Does Ofcom's approach in the WLA market review honour the fair bet principle?

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Contents

1 Introduction and main findings

As part of the Wholesale Local Access (WLA) market review, Ofcom has set out a number of proposals aimed at achieving the right balance between protecting consumers in the short term and delivering on its strategic objective of encouraging the deployment of new ultrafast full-fibre networks. These include, in particular, regulatory remedies aimed at the strengthening of the duct and pole access (DPA) regime, and the introduction of price controls on the most popular FTTC/VULA access product provided by Openreach. Ofcom claims that the proposed FTTC controls are consistent with the 'fair bet' principle.[1]

BT has asked Oxera to assess whether Ofcom's approach and proposals in the WLA market review are consistent with the fair bet principle, and whether they will achieve Ofcom's strategic objectives, most notably of promoting investment in (risky) assets.

A team of Oxera consultants has prepared this report, with the support of Julian Franks, Professor of Finance at the London Business School, and former Academic Director of London Business School's Centre for Corporate Governance.[2]

Main findings

On the basis of our analysis, we find the following.

- In practice, applying the fair bet framework requires giving investors at project inception the opportunity to earn the project-specific cost of capital, on an expected basis. This means allowing them to earn returns in excess of the cost of capital in the upside scenarios in order to balance downside risks.
- Imposing price regulation to cap returns above the project-specific cost of capital is not a sufficient condition for concluding that the fair bet has been honoured. This is because any price cap will truncate the distribution of returns on the upside, leading to a reduction in the overall expected return of this investment. Therefore, the cap needs to be *sufficiently high* to compensate for downside risks—i.e. the new (truncated) expected returns need to be equal to the project-specific cost of capital.
- With this in mind, in order to implement the fair bet principle in practice, the regulator must take a view on three key parameters of the investment decision, and what their levels were at project inception:
    1. the project-specific cost of capital, taking account of the systematic risks of the project;
    2. the expected returns over the lifetime of the project, taking account of both upside and downside scenarios;
    3. the shape of the distribution of returns, taking account of how wide or narrow the potential returns of this investment are.
- With this information, the regulator will be able to estimate the critical level of returns that determines the threshold for both: returns that could be considered excessive (ex post project returns exceeding the critical level);

[1] Ofcom (2017), 'Wholesale Local Access Market Review – Volume 1 Consultation on the proposed market, market power determinations and remedies', para. 8.23.
[2] Professor Franks is also a Partner at Oxera.

and regulatory interventions that would not honour the fair bet (capping returns below the critical threshold). In our report, we call this critical level of returns 'Y'.

- Furthermore, when introducing price caps consistent with the fair bet principle, the regulator should ensure that the welfare-enhancing incentive properties of RPI - X charge controls are preserved. That is, investors should be allowed and incentivised to earn adequate returns in excess of the cost of capital from (higher-than-expected) efficiency or technology gains, and these additional returns should not be clawed back through ex post regulation. In terms of the fair bet principle, this means recognising that efficiency performance is a facet of risk. Therefore, when estimating Y, the assumed distribution of returns needs to be wide enough to capture the cash-flow risk of managerial outperformance and underperformance.

- Ofcom's overall approach to regulation recognises many of these principles; however, some of the fundamental building blocks of the approach have been misunderstood and therefore Ofcom does not apply the framework on a consistent basis. For example, the regulator has not sought to estimate the project-specific cost of capital relevant for the entire NGA project, taking account of the systematic risk of the investment at the point of project inception. As a result, the proposal to introduce price regulation on BT's FTTC product runs a high risk of regulatory failure since Ofcom cannot be confident how its decision to cap the returns at 11.8% would have affected BT's investment decision at project inception.

- Our analysis suggests that Ofcom's price control proposals are not consistent with the fair bet principle. In particular, we estimate that the relevant project-specific cost of capital for this investment lies within a range of 11.4–12.8%, with estimates close to the top of this range (i.e. above 12.1%) considered to be more representative of the risk profile of BT's FTTC investment. This is considerably higher than Ofcom's current cost of capital estimate for FTTC (of 9.4%), which is a forward-looking measure and therefore does not take account of the funding costs and risk profile of the investment at project inception, as required under the fair bet principle.

- Ofcom's proposed FTTC price control will cap returns below this level. Knowing this, a rational investor is unlikely to have gone ahead with this investment. By definition, capping returns at or below the cost of capital means that the expected returns on this investment at inception can only be lower than the cost of capital. This breaches the fair bet principle.

- Having concluded that Ofcom's proposals to cap BT's FTTC lifetime returns at 11.8% will not be consistent with the fair bet principle, a key question remains: should Ofcom continue to provide price flexibility to BT during this charge control or would price regulation at another (less restrictive) level be consistent with the fair bet principle? While it is beyond the scope of this report to provide a definitive answer to this question, we present evidence and analysis that supports continued price flexibility during this market review and delaying the imposition of a cost-based charge control to 2020/21 (or any other profile of price controls capping returns at an internal rate of return (IRR) of 15%). Our analysis suggests that a price cap below this level runs the risk of breaching the fair bet principle, and could not be interpreted as being generous to BT.

The report is structured as follows.

- **Section 2** describes the building blocks of the fair bet principle from a financial economics perspective, and considers how a regulator should apply the framework in practice when regulating risky assets, such as BT's fibre investments.
- **Section 3** assesses Ofcom's approach against this framework, and considers whether the decision to price control BT's VULA services in this market review is consistent with the fair bet principle.

2 Regulating risky investments: the fair bet principle

2.1 The broad objectives of the fair bet principle and Ofcom's views

Enshrined in the founding principles of corporate finance is the idea that investments will be undertaken only if investors believe that they will make a reasonable return.

On this basis, a 'fair bet' is one where the firm making an investment should, in expectation, be allowed to earn a return equal to the investment's cost of capital. That is, for an investment to be a fair bet, the firm should be allowed to enjoy some of the upside benefit when demand turns out to be high or costs low (i.e. be allowed returns higher than the cost of capital) in order to balance the probability that it will earn returns below the cost of capital if demand turns out to be low or costs high.

Ofcom itself proposes this principle:[3]

> ensuring that the fair bet is satisfied may entail BT earning returns above the cost of capital to compensate for the additional downside risks that were faced when the investment was made

In considering the broad objective of preserving the investment incentives of the regulated firm, and testing whether the fair bet has been honoured, one question to ask is whether the regulated firm, knowing at project inception what it now knows about regulatory intervention, would still have gone ahead with the investment.

Ofcom also accepts this principle:[4]

> In making a judgement as to whether the fair bet has been met, we have considered whether, at the time it took the decision to invest in SFBB, BT would have gone ahead with the investment if it had understood the approach to regulation we are proposing now

Back in 2007, Ofcom recognised in a discussion document that NGA were characterised by high levels of uncertainty and that there was limited clarity on the levels of expected returns to investors:

> these networks are characterised by high uncertainty about consumer demand and willingness to pay, with limited clarity on the applications and services they will deliver. In this situation, investors in a free market would seek higher returns from their investment to compensate for the higher degree of risk.[5]

In subsequent fixed access market reviews (2011 and 2014), Ofcom chose to allow BT to invest in this uncertain project without the imposition of an immediate price control.[6]

Ofcom did not specifically set out ex ante conditions for regulatory intervention. However, in its 2007 consultation on the future of broadband, Ofcom recognised the risk that ex ante regulation can reduce incentives for investment.[7]

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[3] Ofcom (2017), 'Wholesale Local Access Market Review – Volume 1 Consultation on the proposed market, market power determinations and remedies', para. 8.31.
[4] Ofcom (2017), 'Wholesale Local Access Market Review – Annexes', para. 8.18.
[5] Ofcom (2007), 'Future broadband: Policy approach to next generation access', para. 5.3.
[6] Although BT was subject to the obligation to provide VULA access on fair and reasonable terms and, from 2015, the VULA margin. See Ofcom (2015), 'Fixed Access Market Reviews: Approach to VULA margin', 19 March.
[7] Ofcom (2007), op. cit., para 5.12.

Furthermore, Ofcom recognises the risk of regulatory failure from intervening too early, and highlights how that risk is likely to be asymmetric. As a result, Ofcom concludes that it should err on the side of caution to retain appropriate investment incentives:[8]

> We also recognise that the effects of regulatory error are likely to be asymmetric in this case: in that if we intervene too early the harm caused by deterring future investment in UFBB may be greater than the harm caused by intervening too late. Therefore, as we set out in our Strategic Review, in determining whether returns are appropriate, we will tend to err on the side of caution with respect to investment incentives in the case of fibre networks. Para A8.9

In light of the broad objectives of the fair bet principle, we now turn to consider what would be an appropriate regulatory framework to ensure that a fair bet is implemented.

