Annex 9

Technical and commercial evidence

Introduction

A9.1 This annex sets out further material on technical and commercial evidence which supports our assessment in Section 1 on future spectrum availability and in Section 3 on estimating lump sum values.

A9.2 This annex covers:

- Possibility of greater certainty around spectrum availability; and
- Network cost modelling.

A9.3 Stakeholders provided a significant level of comment on other matters relating to technical and commercial factors in the October 2013 consultation which they argued should inform our estimates of spectrum value. While we will address these comments when we make our final decision (to the extent necessary to explain our reasoning), we focus here on the points on which we have done further work to inform our proposals and position.

Possibility of greater certainty around spectrum availability

A9.4 Vodafone highlighted the difference in mobile downlink spectrum available by 2030 shown in Real Wireless' work for Ofcom in March 2012 compared to our Mobile Data Strategy consultation, suggesting this showed "a very significant increase since the Auction".[1] It argued that greater certainty over future spectrum availability moves 900 MHz 'further down the queue' in the expectation of future incremental LTE use. It suggested that 700 MHz, 2.3 GHz and 3.4 GHz spectrum will become available to operators for 4G use before 900 MHz spectrum can be so used.

A9.5 Vodafone also highlighted a number of international developments since some of the European benchmark auctions, which it said generally indicated that more spectrum will be available than previously expected and in generally shorter timeframes.

A9.6 The bands where there is currently most momentum behind mobile use are 700 MHz, 2.3 GHz, 3.4 GHz and 1452 - 1492 MHz. For all of these bands, the suggestion that they could be used for mobile broadband pre-dates bidding in the UK 4G auction in January and February 2013. However, we accept that there have been further developments since then.

- **700 MHz.** We published our UHF Strategy statement in November 2012, which set out our intention to enable the 700 MHz band to be used for mobile broadband once internationally harmonised. This followed the World Radio Conference in February 2012 which paved the way to a decision to enable the 700 MHz band to be used for mobile broadband after the next World Radio Conference in 2015. Work on the 700 MHz band has progressed since the 4G

[1] Vodafone response, Annex 8, pp.18-19

auction, leading to us publishing a consultation document on 28 May 2014 that proposed change of use of the band to mobile broadband from 2022, or possibly up to two years earlier. Whilst the future of this band remains subject to final decisions which are yet to be taken, 2x30 MHz plus 20 MHz of unpaired spectrum for SDL could be made available.

- **2.3 GHz and 3.4 GHz.** This spectrum comprises 40 MHz in the 2.3 GHz band and 150 MHz above 3.4 GHz. It has been earmarked for release by the MOD since early 2011 and an update was provided in December 2011 indicating that MOD was prioritising this release[2]. A ministerial statement in December 2012 indicated that the MOD intended to auction around 200 MHz of spectrum usage rights, and that the preparations for the auction were expected to start at the end of 2013.[3] The MOD has asked Ofcom to award this spectrum and the auction is planned to occur in 2015/16. We have published four consultations / calls for inputs on this award since the 4G auction including a call for input in October 2013 and a consultation on technical coexistence issues in February 2014).[4]

- **1452-1492 MHz.** The prospect that this band could be made available for mobile use first arose in early 2011, around which time a project team was formed to investigate possible uses of this band, one of which was mobile multimedia or SDL. This would likely have solidified into a stronger expectation towards the end of 2012 and during 2013 with the issued ECC report in February 2013[5] and the approval of the ECC Decision that harmonised the band for SDL in November 2013. More recently, in March 2014 the Commission mandated CEPT to develop harmonised technical conditions in this band for wireless broadband electronic communications services. CEPT issued a draft report in relation to this band in June 2014. The actual use of the band for mobile depends on the willingness of manufacturers to begin producing devices that support SDL in the band. We understand that a standards meeting in June 2014 (3GPP – RAN Plenary) officially endorsed 1452-1496 MHz as band 32 in their list of mobile broadband bands, which is a significant milestone in developing equipment for the band, although more work on international agreement over the use of the band may also be important. We are currently considering a request for licence variation by the UK licensee, Qualcomm, which, if granted, would help facilitate the introduction of SDL in this band.

A9.7 We also identified a number of other bands for potential mobile use in our Mobile Data Strategy statement in May 2014 which set out our plans to consider the bands in more detail in the future. However, the statement (as well as the preceding consultation) identified a range of constraints in relation to change of use of those bands and did not set out a definitive plan for their release.

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[2] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/77460/Spectrum-Public-Update-December-2011.pdf . "Spectrum with clear commercial applications and value, such as public mobile, where demand is highest and can contribute the greatest value to the economy has been prioritised for release: • Action is underway by the MOD to free 160MHz from 2.3 GHz-2.4 GHz and 3.4 GHz-3.6 GHz bands which have been identified for public mobile use by the end of 2016."

[3] http://www.publications.parliament.uk/pa/cm201213/cmhansrd/cm121217/wmstext/121217m0001.htm#1212171000006

[4] http://stakeholders.ofcom.org.uk/spectrum/public-sector-spectrum-release/

[5] http://www.erodocdb.dk/Docs/doc98/official/Word/ECCREP188.DOCX

A9.8 At the same time there has been some progress in international fora on potential future mobile spectrum, in particular preparations for Agenda Item 1.1 of WRC-15, although at this stage the outcome of that Agenda Item is still uncertain.

A9.9 In any case, most further spectrum releases will take place some years into the future. We discuss the development of the ecosystem for LTE900 (which has implications for the timing of LTE use by 900 MHz compared to other bands) in paragraphs A7.80-A7.82 of Annex 7.

Network cost modelling

A9.10 Vodafone, and Plum on behalf of EE, argued that technical modelling could provide useful information alongside auction values as to the value of spectrum, and highlighted that Ofcom has used technical cost modelling in the past. Vodafone said that the model used for the 700 MHz CBA could provide a useful high level indicator of the value of 900 MHz spectrum and could be a useful starting point for developing a model specifically for valuing 900 MHz, while Plum suggested the 2012 Real Wireless model for Ofcom could be used to draw some high level conclusions to inform Ofcom's valuations.

A9.11 In general, we recognise the value of technical modelling, and clearly this is a source of information which Ofcom has employed in numerous circumstances. However, as set out in the October 2013 consultation, such modelling is highly sensitive to the range of assumptions that need to be made, such that we considered that an attempt to derive point estimates of value based on this approach would be of limited additional benefit in deriving our proposals on ALF.

A9.12 To test this position we have adapted the Analysys Mason 700 MHz model in an attempt to assess the value of 900 MHz spectrum. This is an updated version of the model flagged by Vodafone that was used to assess the benefits of using the 700 MHz band for mobile services. Below we set out the changes we have made to this model, the key results of our analysis and the reasons why we do not propose to use this evidence in informing our proposalson ALFs.

Changes to 700 MHz model

A9.13 A full explanation of the modelling approach and the assumptions used in the 700 MHz model are explained in the Analysys Mason report.[6] This model focussed on the award of sub-1 GHz spectrum to a generic operator in 2022. We have made some adjustments to this model to be more representative of the 900 MHz band and focussed on an operator that does not currently hold 900 MHz rather than a generic operator. We summarise these changes in Table A9.1.

A9.14 We have modelled the following two scenarios:

- Include the cost of deploying 900 MHz carriers on all sites in 2015. This is likely to underestimate the net cost saving because, if EE or H3G acquired 900 MHz spectrum, we expect that in a large proportion of sites there would be no need to deploy 900 MHz.

[6] Analysys Mason, May 2014, *Assessment of the benefits of a change of use of the 700 MHz band to mobile*
http://stakeholders.ofcom.org.uk/binaries/consultations/700MHz/annexes/benefits_700MHz.pdf

- Include the cost of deploying 900 MHz carriers on 15% of sites in 2015. In our study of the benefits of changing use of the 700 MHz band we estimated 700 MHz carriers would be deployed on less than 15% of macro sites. Therefore this scenario is likely to give a more accurate estimate of the value of the 900 MHz band.

