Assessing the anticipated shape and distribution of BT's FTTC returns

Supplementary report prepared for BT

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Executive summary

In Oxera's first report, submitted to Ofcom on 16 June 2017 ('Oxera 1'),[1] we identified that there are three key parameters that are required in order to implement the fair bet principle in practice. These are:

1. the project-specific cost of capital;
2. the expected returns over the lifetime of the project;
3. the shape of the distribution of returns.

In this supplementary report, we undertake further analysis on the third parameter: the shape of the distribution of returns of BT's FTTC investment. Our analysis is based on BT's 2008 FTTC business plan model and the contemporaneous evidence contained in BT's 2008 business plan regarding the key factors affecting project returns.

We consider the 2008 business plan model to be an appropriate basis for conducting this analysis, since the outputs of this model are contained in the June 2008 Board paper which resulted in BT's Board green-lighting the fibre investment programme. Furthermore, Ofcom itself relies heavily on BT's Board paper for evidence regarding the expected payback on the FTTC investment.

Summary of approach and main findings

- Our analysis finds that both the BT Group and the Openreach internal rate of return (IRR) are highly sensitive to the Openreach and BT Retail 'pricing premium' over copper that FTTC could have commanded, with the Openreach pricing premium in particular having the largest impact on returns.

[1] Oxera (2017), 'Does Ofcom's approach in the WLA market review honour the fair bet principle?', June.

Other factors, such as the 'take-up rate' and 'capex/opex costs', are also important, but are not as significant as the 'pricing premium'.

- As a starting point, our analysis focuses on exploring how the shape of the distribution of the **Group IRR** is affected by the potential range of scenarios and the variability of just the **Openreach pricing premium**. Modelling the cumulative impact of other key parameters, such as the BT Retail pricing premium and the take-up rate, would increase the potential range of outcomes and widen the distribution of returns (i.e. including other factors would act to increase the standard deviation of returns).[2] The analysis presented here is, therefore, conservative.

- Based on information contained in the June 2008 BT Board paper, we understand that, in 2008, there was evidence of FTTx pricing premiums across Europe ranging from £0 to £12.0.[3] Furthermore, in the 2008 business plan model, BT had specified a Base case Openreach pricing premium of £5.0/month, with a 'Medium' scenario of £3.7 and a 'High' scenario of £10.0. A 'Low' scenario was not explicitly included in the model.

- A conservative starting assumption for the pricing premium distribution would be one in which the vast majority of possible outcomes lie within the range of pricing premiums observed or expected in 2008, as outlined in the Board papers. We consider that a normally distributed Openreach pricing premium with an average of £5.0 and a standard deviation of £1.0 would be consistent with this. This would mean an equal likelihood of the pricing premium being higher or lower than £5.0, and 95% of pricing premium outcomes lying between £3.0 and £7.0.[4] This range is well within the range of evidence of pricing premiums obtained by FTTx projects in Europe at the time (and is, therefore, a conservative assumption).

- Taking this distribution of the Openreach pricing premium and using it in the 2008 business plan model, we have been able to derive the shape of the distribution of the Group IRR. We did this by 'running' 10,000 Monte Carlo simulations selecting the value of the Openreach pricing premium parameter at random from the distribution defined above, and recording the resultant impact on the project Group IRR.

- Through this process, we found that the Group IRR distribution would have a similar shape to a standard normal distribution with an expected (average) IRR of 13.7% and a standard deviation of 3.6%. Given this shape of the distribution of returns, we were able to calculate that a price control capping returns below a critical level of 14.8% would breach the fair bet principle, since it would result in an expected IRR of less than 12.8% (the high-end of the cost of capital range).

- We note that this result is almost identical to that presented in Oxera 1, and is obtained by considering the impact of just one parameter (the Openreach pricing premium) on the Group IRR. Introducing the impact of other key

[2] This is because for any given level of the Openreach pricing premium, there is also uncertainty around the level of take-up that could be achieved, or the mark-up that could be applied above the Openreach price at the retail level. The range of possible outcomes would therefore widen if these factors were also taken into account.
[3] Although not specified in the Board papers, it would appear that these are retail price premiums.
[4] In other words, an equal likelihood of BT having to set a modestly lower price (relative to the Base case) in order to achieve target take-up rates, or of being able to charge a modestly higher price while still achieving target take-up rates.

parameters, such as the BT Retail pricing premium and the take-up rates, would increase the critical level of capped returns even further.