2.2 Lessons from financial economics: the building blocks of the fair bet principle

Any regulatory framework that aims to honour the fair bet principle needs to reflect some principles of corporate finance and regulatory economics, as follows:

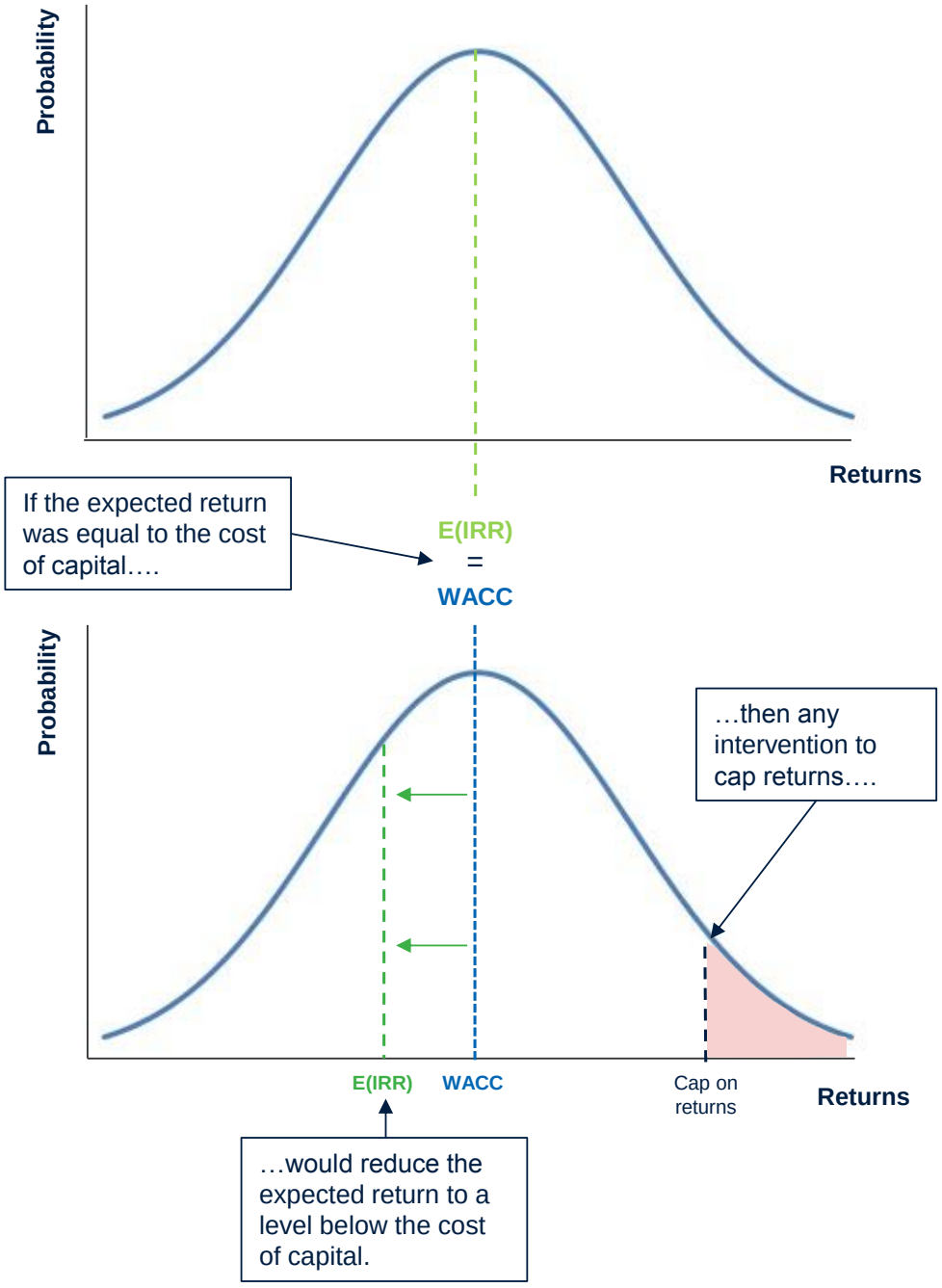
1. the regulator needs to take an ex ante view on the key parameters of the investment—in particular (a) the relevant cost of capital; (b) the distribution of returns (i.e. cash-flow risks); and (c) the expected lifetime returns of the investment absent regulation;
2. the cost of capital should be project-specific—i.e. reflect the systematic risks of the particular project under consideration;
3. any future regulatory intervention imposing a price control must ensure that if investors had factored in this intervention at inception, their expected return over the life of the project would still be equal to the project-specific cost of capital;
4. the properties of incentive-based regulation need to be preserved when applying the fair bet framework. This means incentivising and allowing investors to earn returns in excess of the cost of capital from (higher than expected) efficiency or technology gains, and that these additional returns are not clawed back through ex post regulation;
5. the framework needs to offer regulatory certainty and predictability in order to incentivise investment.

Given these principles, below we set out what we consider to be the theoretically correct approach to honour the fair bet principle when applied to risky assets, such as BT's FTTC network.

We start with a basic but fundamental observation: if the ex ante expected returns over the life of the project (the expected IRR) were equal to the project-specific cost of capital (WACC), then imposing price controls on this asset at any point in its lifetime would not be consistent with a fair bet. This is because any cap on total project returns would necessarily shift the expected project IRR to a level below the project-specific WACC, as illustrated in Figure 2.1.[9]

[8] Ofcom (2017), 'Wholesale Local Access Market Review – Annexes', para. A8.9.
[9] This risk was also recognised by Ofcom in its 2007 consultation document. See Ofcom (2007), 'Future broadband: Policy approach to next generation access', para. 5.3.

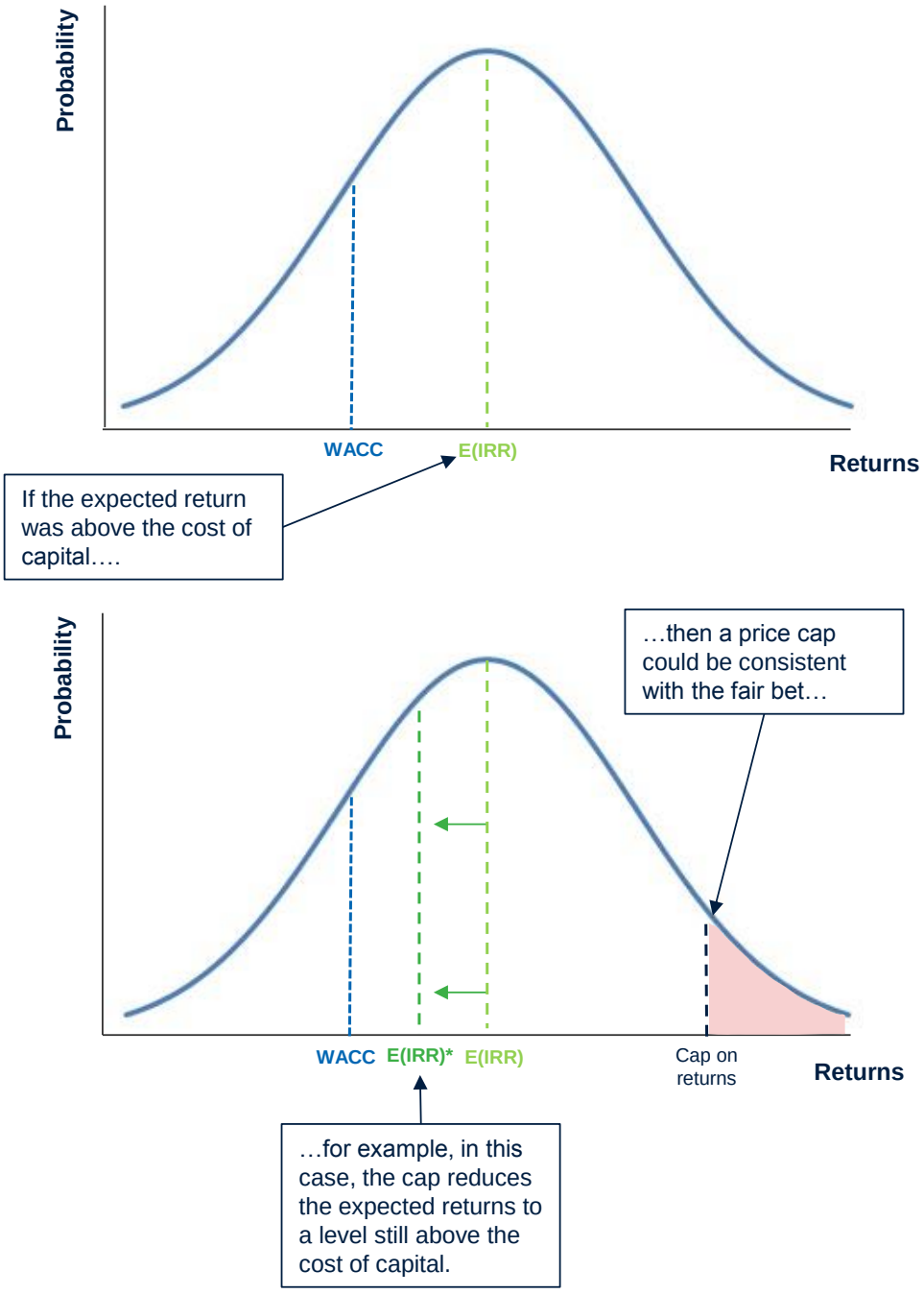
Figure 2.1 If expected returns equal the cost of capital, any price control would breach the fair bet