Table A9.1: Changes to the Analysys Mason 700 MHz model

Change	Explanation
Model 900 MHz rather than 700 MHz	We have modelled 2x5 MHz of sub-1 GHz spectrum being made available from 2015 and used for LTE. We also assume 2x30 MHz of sub-1 GHz spectrum (the 700 MHz band) is made available in 2022.[7]
Adjusted modelling period	The 700 MHz modelling period was 2022 – 2041. We have changed this to 2015 – 2034.
Adjust spectrum holdings	The 700 MHz model focussed on a generic operator. Here we have focussed on an operator not currently holding 900 MHz – that is, EE or H3G. We have adjusted the assumed spectrum holdings of the generic operator to reflect either EE's or H3G's holdings. All future spectrum awards are assumed to be the same as in the 700 MHz model, i.e. each operator is awarded approximately 25% of each new spectrum band.
Adjust starting number of sites	In the 700 MHz model it was assumed the generic operator would have between 16,000 and 17,500 macro sites at the start of 2018. We have adjusted the starting number of sites to reflect the earlier modelling period and the difference between EE, H3G and the generic operator. For these purposes, we have assumed EE will have between 16,000 and 17,500 macro sites at the start of 2015, while H3G will have between 12,000 and 16,000.
Adjust market / traffic share	The 700 MHz model focussed on a generic operator which had a 25% market / traffic share. Given the length of the modelling period there is significant uncertainty over individual operators' traffic shares. Therefore we have kept the 25% assumption for EE and H3G. However we have also modelled an alternative scenario where H3G's traffic share is 15%.
Discount at the WACC	The 700 MHz model used the Spackman method to discount capital costs. For assessing the value for ALFs we have used the pre-tax nominal WACC of 9.0% as discussed in the second footnote of Annex 10, attached to paragraph A10.5.

900 MHz: network cost savings

A9.15 Based on these assumptions we have estimated the network cost savings from availability of the 900 MHz band to EE and H3G between 2015 and 2034. For each scenario we have presented a range due to uncertainty over the proportion of sites that 900 MHz spectrum will be deployed on. In the 700 MHz model we also

[7] We have not included possible use of the 700 MHz centre gap for SDL in our modelling. Use of the centre gap for SDL is more uncertain than paired use of the band. In any case, including an additional 20 MHz of sub 1 GHz spectrum from 2022 would have a limited impact on the results below.

considered the additional performance benefits that the spectrum may deliver. We have not considered this type of benefit here but it would increase the value of the 900 MHz spectrum above the estimates in Table A9.2.

Table A9.2: Net present value of network cost savings of holding 2x5 MHz of 900 MHz spectrum between 2015 and 2034 (in £m per MHz)

	EE 25% traffic share	H3G 15% traffic share	H3G 25% traffic share
High	107 – 123	45 - 56	127 - 138
Central High	87 – 102	37 - 47	111 - 121
Central Low	57 – 73	4 - 18	68 - 82
Low	24 – 38	0 - 6	32 - 45

A9.16 The modelling results indicate a very wide range for the value of the 900 MHz band of between zero and £138 million per MHz. The range of results illustrates the significant uncertainty over a number of parameters in the model. Amongst other factors the high and central high estimates are driven by higher traffic forecasts, lower growth in spectral efficiency and higher dependence on sub-1 GHz spectrum than the low and central low estimates. The assumptions that drive the low, central-low, central-high and high estimates are set out in full in the Analysys Mason report.

A9.17 In most cases the results are significantly higher than the estimated value of the 700 MHz band. This high value is principally a result of EE's and H3G's low holdings of sub-1 GHz spectrum between 2015 and 2022 combined with a modelling assumption that between 18% and 22% of traffic must be served with sub-1 GHz spectrum. Therefore, without access to the 900 MHz band both operators need to deploy a large number of sites in the 2015 – 2022 period. This assumption attempts to capture the importance of sub-1 GHz spectrum to a generic operator. The rationale behind the range used is explained in the Analysys Mason report.

A9.18 In fact, both EE and H3G offer mobile broadband services today using little or no sub-1 GHz spectrum. This could be taken as evidence that operators without significant holdings of sub-1 GHz spectrum can adapt their commercial strategies to mitigate the coverage and performance disadvantages they face as a result of their predominantly higher-frequency spectrum holdings.

A9.19 Alternatively, it could be argued that these operators could gain a competitive advantage, relative to their current position, if they had access to more sub-1 GHz spectrum. The 700 MHz model treats the amount of traffic as fixed and estimates the cost of providing capacity to meet this level of traffic for different spectrum holdings. However, in practice an operator which is able to serve more traffic will be able to compete more effectively and therefore win more customers. The model does not capture this effect. For operators that hold relatively little sub-1 GHz spectrum, EE and H3G, the benefit of being able to serve more traffic could be more important than the network cost savings that low frequency spectrum can deliver.

A9.20 The model is not designed to reflect this, which is a significant limitation in the context of ALF. The model outputs are sensitive to this assumption. As an illustration we reduced the proportion of traffic that must be served by sub-1 GHz spectrum in the model to between 10% and 14%. This reduces the value per MHz

substantially. For example, in the central high case for EE the value per MHz is between £24 million and £38 million.

A9.21 Therefore, there is a significant risk that the structure of the model, which was designed for a different purpose, is not well-suited to modelling the value of 900 MHz to specific individual operators.

A9.22 We have not attempted to adapt the Real Wireless model highlighted by Plum. We believe adapting this model would face similar difficulties as illustrated in our adaption of the Analysys Mason model. In addition, the model faces a further problem in modelling absolute values as it focuses on sub sections of the country, and therefore any results would need to be extrapolated which would be subject to added uncertainty.

Relative value of 800 MHz and 900 MHz

A9.23 The model as currently designed and specified does not distinguish between 800 MHz and 900 MHz spectrum. In principle it would be possible to introduce additional assumptions to attempt to capture the difference in device ecosystems and other factors.

A9.24 However, there is considerable uncertainty about the relevant assumptions to make and the results would be highly sensitive to the input assumptions. In addition, the model's focus on network cost savings may not fully capture the difference in commercial value between the two bands.

Our view on network cost modelling

A9.25 Overall we do not believe the adjusted 700 MHz model is well-suited to modelling the value of 900 MHz spectrum to those operators who do not currently hold any of this spectrum. Therefore we have not placed weight on the above results in informing our proposals on ALFs.

A9.26 The example above illustrates some of the difficulties of network cost modelling in deriving reliable estimates of the value of spectrum to individual operators. Any such model will be subject to significant uncertainty about appropriate parameter assumptions, leading to valuation estimates that vary over a wide range (e.g. see Table A9.2 above).

A9.27 We have not attempted to model the value of 1800 MHz spectrum or the relative values of different frequencies as the 700 MHz model is not immediately suited to these tasks. Adapting the existing model or developing a new model to look at these questions would face similar issues as those identified above.

Annex 10

Deriving annual licence fees from lump-sum values – supporting material

Introduction

A10.1 This annex provides details of the underlying evidence and reasoning which supports the proposals set out in Section 4. Specifically, this annex sets out the assessment underlying our views on:

- The discount rate; and
- The choice of inflation index and how this is incorporated into the discount rate.

Discount rate

A10.2 In this section, we set out our analysis for what the relevant discount rate would be for the two polar cases discussed in Section 4 – where the risk of the ALF payments were the same as the risk of the underlying cash flows, and where the risk of the ALF were completely unrelated to the risk of the underlying cash flows.

What would be the relevant discount rate if the risk of the ALF payment were the same as the risk of the underlying cash flows?

