- A9.22 We note that this full set of outcomes can only arise if efficient trading does not, take place. If spectrum licences are always efficiently traded, then the outcomes in the bottom row – i.e. where another user is the highest-value user – would not be sustainable. In this case then only outcomes [I] to [III] in Figure 9.1 would be possible – i.e. the effect of ALF on this aspect of the efficient use of spectrum would either be zero ([I] or [II]) or negative [III].
- A9.23 The Frontier Economics report for Vodafone makes two points of direct relevance here: first, that current licence holders will generally be the most efficient users of spectrum in future; and, second, to the extent that re-allocation of spectrum could increase efficiency, operators will have incentives to trade regardless of ALF (so that the spectrum transfers to the highest value user).
- A9.24 While we accept that it may be true that current licence holders will often be the most efficient users of spectrum, we note that this need not invariably be, or remain, the case. The possibility of this situation arising is illustrated by the auction of spectrum in the 900 MHz band in the Netherlands, in which KPN and Vodafone won 2x10MHz each (a reduction from their pre-auction holdings of 2x12.5MHz), while T-Mobile increased its holdings from 2x10 MHz to 2x15MHz.
- A9.25 The identity of the most efficient user has the potential to change over time and is difficult for the regulator to accurately assess.
- A9.26 We considered the issue of trading in our Strategic Review of Spectrum Pricing (SRSP).¹⁷⁸ This Statement set out the principle (paragraph 4.191) that:

Many secondary markets are unlikely to be sufficiently effective to promote the optimal use of the spectrum without the additional signal from AIP. Therefore AIP will likely continue to be needed to play a role complementary to spectrum trading for most licence sectors.

- A9.27 We note that the fee review in this consultation document does not come within the scope of the SRSP. However, we consider that our analysis of AIP and spectrum trading in the SRSP is relevant to the argument put forward by Frontier Economics in the context of ALF.
- A9.28 Some commentators on our SRSP commented that AIP was incompatible with tradable licences. We set out our view (paragraphs 4.200 to 4.204) that:

“[T]he key question enabling us to reduce the need for AIP would be the existence of a sufficiently effective secondary market”, but “we would need to assess this on a case-by-case basis”

“AIP can improve spectrum efficiency where there are high transaction costs, lack of price information, and co-ordination problems”;

“Some licensees might be more responsive to a direct cost such as AIP than to forgone revenue that they might achieve through trading.” One example of this was public sector users, but we noted that “More generally, when strong pressures are put on managers to reduce or contain their operating budgets, but less importance is placed on realising untapped revenue sources such as might arise from selling spectrum, AIP can provide a more powerful incentive for licensees to use spectrum efficiently than the possibility of selling unwanted spectrum”.

- A9.29 In the present case, we note that there is a small number of sophisticated licence-holders, who are aware of each others’ spectrum holdings, and who are likely to be relatively well-informed about price. However, there is also the potential for strategic considerations to affect the efficiency of trading. Ofcom has allowed mobile operators to trade their spectrum rights since June 2011.¹⁷⁹ To date, the only spectrum trade that has occurred has been the divestment by EE of 2x15 MHz of 1800 MHz spectrum, as a merger condition.
- A9.30 We therefore consider that there is a risk that efficiency-improving re-allocation of spectrum will be foregone if ALF is set below market value. However, on balance, taking all the above points together, we agree that the potential for the level of ALF to lead to inefficiency in allocation is likely to be greater where ALF is (inadvertently) set too high than where it is (inadvertently) set too low. The risk of inefficiency from ALF being set (inadvertently) too high is greatest where (a) there is no higher-value user than the current licence holder, and (b) the ALF is set above the value to the current licence holder.
- A9.31 Having set out the scenarios where the level of ALF might, or might not, trigger a return of spectrum, we now consider two further issues:
- The potential impact of allocation inefficiencies;
 - The likelihood that ALF could be set at a level above the value to the current licence holder in a way which could lead to an inefficient fallow period.