Source: Oxera analysis.

The only scenario in which a future price cap intervention can be considered is when the expected project IRR at inception is greater than the project-specific WACC, as illustrated below.

Figure 2.2 If expected returns greater than cost of capital, a price cap *might* be appropriate



Source: Oxera analysis.

In this latter case, the regulator could intervene at some stage during the project's life. The question is when? We consider that regulatory intervention should occur only if two conditions are met:

1. the project has matured (i.e. it is in a steady state and most of the uncertainties that existed at project inception have been resolved);
2. lifetime returns in the absence of regulation are forecast to be 'excessive'.

2.2.1 Defining excessive returns: critical level of returns (Y)

In a competition policy context, an indication that a firm is earning excessive returns is when such returns are substantially and persistently in excess of the cost of capital.[10] However, in a fair bet context, allowing a firm the opportunity to earn returns above the cost of capital is precisely what is required in order to honour the principle. In this regard, comparing BT's current return on capital employed (ROCE), or even the project's lifetime IRR against today's cost of capital, is not informative and on its own provides no justification to introduce price regulation.[11]

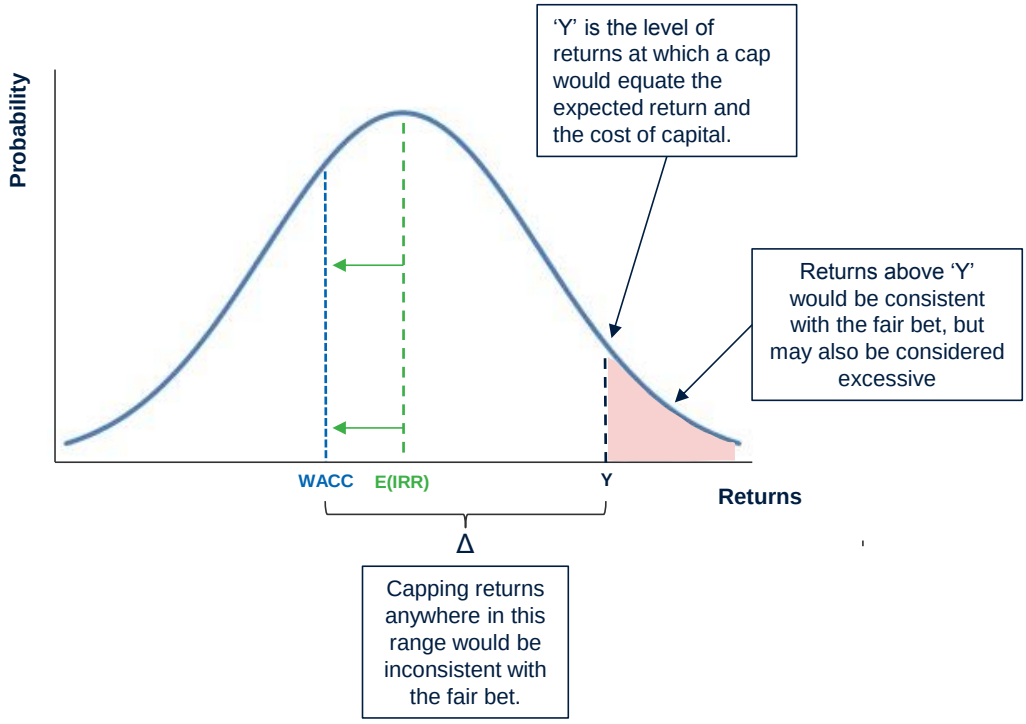
The question is therefore how much higher than the cost of capital can lifetime project returns be, before they are considered excessive under a fair bet framework. Let's call this critical level of returns beyond which returns are excessive 'Y', where Y equals the project-specific WACC plus a 'delta' (Δ).

An important constraint for determining Y is that it must be consistent with the fair bet principle described above. Thus, if the regulator imposes a price control at some point in the future which has the effect of capping the ex post project IRR at Y, the impact of this cap on the ex ante expected project IRR (i.e. at the project inception) should be such that the new (truncated) expected project IRR equal to the project-specific WACC.

Defined in this way, if a project is forecast to earn a lifetime IRR above Y,[12] this could be considered excessive from a fair bet perspective, since it would be possible for the regulator to cap returns at Y (but not below), and still honour the fair bet. Indeed, Y can be thought of as the threshold that determines both: excessive returns on a lifetime basis (for returns that exceed Y); and regulatory price caps that breach the fair bet principle (for price controls that cap returns below Y) This is as illustrated in —see Figure 2.3 below.

[10] See for example, Office of Fair Trading (2003), 'Assessing profitability in competition policy analysis', Economic Discussion Paper 6, July, a report prepared for the Office of Fair Trading by Oxera.
[11] Yet, this is precisely what Ofcom appears to be doing. See Ofcom (2017), 'Wholesale Local Access Market Review – Annexes', paras A8.22 and A8.23. We also note Ofcom's conclusion that, absent regulation, there is a risk BT would have the incentive and ability to maintain VULA prices at an excessive level and that it will face weak competitive constraints to keep prices low (see para. A8.24). However, Ofcom does not define what 'excessive level' means in this context. In a fair bet context, returns above cost are precisely what are required to incentivise investment. Therefore, it is possible that copper-based services and competition from Virgin Media do constrain BT's VULA prices below levels that would be excessive under a fair bet framework
[12] Assessed after the project has matured and is in a steady state.

Figure 2.3 Identifying the critical level of returns (Y)



Source: Oxera analysis.

2.2.2 Preserving the incentive properties of RPI - X charge controls

An important principle of incentive-based regulation is that the regulated firm should have strong incentives to achieve efficiency savings and 'beat the price cap'. This means that while the regulated firm is expected to earn returns equal to the cost of capital, if it outperforms on efficiency and earns more than the cost of capital, there should be no claw-back of returns. This is a principle embedded in all RPI - X charge controls imposed by Ofcom.

Therefore, when introducing price caps consistent with the fair bet principle, the regulator should ensure that the welfare-enhancing incentive properties of RPI - X charge controls are preserved.

If the regulation of risky assets involved having an ex ante regime in which Ofcom set the rules of the game from day one, we would expect the planned regulatory intervention to be such that BT will make its project-specific cost of capital in expectation. If BT outperformed (i.e. made unanticipated efficiency improvements), BT should be allowed to keep that until the next price control. This is exactly as in any standard RPI - X (charge control) regime, in that this regime gives the correct incentive properties to BT to beat the cap.

The problem we have is that we are not in this world; rather, we are in a world where we have to determine ex post what should be the price cap, based on observing just one outcome from a wide range of possible outcomes at project inception. In this world, we need to make sure that the same efficiency incentive properties remain. That is, Ofcom needs to make sure its planned intervention allows BT to keep the benefits of cost efficiency savings or technological gains resulting from managerial excellence, beyond those anticipated or expected at project inception.

In terms of the fair bet framework described above, the challenge is to identify a critical level of returns Y that provides these incentives and does not claw back returns that result from efficiency outperformance.