A10.3 If the ALF regime were set up such that the risk of the ALF payment were the same as the risk of the future after-tax free cash flows, the relevant discount rate would be the WACC associated with those cash flows. We consider the WACC calculated for the MCT charge control would be a reasonable proxy for this.[8] As we set out in the October 2013 Consultation, 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. It is therefore 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 MCT.

A10.4 However, given we are considering forward looking payments beginning from next year, depending on the Common Effective Date (discussed in Section 6), we consider there is an argument for updating the WACC to reflect the latest information on the long-term WACC for MNOs.

[8] We note that this is the WACC for an average efficient MNO. Similarly, where we discuss the cost of debt, this is the cost of debt faced by an average efficient MNO. Vodafone argued that we should use a rate specific to them to reflect their enhanced ability to borrow to fund an equivalent lump-sum. However, we are setting fees based on the whole market rather than for each individual operator. It is therefore appropriate to use the position of an average efficient operator, not the position of individual operators, in coming to a discount rate. However, we note that the estimation of the WACC for an average operator is based on underlying metrics specific to the MNOs (and in fact we put significant weight on Vodafone's data, as discussed in paragraph A10.14).

A10.5 We are currently consulting on the mobile WACC in the context of the forthcoming 2015 MCT market review. This suggests a post-tax nominal WACC of 7.2%[9] is appropriate, giving a post-tax real[10] WACC of 5.1%.

A10.6 We acknowledge that we are currently consulting on our proposed MCT WACC and by the time this is finalised for the MCT Statement later in the year, more data may have come to light such that a different figure is used. However, this reflects the best information available at this time and so we consider this is an appropriate benchmark.

What would be the relevant discount rate if the risk of the ALF was unrelated to the risk of the underlying cash flows?

A10.7 If the ALF obligation was an entirely fixed fee MNOs had to pay under all circumstances, it would be very similar to a leasing arrangement. Under a leasing arrangement, the MNO would be paying a fixed amount for the use of an asset. If it defaulted on that payment, the lessor would reclaim the asset and lease it to someone else.

A10.8 The equivalent discount rate would therefore be a current market long-term fixed index-linked secured debt rate for UK MNOs. The closest comparator data available are the bonds issued by the UK MNO parent companies. We set out below the data on these forms of debt.

A10.9 In principle, there are two ways of deriving a debt rate. The first is to consider the spread of the debt over nominal UK government gilts, then add this to our estimate of the risk-free rate. This is the approach we typically take in calculating the cost of debt in estimating the WACC. The second would be to just take the current yield to maturity (YTM) of the debt, which reflects the expected rate of return on the debt if it was bought today and held to maturity. This reflects actual market data on the return investors expect from holding this asset. We show the results of both approaches in turn, and then assess which we consider to be the more appropriate approach.

Spread analysis

A10.10 We have considered a sample of the sterling denominated debt of each MNO parent company[11] with a maturity date at least 20 years in the future, or with the longest maturity date (whichever is shorter).[12] Table A10.1 summarises the debt we have considered alongside the average spread of this debt in the last 12 months over nominal UK government gilts. The spread over the last two years is illustrated in Figure A10.1.

[9] The most recent MCT consultation uses a pre-tax nominal WACC of 9.0% (See Table A14.7 at http://stakeholders.ofcom.org.uk/binaries/consultations/mobile-call-termination-14/annexes/z_Annex_11_to_17.pdf). The corresponding post-tax nominal WACC would be 9.0%*(1-tax rate), which with a 20% tax rate gives 7.2%.

[10] i.e. real with respect to CPI inflation.

[11] Hutchison Whampoa, the owner of H3G, is a diversified conglomerate operating across a number of sectors including retail, ports and telecoms. We consider that estimates for Hutchison Whampoa are therefore unlikely to convey useful information about a UK MNO.

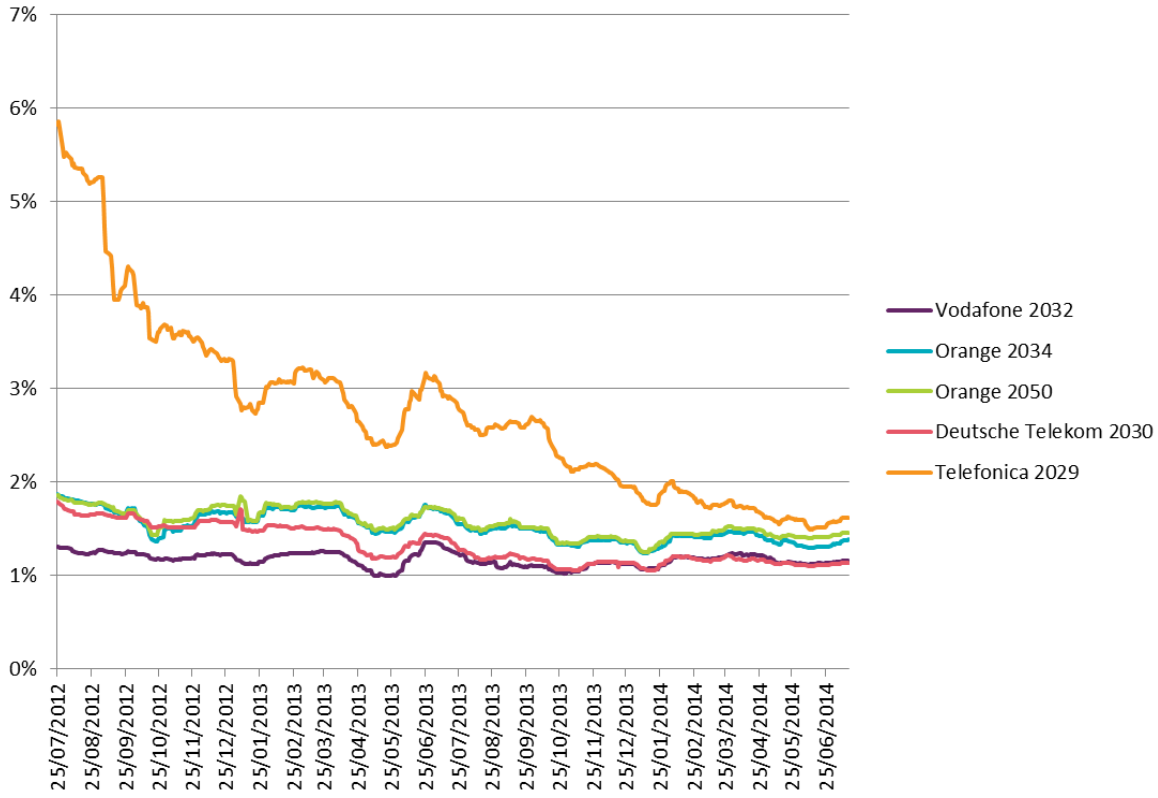
[12] Telefonica and Orange also offer perpetuities, but as this is ranked as junior subordinated debt it is not an appropriate comparator. In addition, they have call dates in the next 6-8 years and so could in theory expire at that point.

Table A10.1: Spread over government gilts for parent companies of UK MNOs

	Debt maturity	12 month average spread	12 month min	12 month max	Current spread (July 2014)
Vodafone	2032	1.1%	1.0%	1.3%	1.1%
Telefonica	2029	2.0%	1.5%	2.9%	1.6%
Orange	2034	1.4%	1.2%	1.7%	1.3%
	2050	1.4%	1.2%	1.7%	1.4%
Deutsche Telekom	2030	1.2%	1.0%	1.4%	1.1%

Source: Bloomberg, Ofcom analysis as at 15 July 2014

Figure A10.1: Spread of UK MNO sterling denominated debt over benchmark yields



Source: Bloomberg, Ofcom analysis as at 15 July 2014

A10.11 The chart shows that the debt premia for the UK MNOs have declined to some extent over the past two years, but most have been fairly stable over the last six months. Vodafone and Deutsche Telekom show a premium of around 1.1 or 1.2% over the benchmark yield, while Orange has a slightly higher premium of around 1.4% on average over the last 12 months.