Potential impact of allocation inefficiencies

- A9.32 The scale of inefficiencies that could arise from setting ALF too high or setting ALF too low may be affected by a range of considerations. For example, if an inefficiency were to arise from setting ALF too high, the following reasons might limit its impact:
- In general terms, the spectrum licences that are most at risk from being handed back in response to ALFs are those which are likely to be generating least value in their present use. Even if the typical social value of a 2x5 MHz block of spectrum were around £500 million, this might over-state the cost of a fallow period. For example, a mobile operator might consider that a particular block of spectrum to which it holds a licence is under-utilised, so that it can be relinquished with less impact on network performance, and hence on competitiveness or customer experience, than other licences held by the same operator. Furthermore, in a competitive market, consumers who perceived some drop in network performance following the return of this licence could potentially

switch to a different provider¹⁸⁰ – so the loss of consumer value would largely be limited to those consumers who are tied in to their existing provider through long-term contracts, or who perceived the next-best provider as being substantially inferior.

- Our view is that the UK mobile market is broadly competitive, and that following the 4G Auction all four national operators have the spectrum licences they need to be credible. Even if ALF is set above the marginal value to an operator of some of its licences, it is less likely that this ALF will be above the value, to the operator, of licences which that operator requires to be credible. Any operator who needs a particular block of spectrum in order to be credible is likely to place a high valuation on it, and is relatively unlikely to hand it back to avoid paying ALF. Of course, there is a potential level of ALF above which mobile operators would return even licences they needed to be credible. However, if any spectrum is relinquished in response to ALF this is more likely to be spectrum which that operator does not require to be credible, so this return of spectrum is relatively unlikely to have a significant impact on the competitive dynamic. Similarly, if an operator needed a specific block of its spectrum portfolio to introduce innovative services, or to support an important aspect of its network performance offer, it would be likely to value that block of spectrum significantly above market value.
- In contrast, an operator would be more likely to respond to ALF by handing back a spectrum licence if it did not need that particular spectrum licence in order to be a credible competitor, or to support innovative services, or as a basis for its network performance offer. However, in that case, it is less likely that a period in which that licence lay fallow, rather than continuing to be used by the incumbent operator, would have a significant impact on broader social welfare, and more likely that a change in use would improve efficiency.

Likelihood that ALF could be set at a level which would lead to inefficient fallow period

A9.33 It is useful to recap on how our proposed ALFs are informed by auction outcomes when considering the likelihood that ALF could be set at a level above the value to the current licence holder (in a way which could lead the licence holder to return its licence, thereby leading to an inefficient fallow period). Figure A9.3 provides a stylised illustration of how the level of ALF for the licence on which ALF is paid relates to the price paid for an equivalent licence acquired at auction. For simplicity, this is shown as an auction for a single licence, and with an ALF lump sum value that is calculated for a hypothetical licence which is identical in licence terms and spectrum value to the auctioned licence. The Figure distinguishes between:

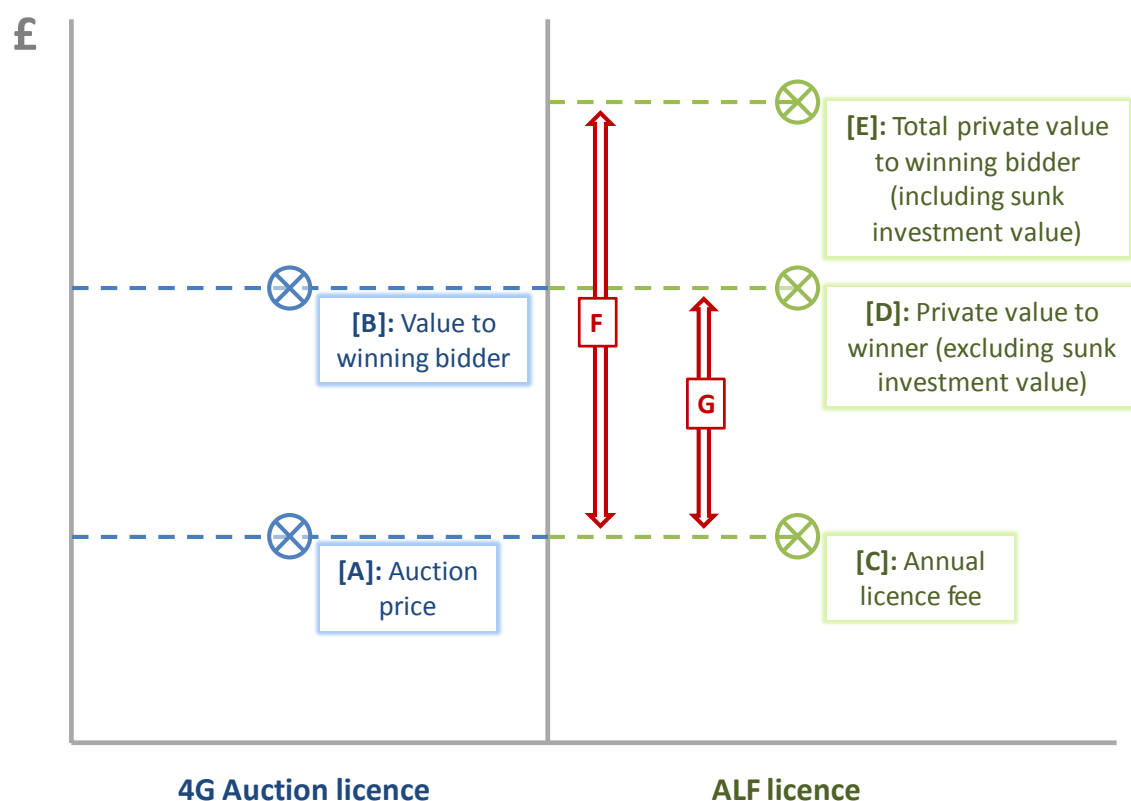
- The *auction price*, marked as [A]. In a second-price auction, this broadly reflects the *opportunity cost* of a licence – i.e. its value to the highest-value alternative user of the spectrum (i.e. other than the winning bidder in the auction).
- The *private value to a winning bidder* for a licence [B], as reflected in its auction bids (assuming the auction succeeded in ensuring bidders bid their true valuation).
- The lump-sum value from which ALF is derived [C]. As the Figure illustrates, the proposed ALFs on which we are consulting are based on prices paid in 4G

¹⁸⁰ This might not be a bad outcome for the former licence holder if the savings in ALFs exceeded the loss in profit from losing these customers.

auctions in the UK and elsewhere. For convenience we shall refer to [C] as the “target” ALF.

- The private value which a licence holder would have for its licence, if it had not made any sunk investments in assets linked to that licence [D]. While this is a somewhat abstract concept, particularly in the context of licences which have been held for many years, it is worth distinguishing this value from the total private value of a licence holder to draw out the implications of sunk costs (and the risk of perceived asset appropriation).
- The total private value of a licence holder including sunk investments [E].

Figure A9.3 Relationship between auction prices, ALF, and private valuations



- A9.34 Winning bids in the UK 4G Auction [B] were from around 80% to 160% higher than the auction prices paid by bidders [A], indicating that the four national mobile network operators each had a high private value of incremental spectrum, well above prices in the auction.
- A9.35 We are using these auction prices, rather than the higher private valuations to winning bidders, as the basis of ALF [C]. On the assumption (again) that the licences are identical, and if the holder of the ALF licence had not made any sunk investments relating to the licence, its private valuation of the ALF licence would be [D]. If the licence holder had made sunk investments, this could lead it to have a higher valuation of the licence [E].
- A9.36 The potential source of asymmetry noted above is that ALF would be set at a level which caused licence holders to return licences leading to spectrum being unused or under-used for a period of time. This risk would only materialise if ALF was set at a level above [E] i.e. substantially higher than the target ALF [C]. The arrow marked

[F] illustrates how much higher the actual ALFs would have to be than the target ALF for this to come about. In other words, ALF would need to be set at a level significantly above true market value so that it exceeded the additional private value, including the value associated with sunk investment.¹⁸¹

- A9.37 Of course, the level of [C] for the 900MHz and 1800MHz licences will not be the same as the level [A] that applies to the 4G Auction licences. However, this is captured in our assessment of benchmarks, in our consideration of the absolute value of auctioned 900 MHz and 1800 MHz spectrum in other countries, and of the relative value of these bands compared to 800 MHz and 2.6 GHz licences auctioned in the same country.