The starting point is to recognise that efficiency performance is a facet of risk. In other words, outcomes where BT over- or under-performs on efficiency would result in higher or lower project returns, and these outcomes would be reflected in the distribution of returns for the project. Therefore, when estimating Y, the assumed distribution of returns needs to be wide enough to capture the cash-flow risk of managerial out- or underperformance.

2.2.3 Taking account of asymmetric regulatory risk

We have explained above that the critical level of returns Y determines both excessive returns and breaches of the fair bet principle. This means that there is a high risk of regulatory failure if this test is applied too rigidly. Regulatory judgement is therefore required, taking account of the asymmetric risk of regulation with respect to investment incentives in the case of fibre networks, as noted by Ofcom.

In practical terms, the implication for regulators is that when making judgements about the parameters required to implement the fair bet principle and calculate Y, they should err on the side of caution.[13]

2.3 Applying the fair bet in practice: the project-specific cost of capital

To apply the fair bet framework described above, the following parameters need to be identified:

1. the project-specific cost of capital, taking account of the systematic risks of the project;
2. the expected returns (IRR) over the lifetime of the project, taking account of upside and downside scenarios;
3. the shape of the distribution of returns, taking account of how wide or narrow the potential returns of this investment are.[14]

After estimating these parameters, it would be possible to calculate the level of capped returns (Y) that would provide the lower bound for a regulator considering whether to introduce price controls on this asset.

As we explain in section 3 below, estimating the project-specific cost of capital is essential to assess whether Ofcom's proposals are consistent with a fair bet.

If there is only one tranche of investment, the estimation of the project-specific cost of capital is relatively straightforward. This is the cost of capital at the point in time the investment was committed. Importantly, Ofcom's estimated forward-looking WACC for NGA of 9.4% would not be a relevant benchmark in this

[13] Furthermore, we note that the fair bet framework we have described above allows returns that are just equal to the cost of capital, in expected terms. While theoretically correct, the practical realities of how investment decisions are made could result in these bets not being sufficiently attractive for an investment to go ahead. With large uncertain investment projects such as NGA, Boards of directors might feel that an expected return equal to the cost of capital is an inadequate benchmark. The uncertainty surrounding innovation projects may lead the Board to require returns above the cost of capital, especially where projects are competing for scarce capital and scarce managerial resources. The framework described in this report does not take account of these considerations, but regulators might wish to consider them when setting the cap and incentivising future innovation.

[14] A wide distribution indicates a higher degree of uncertainty and a narrower distribution indicates less uncertainty—i.e. this is a measure of risk.

scenario, as it does not take account of the risks of the investment at its inception.

If the overall project involves multiple tranches of investment that are fully or partially independent of each other (i.e. there is a degree of optionality attached to each subsequent investment tranche), the framework for estimating the project-specific cost of capital is more complex. Adjustments would be required to take account of the value of these options, as well as to capture the change in risk over time for each subsequent tranche of (non-committed/independent) investment. This would allow for the estimation of a weighted average project-specific WACC, weighted by the value of each tranche of CAPEX, adjusted for the value of the investment options.

Oxera has estimated an indicative range for the project-specific WACC based on two broad scenarios.

Scenario 1 The degree of optionality associated with the CAPEX profile was low, and all investments in the NGA network were committed and tied to BT's announcements in 2008 and 2010 to build the fibre network and reach 40% and 66% of the UK households, respectively;

Scenario 2 there is some discretion and optionality in the CAPEX profile, in particular for investments that take place after the project has matured and is no longer risky. For the purposes of estimating a lower bound, we assume the project to have fully matured at the start of this market review and that all investments taking place from now onwards (c. 41% of the overall NGA investment, based on Ofcom's model[15]) are independent from previous investments, and could have been stopped if the investment had underperformed.

Under scenario 1, we estimate that the relevant cost of capital for the investment is c. 12.8%. To obtain this estimate, we took the contemporaneous WACC parameters for BT Group in the 2009 LLU/WLR charge control decision, and estimated a conservative value of the NGA asset beta[16] at the time, which we know must be higher than the NGA asset beta in Ofcom's recent determinations (in FAMR 2014 and in the current consultation). Details of this calculation are provided in Appendix 1.

Under scenario 2, 59% of the CAPEX profile is assumed to be linked to the investment commitment decisions of 2008 and 2010, and therefore to attract a WACC of 12.8%. The remaining 41% of CAPEX, which Ofcom estimates will take place from 2016/17 onwards, would attract Ofcom's current WACC estimate of 9.4%. The weighted average project-specific cost of capital in this scenario is 11.4%.

Hence an indicative range for the benchmark project-specific cost of capital is 11.4–12.8%.

While picking a point estimate within this range is not straightforward, we consider that any indicative point estimate of the project-specific WACC is likely to be towards the top end of this range (i.e. above 12.1%), for the following reasons.

[15] Shown to Oxera by BT.
[16] The asset beta is a measure of the systematic risk associated with an investment (in this case, BT's FTTC NGA network). The systematic risk of an investment will vary over time.

- Ofcom considers the first tranche as most relevant to its assessment of the fair bet.[17] This would suggest that our WACC estimate of 12.8% under scenario 1 should carry most weight in the analysis.

- Oxera's estimate of the asset beta for NGA at project inception is conservative, as it extrapolates the asset betas in 2017 and 2014 backwards to 2009 in a linear way, without considering the longer time period elapsed, and the fact that risk might have declined more steeply over this period than inferred from a linear extrapolation. Adjusting for these factors would increase both the lower and upper bounds of our WACC range.

- In scenario 2, which defines the lower bound of our WACC range, we have assumed there is a discretionary (optional) element to subsequent tranches of CAPEX. One effect of this optionality is to de-risk some of the future cash flows, which we capture by linking CAPEX from 2016/17 to the lower forward-looking NGA WACC calculated by Ofcom (9.4%). However, optionality also means there is an 'option value', and the cost of this option is likely to raise the overall project-specific cost of capital. We have not adjusted for this latter effect, and our WACC estimate in scenario 2 is therefore conservative. In Appendix 2, we describe how this optionality effect could be measured.

- Successive tranches of CAPEX are unlikely to be entirely independent. For instance, it is highly unlikely that BT could have completely abandoned all future CAPEX if it had not earned adequate returns from the first tranche of investment. For example, it would still have had to incur maintenance expenditure for the investment already made. Furthermore, even though it is possible in theory to envisage scenarios where BT could have abandoned the project; in practice, it is unclear what triggers would have led it to exercise this option. Having announced that NGA was part of its future strategy, we consider that there are not many scenarios where BT would have decided to abandon the project a few years later, even if customer take-up or the level of the price premium assumed were lower than its initial forecasts. Given the large fixed and sunk costs of the investment, these parameters would need to have been materially below forecasts for the abandonment option to be attractive. This means that, in scenario 2, the weight associated with a WACC of 9.4% could in fact be significantly lower than the 41% assumed in the calculations.

- The low end of the range takes Ofcom's proposed estimate of a 9.4%[18] NGA WACC at face value. However, as we argue in a separate report, the current relevant WACC for NGA may be as high as 10.8%.[19] This is largely because Ofcom has overestimated BT's gearing, and therefore underestimated BT's asset beta. This adjustment alone would result in a value-weighted average project WACC under scenario 2 of around 12%.

Having described the financial economics building blocks of the fair bet principle, and how it should be implemented in practice, we now consider how Ofcom has

[17] See Ofcom (2017), 'Wholesale Local Access Market Review – Annexes', para. A8.14, where Ofcom states: 'In our view, it is the first tranche that is most relevant to our assessment of the fair bet. We recognise that BT has continued to invest beyond its initial £1 billion tranche, in order to extend the footprint of the network and that the expected payback period for this subsequent investment may extend beyond 2020/21. However, the fact that BT was able to stagger the rollout to some degree means the risk of subsequent tranches of investment would have declined significantly over time as demand and costs became better understood.'

[18] Based on Oxera's calculations derived from Ofcom's parameter estimates, the relevant WACC estimate rounded to one decimal place is 9.5%.

[19] Oxera (2017), 'Response to Ofcom's WACC proposals for the WLA charge controls', June.

implemented the fair bet principle and how it compares against this optimal approach.

3 Has Ofcom honoured the fair bet principle for FTTC investments?

In this section, we provide a critique of Ofcom's implementation of the fair bet in respect of FTTC. Based on our assessment, we find the following.