A10.12 Until recent months, the average debt premium for Telefónica appears somewhat of an outlier compared to that for the UK MNOs. Nevertheless, Telefónica's debt premium has reduced steadily over most of the last year (and more broadly since about July 2012) and appears to be converging to the upper end of the debt premium range seen for the other UK MNOs in the last year – the highest debt premium being for Orange at 1.7%. Telefónica currently stands at 1.6%, still somewhat above the latest debt premium for Orange (at 1.3-1.4%), Deutsche

Telekom (1.1%) and Vodafone (1.1%).The debt premium for Telefonica has declined markedly over the last two years from a high of nearly 6% to 1.6% today.

A10.13 Based on this data, we consider that a reasonable range for the long-term debt premium for an average efficient MCP is 1.0% - 1.7%. This range captures the average debt premium over the last 12 months for Vodafone, Deutsche Telekom and Orange (across all maturities) and is bounded by the minimum and maximum debt premia for these companies over the last year. A range of 1.0% to 1.7% also encompasses the level to which Telefónica's average debt premium has converged from its historically high level.

A10.14 In our analysis for the MCT WACC, we placed particular weight on the data for Vodafone, as it has a predominantly mobile oriented business (i.e. 89% of revenue), in contrast to the other MNO parent companies where a lower proportion of their revenues come from mobile. Placing weight on Vodafone would imply a debt premium closer to the lower end of the range, since over the last year Vodafone's premium on this debt has been between 1.0% and 1.3%, with an average of 1.1%.

A10.15 Following our earlier analysis, we might also place less weight on Telefónica's debt premium since it appears to be an outlier compared to the others, and place more weight on the average of the other three UK MNOs. The average debt premium of the other three UK MNOs is 1.2% over the last year.

A10.16 In light of the above, we consider that a debt premium slightly below the mid-point of the 1% to 1.7% range is appropriate. We have therefore used a debt premium of 1.2%.

A10.17 This is also in line with the proposed debt premium for the MCT WACC set out in our June 2014 MCT consultation. That analysis involved very similar data on the debt premia of long term debt, although shorter term debt is also considered. For ALFs we focus only on long term debt, for which the range is generally between 1.0% and 1.7% (excluding the higher historical spreads for Telefónica).

A10.18 The proposed MCT WACC uses a nominal risk-free rate of 4.6%, using the same real risk-free rate of 1.3% as used in the LLU and BCMR Statements (since these are market-wide factors we had recently considered in those market reviews), although we will consider whether this remains appropriate in the final MCT Statement in light of further market data which will be available at that point. Combining the risk-free rate and the debt premium gives a pre-tax nominal cost of debt of **5.8**%, and a post-tax nominal cost of debt of **4.7**% (with a range of **4.5-5.1**%).

Yield to maturity analysis

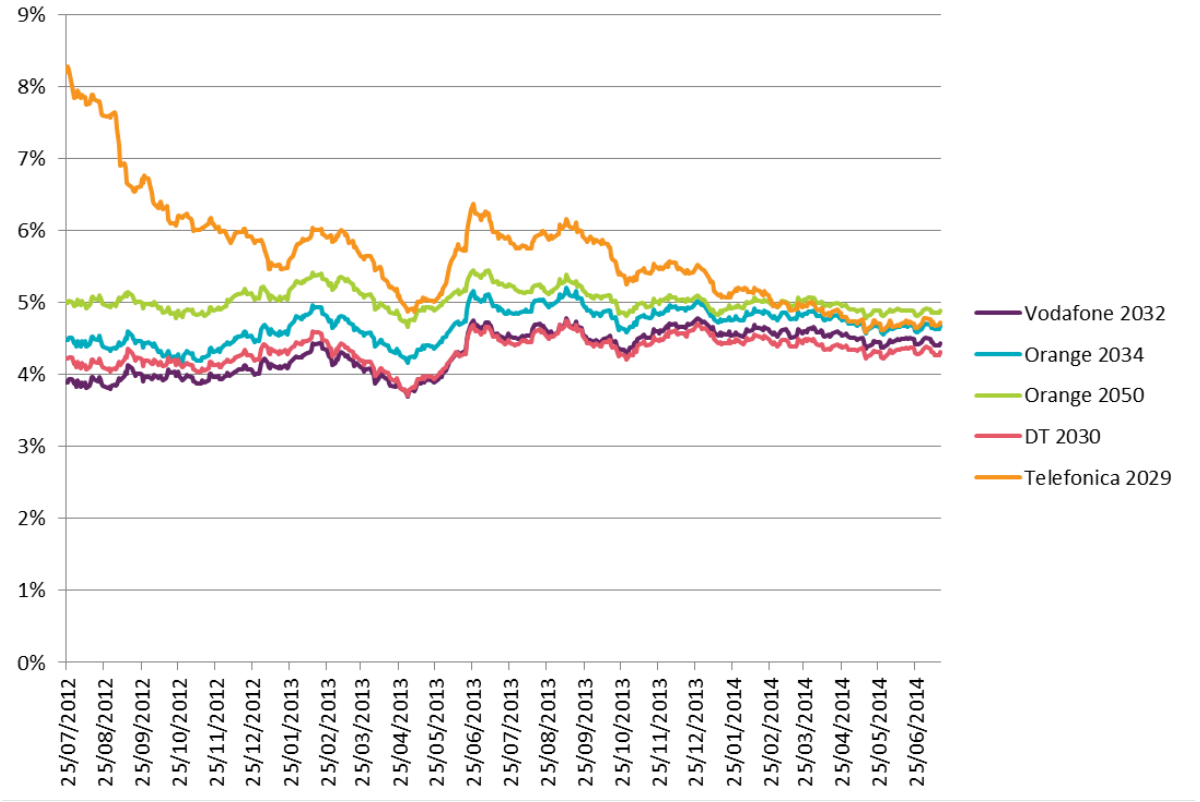
A10.19 We have looked at the YTM of the same sample of sterling denominated debt. Table A10. summarises the debt we have considered alongside the average YTM over the last 12 months. Figure A10.2 illustrates the YTM over the last two years.

Table A10.2: Yield to maturity for UK MNO parent companies' debt

	Debt maturity	12 month average YTM	12 month max	12 month min	Current YTM (July 2014)
Vodafone	2032	4.5%	4.8%	4.3%	4.5%
Telefonica	2029	5.3%	6.2%	4.6%	4.7%
	2034	4.8%	5.2%	4.6%	4.7%
Orange	2050	5.0%	5.4%	4.8%	4.9%
Deutsche Telekom	2030	4.4%	4.8%	4.2%	4.3%

Source: Bloomberg, Ofcom analysis as at 15 July 2014

Figure A10.2: Yield to maturity on UK MNO sterling denominated debt



Source: Bloomberg, Ofcom analysis as at 15 July 2014

A10.20 As with the debt premia, the chart shows that the yields have fallen to some extent over the past two years, but have been reasonably stable since the start of the year. Yields for Vodafone and Deutsche Telekom have been 4.4%-4.5% on average over the last year, while Orange has a slightly higher yield of around 4.8-5%. Telefonica's yield has fallen substantially over the last two years and is currently around 4.7% (although it has been higher than that on average), similar to Orange.

A10.21 Based on this data, we consider that a reasonable range for the YTM for an average efficient MNO is 4.2% - 5.4%. This range captures the average YTM over the last 12 months for Vodafone, Deutsche Telekom and Orange (all maturities) and is bounded by the minimum and maximum YTM for these companies over the last year. This range also encompasses the level to which Telefónica's average debt premium has converged from its historically high level.

A10.22 As with the debt premia analysis, we consider there is an argument to put greater weight on Vodafone's data. This gives one of the lowest YTM on average over the last year (although this is very similar to that for Deutsche Telekom, and its current YTM is actually below that for Deutsche Telekom).