Provisional conclusion on risk of asymmetry associated with spectrum being returned and lying fallow

- A9.38 While we agree that there may be an asymmetry associated with the potential for an ALF which is too high to trigger a return of spectrum (with a consequent fallow period), the risk of inefficiency is not one-sided in that there is also a risk in this regard from ALF being set too low. However, for the reasons set out above, we consider that the evidence we are using to derive ALF significantly mitigates the asymmetric risk concern.

Risks of inefficient use of spectrum by current licence holders

Regulatory risk associated with perceived asset expropriation

- A9.39 We recognise that, in principle, there is a level of ALF which could lead to expropriation of some of the value of existing assets which are tied to the spectrum holdings concerned, in the manner argued by Frontier Economics.
- A9.40 If the level of ALF has the effect of appropriating the legitimate return on sunk investment (whether or not ALF is so high that it also makes licence holders return their licences), then this could increase the perceived regulatory risk and dampen the level of future investment in the sector in a way that is sub-optimal.
- A9.41 But, although setting ALF above market value could lead to a windfall loss of this type, setting ALF below market value could, conversely, constitute a windfall gain. We consider that, if we seek to derive ALFs based on our best estimate of market value (so that there is no systematic bias upwards or downwards) then there is no reason to expect that the potential for windfall losses will exceed the potential for windfall gains.¹⁸² In this context, we note that the potential for ALF to become out of line with market value is but one of many uncertainties that the operators face in their business. It is not clear that there should be a significant risk premium arising from this particular source of uncertainty.

¹⁸¹ The risk of asset appropriation, discussed below, is that ALF captures some of the value of sunk investments. The arrow marked [G] shows how much higher ALFs would have to be for this to happen. Clearly, this risk could come about with a smaller premium above the target ALF – i.e. [G] is smaller than [F]. Nevertheless, for this risk to materialise we would have to set an ALF that captured the whole non-sunk-investment private value of the licence holder. Again, the results from the UK 4G Auction indicate that this may be a substantial premium above an ALF based on auction prices.

¹⁸² We also note that in most cases the licences concerned have been held for a number of years, and that licence holders have paid fees which are substantially below those we are currently proposing.

Incentive to innovate

- A9.42 A licence holder has put to us that mobile operators may be deterred from innovating by the risk that this will lead to a subsequent increase in the value of spectrum and to an increase in ALF; this licence holder suggests that the effect would be greater for higher ALFs than for lower ALFs.
- A9.43 This concern appears to rely on a feedback mechanism in which the investment that a firm makes leads to an increase in the value of spectrum and, as a result, the same firm is then required to pay higher ALFs. A distinction can be drawn between (a) innovation that raises the market value of the spectrum (such as innovative in new downstream products that are valuable to consumers and increased the profits that can ultimately be earned by other relevant licence holders) and (b) innovation that (perhaps temporarily) improves the innovator's relative competitive strength and profitability but does not lead to a longer term increase in industry-wide profits because the benefits are passed on to customers through the effect of competition. In the first case the full market value would increase; however, the innovator will earn higher profits before its innovation becomes available to other operators to exploit and before the level of ALF is adjusted in response. In the second case, the market value of the associated spectrum would not increase and, hence, ALF will not increase.
- A9.44 More generally, we consider there is a strong incentive to innovate. Our view is that the market is broadly competitive, and we expect this to continue following the 4G Auction. As a result we consider that the operators have a strong incentive to innovate, both to differentiate their offers from competitors, which can allow them to earn supernormal profits until the rest of the market catches up (as in other competitive market environments), and also to avoid being placed at a competitive disadvantage. If a firm expected an innovation to increase the future market value of spectrum, we consider that it is unlikely to be deterred from such an innovation by the prospect of future ALF increases.

