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BCMR 2015 – Efficiency estimation

Review of Ofcom's approach

Non-confidential version

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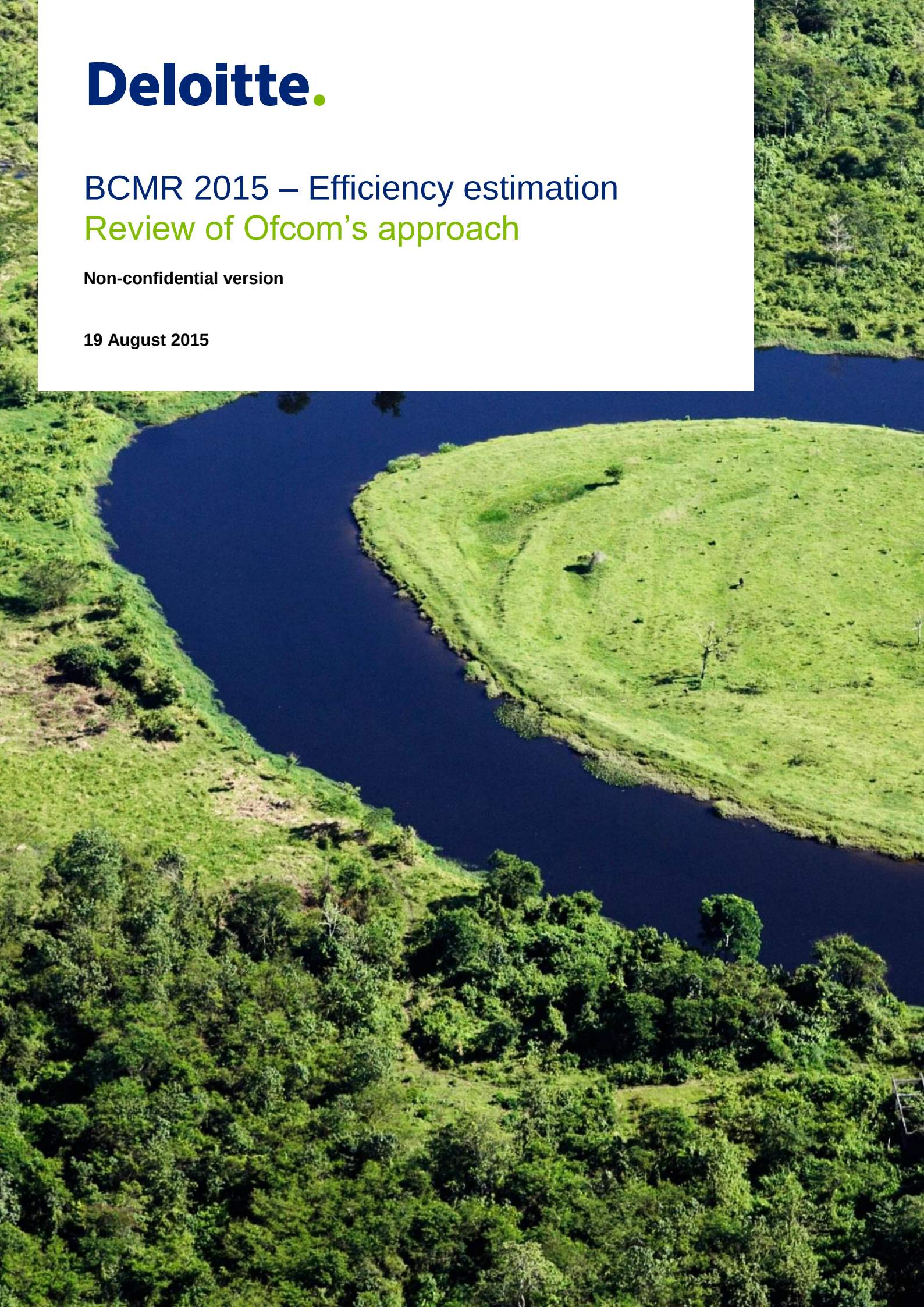