- We have conducted a number of sensitivities to test the robustness of this result. A particularly relevant one is to consider how our central result would vary if we assumed that the Openreach pricing premium distribution was positively skewed (i.e. if there was more likelihood of pricing upside than downside relative to the Base case of £5.0).
- Our analysis finds that for a large number of 'positive skew' scenarios, the conclusion of Oxera 1 still holds. For example, we tested scenarios where the Openreach pricing premium is assumed to range between £0 and £12.0 ('mild' skew) and between £0 and £20.0 ('strong' skew), and found that the critical cap would be even higher, at 18.2% and 16.6%, respectively.
- This somewhat counterintuitive result arises because the effect of a positive skew is to increase the frequency of scenarios lying above the Base case level of returns. This makes the negative impact of any given cap on returns much stronger (because the scale and likelihood of upside removed by the cap is greater than under a standard normal distribution), counteracting the higher expected (average) return created by the positive skew.
- In fact, for the Oxera 1 conclusion to be reversed (i.e. to find critical levels of the cap below 15.0% as implied by Ofcom's proposed pricing for GEA 40/10 in March 2017), we would need to assume either a considerably higher upside for the pricing premium (e.g. up to £58.0) and/or rule out scenarios where the pricing premium could be less than £2.0. Based on the contemporaneous evidence we have reviewed, these are not credible scenarios to consider, and we are therefore confident of the robustness of the conclusions reached in Oxera 1.

1 Background

Since May 2017, Oxera has been supporting BT in its response to Ofcom's 2017 Wholesale Local Access Market Review (WLA MR), in relation to whether Ofcom's proposals to regulate the prices of BT's 40/10 FTTC product are consistent with the fair bet principle.

In this context, Oxera developed a conceptual framework for assessing whether the fair bet had been honoured, which was set out in a paper entitled 'Does Ofcom's approach in the WLA market review honour the fair bet principle?', dated 16 June 2017 ('Oxera 1'). This paper was submitted to Ofcom annexed to Openreach's response to the WLA market review consultation and is also referenced in BT Group's response.

Oxera 1 explained that 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. These parameters are:

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.

On the first parameter, the analysis in Oxera 1 showed that the project-specific cost of capital for BT's FTTC investment lies within a range of 11.4–12.8%, with estimates close to the top of this range more representative of the risk profile of BT's FTTC investment. Based on this, we were able to conclude that Ofcom's price control proposals would not be consistent with the fair bet principle, as they would cap BT's returns at 11.8%, which lies at the bottom of this range.

On the second parameter, in Oxera 1 we referred to contemporaneous evidence contained in BT's 2008 business plan for the FTTC investment on the 20-year IRR of the project. This ranges between 13.8% and 14.4% for the BT Group and Openreach IRRs, respectively.

In relation to the third parameter, in Oxera 1 we assumed that the distribution of returns was a standard normal distribution with a mean of 13.8–14.4%, and a standard deviation of 3.5% (the mid-point of a 2.0–5.0% range). We considered this to be a reasonable working assumption, since it implies that 95% of plausible outcomes at project inception would lie within an IRR range of 7.0–21.0%.[5]

Based on these parameters, the analysis in Oxera 1 showed that imposing a price control that had the effect of capping lifetime project returns at anything less than 14.7% would have a high likelihood of breaching the fair bet principle.[6] This was because the effect of a cap below this level would reduce the expected level of the Group IRR at project inception below 12.8%, which is the top-end of the project-specific WACC range. Furthermore, for a standard deviation of 5.0%, this critical level of capped returns could be as high as 16.3%.

The shape of the distribution of returns therefore plays a crucial role in implementing the fair bet principle.

In this supplementary report, we undertake further analysis on this parameter, based on BT's 2008 FTTC business plan model and the contemporaneous evidence contained in BT's 2008 business plan regarding the key factors affecting project returns.