- Ofcom's intervention (to price-regulate access to BT's FTTC network) raises significant risk of regulatory failure, since it does not appear to be informed by a detailed analysis of the key parameters identified in the previous section: the project-specific WACC; an assessment of the probability distribution of investment outcomes at the point of project inception; or the expected returns of the project at inception.
- Our analysis suggests that Ofcom's price control proposals are not consistent with the fair bet principle. In particular, we estimate that the relevant project-specific cost of capital for this investment lies within a range of 11.4–12.8%, with estimates lying close to the top of this range (i.e. above 12.1%) considered to be more representative of the risk profile of BT's FTTC investment.
- Ofcom's proposed price controls will cap returns at 11.8%, which is below this level. Knowing this, it is unlikely that a rational investor would have gone ahead with this investment. By definition, capping returns at or below the WACC means that the expected returns on this investment at inception can only be lower than the WACC. This breaches the fair bet principle.
- We also present evidence and analysis that supports a profile of price controls capping returns at an IRR of 15%.[20] Our analysis suggests that a price cap below this level runs the risk of breaching the fair bet principle, and could not be interpreted as being generous to BT.

3.1 Ofcom's proposed price cap breaches the fair bet

As set out in section 2, to be able to determine how regulatory intervention (to cap prices) will affect the fair bet, an understanding is required of the conditions and beliefs that prevailed at the point of project inception (i.e. at the point of investment).

Given such an ex ante belief about the probability distribution of investment outcomes at the point of project inception (as well as the project-specific cost of capital), decisions can be made (ex post) about the timing and nature of regulatory interventions that would ensure consistency with the fair bet principle.

However, without such an understanding, any regulatory intervention to cap prices runs the risk of breaching the fair bet, by reducing the overall expected returns of the investment (at project inception) to a level below the (project-specific) cost of capital.

Ofcom seems to recognise this principle, and appears to be trying to implement these building blocks for assessing a fair bet. For example, we have noted above that Ofcom correctly identifies that, in order to determine whether the fair bet has been met, it is important to consider whether BT would have gone ahead

[20] By a cap on returns at 15% we mean a price control profile which would allow BT to earn lifetime returns of 15% in expected terms, from now onwards. This means that if BT were to achieve efficiency savings going forward, they would be allowed to keep them. Equally, underperforming on efficiency would result in a lower level of return.

with the investment had it understood the approach to regulation that is now being proposed.

However, Ofcom seems to have misunderstood some of the fundamental building blocks of the approach, and as a result, does not apply the framework on a consistent basis. For example, Ofcom states that:[21]

> setting a cost-based charge control at, or after, the original expected payback period for an investment should be sufficient to ensure a fair bet, and to the extent that the charge control subsequently allows a return on undepreciated assets, setting a charge control at the point of payback would be generous to BT (para. 8.20)

It then explains that:

> If BT knew that it would not be subject to price regulation in the expected payback period, then it would expect to earn an NPV of at least zero and would therefore choose to invest (para. A8.5)

This reasoning, however, is incorrect. The confusion arises because Ofcom is observing an outcome (BT achieving payback) after it has materialised, and appears to ignore that this outcome was uncertain. At project inception, the downside risks can be large, and, even if the investor expects, on average, to achieve payback before the end of the economic life of the asset, there is no guarantee that it will. Therefore, consistent with the fair bet principle, the investor needs to be allowed to make sufficiently high returns in the upside scenarios to compensate for downside risks at inception.

It follows that if the investor knew that price regulation would be imposed at the point of expected payback, especially if it constrains returns at the WACC going forward (i.e. cost-based price regulation), it may well have chosen not to go ahead with the investment. The fact that Ofcom allows the investor to make a positive NPV when demand turns out to be high is irrelevant; what matters is whether the NPV is *sufficiently high* to compensate for the downside risks at inception. In other words, what matters is whether the level of capped returns imposed by price regulation lies above the critical level Y, below which the fair bet would be breached. Ofcom has not undertaken this assessment.

As we have set out in section 2, one of the key parameters that can answer the question of whether the fair bet has been honoured is the (ex ante) project-specific WACC. Any regulatory intervention that acted to reduce expected returns at project inception below the project-specific WACC would not be consistent with the fair bet. Therefore, the starting point for any assessment of whether the fair bet has been honoured is an assessment of this question.

On the basis of Ofcom's analysis, its proposed interventions would () allow BT a lifetime (20-year) IRR of 11.8%. Therefore, for Ofcom's intervention not to breach the fair bet principle, the project-specific WACC for this investment must be below 11.8%. Otherwise, capping returns at or below the WACC for a risky investment would, by definition, shift the expected returns at project inception below the WACC, which would be in breach of the fair bet principle.

Based on the analysis explained in the previous section (and which we set out in full Appendix 1), we find that the relevant project-specific WACC for BT's FTTC investment lies in a range between 11.4% and 12.8%, with estimates towards

[21] Ofcom (2017), 'Wholesale Local Access Market Review – Annexes'.

the top of this range (i.e. above 12.1%) being more likely.[22] Ofcom's proposed cap on returns lies below this level.

Given this, there is a material risk that Ofcom's proposed intervention breaches the fair bet principle, as it implies returns at project inception below the relevant WACC. A rational investor would therefore not have taken this bet.

3.2 Continued pricing flexibility during this market review period would be consistent with the fair bet (and would not result in excessive returns)

We have explained above that Ofcom's proposals to cap BT's FTTC lifetime returns at 11.8% will not be consistent with the fair bet principle, but a key question remains: should Ofcom refrain from introducing price regulation on FTTC in this market review? Would this be consistent with the fair bet, or would it allow BT to earn 'excessive' returns?

Below, we seek to answer this question using three different approaches, set out below. Each one aims to estimate the level of returns above the project-specific cost of capital that would be consistent with the fair bet (and therefore not excessive), given the downside risks faced by investors at project inception.

Only the third approach is a direct application of the fair bet framework described in this report. Nevertheless, the first two approaches are useful reference points to assess whether continued pricing flexibility on BT's FTTC network might be appropriate.

3.2.1 Approach 1: Ofcom's implied spread over WACC

Ofcom's decision to impose a price control effectively relies on its assessment that an IRR of 15% over the life of the FTTC project is excessive. However, it is unclear how it has reached this conclusion other than stating that returns of 15% would be 'well in excess of BT's cost of capital'.[23]

Under Ofcom's approach, performance against expectations provides a useful indicator on when to intervene. As Ofcom puts it: [24]

> Performance against expectations and, in particular, the level of returns, provide a useful indicator of whether it is appropriate to intervene. Although it is consistent with the fair bet principle to allow BT the opportunity to earn returns above cost, if the level of returns becomes very high it could be appropriate to impose a charge control, even if expected payback has not been met. The fair bet would still be met if we intervened before expected payback, **but only when returns are significantly above the benchmark cost of capital**. We would have a greater tolerance for higher returns where the downside risk is greater (para. A8.8) [emphasis added]

At different points in the consultation, Ofcom refers to BT's unregulated returns, on both a ROCE and IRR basis, and suggests that they are 'well above the cost of capital'.[25]

We have already explained why such comparisons cannot provide a basis to implement the fair bet framework without an understanding of what is the critical level of returns (Y) above which returns could be considered excessive.

[22] We note that this estimate is considerably larger than Ofcom's forward-looking WACC estimate of 9.4% applicable to FTTC. This is because Ofcom's estimate applies on a forward-looking basis only, and is not the appropriate benchmark for the initial investment tranches. Appendix 1 provides further details.
[23] Ofcom (2017), 'Wholesale Local Access Market Review – Annexes' para. A8.23.
[24] Ibid.
[25] Ibid., paras A8.22 and A8.23.

However, Ofcom's comparison between the IRR of 15% and BT's cost of capital would suggest that Ofcom regards such a spread as a useful indicator of whether returns are excessive and in line with the fair bet principle.

Therefore, following Ofcom's logic, comparing Ofcom's proposed cap on BT's returns of 11.8% with its estimate of the cost of capital for NGA (9.4%)[26] suggests that Ofcom considers a spread of 2.4% (i.e. Δ) over the project-specific WACC to be appropriate and in line with the fair bet principle. (In other words, it does not regard this level of returns over the cost of capital as excessive.)