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Executive Summary

In the 2015 Leased Lines Charge Control (LLCC) consultation, which forms part of the Business Connectivity Market Review (BCMR) covering regulation for Traditional Interface (TI) and Ethernet services, Ofcom has proposed an efficiency range of 4% to 7%, with an assumed base case of 5%. This is significantly higher than in the previous LLCC. In the 2013 LLCC Statement, Ofcom assumed an efficiency factor of 1.5% and 4.5% for TI and Ethernet respectively. It is also significantly higher than previous estimates of efficiency improvements. Historical Total Factor Productivity (TFP) studies suggest a potential efficiency annual improvement range of between 0.6% and 3.0%, as BT described in its response to Ofcom's 2013 WBA Market Review.[1]

BT has commissioned Deloitte to provide an assessment of Ofcom's approach to setting the efficiency factor. This assessment has focused on the following areas:

- The importance of analysing both internal and external data in setting charge controls;
- Ofcom's methodology in applying the efficiency factor in the charge control; and
- External data analysis to test whether the efficiency factor included in the proposed charge control is consistent with historical efficiency improvements achieved by a benchmark set of European operators.

The importance of analysing both internal and external data in setting charge controls

Ofcom has relied almost entirely on internal data from BT to set the efficiency factor in the charge control. There has been insufficient external analysis which could have been used to complement this internal data and mitigate some of the adverse effects of over-reliance on internal management information in setting the efficiency factor in the charge control.

The efficiency factor in a charge control should be a target which the regulated company can be reasonably expected to achieve and possibly exceed. However, research on management incentives indicates that companies raise performance by setting "stretch" targets for business units, even though these targets are less likely to be met than moderate targets. Internal management targets are therefore unlikely to be an appropriate basis for setting the efficiency factor in the charge control.

BT management also sets ambitious targets when computing their internal management reports (PVEOs).[2] The internal efficiency ("E") factor included in BT's PVEOs describes the necessary cost savings that the company needs to make in order to achieve its margin targets. Discussions with BT and a review of their internal documents show that the company often fails to meet the "E" targets. In recognition of the aspirational nature of these targets, BT has also highlighted that it is common practice for BT Group to set contingencies for the failure to reach goals in a given financial year.

This approach to setting internal efficiency targets is consistent with the research that indicates that companies improve performance by setting stretch targets. It shows that the "E" factor in BT's PVEOs is likely to overstate the company's actual potential to reduce costs and is therefore not appropriate as the only basis for setting the efficiency factor in the charge control.

The use of ambitious, internally-derived targets without consideration of external benchmark analysis also creates a number of other issues:

- **Asymmetric impact of regulation:** A charge control that is too demanding may reduce an operator's ability to operate viably while a charge control set too low will increase costs for consumers. Without

[1] BT (2013), "BT response to Ofcom's consultation document", p. 27.

[2] PVEOs refer to an analysis of Price, Volume, Efficiency and Other costs.

external analysis Ofcom cannot confirm the degree to which internal management documents overstate the potential for efficiency improvements during the charge control period.

- **The ratchet effect:** Good performance by an operator in one period is "punished" in later charge controls, reducing the incentive to reduce costs.
- **Overstating catch-up effects due to historical data:** Basing future charge controls on previous cost savings will overstate the potential for future efficiency improvements if past savings have included catch-up as well as frontier-shift effects. The closer operators get to the frontier, the less they can be expected to reduce costs in future beyond the frontier shift.

Ofcom's methodology in estimating the efficiency factor in the charge control

In addition to the challenges created by focusing on internal data in setting a charge control, interviews with BT managers have also highlighted a number of practical and computational issues with the E component from PVEOs which do not appear to have been fully taken into account by Ofcom in its analysis:

- **Double counting of some economies of scale effects:** BT and Ofcom have different methodologies for estimating economies of scale efficiencies. Ofcom models these scale effects as part of its cost-volume elasticities (CVEs) analysis while BT includes most of these effects in the E component of the PVEOs. Using the E component without an adjustment for this difference in approaches is likely to overstate the potential for efficiency improvements.
- **The E component does not only relate to "efficiency":** The E component in PVEOs does not only reflect cost "efficiencies". In addition to the economies of scale effects, other things captured under E include: savings related to inventory cleansing, settlements from legal proceedings and regulation that changes internal costs of purchasing from Openreach.
- **Double counting of efficiencies across LoBs:** Internal cost items in the PVEOs are transferred between business units within BT so multiple teams may benefit from a single E component. For example, BT confirmed that its Technology, Service and Operations (TSO) division transfers 100% of its costs internally to other LoBs, so some of the efficiencies identified within the TSO PVEOs will also be reflected in Openreach or Wholesale management accounts, to the extent that those TSO costs are recharged to Openreach or Wholesale. However, it is not possible to identify separately within Openreach or Wholesale PVEOs the part of the efficiency which is related to TSO's efficiency.
- **Efficiency initiatives vary significantly across products:** The scope for efficiency gains varies across products. There is little new efficiency associated with the "20C" network and products, which include TI services. For these legacy products significant efficiency improvements have either already been made in the past or large decreases in volumes are reducing the operator's incentive to make further investments. BT has indicated that voice and other 20C products tend to have negligible E components.
- **Efficiencies linked to capex may be significantly lower than for opex:** Ofcom has applied a single efficiency target to both opex and capex. All BT managers interviewed agreed that the scope for cost reduction initiatives for capex is consistently much smaller than for operating costs. This is because a large proportion of capex is related to contracts with external contractors for construction works. These contracts often cannot be renegotiated and, to the extent they are, have generally seen a price increase rather than decrease in line with the general trend of construction prices. Also, for legacy networks and services, capex is primarily related to equipment replacement for which very limited efficiency gains exist. Ofcom should also consider that to some extent efficiencies related to capex, and in particular replacement capex for legacy equipment, are already captured in the Modern Equivalent Asset (MEA) valuations which are included in Ofcom's model.

External data analysis

External data should be used to complement the regulated operator's internal data. This provides a check on the estimate of the efficiency factor by comparing it to efficiency improvements made by operators in other markets.

An updated external benchmarking analysis was carried out in order to assess the average efficiency improvements achieved by other operators.

A TFP growth approach was taken. This is similar to an exercise carried out for a study by Deloitte for BT in 2008. It is also similar to that used by the FCC (the U.S. communications regulator) to measure annual productivity changes for U.S. operators and to inform the rate of X within their network charge controls.

Eight European operators, in addition to BT, were studied to assess how TFP has been changing on an annual basis from 2004-2014. Telecommunications operators across Europe have seen average annual productivity improvements of 0.49% - 1.33% over the period, considering both fixed-base and chained indices. This range is far below Ofcom's proposed efficiency factor of 5%. The difference between this average TFP growth and Ofcom's efficiency factor is even more significant when it is considered that the benchmark number includes both catch-up and frontier shift effects whereas several studies have concluded that BT is within the top efficiency decile.

These results are quite robust when examining how the estimates change with different measures. Examining different ranges of years does not materially change the estimated efficiency growth for the operators considered in the sample. These results are also fairly consistent with previous TFP growth analyses.

Conclusion

This analysis indicates that Ofcom's estimates of the efficiency factor appear overstated for three main reasons:

- Ofcom's analysis is mainly based on internal data, which may cause a number of issues in estimating efficiency improvements. In particular, it might significantly overstate the potential for efficiency improvements in BT;
- Ofcom's usage of BT's internal PVEOs does not take in account a number of adjustments for double counting; and
- The external benchmark analysis shows that operators in Europe have, on average, been achieving efficiencies of between 0.49% - 1.33% in recent years. This is significantly lower than Ofcom's estimate.

1 Introduction

1.1 Background

On 12 June 2015 Ofcom launched a Leased Lines Charge Control ("LLCC") consultation, which forms part of the Business Connectivity Market Review ("BCMR"), as part of its periodic review of markets subject to ex-ante regulation. This includes an updated calculation of the proposed efficiency adjustment to be included for the next charge control period for Traditional Interface ("TI") and Ethernet connectivity services.

Ofcom has estimated an efficiency range of 4% to 7%, with an assumed base case of 5%, applicable to both TI and Ethernet services, which is to be applied to all cash costs, i.e. operating costs ("opex"), excluding depreciation, and capital expenditures ("capex"). Ofcom's analysis depended heavily on BT's internal data, rather than external benchmarking, as for previous LLCCs. The basis for this estimation is described in Section 2 of this report.

BT has requested Deloitte to review aspects of Ofcom's efficiency estimation. The results of this review are described in this report.

1.2 Scope of this report

The scope of this report is to:

- Discuss the importance of analysing both internal and external data in setting charge controls;
- Review Ofcom's approach to setting the efficiency factor and discuss challenges with its methodology; and
- Conduct an efficiency analysis based on external data to test whether average efficiency improvements across European operators appear to be consistent with the proposed charge control.