A10.23 We might also place less weight on Telefónica's data since it appears to be an outlier compared to the others, and place more weight on the average of the other three UK MNOs. The average YTM of the other three UK MNOs is 4.6% over the last year.

A10.24 In light of the above, we consider that a YTM of 4.6% is appropriate. This is slightly below the mid-point of the 4.2% to 5.4% range and is the average of the UK MNOs (excluding Telefonica). We have therefore used a YTM of 4.6% (pre-tax, nominal). This gives a post-tax nominal rate of **3.7**% (with a range of **3.4-4.3**%).

Which approach should we use to estimate the benchmark debt rate?

A10.25 We have set out above the results of using two different methods for evaluating the post-tax nominal cost of debt:

- Option A (spread analysis) – adding a debt premium (based on the spread between corporate debt and government gilts, which are a proxy for very low risk assets) to a risk-free rate. This gives a range of **4.5-5.1**%, with a point estimate of **4.7**%.

- Option B (YTM analysis) – observing actual yields-to-maturity on comparator bonds. This gives a range of **3.4-4.3**%, with a point estimate of **3.7**%.

A10.26 The observed yields produce lower estimates than the spread analysis. This seems primarily to be because our risk-free rate estimate in the spread analysis is higher than observed gilt rates currently available in the market, as we consider we should be cautious about interpreting the evidence on index-linked gilts since a number of temporary distortions may be affecting the data. Which approach we choose to take will therefore affect the number we start from in determining our benchmark rate, and from there any further adjustments we may deem necessary.

A10.27 We recognise that Option B reflects data on the actual returns investors currently expect at this point in time, which is the return a generic MNO would have to offer if seeking financing. By contrast, Option A involves taking a longer term view as to likely changes in equilibrium market rates.

A10.28 In determining which option is preferable it is important to consider the long term nature of the ALF obligation. We need to set a value of ALF that will apply in the near future and that will remain in force until changed, as explained in Section 6. The (starting) level of ALF is derived from a calculation which assumes that it remains unchanged in real terms over 20 years.

A10.29 We are therefore setting these fees, including the discount rate, for an extended period of time. This makes potential short-term distortions more serious, since there are fewer prospects for these being removed in further reviews than in the case of setting WACC for periodic market reviews. For example, in setting WACC for BT and mobile operators, we have been able to reflect changes in the data as to required returns by reducing the risk-free rate estimate over time (for example, from 2% in 2007 to 1.5% in the 2011 MCT WACC, then to 1.3% in the proposed 2015 MCT WACC). If the data suggested the risk-free rate were recovering to previous

levels, we would be able to reflect that with a shorter degree of delay (at the limit, within three years). We may therefore be more interested in the long-term equilibrium market rate as reflected in Option A, which is likely to be less affected by short-term distortions.

A10.30 Option A is also the approach we generally take in calculating the cost of debt for the WACC for a similar reason of consistency through time, and so there is also a potential benefit from regulatory consistency to consider. Moreover, this will ensure consistency between different stakeholders and different market interventions. We also note that the Competition Commission took a similar approach to deriving the risk-free rate in their cost of equity calculation in the recent NIE determination, where it used a risk-free rate of 1-1.5%.[13]

A10.31 We therefore favour setting the benchmark rate using the Option A approach.

Other potential modifications to the benchmark

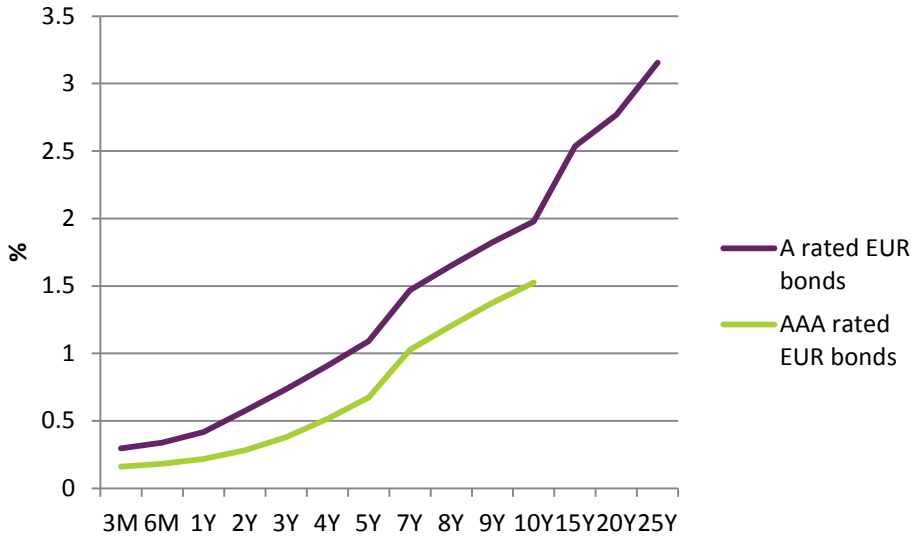
A10.32 The characteristics of these bonds do not correspond exactly to the type of debt we consider the benchmark represents – in particular, the bonds issued by the MNO parent companies are not index-linked and are senior unsecured debt. We consider the implications for our benchmark rate of trying to adjust for these factors below.

A10.33 Looking first at security, we note that the bonds we observe are senior unsecured debt. It is likely that a secured debt would attract a lower rate than an unsecured debt due to the greater probability of the creditor recovering a greater proportion of their investment in the event of a default.

A10.34 However, Oxera (on behalf of Vodafone) note that "in practice, we understand that the bond markets have the benefit of increased liquidity, and are therefore the core source of financing for MNOs. The cost of financing cannot be higher for a secured debt than an equivalent unsecured debt, but could be very similar where debt premia in the bond markets are already low." (Oxera, p.22) This suggests that there may not be a large difference between the rate which a secured debt would attract compared to an unsecured debt. This is supported by the fact that the spread between AAA-rated bonds (which indicates "extremely strong capacity to meet financial commitments"[14]) and A-rated bonds seems low, which is likely to indicate a low spread between secured and unsecured. In addition, empirical research suggests the actual yield difference between secured and unsecured debt is complex and can even be counterintuitive.[15] Therefore, there is no simple generic adjustment one can make.

[13] Competition Commission, Northern Ireland Electricity Limited price determination: Final Determination, March 2014, in particular paragraphs 13.117-13.129, available at https://assets.digital.cabinet-office.gov.uk/media/535a5768ed915d0fdb000003/NIE_Final_determination.pdf.
[14] http://www.standardandpoors.com/ratings/definitions-and-faqs/en/us
[15] John, Kose, Anthony W Lynch, and Manju Puri, 2003, "Credit ratings, collateral, and loan characteristics: Implications for yield", *Journal of Business*, Vol. 76, Iss. 3, p.371-409.

Figure A10.3: EUR Europe Composite A BVAL Curve vs. EUR Europe Covered Bonds AAA BVAL Curve



Source: Bloomberg, Ofcom analysis

A10.35 Further, secured debt is usually secured on general purpose assets, such as real estate. However, under this analogy, ALF is not 'secured' on a general purpose 'asset' but on a specific asset (the spectrum licence). Therefore, even if it was possible to calculate the 'generic' spread difference between actual secured and unsecured debt, it is not clear it would be appropriate to apply this as an adjustment to get a rate for a debt secured on the licence in this instance.

A10.36 In addition, if the MNO defaults on the ALF payment and the Government reclaims the spectrum, there may be a fallow period before the spectrum is re-awarded during which time the Government would not receive any spectrum licence fees. This is likely to reduce the amount of the 'debt' the Government would recover in the event of default, implying that it is not fully secured.