We consider the 2008 business plan model to be an appropriate basis for conducting this analysis, since the outputs of this model are contained in the June 2008 Board paper which resulted in BT's Board green-lighting the fibre investment programme. Furthermore, Ofcom itself relies heavily on BT's Board paper for evidence regarding the expected payback on the FTTC investment. Indeed, as highlighted in Oxera 1, the fact that price regulation is being imposed on the FTTC network after BT's Base case expected payback period is one of Ofcom's main arguments to justify imposing charge controls in this regulatory period.

2 Methodology

The analysis we have conducted involved assessing the distribution of FTTC returns by considering how key parameters and assumptions within the business case affect the overall expected FTTC returns.

[5] Two standard deviations above and below an expected return of 14.0%.

[6] As noted in Oxera 1, this would consistent with 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 15.0%).

We have focused our analysis on the 20-year IRR of the investment based on BT's 2008 business plan model, which projects the FTTC cash flows over a 20-year period.

Our analysis of the model reveals that there are three key parameters that influence the FTTC returns:

- the **pricing premium** of fibre over copper, for both Openreach and BT Retail—BT's Base case scenario was a £5.0 per month Openreach pricing premium, and an £8.50 per month BT Retail pricing premium. Hence, there was an implicit £3.50 fibre mark-up at the retail level;
- the proportion of **take-up** within the coverage area—BT's Base case scenario assumed a 20% take-up would be achieved over a three-year period from the start of roll-out;
- the magnitude of **costs**—BT's Base case assumed an additional cost of £16.0 per year per connected FTTC customer.

Of these parameters, the BT Group and Openreach IRRs were most sensitive to the Openreach and BT Retail 'pricing premium' over copper that FTTC could have commanded, with the Openreach pricing premium in particular having the largest impact on both Group and Openreach returns.

Therefore, as a conservative starting point, our analysis has focused on exploring how the shape of the distribution of the Group IRR is affected by the potential range of scenarios and the variability of just the Openreach pricing premium.

Modelling the cumulative impact of other key parameters, such as the BT Retail pricing premium and the take-up rate, would increase the potential range of outcomes and broaden the distribution of returns. This is because for any given level of the Openreach pricing premium, there is also uncertainty around the level of take-up that could be achieved and/or the retail mark-up that could be applied above the Openreach price level. The range of possible outcomes would therefore widen if these factors were also taken into account.

The analysis proceeded in three steps, as follows.

- **Step 1**—we estimated a distribution around the Base case for the Openreach pricing premium, based on contemporaneous evidence of the possible range of values of this parameter.
- **Step 2**—we 'ran' 10,000 Monte Carlo simulations selecting the value of the pricing premium parameter at random from the distribution defined in Step 1, then recorded the resultant impact on the project IRR. To run this simulation, we used 'Crystal Ball' software in Excel.[7]
- **Step 3**—based on the distribution of IRRs obtained from Step 2, we estimated the critical level of capped returns consistent with the fair bet principle, using the analytical framework described in Oxera 1. As explained in Oxera 1, the fair bet principle requires that the expected IRR at project inception remains above the project-specific cost of capital, after accounting for the effect of a price control. The critical level of capped returns is therefore the lowest cap on returns that achieves this outcome.

[7] For a description of Crystal Ball software, see: http://www.oracle.com/technetwork/middleware/crystalball/overview/index.html.

The results of this analysis are presented below. We started our analysis by assuming a normal distribution for the pricing premium parameter (section 3) before relaxing this assumption to consider positively skewed distributions (section 4).[8]

3 Results for a normally distributed pricing premium distribution

Information contained in the June 2008 BT Board papers shows that, in 2008, there was evidence of FTTx pricing premiums across Europe ranging from £0 to £12.0.[9] Although not specified in the Board papers, it would appear that these are retail price premiums.

Furthermore, in the 2008 business plan model, BT had specified a Base case Openreach price premium of £5.0 per month, with a 'Medium' scenario of £3.7 and a 'High' scenario of £10.0. A 'Low' scenario was not explicitly included in the model, but the wider range of pricing premiums cited above would indicate that a lower scenario was being contemplated.

A conservative starting assumption for the pricing premium distribution would be one in which the vast majority of possible outcomes lie within the range of pricing premiums observed at the time. We consider that a normally distributed Openreach pricing premium with an average of £5.0 and a standard deviation of £1.0 would be consistent with this. This would mean an equal likelihood of the pricing premium being higher or lower than £5.0, and 95% of pricing premium outcomes lying between £3.0 and £7.0. This range is well within the range of evidence of pricing premiums obtained by FTTx projects in Europe at the time (and is, therefore, a conservative assumption).