Impact on efficient investment and use of spectrum by operators

- A9.45 Spectrum prices have an important role in informing efficient investment decisions and encouraging efficient use of spectrum. In this context, we do not consider that there are material sources of asymmetry as between the effects of ALFs being set too high or too low. That is, in terms of incentivising efficient use of spectrum compared to alternative inputs such as network investments, ALFs that are too low and ALFs that are too high both have the potential to distort efficient choices by sending the wrong price signals.

Impact on downstream market signals

- A9.46 A further risk relates to the potential to distort downstream market signals to the extent that the level of ALF affects consumer prices. For example, if consumer demand is made to seem artificially high because prices do not reflect the true opportunity cost of the spectrum used to serve them, then this could lead mobile operators to seek more additional spectrum to meet this demand (at the expense of other uses of the spectrum) than they would seek if downstream prices fully reflected the market value of spectrum.¹⁸³

¹⁸³ We note in this context an argument by Vodafone that “[L]ower charges can be assumed to translate into clear benefits to consumers, through lower prices and/or increased investment and

Provisional conclusion on risks to efficiency of use by current licence holders

- A9.47 In summary, whilst there are risks to the efficiency of use by current licence holders, we see no clear reason why there should be an asymmetry in this regard as between (inadvertently) setting ALFs that are above true market value and (inadvertently) setting ALFs that are below true market value .

Allowing for the possibility of changing spectrum values

- A9.48 Finally we consider the argument that, if Ofcom intends to revise ALFs infrequently to minimise uncertainty, ALF should be set on a conservative basis to allow for the possibility of falling spectrum values over the coming years.
- A9.49 UK and international auction prices, which are our primary source of evidence on the market value of spectrum, reflect the market's current view of the value of spectrum over the next twenty years. Such auction prices paid for long-term licences should take into account expectations of future increases in supply and fungibility of spectrum as well as other factors affecting the value of the spectrum.
- A9.50 There remains the potential for such expectations to be too optimistic or pessimistic about the value of spectrum (or for there to be changes in the relative value of bands, e.g. sub-1 GHz and higher-frequency bands). However, it is not clear-cut whether the value of spectrum is more likely to increase or decrease in future.
- A9.51 Turning to the argument that increased availability of spectrum in future is likely to reduce its value, this is only relevant if the increase was more than was expected at the time of the auction and so was not already built into bidders' valuations. Moreover, there are factors that work in the other direction, notably in relation to consumer demand. For example, in our November 2012 UHF strategy statement (paragraph 1.4) we noted that:

In particular there is unprecedented growth in the demand for mobile data [...] between 2011 and 2012 the amount of data handled over UK mobile networks has more than doubled. In future, under a mid growth scenario, there could be an 80-fold growth in this demand by 2030, driven by the increasing take-up and use of smartphones, tablet PCs and machine-to-machine applications.¹⁸⁴

- A9.52 Changes in the underlying drivers of spectrum value (that were not anticipated at the time of the auction) could, if sufficiently material, be taken into account in a future review of ALF (discussed in Section 6).
- A9.53 We provisionally conclude that it is not appropriate to set ALFs below our best estimate of market value to allow for the possibility of falling spectrum values over the coming years.

innovation. Conversely, higher charges may well result in higher prices and/or may deter operators from investing in network improvements or expansion." For the reasons set out here, we do not consider that there is a basis for Ofcom bringing about lower consumer prices if this entails introducing a market distortion.

¹⁸⁴ http://stakeholders.ofcom.org.uk/binaries/consultations/uhf-strategy/statement/UHF_statement.pdf.

See also "Valuing the use of spectrum in the EU; an independent assessment for the GSMA", Plum Consulting, June 2013, http://www.plumconsulting.co.uk/pdfs/Plum_June2013_Economic_Value_of_spectrum_use_in_Europe.pdf.