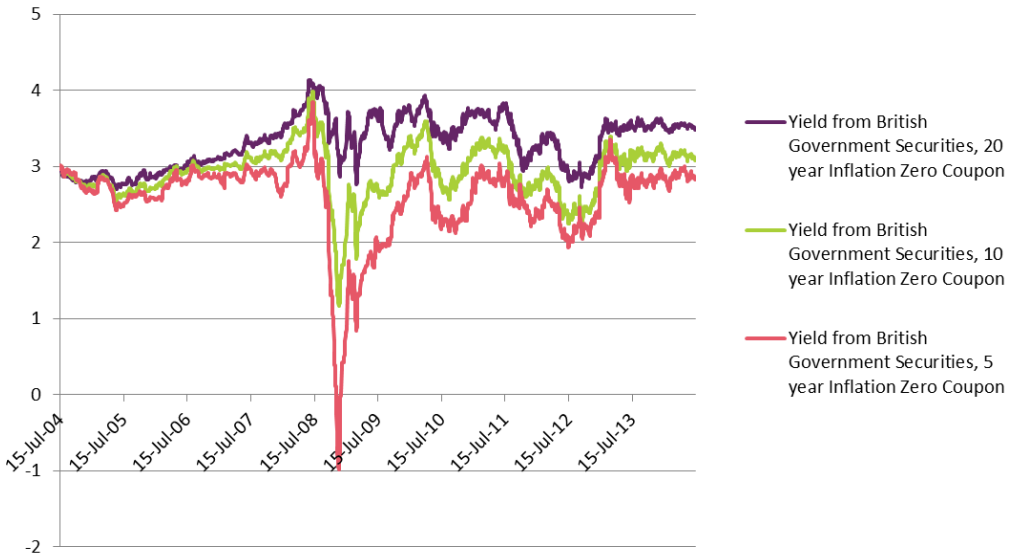
A10.37 Moreover, the most likely situation where default would occur (leaving aside the case where default was associated with the MNO getting into serious financial difficulties) would be if the market value of the spectrum had fallen such that the MNO could not sell on its spectrum usage rights to another party with the current level of licence fees attached.[16] This would imply that, when re-awarding the spectrum, the Government would receive a lower payment than initially set. At the limit, if the fallow period is long enough and/or the revision to the ALF is large enough, this could imply the ALF liability has features of an unsecured debt.

A10.38 The above analysis suggests that it is not appropriate to make an adjustment for the security of the equivalent debt. We therefore consider the unadjusted senior unsecured debt rate as the starting point.

[16] For example, if the true market value of spectrum remained unchanged but the licence holder experienced financial distress such that it could not meet its ALF obligations, it could sell the spectrum to another MNO. This MNO would be willing to pay the current ALFs (as these would still reflect the underlying market value) and, since the spectrum is traded through a private transaction between the two MNOs, there would be no fallow period. The Government would therefore still receive the same cashflow from the spectrum, just from a different party.

A10.39 The second difference between our comparator bonds and the 'ideal' benchmark we wish to emulate is that the yields and spreads we observe are not index-linked, and so will move as inflation expectations change (as investors will demand a higher return to compensate for higher inflation). We cannot know what inflation expectations are with certainty, and so cannot be certain what actual real interest rate investors are demanding to hold these bonds. Figure A10.4 shows the RPI inflation expectations implied by the difference between real and nominal yields on British government securities with different maturities. This suggests that investors are building expected inflation of 3%-3.5% into the returns they expect on government securities, and that longer term expectations tend to be more stable but higher than those incorporated into shorter-term securities. However, it should be noted that the real yields are indexed to RPI and so this reflects expectations of RPI inflation, not CPI. We cannot directly infer from this what investors expect CPI inflation to be in future.

Figure A10.4: Implied RPI inflation from government security yields



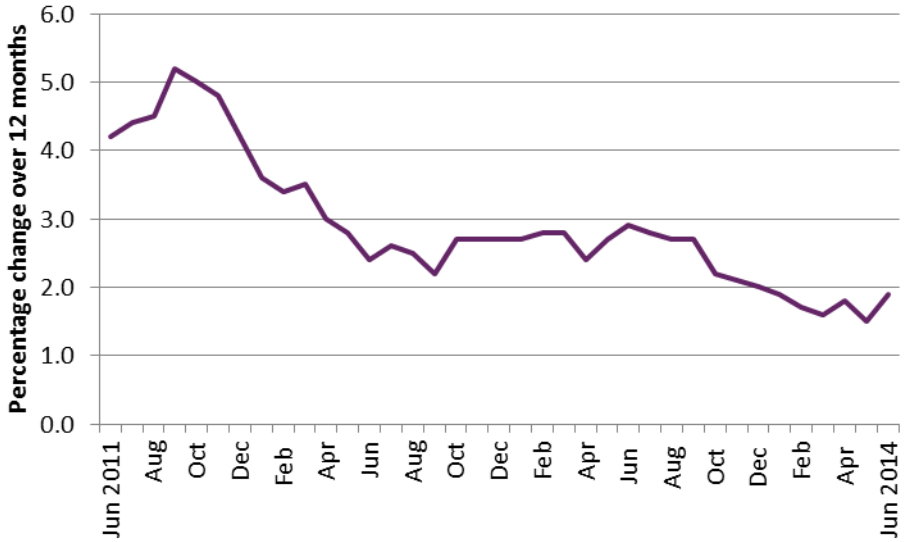
Source: Bank of England

A10.40 Instead, we need to adjust for inflation using some known information. There appear to be two options:

- Adjust based on historical actual CPI inflation.
- Adjust based on the Bank of England's CPI target.

A10.41 Figure A10.5 shows CPI inflation over the last three years. Although higher at the start of the period, for the most part inflation has been low and relatively stable between 2%-3% (although it has fallen below this more recently). If investors expect this trend to continue, we should be allowing for 2-3% CPI inflation within the nominal returns. However, while it is likely that expectations will be guided to some extent by previous trends, this is not the only factor which will be important. We set out in paragraph A10.53 below (and in the CPI consultation) that the Bank of England's target of 2% CPI inflation provides the best view as to what inflation will be in the long run, as achieving this target is of central importance to monetary policy.

Figure A10.5: CPI inflation June 2011-June 2014



Source: ONS

A10.42 This would suggest the appropriate option for the purpose of ALF is to adjust the nominal rate assuming 2% CPI inflation. This would give a post-tax real rate of **2.6%** (Option A) or **1.6%** (Option B), based on the point estimates of the two methods for calculating the rate in paragraph A10.25 (and assuming no adjustment is made for the debt security).

Choice of inflation index and how this is incorporated into the discount rate

A10.43 We set out in Section 4 that we favoured using CPI as the inflation index for setting ALFs.

A10.44 However, we still need a long run estimate of RPI inflation as well as CPI inflation. The reason for this is that, as discussed above, our preferred approach to calculating the discount rate involves deriving a debt premium and combining this with our estimate of the risk-free rate. Our estimate of the real risk-free rate used to calculate the discount rate is informed by RPI-linked gilts. Combining the real risk-free rate (defined by reference to RPI-linked gilts) with a forecast for RPI inflation enables us to calculate a nominal risk-free rate on a consistent basis and, from this, a nominal debt rate. This nominal debt rate can then be translated into a real debt rate with respect to CPI, by deflating it by forecast CPI.[17]

[17] Stakeholders suggested some alternative approaches to adjusting the discount rate for CPI in response to the CPI consultation. Economic Insight on behalf of H3G suggested re-stating the real risk free rate based on CPI inflation of 2.0%. This essentially involves adding the 'wedge' between CPI and RPI into the real risk-free rate. The real WACC is then re-calculated reflecting an overall inflation rate of 2.0% rather than 2.5% leaving all other parameters unchanged. We note that adding the wedge to the real RFR and inflating this by CPI would produce an identical result to adding the wedge to CPI and using this to inflate the original real risk-free rate. The difference in result found by Economic Insight arises purely because it is using the wedge as derived based on 2011 RPI assumption (as would be appropriate if using 2011 parameters) whereas in the CPI consultation, we used a wedge derived from 2014 parameters to be clear about the approach to deriving inflation

A10.45 We therefore need an estimate of CPI inflation and of RPI inflation. We set out in the CPI consultation that we proposed to use the Bank of England's target rate of CPI inflation of 2% as our CPI assumption.