Taking Ofcom's estimate of the Δ at face value, and simply applying Ofcom's Δ of 2.4% to Oxera's revised estimate for the appropriate ex ante project-specific WACC (of 11.4–12.8%), suggests that price regulation which caps FTTC returns at anything less than 13.8–15.2% would be inconsistent with Ofcom's own logic. This is considerably above its proposals, and much closer to the unregulated status quo.

3.2.2 Approach 2: Comparator/benchmarking analysis

To assess an excessive return requires an estimate of the ex ante project probability distribution of returns or a distribution of returns on a benchmark set of projects. In this section, we undertake a benchmarking exercise.

In particular, we undertake a benchmarking analysis of the returns above the WACC (i.e. Δ) that BT is expected to make on its FTTC investment in the absence of price controls (c. 2.2–3.5% above the relevant project-specific WACC calculated by Oxera),[27] and how these compare to the returns observed in a sample of other similar projects. The objective is to assess whether such an unregulated spread of returns appears to be unreasonably high (and could therefore be considered excessive), or whether the returns are in line with the spread of returns obtained by similar projects.

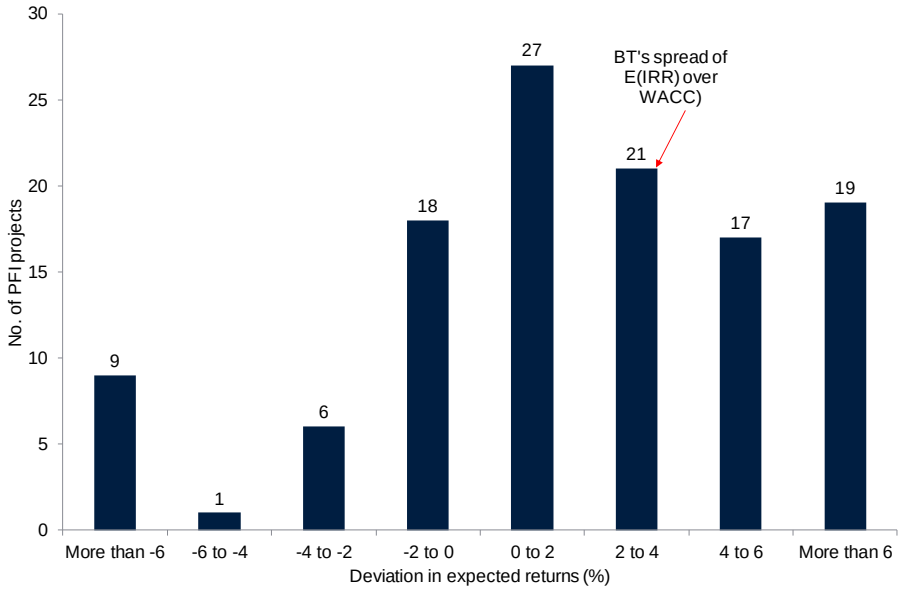
The ideal data to benchmark returns for BT's FTTC investment would be the spread of returns earned by other investors in fibre networks. However, this data is likely to be highly confidential and not available publicly.

As an alternative, the spread of returns earned by private investors in private finance initiatives (PFIs) might be informative for benchmarking purposes. PFI projects are similar to BT's FTTC investment, in that both are typically long-lived projects, involve infrastructure investments, and might involve multiple tranches of investment.[28]

A database of 118 PFI projects provides a summary of the spread of expected project returns over the investors' project cost of capital at some point in the project's lifetime (i.e. it provides a measure of 'Δ' for these projects). In that respect, this is similar to the situation at hand, as Ofcom has also analysed BT's expected project returns midway through the project's life.

[26] According to Ofcom, the relevant WACC for NGA is the WACC for 'Other UK Telecoms', which Ofcom estimates at 9.4%.
[27] 15% IRR (calculated by Ofcom), less WACC of c. 11.5–12.8% (calculated by Oxera).
[28] Two important differences are worth highlighting. First, the PFI project dataset measures the spread of returns for equity investors. The ideal dataset would adjust for gearing in order to make it directly comparable to BT's FTTC investment. Second, the PFI projects are characterised by low systematic risk. Adjusting for gearing would potentially reduce the spread in expected returns. However, adjusting for systematic risk would likely increase the spread. These two differences work in opposite directions and could therefore cancel each other out. However, we have not attempted any adjustments to the dataset.

Figure 3.1 Variation in observed returns for PFI projects over the project WACC



Source: Oxera analysis based on data from NAO (2012), 'Equity investment in privately financed projects', February 10.

Based on the observed variation in returns for PFI projects, BT's unregulated spread above the correct project-specific WACC calculated by Oxera is consistent with the observed deviations for nearly 50% of the PFI projects.[29] Furthermore, over a third of the PFI projects were expected to earn a return spread above that being earned by BT. This indicates that the level of returns that Ofcom estimates that BT would earn in the absence of regulation (15%) does not appear excessive against this benchmark. In fact, BT's unregulated spread is well within the range of spreads observed for other privately financed investment projects with similar characteristics.

3.2.3 Approach 3: Estimation of critical level of returns based on the building blocks of the fair bet framework

In section 2, we explained that it is possible to estimate the critical level of lifetime project returns that determines the threshold for both: returns that can be considered excessive (lifetime IRRs exceeding Y); and regulatory interventions that would breach the fair bet (capped returns below Y).

To estimate the critical Y for BT's FTTC investment, three important parameters are required:

1. the relevant project-specific WACC, which Oxera has estimated to be between 11.4% and 12.8%;

2. the returns BT expected to make at project inception over the lifetime of the investment— Oxera has been provided with BT's estimate of the expected 20-year IRR for the NGA investment based on the 2008 business plan. This ranges between [✂];[30]

[29] This is based on the c. 57 projects expected to earn more than 2% above expected returns, divided by the 118 projects in the sample. 21 between 2% and 4%; 17 between 4% and 6%; and 19 above 6%.
[30] The difference is whether the returns are assessed at the level of BT Group or Openreach, respectively.

3. the shape of the distribution of returns of the project at inception—in the absence of detailed data to infer the shape of the returns distribution, we assume a normal distribution centred around the excepted lifetime returns, with a standard deviation range of 2.0–5.0%[31]

For illustrative purposes, taking the midpoint of the ranges for all three parameters[32] results in a critical level of Y of [✂].[33] However, there would be considerable risk of regulatory failure with this proposal. In particular, a price cap that capped returns at this level would only allow investors a return equal to the midpoint of the WACC range, whereas our analysis indicates that something close to the top end of the range is more appropriate. It is also unclear whether such a price cap would be consistent with the incentive properties of RPI – X charge controls.

To allow a return at the top end of the WACC range (12.8%) and continuing to assume a normal distribution of returns with a standard deviation of 3.5%, the level of capped returns would need to be at least [✂],[34] rising to [✂] if the expected project IRR at the time of inception was [✂] (see Figure 3.2).[35] This is close to Ofcom's 15% IRR estimate, and would therefore be consistent with continued pricing flexibility on VULA services during this market review and delaying the imposition of a cost-based charge control to 2020/21.[36]

Figure 3.2 [✂]

Source: Oxera analysis.

The results presented above all assume a standard deviation of 3.5%. However, it could be argued that a standard deviation at the top of our range would be more appropriate (i.e. 5%). This could preserve the incentive properties of RPI - X regulation and ensure there is no claw-back of returns earned as a result of efficiency savings over and above expectations. As explained in the previous section, this requires assuming a distribution of returns that is wide enough to capture the cash-flow risk of efficiency out- or underperformance.[37]

To allow a return at the top end of the WACC range (12.8%) and assuming a normal distribution of returns with a standard deviation of 5%, the level of capped