Put differently, this can be interpreted as an equal likelihood of BT having to set a modestly lower price in order to achieve the Base case take-up rates, or BT being able to charge a modestly higher price and still achieving these take-up rates.

As described in section 2, we then 'ran' 10,000 Monte Carlo simulations, using the Crystal Ball software, by selecting the value of the pricing premium parameter at random from the normal distribution defined above and recording the resultant impact on the 20-year FTTC project Group IRR.

Through this process, we found that the Group IRR distribution would have a similar shape to a standard normal distribution with an expected (average) IRR—E(IRR)—of 13.7% and a standard deviation of 3.57%. Given this shape of the distribution of returns, we were able to calculate that a price control capping returns below 14.8% would breach the fair bet principle, since it would result in an expected IRR of less than 12.8% (the high-end of the project-specific cost of capital range). This is shown in Figure 3.1 below.

We note that this result is almost identical to that presented in Oxera 1, and is obtained by considering the impact of just one parameter (the Openreach pricing

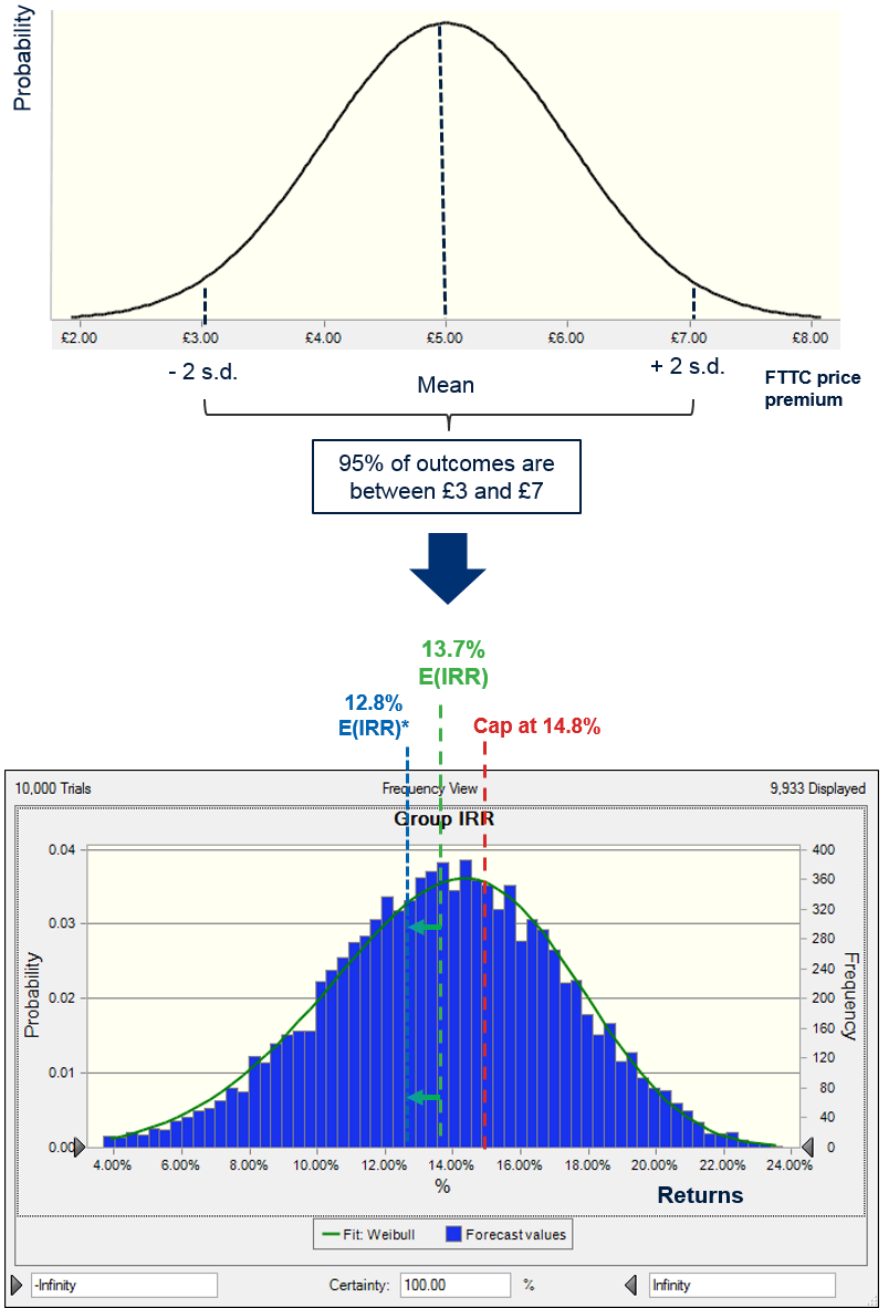
[8] A negatively skewed distribution is also potentially a valid sensitivity. However, since the effect would be to reduce the expected return (potentially below the cost of capital), the impact would be to deliver a higher critical cap than under a normal distribution. This sensitivity is therefore unnecessary to stress-test the findings in Oxera 1.