A10.46 We proposed to estimate a long-run RPI rate by adding the Bank of England's long-run estimated difference between RPI and CPI to the Bank of England's CPI target of 2%. In its 2014 Inflation Report the Bank of England published a 'long run' estimate of the wedge between RPI and CPI of 1.3%.[18] This implies an RPI forecast of around 3.3% based on long-run expectations. A number of stakeholders suggested that this wedge estimate was too high and should instead be in the region of 0.9 to 1.1 percentage points. Stakeholders cited evidence on the historical size of the wedge,[19] assumptions used by other regulators, independent forecasts and bottom up analysis of the factors contributing to the wedge in support of this view.

A10.47 The Bank of England's central, long-run estimate of the wedge is based on its assessment of the different factors which contribute to the wedge, and their likely size over the long-run. The Bank's approach is aligned with the approach taken by the ONS to decomposing the different contributions to the wedge each month. The Bank assessed the size of each of these factors, assuming 2% price growth (which is the target inflation rate) and 4.5% earnings growth (which is the long-run average).

- For the formula effect, the Bank (in common with other analysis) considers that the contribution increased permanently after 2010, and revised up its estimate of the contribution of the formula effect to the wedge from 2010 onwards in light of this.

- The housing costs in RPI but excluded from CPI are around 14% of the RPI's weight. The Bank's calculation assumes these components grow at 4.5% (in line with long-run earnings growth).

- The Bank looked at the contribution that other differences in coverage and weights have been making to the wedge since 2005. The average total contribution from these differences over the past was -0.5 percentage points. But over 2005-2013 there were increases in energy and import prices, tuition fees and VAT, which have a smaller weight in the RPI than in the CPI, and therefore boosted RPI inflation by less than CPI inflation. For its long run assumption, the Bank assumed that these components would grow at rates consistent with CPI

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assumptions we intended to use, and to illustrate how this flows through the calculation of the real discount rate. Vodafone argued that it is unnecessary to make any assumption about the size of the wedge in calculating the cost of debt. Instead, it suggested that it is simple to obtain a representative company specific or industry specific nominal cost of debt from nominal market yields and discount this by the CPI inflation factor. The result can be interpreted as the real CPI based cost of debt (see also Oxera report for Vodafone, p.2 and 4-6). This is essentially Option B for deriving the discount rate. We discuss Options A and B and our preference for the former in paragraphs A10.25-A10.31.

[18] Page 34, Bank of England, Inflation Report, February 2014. http://www.bankofengland.co.uk/publications/Documents/inflationreport/2014/ir14feb.pdf.

[19] Stakeholders noted that the wedge has increased since 2010 following a change in the way clothing price data has been collected, which has exacerbated the difference between the two indices resulting from the different formulae used in their derivation (known as the formula effect). Stakeholders therefore focused on trends post-2010, or adjusted pre-2010 data for the increased size of the formula effect in their analysis.

inflation at the 2% target, which implies a contribution to the wedge of -0.2 percentage points.

A10.48 The Bank of England notes that its estimate of 1.3 percentage points is similar to the Office of Budget Responsibility's estimate of 1.3 to 1.5 percentage points,[20] although it also notes discussions with market participants suggest that the long-run wedge priced into inflation break-evens is a little lower than the Bank staff estimate, at around 0.9 to 1 percentage points on average.

A10.49 Oxera on behalf of Vodafone suggested that, while 1.3% may be a reasonable anchor in the long term, in the interim the wedge is likely to be smaller, implying either a higher CPI or lower RPI for at least some period over which ALF is payable. One issue which arises from this argument, and from the evidence adduced by the respondents, is exactly what is considered to be the long run. The description given by the Bank in the February 2014 Inflation Report (p.34) is "when short-term shocks have washed out." Clearly, the length of time it takes for such shocks to wash out and long-term trends to reassert themselves can be uncertain, although it is unlikely such simple trends as earnings and price inflation would be out of line with long-term trends for as significant a period as we are considering in setting ALFs. We also note that the Bank sets out a description of the transmission mechanisms for monetary policy which suggests that the maximum impact of changes in interest rates on consumer price inflation takes up to about two years,[21] and the Bank's Inflation Report gives forecasts for macroeconomic variables such as CPI inflation, unemployment and GDP growth for up to three years,[22] which may provide an indication of the time horizon which is relevant for its forecasting more generally.

A10.50 We acknowledge that 1.3% is a point estimate, and that the actual size of the wedge is likely to vary to some degree over the period (as, indeed, CPI and RPI are likely to vary). However, we consider it is preferable to use a single estimate for CPI and RPI inflation to apply to the whole period, rather than try to incorporate changing rates of inflation. We therefore need a wedge suitable to the long term nature of the ALF obligation. In addition, we consider that the Bank is likely to have significant insight into the underlying drivers of the wedge and the likely changes to these, given its role in monitoring and controlling inflation. We therefore maintain our view that the Bank of England's estimate is an appropriate indicator of the long-run size of the wedge between CPI and RPI, and so we propose to use a value for the difference between RPI and CPI of 1.3%.

A10.51 Vodafone also took issue with the use of a CPI assumption of 2%. It highlighted that CPI of 2% is a Bank of England target, and not a robustly derived forecast of the likely average outcome. It argued that historically the target has been exceeded, both in detail and in average, and this may not be an unrealistic expectation of the future outcome as well. Vodafone highlighted the risk of the forecast inflation being adopted into the discount rate calculation being different from the actual outcome that is applied to increase the ALF over time may mean that operators pay significantly more than Ofcom intended (for example, if the CPI target of 2.0% were to be adopted in the discount rate calculation and the real outturn were to be an average of 2.5%). Vodafone argued that such an inflation risk cannot be managed

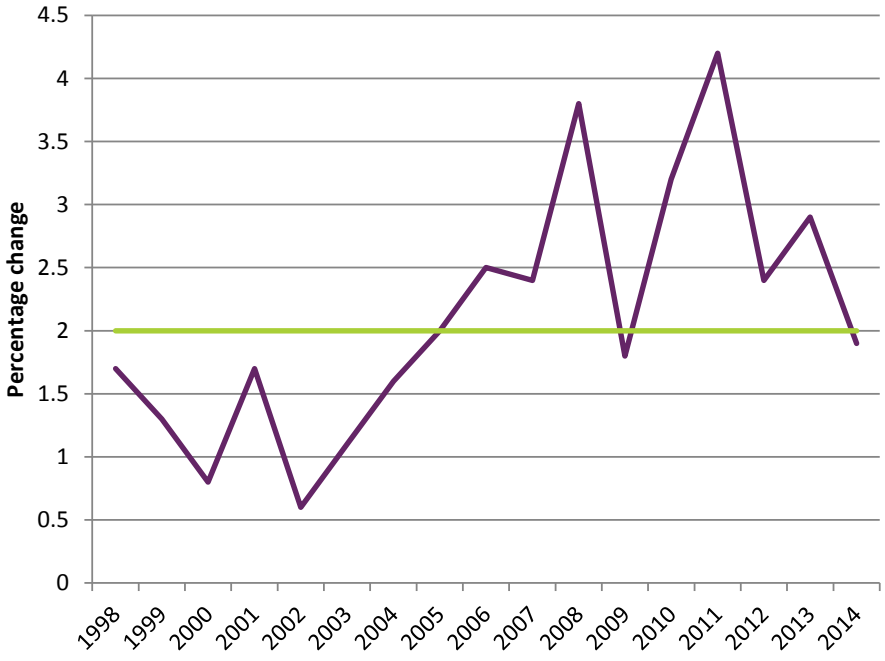
[20] Miller, R (2011), The long-run difference between RPI and CPI inflation, OBR Working Paper No. 2 http://cdn.budgetresponsibility.independent.gov.uk/Working-paper-No2-The-long-run-difference-between-RPI-and-CPI-inflation.pdf.
[21] http://www.bankofengland.co.uk/monetarypolicy/Pages/how.aspx
[22] See Section 5 of the Inflation Report.

through its approach to financing, and therefore it cannot be truly indifferent. Vodafone suggested this could be avoided by capping the annual inflation uplift to ALF at 2%.