[31] By way of illustration, for an expected return of 14%, a standard deviation of 2.0% would mean that 68% of possible outcomes lie within a range of 12% and 16% (± one standard deviation), rising to 10% and 18% for 95% of outcomes (± two standard deviations). For a 5% standard deviation, the corresponding figures are 9–19% for 68% of outcomes and 4–24% for 95% of outcomes. We consider this to be a reasonable approximation of a plausible range of outcomes for this investment. For example, visual inspection of the distribution of return spreads for PFI projects shown in Figure 3.1 would suggest a standard deviation of around 3%, since around 70% of the outcomes are within a range of ±3% of the sample's average (one standard deviation). However, we note that the actual standard deviation of the PFI distribution might be higher since the data provided does not split out the tails of the distribution, and makes it look narrower than it actually is.
[32] A WACC of 12.1%, an expected IRR of [✂] and a standard deviation of 3.5%.
[33] Appendix 3 describes how the critical level (Y) can be estimated using the three key parameters.
[34] If the expected IRR at inception were [✂].
[35] This is based on BT's lower-end estimate of the 20-year IRR ([✂]) and a standard deviation of 3.5%.
[36] Or some other profile of price controls that would deliver an expected IRR of 15%, going forward.
[37] Efficiency out- or underperformance can have a material effect on estimated lifetime IRRs and therefore on the ex ante the distribution of returns. For example, consider a regulated asset with a lifetime CAPEX:OPEX ratio of 1:2 (i.e. OPEX spend is roughly double the CAPEX spend over the lifetime of the asset), which is broadly comparable to BT's NGA investment, based on Ofcom's model. If revenues are assumed to remain constant at a level that allows the firm to earn its WACC at target efficiency levels, each ±1% of year-on-year OPEX and CAPEX efficiency saving would result in a change in the 20-year IRR of around ±1%. However, the effect is non-linear. Underperformance on efficiency has an exponentially negative effect on returns (e.g. underperformance of -3% year on year would reduce the IRR by around 5%), whereas outperformance has a broadly linear effect on returns (e.g. outperformance of 3% per year results in an increase in the IRR of 2.8%). Precise figures will depend on the cost of capital of the asset in question.

returns would need to be at least [✂],[38] rising to [✂] if the expected project IRR at the time of inception was [✂] (see Figure 3.3).[39]

Figure 3.3 [✂]

This is above Ofcom's 15% IRR estimate, and would therefore support continued pricing flexibility on VULA services during this market review. On the other hand, this analysis suggests that a price cap which resulted in an IRR of less than 15% runs the risk of breaching the fair bet principle, and could not be interpreted as being generous to BT.

[38] If the expected IRR at inception were [✂].
[39] This is based on BT's lower-end estimate of the 20-year IRR ([✂]) and a standard deviation of 5%.

A1 Estimating the ex-ante project-specific WACC for BT's FTTC network

This appendix presents the analysis for the project-specific WACC as estimated by Oxera under the two scenarios described in section 2.3.

The two scenarios are largely characterised by the assumptions around BT's CAPEX profile. Figure A1.1 describes the CAPEX profile for the fibre network taken from Ofcom's IRR model.[40]

Figure A1.1 [✂]

Based on information from BT's 2008 board papers, we observe that at least £1 billion of CAPEX in 2008 had been committed to roll out the NGA service to around 40% of households.[41] Subsequently in March 2010, BT committed to invest a further £1 billion of CAPEX.[42] The combined £2 billion of CAPEX represented the total outlay of CAPEX originally envisaged by BT for the NGA network. Ofcom's current model for assessing BT's returns estimates a CAPEX spend of £[✂]billion over the life of the project.

Under scenario 1, it is assumed that the degree of optionality associated with the CAPEX profile for the fibre network was low, and all investments in the NGA network were committed and tied to BT's announcements in 2008 and 2010. This suggests that once BT had committed the additional £1 billion spend in 2010, there was effectively limited scope for revising the committed CAPEX programme.

We consider that an indicative point estimate of the project-specific WACC is likely to be towards the top end of our range. This key reason for this is that successive tranches of CAPEX are unlikely to be entirely independent.

For instance, it is highly unlikely that BT could have completely abandoned all future CAPEX if it had not earned adequate returns from the first tranche of investment—for example, BT would still have had to incur maintenance expenditure to maintain the assets already invested in.

Furthermore, even though it is in theory possible to envisage scenarios where BT could have abandoned the project, in practice, it is unclear which triggers would have led it to exercise this option. Having announced that NGA was part of its future strategy, we consider that there are not many scenarios where BT would have decided to abandon the project a few years later, even if take-up or the level of the price premium assumed were lower than its initial forecasts. Given the large fixed and sunk costs of the investment, these parameters would need to have been materially below forecasts for the abandonment option to be attractive.

In contrast, and in order to define the fullest possible range of outcomes, we assume in Scenario 2 that there is some discretion and optionality in the CAPEX profile—in particular, for investments that take place after the project has matured and has reached a steady state. For the purposes of estimating a lower bound, we assume the project to have fully matured at the start of this market review and that all investments taking place from now onwards are independent from previous investments.

[40] This was provided by BT to Oxera.
[41] BT (2008), 'NGA Strategy – BT Group PLC Board'.
[42] Ofcom (2017), 'Wholesale Local Access Market Review – Annexes', 31 March, para.A8.10.

As illustrated in Figure A1.1 above, according to Ofcom's model, approximately 59% of the total CAPEX spend for the fibre network has materialised to date and 41% of the CAPEX is expected to be spent between 2017 and 2029. This forms the basis for the relevant weights associated with the two tranches of CAPEX under this scenario.

The rest of this appendix explains the calculations underlying the project-specific WACC estimates with each of the scenarios.

A1.1 Benchmark WACC under scenario 1

With respect to estimating the WACC under scenario 1, the relevant contemporaneous WACC parameters for the 2008 and 2010 CAPEX announcements can be inferred from Ofcom's 2009 LLU charge control determinations for BT. Table A1.1 sets out the generic WACC parameters as determined by Ofcom.

Table A1.1 Ofcom's parametric determinations for BT's WACC in 2009

WACC parameter	Ofcom determination (Rest of BT, LLU 2009)
RPI inflation	2.5%
Tax rate	28%
Risk-free rate, real	2.0%
Equity risk premium	5.0%
Debt beta	0.15
Gearing	35%
Debt premium	3.0%
Asset beta	*0.68*

Note: Oxera has assumed Ofcom's WACC determination for 'Rest of BT' as relevant for the NGA network.

Source: Oxera analysis based on Ofcom (2009), 'A New Pricing Framework for Openreach', 22 May.

As indicated in Table A1.1, the asset beta estimate for 'Rest of BT' in 2009 was 0.68. However, this is unlikely to accurately reflect the forward-looking asset risk of the NGA investment in 2008.

A Brattle report in 2016 considered that the systematic risk of NGA services was driven by systematic demand risks, capital leverage and long-term payoffs.[43] Ofcom's current proposals appear to recognise that all three risk factors for the fibre network were much higher previously, in stating:

> Overall, we consider that the systematic risk for NGA services stemming from the income elasticity of demand is likely to be greater than for copper access. While **the systematic demand risk of NGA services may have been higher in the past**, it is likely to have reduced over time…[44] [emphasis added]
>
> …the **risk of subsequent tranches of investment would have declined significantly** as demand and costs became better understood…[45] [emphasis added]
>
> …the expected payback period may have resulted in a **higher asset beta for NGA activities at the time of the initial investment**,[46] [emphasis added]

[43] Ofcom (2017), 'Wholesale Local Access Market Review – Annexes', 31 March, para. A16.142.
[44] Ibid., para. A16.153.
[45] Ibid., para. A16.157.
[46] Ibid., para. A16.160.

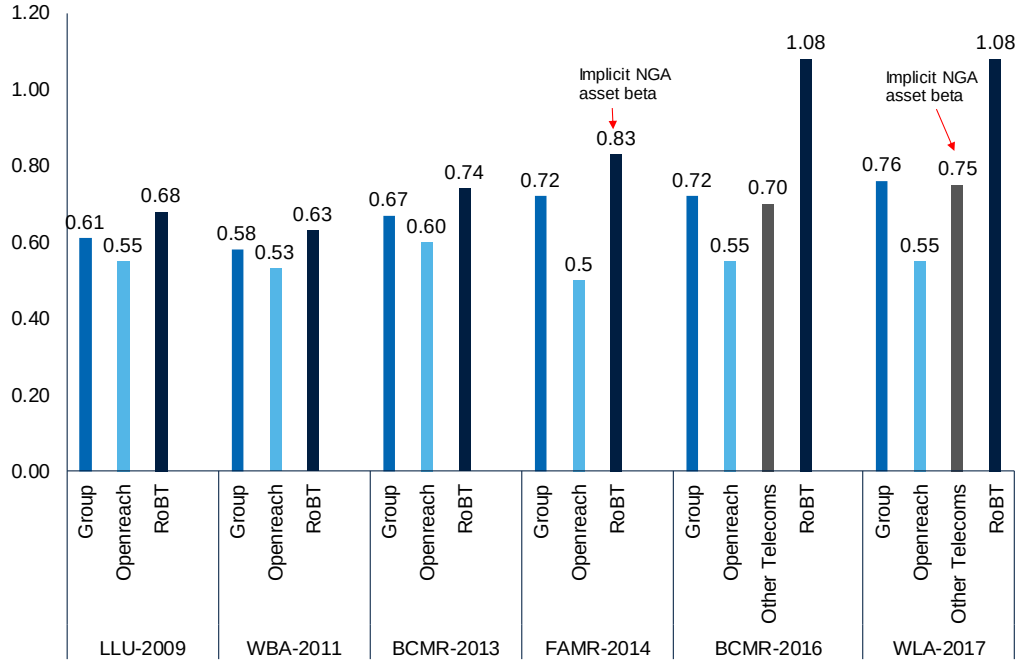
Ofcom also recognised the notion of the first tranche of investment being the riskiest in 2007:

> the risk profile of investments changes over time, with later tranches of investment potentially being lower risk than initial investments. Therefore, any estimation of risk needs to vary over time.[47]

Thus, it follows that the overall project asset beta must decline over time.