[9] This range includes, at the low end, Free's FTTP product in France which was being offered at no premium over the ADSL product. At the high end, the range includes Virgin Media's DOCSIS 3.0 cable broadband product and a Deutsche Telekom FFTC/VDSL product which were both being offered at a £12.0 premium. This range excludes Virgin Media's Trial Price as well as bundled price points, such as France Telecom's and the US operators (AT&T and Verizon).

premium) on the Group IRR. The result supports the conclusion that refraining from price regulation during the current market review and imposing cost-based controls in the next review, or any other profile of charge controls consistent with a cap on project returns of around 15.0% or above, would be consistent with the fair bet principle.

Furthermore, we note that introducing the impact of other key parameters, such as the BT Retail pricing premium and the take-up rate, would increase the critical level of capped returns even further, as would assuming a marginally larger standard deviation for the Openreach pricing premium distribution.[10]

Figure 3.1 Normal distribution for the Openreach pricing premium, £1.0 standard deviation



[10] For example, under a £1.5 standard deviation, where 95% of pricing premium outcomes could be between £2.0 and £8.0, the critical level of capped returns rises to 17.0%.

Source: Oxera analysis.

4 Results for a positively skewed pricing premium distribution

We have conducted a number of sensitivities to test the robustness of this result. A particularly relevant sensitivity is considering how our central result would vary if we assumed that the Openreach pricing premium distribution was positively skewed (i.e. if there was more likelihood of pricing upside than downside relative to the Base case of £5.0).

To construct this scenario we started by noting that, based on information contained in the June 2008 Board paper, FTTx pricing premiums across Europe ranged between £0 and £12.0. We therefore considered this to be a reasonable upper and lower bound for the FTTC pricing premium over copper.

To build a positively skewed distribution with this upper and lower bound into our analysis, we assumed a beta-PERT[11] distribution for the Openreach pricing premium with a Minimum value of £0, a Maximum value of £12.0, and a Mode of £5.0 (i.e. equal to the Base case).[12]

As described in the section 2, we then 'ran' 10,000 Monte Carlo simulations, using the Crystal Ball software, by selecting the value of the pricing premium parameter at random from the beta-PERT distribution defined above, and recording the resultant impact on the 20-year FTTC project Group IRR. Having done this, we calculated the critical level of capped returns below which the fair bet principle would not be honoured.

With a positively skewed distribution, there are two opposing effects that have an impact on the critical cap.

On one hand, a positively skewed distribution for the pricing premium would increase the E(IRR) for the Group. Indeed, we estimated this to be 14.5% (compared with 13.7%). All else equal, this means that any given cap on returns is less likely to breach the fair bet principle, since the starting point is an expectation of a more profitable project. Hence, the cap on returns could be even tighter (i.e. lower) and still be consistent with the fair bet principle.