A10.52 The reason for uplifting by inflation is to maintain a constant real level of ALF, reflecting broadly constant spectrum value, as discussed in Section 4 and the October 2013 consultation. If we were to sever the link between the ALF and actual inflation, there is a risk that we would no longer maintain this same real level if inflation were to unexpectedly increase or decrease. We therefore do not agree that we should uplift the ALF by some notional or assumed inflation rate.

A10.53 We note that stakeholder concerns in this regard arise due to the belief that the 2% CPI inflation incorporated into the underlying calculation of ALF is too conservative, given past inflation trends. Our CPI assumption should be a reasonable expected value, in order to avoid the possibility that MNOs could be disadvantaged as Vodafone suggested. We consider that 2% is a reasonable expectation as to long-term CPI inflation. Figure A10.6 shows CPI inflation between June 1998 and June 2014. This shows that while CPI inflation more recently has been above 2%, it has not been consistently above this level over this period, having been below 2% prior to 2005. More recently, inflation has fallen to around 2% again, standing at 1.9% in the year to June 2014. The annual average CPI inflation between 1998 and 2013 was 2.2%. While CPI inflation is unlikely to be constantly at 2%[23], we are not convinced that there is evidence that inflation will be consistently and significantly greater than 2% such that we should prefer a different inflation assumption.

Figure A10.6: CPI - percentage change over 12 months June 1998 to June 2014



Source: ONS data

[23] In fact, the Bank of England note that it would be neither possible nor desirable to hold inflation constantly at 2%, as the large and frequent interest rate changes this would imply would cause unnecessary uncertainty and volatility in the economy. See http://www.bankofengland.co.uk/monetarypolicy/Pages/framework/framework.aspx

A10.54 We therefore propose to maintain our position in the CPI consultation with regard to the inflation assumptions used in deriving the real discount rate i.e. a CPI assumption of 2% and an RPI assumption of 3.3%.

Annex 11

Glossary of terms

2G	Second generation of mobile standards and technology, including the GSM technology standard.
3G	Third generation of mobile standards and technology, including the UMTS technology standard.
4G	Fourth generation of mobile standards and technology, including the LTE technology standard.
ALF	Annual Licence Fees to be paid by the holders of the licences for 900 MHz and 1800 MHz spectrum (which are currently Vodafone, Telefónica, EE, and H3G).
AM&A	Analysys Mason and Aetha
AMPU	Average margin per user. A measure of the profitability of the mobile sector.
ASM	The Additional Spectrum Methodology 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.
CBA	Cost-Benefit Analysis
CCA	A Combinatorial Clock Auction is a package or combinatorial auction format in which bids are made for packages of spectrum (not individual lots, as in an SMRA). If there are multiple bands available in the auction (as, for example, in the UK 4G auction and in Austria and Ireland), such packages may include spectrum in more than one band.
CED	Common Effective Date. A CED is a date that we propose to use to ensure that all of the licensees would pay a rate that reflects the full market value of their spectrum from the same point in time.
Communications Act	The Communications Act 2003, which came into force in July 2003.
CPI	The Consumer Price Index (CPI) is a measure of inflation. It measures changes in the price level of consumer goods and services purchased by households. The most significant item excluded in the CPI, but included in the RPI, is mortgage interest rate payments.
DotEcon	DotEcon Ltd is a consulting firm.
DTT	Digital Terrestrial Television - Broadcasting delivered by digital means. In the UK and Europe, DTT transmissions use the DVB-T and DVB-T2 technical standards.
EC	The European Commission
EE	EE Ltd.

EU	The European Union
Excursions	The excursions for a bidder are used in the derivation of LRPs – they are a measure of the amount by which a bidder would prefer one of its losing bids to its winning bid at the particular set of LRPs considered.
FDD	Frequency Division Duplex – a technology that deals with traffic asymmetry between uplink and downlink where separate frequency bands are used for sending and receiving operations.
GHz	Gigahertz. 1,000,000,000 (or 10^9) oscillations per second
Government Direction	The Wireless Telegraphy Act 2006 (Directions to Ofcom) Order 2010 (S.I. 2010/3024)
GSMA	The GSM Association is an association of mobile operators, handset and device makers and other related companies.
H3G	Hutchison 3G UK Ltd – trading as Three.
IMT	International Mobile Telecommunications. The ITU term that encompasses 3G, 4G and 5G wireless broadband systems
IBV	Incremental Bid Value – the difference in bid value between two different packages bid for by a bidder in a CCA, which relates to a specified increment of spectrum (the difference in spectrum between the two packages).
ITU	International Telecommunications Union - Part of the United Nations with a membership of 193 countries and over 700 private-sector entities and academic institutions. The ITU is headquartered in Geneva, Switzerland
LH	Licence holder for 900 MHz and / or 1800 MHz spectrum.
LRP	In a CCA, auction prices are derived for packages of spectrum, not for individual lots or bands. Linear Reference Prices are the output of a mathematical algorithm which takes account of both winning and losing bids in a CCA to generate linear and uniform prices (i.e. a single price per MHz for each band that is the same for each bidder) that best support the auction outcome.
LSV	Lump-sum value. The value per MHz of a notional licence for 900 MHz and 1800 MHz spectrum with a 20-year initial term
LTE	Long-Term Evolution is a standard for communication of high-speed data for mobile phones and data terminals. The term 4G is generally used to refer to mobile broadband services delivered using the next generation of mobile broadband technologies, including Long Term Evolution (LTE) and WiMAX.
Market value	The market-clearing price in a well-functioning market, or the marginal opportunity cost of the spectrum. This is also the highest losing bid for the marginal increment of spectrum in a (competitive) auction.
MCT	Mobile Call Termination. MCT is a wholesale service provided by a mobile communications provider to connect a call to a recipient on its network.

MHz	Megahertz. 1,000,000 oscillations per second.
MNO	Mobile Network Operator
NPV	Net Present Value
NRA	National Regulatory Authority. The relevant communications regulatory body for each country in the EU. Ofcom is the NRA for the United Kingdom
Ofcom	The Office of Communications
ONS	Office for National Statistics
PPC	Price Point Calculator software provided by DotEcon to calculate LRPs.
PPP	Purchasing Power Parity. An additional adjustment made to exchange rates between countries in order for the exchange to be equivalent to each currency's relative purchasing power.
Revenue constraint	Constraint imposing the LRPs to sum to the revenue achieved in the auction.
RPI	The Retail Price Index (RPI) is an inflation index which is calculated by measuring the change in the cost of a basket of retail goods and services.
SDL	Supplemental Downlink
SMRA	Simultaneous multiple-round ascending auction. In this type of auction participants bid for specific spectrum lots (not packages as in a CCA).
TAF	Tax Adjustment Factor. An adjustment applied in deriving ALFs from LSVs to reflect the advantageous tax treatment of ALFs compared with a lump-sum payment.
TDD	Time Division Duplex – a technology that deals with traffic asymmetry where the uplink is separated from the downlink by the allocation of different time slots in the same frequency band.
UHF	Ultra High Frequency. The part of the spectrum between 300 MHz and 1 GHz.
WACC	Weighted average cost of capital
WRC	World Radiocommunication Conference. The WRC reviews and revises the Radio Regulations. They are held every three to four years.
YTM	Yield to maturity. The rate of return anticipated on a bond if it was bought today and held until its maturity date.