The analysis has been informed by:

- A review of the methodologies applied by Ofcom in estimating the efficiency factor;
- Theoretical work on how optimum efficiency targets should be set;
- A review of the data and information provided by BT to Ofcom; and
- Previous work conducted for BT on efficiency estimation.

1.3 Structure of this report

This report is structured as follows:

- Section 2 summarises Ofcom's approach to setting the efficiency factor in the 2015 LLCC review and outlines the shortcomings of this approach;
- Section 3 discusses the theoretical and practical shortcomings in more detail;
- Section 4 provides efficiency estimates based on the Total Factor Productivity methodology, using a panel dataset for a number of European incumbent operators; and
- Section 5 concludes.

In addition, the Appendix provides responses to Ofcom's questions of clarification on the efficiency analysis, raised following the initial submission of this report.

2 Ofcom's approach to efficiency in the LLCC

This section discusses the approach used by Ofcom to determine the efficiency factor included in the LLCC model, and its appropriateness in light of an assessment of the data and evidence on which Ofcom's analysis relies.

2.1 Summary of Ofcom's approach to estimating efficiency in the 2015 LLCC

The efficiency adjustment included in the LLCC model is an estimate of the annual improvement in efficiency that Ofcom has assumed BT will be able to achieve during the charge control period. This efficiency improvement reflects reductions in costs, over and above those that are expected to result from changes in the volume of output and which are factored explicitly into the charge control model.

In the 2015 LLCC Consultation document, Ofcom has described how it has considered the following sources of information in setting the efficiency adjustment:

- A review of efficiency assumptions from other recent charge controls;
- An analysis of BT's regulatory accounting (RFS) information over the past few years;
- An analysis of BT management accounting information;
- Efficiency gaps for BT from an independent benchmarking study; and
- Cross checks with other public information about BT.

In practice, Ofcom has based its decision primarily on information relating to the BT's internal management data. It has used some of the other sources of information to cross-check this analysis but has placed little reliance on external sources of information such as benchmarking studies.

2.2 Ofcom's approach to estimating the efficiency factor

In its consultation document, Ofcom has discussed and evaluated each source of data that it has considered for estimating the efficiency factor.

- **Regulatory Financial Statements (RFS).** Ofcom has looked at data from RFS to assess whether trends in reported unit costs can be used to determine potential annual efficiency improvements. It has concluded that this approach suffers from some significant shortcomings because of changes to the cost allocation methodology from one year to the next. In order to try to correct for these limitations, Ofcom has undertaken "pairwise comparisons" between adjacent years. However, this adjustment does not fully account for all inconsistencies and it has concluded that limited reliance can be placed on such analysis. Moreover, this analysis was only conducted using operating cost estimates and therefore does not provide any insight on capex efficiencies. For all these reasons, Ofcom does not appear to place much reliance on this analysis in setting the efficiency adjustment in the charge control.
- **Benchmarking analysis.** Ofcom has reviewed evidence from the results of the AT Kearney benchmarking study which compares BT's costs with other operators. Most of the analysis of this study has been redacted in the consultation document for confidentiality reasons so it is not possible to comment on Ofcom's conclusions in this respect. However, it is clear from Ofcom's discussion of this benchmarking data that it has not placed significant reliance on it in setting the efficiency adjustment in the charge control. For example, the consultation document references "issues with interpreting benchmarking data"[3] and describes the study as being problematic due to providing a "historical view",[4]

[3] Ofcom (2015), "Business Connectivity Market Review – Annexes: Leased lines charge controls and dark fibre pricing", Para A8.218, p. 133.

[4] Ofcom (2015), "Business Connectivity Market Review – Annexes: Leased lines charge controls and dark fibre pricing", Para A8.231, p. 134.

despite considering BT's historic data as "the most relevant evidence for proposing efficiency assumptions".[5]

- **Internal management information.** In arriving at its estimate of the efficiency adjustment, Ofcom relies primarily on BT's own internal management data. These include the "PVEO" analyses,[6] which are intended to break down expected changes in costs in the following year resulting from expected changes in input prices, volumes and efficiency initiatives. These PVEO analyses are described in more detail later in this report.
- **Other public information.** Finally, Ofcom considers two categories of public information: analyst reports and BT's most recent press releases in relation to its results for 2014/15.
  - Three analysts were quoted in the consultation document but two were redacted, providing only Deutsche Bank's view. Ofcom focuses on a comment regarding future cost savings opportunities and briefly notes an observation that cost reductions are likely to be more difficult to achieve in future.
  - Ofcom observes cost reductions in BT's press releases and interprets these as evidence that BT is able to continue to cut costs. In the consultation document, Ofcom considers these to be in line with its analysis of BT Wholesale's PVEO and, in addition, comments that cost reductions in BT's Wholesale and Openreach divisions feed into both Ethernet and TI services.