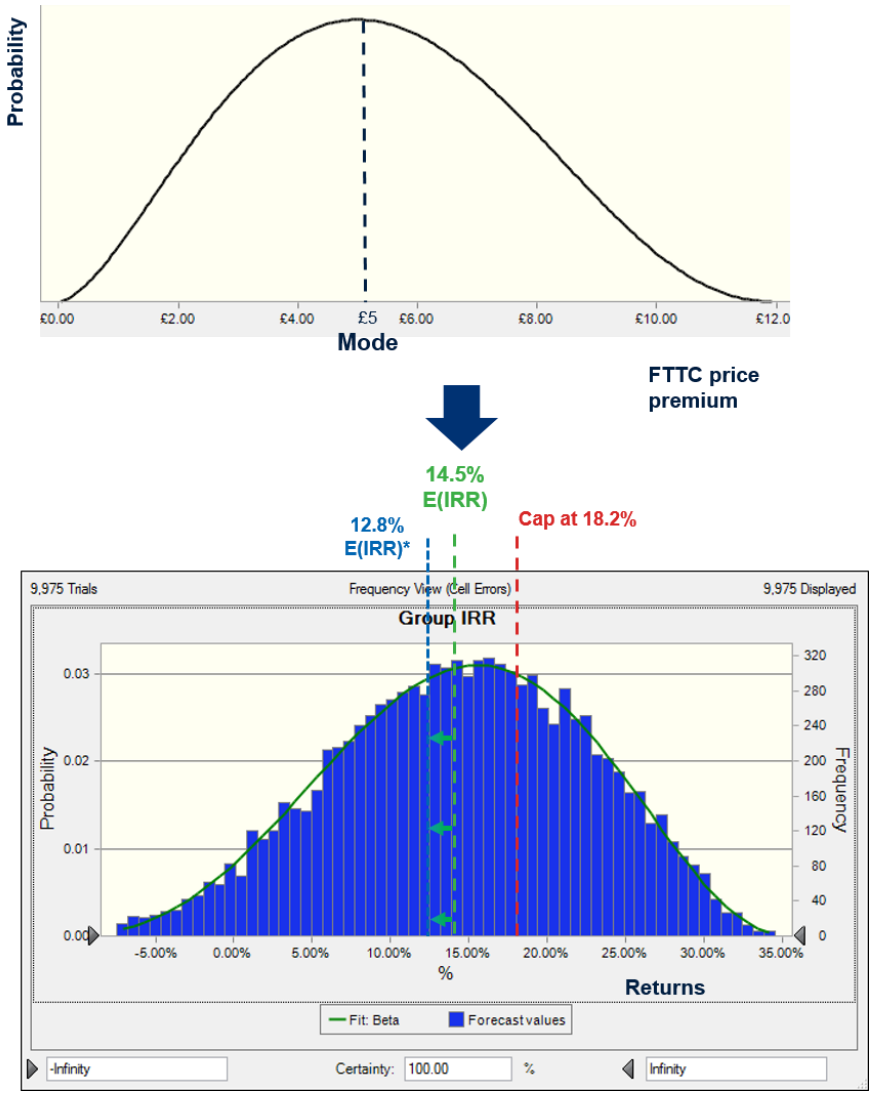
On the other hand, because there are now proportionately more outcomes lying above (and which would be removed by) any given cap (given the positive skew), the effect of a given cap on returns will also have a proportionately larger negative effect on the average IRR as compared with a normal distribution. All else equal, this means that the cap would need to be looser (i.e. higher) in order to be consistent with the fair bet principle.

[11] See https://www.riskamp.com/beta-pert. This is a very flexible distribution specification, widely used in risk analysis to represent the uncertainty of the value in a critical parameter because the three parameters needed to define it (Min, Max and Mode) are very intuitive and easy to verify. In this case, when the Min and Max are defined to be £0 and £12.0 (which are data points informed by the contemporaneous evidence cited above) and the Mode (the most likely outcome) is set at £5.0 (consistent with BT's Base case), the resulting distribution will be positively skewed.

[12] The average (mean) value of this distribution would be £5.4 (higher than the Mode, reflecting the positive skew) and 95% of outcomes ranging between £1.3 and £9.8. We note that this range is consistent with the scenarios that BT included in its business plan model—i.e. a Base case of £5.0, a High scenario of £10.0 and a Medium scenario of £3.7. While a Low scenario was not specified, we can observe that £1.3 would be consistent with a positively skewed distribution.

Under the scenario modelled here, we found that the second effect is larger than the first, resulting in the level of capped returns below which the fair bet would be violated needing to be much higher, at 18.2%. This is shown in Figure 4.1 below.

Figure 4.1 Positively skewed Openreach pricing premium, range between £0 and £12.0



Source: Oxera analysis.