As illustrated in Figure A1.2 below, Ofcom's current forward-looking asset beta estimate for fibre investments is 0.75. Furthermore, in the 2014 FAMR charge controls, Ofcom considered the FTTC network to be part of 'Rest of BT', which had an asset beta estimate of 0.83.[48]

Figure A1.1 Ofcom's asset beta determinations for BT's business divisions over time



Source: Oxera analysis based on Ofcom decisions.

Given that, as Ofcom accepts, the risk of the fibre investment was higher at the time of the initial investment,[49] the relevant asset beta for NGA during the period 2008–10 would be at least higher than 0.83.

To estimate the asset beta for the FTTC investments at inception, a simple approach is to assume a linear extrapolation of the asset beta estimates from the 2017 WLA and 2014 FAMR decisions. This indicates that an asset beta estimate of c.0.92 for the first tranche of the investment would be reasonable.[50]

[47] Ofcom (2007), 'Future broadband', 26 September, para. 5.18
[48] Ofcom (2014), 'Fixed access market reviews: wholesale local access, wholesale fixed analogue exchange lines, ISDN2 and ISDN30 – Annexes', 26 June, Table A14.1 and para. A14.262.
[49] See Ofcom (2017), 'Wholesale Local Access Market Review – Annexes', 31 March, paras A16.153, A16.157 and A16.160.
[50] Given that the asset beta estimate in 2017 (0.75) is approximately 10% lower than the asset beta estimate in 2014 (0.83), and assuming the same relationship holds across the asset betas between 2008–10 and 2014, this suggests an asset beta estimate of approximately 0.92 for the initial investments. This estimate could be considered conservative as, if one factors in the duration between the points in time over which the asset beta is being extrapolated, and the fact that risk may have declined considerably over time, the NGA asset beta at project inception could be even higher than our estimate. For the sake of simplicity and given the relatively short period of time between the 2008 and 2010 investment commitments, Oxera assumes the asset beta estimates for both these investments to be the same.

Applying this estimate of the asset beta to the generic WACC parameters set out in Table A1.1 yields a pre-tax nominal cost of capital estimate of 12.8%.

A1.2 Benchmark WACC under scenario 2

Under scenario 2, we estimate a weighted average of two notional tranches of investment: pre 2016/17 and post 2016/17. Investments prior to 2016/17 are associated with the 2009 WACC estimate of 12.8%, whereas investments after 2016/17 are associated with Ofcom's 'Other UK Telecoms' WACC estimate of 9.4% under the proposed charge control for VULA (see Table A1.2 below).

Table A1.2 Ofcom's parametric determinations for BT's WACC in 2009 and 2017

WACC parameter	Ofcom determination (Rest of BT, LLU 2009) Tranche 1	Ofcom determination (Other UK Telecoms, WLA 2017) Tranche 2
RPI inflation	2.5%	3.2%
Tax rate	28%	17%
Risk-free rate, real	2.0%	0.5%
Equity risk premium	5.0%	5.7%
Debt beta	0.15	0.10
Gearing	35%	35%
Debt premium	3.0%	1.0%
Asset beta	0.92*	0.75
WACC (pre-tax, nominal)	**12.8%**	**9.4%**

Note: For Tranche 1, Oxera has assumed Ofcom's WACC determination for Rest of BT as relevant. * Revised Oxera asset beta estimate for fibre network.

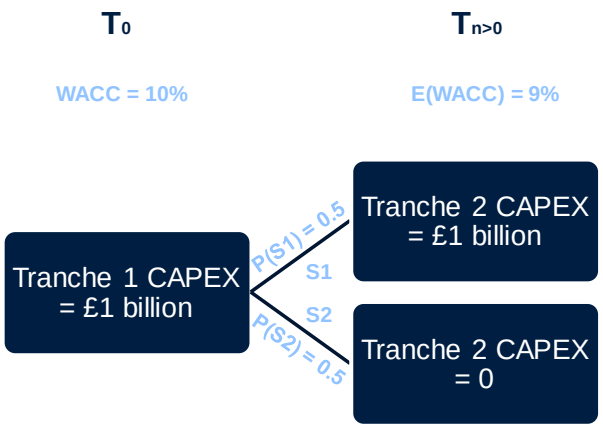
Source: Oxera analysis based on Ofcom's regulatory determinations.

Based on the CAPEX split between the period before and after 2016/17 of 59% and 41% respectively (as indicated by Ofcom's 2017 model), the value-weighted average cost of capital for the entire project across these two tranches of CAPEX is estimated to be 11.4% on a pre-tax nominal basis.

A2 Illustration of option value adjustment on project-specific capital

The following stylised example of a two-tranche investment demonstrates the impact of the option value of the second tranche of investment on the overall project-specific WACC.

Figure A2.1 Stylised example of a value weighted ex ante WACC for a project with two investment tranches



Source: Oxera analysis.

Consider a sample project as characterised in Figure A2.1. The first tranche of investment is £1 billion with an associated WACC of 10%. Following this, two states of the world (S1 and S2) may be possible, each with a probability of 0.5. In S1, the project goes forward with another investment tranche of £1 billion and a contemporaneous WACC of 9%. In S2, no further investment is considered.

A simple value-weighted WACC for this project, ignoring any optionality of Tranche 2, would be 9.5%. However, including the option to abandon Tranche 2 results in the following estimate for the project-specific WACC:

$$Project\ specific\ WACC$$

$$= P(S1) * \left(\frac{Tranche\ 1\ CAPEX}{Total\ CAPEX\ (given\ S1)} * WACC_{Tranche\ 1} + \frac{Tranche\ 2\ CAPEX}{Total\ CAPEX\ (given\ S1)} * WACC_{Tranche\ 2} \right) + P(S2) * \left(\frac{Tranche\ 1\ CAPEX}{Total\ CAPEX\ (given\ S2)} * WACC_{Tranche\ 1} + \frac{Tranche\ 2\ CAPEX}{Total\ CAPEX\ (given\ S2)} * WACC_{Tranche\ 2} \right)$$

$$= (0.5) * \left(\frac{1}{2} * 10\% + \frac{1}{2} * 9\% \right) + (0.5) * (1 * 10\% + 0)$$

$$= 9.75\%$$

As shown above, including the option value associated with later tranches of the investment would result in an increase in the overall project-specific cost of capital (all else being equal).

A3 Mathematical derivation to determine the level of capped returns

Denote the ex ante uncapped distribution of returns as $p(x)$. We have assumed that p is a normal distribution, but the derivation of the capped return does not depend on that assumption:

The expected return from this distribution can be written as:

$$E(X) = E(X|x < Y) \cdot P(x < Y) + E(X|x > Y) \cdot P(x > Y)$$

If Ofcom were to cap returns at Y, then the 'new' (truncated) ex-ante expected returns is:

$$E(X^*) = E(X|x < y) \cdot P(x < Y) + Y \cdot P(x > Y)$$

In order for the cap Y to be consistent with the fair bet, it must be the case that $E(X^*) \geq w$ where w is the WACC:

$$E(X|x < y) \cdot P(x < Y) + Y \cdot P(x > Y) \geq w$$

Converting these expressions into integrals reflecting the areas under the distribution of returns curve, gives:

$$\int_{-\infty}^{Y} xp(x)\,dx + Y \int_{Y}^{\infty} p(x)dx \geq w$$

With knowledge of the relevant WACC (w), the shape and location of the uncapped distribution of returns p; this expression can be solved for Y (the critical level of the price cap) using standard mathematics software.

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