As a sensitivity, we also modelled the effect of an even larger positive skew for the Openreach pricing premium parameter, ranging between £0 and £20.0.[13] We found that the critical level of capped returns in this scenario would be 16.6% (i.e. the second effect still outweighs the first but by less).

In summary, our analysis finds that for a large number of positively skewed scenarios, the conclusion of Oxera 1 still holds. In fact, for the first effect to outweigh the second and for the Oxera 1 conclusion to be reversed (i.e. to find critical levels of the cap below 15.0%) we would need to assume either a

[13] The distribution used in Crystal Ball was a beta-PERT distribution with a Minimum of £0, a Maximum of £20.0 and a Mode of £5.0. The 95% confidence interval is £1.1 to £14.3.

considerably higher upside for the pricing premium (e.g. up to £58.0)[14] or rule out scenarios where the pricing premium could be less than £2.0.[15]

Based on the contemporaneous evidence we have reviewed, these are not credible scenarios to consider. For example, even the highest price point identified in the Board paper (by Verizon in the US for a bundled FTTP product) was £55.0. Given that the BT Retail ADSL product was priced at £25.0 in 2008, this would have meant a pricing premium of more than 100%. Unsurprisingly, BT's June 2008 Board paper excludes this price point as an outlier.

At the bottom end of the range, Free in France was offering its FTTP product at no premium. Whilst BT's June 2008 Board paper also appears to exclude this price point as an outlier, this would not invalidate the use of £0 as the bottom end of the range in our analysis. This is because, as explained above, our analysis tests the impact of just the Openreach pricing premium range on BT's FTTC returns while keeping the BT Retail Base case pricing premium assumption of £8.50.

Hence, a £0 pricing premium at the wholesale level continues to generate £8.50 per month incremental revenue at the retail level for each customer that choose BT Retail as their broadband provider, which in BT's model was assumed to be 30% of customers taking up FTTC broadband. Hence, a £0 wholesale premium combined with an £8.50 retail premium is, in fact, a conservative assumption for the bottom end of the pricing premium range.

Overall, we are therefore confident of the robustness of the conclusions reached in Oxera 1.

[14] This would be in a scenario where the pricing premium would range between £0 and £58.0, with a Mode of £5.0.
[15] For example, our analysis shows that for a positively skewed pricing premium distribution ranging between a Minimum of £2.1 and a Maximum £10.0 (with a Mode of £5.0), the critical level of the cap would be 15.0%.

5 Conclusions

In this supplementary report, we have undertaken further analysis regarding the shape of the distribution of returns of BT's FTTC investment. Our analysis is based on BT's 2008 FTTC business plan model, which takes a 20-year cash-flow view of the FTTC investment and uses contemporaneous evidence regarding the key factors affecting project returns.

We identified the Openreach fibre pricing over copper that BT would have had to charge in order to reach its target take-up rate as a key parameter affecting the IRR of the project.

Making conservative assumptions regarding the shape of this distribution consistent with the contemporaneous evidence, we have confirmed the conclusion we reached in Oxera 1—that capping project returns at less than 15.0% would be likely to breach the fair bet principle.

We have stress-tested this result—in particular, by assuming that BT had better chances of charging a higher premium instead of a lower premium (i.e. a positive skew)—and found that the conclusion in Oxera 1 still holds, and is even strengthened in some scenarios.

For the conclusion in Oxera 1 to be reversed (i.e. for price controls capping returns at less than 15.0% to be consistent with the fair bet principle), we would need to make assumptions that are not consistent with the contemporaneous evidence we have reviewed.

Table 1 Summary of scenarios presented in this report

Openreach pricing premium assumption	Group E(IRR) without cap	Critical cap that would reduce Group E(IRR) to 12.8%
Normal distribution scenarios		
Mean = £5.0, sd = **£1.0**	13.7%	14.8%
Mean = £5.0, sd = **£1.5**	13.6%	17.0%
Positively skewed distribution scenarios		
Mode = £5.0, Min £0, Max £12.0	14.5%	18.2%
Mode = £5.0, Min £0, Max £20.0	19.0%	16.6%
Mode = £5.0, Min £0, Max £58.0	39.0%	15.0%
Mode = £5.0, Min £2.1, Max £10.0	14.9%	15.0%

Source: Oxera analysis.