2.3 Review of Ofcom's approach

This reliance on BT's internal management information for the purposes of setting the efficiency adjustment in the LLCC has a number of shortcomings. These include:

- The way in which the "E" term of BT's PVEOs are set means that it is inappropriate to be used as the efficiency adjustment in the charge control in the way that has been described in the LLCC consultation document. This is for two basic reasons:
  - PVEOs, in common with the way that other companies set efficiency targets, are designed to be "stretch" targets set by management. The efficiency adjustment included in the charge control should be a factor that BT can be reasonably expected to achieve, and potentially exceed, during the course of the charge control period.
  - Ofcom's application of the "E" factor results in double-counting of potential efficiency gains within the business.
- The use of internal sources of data for estimates of the efficiency adjustment creates inappropriate incentives for a regulated entity over time.

Section 3 explains these shortcomings in more detail.

The inadequate consideration of external benchmark data means that Ofcom has not cross-checked its estimate of the efficiency factor with data from other operators. This would have gone some way to mitigating the problems associated with over-reliance on internal data.

An external efficiency analysis was carried out for this study, based on a Total Factor Productivity (TFP) methodology. This is a relatively simple approach which provides estimates of average productivity improvements achieved by operators over time. The results of this analysis are described in Section 4 of the report.

[5] Ofcom (2015), "Business Connectivity Market Review – Annexes: Leased lines charge controls and dark fibre pricing", Para A8.243, p. 136.

[6] PVEOs at BT are internal management reports used to track a business unit's progress from one financial year to the next.

3 The use of internal management information for the purposes of setting efficiency adjustments

Ofcom's dependence on BT's internal data when calculating the X element of the RPI – X charge control is inappropriate. This is because the approach taken to setting internal targets is different to that which should be applied in setting an efficiency factor in a charge control. In addition, the way in which Ofcom has used BT's internal targets in the charge control appears to be flawed.

3.1 Internal management efficiency targets

This section begins by discussing how companies set internal performance targets. It then discusses how it is done within BT before analysing the implications for the use of PVEOs in the LLCC.

3.1.1 Review of literature on management incentives and targets

Research indicates that companies raise performance by setting "stretch" targets for business units. A stretch target is a target based on an upward-biased estimate of future performance. Appropriately set targets are generally perceived by the employee as ambitious and challenging yet achievable so as to be accepted as worthwhile pursuing. Stretch targets are less likely to be met than less ambitious targets but they still result in better performance, on average, than less ambitious but more achievable targets. However in recognition of the aspirational nature of these targets, certain companies choose to set contingencies for the failure to reach goals in a given financial year. This is the approach also followed by BT.

Goal setting and performance benchmarking are considered to be effective management practices by inducing employee engagement and motivation. When perceiving themselves to be on the "losing" side of what they have defined as success, agents are more likely to take risks, and exhibit a more aggressive approach to achievement. A more conservative "frame of behaviour" is instead adopted when people perceive themselves to be on the "winning" side.[7] For this reason, the adoption of stretch targets appears to be the optimal strategy, as this is more likely to lead to an employee or a team being on the "losing" side of it, and therefore exhibit a more aggressive and ambitious drive towards such target.

Stretch targets are not only a means of motivating employee engagement and driving performance but also a means of mediating agency problems between management and employees. A manager is typically unable to have full knowledge of how much effort his employee is exerting, and therefore there is a risk of underperformance being undetected. In principal-agent models that allow for the impact of reference points on behaviour, performance targets affect preferences for exerting effort. It is suggested that the managers can increase employee performance by increasing the difficulty of the agreed upon objectives.[8] Such underlying mechanisms are illustrated in empirical findings of significant positive correlation between target difficulty and performance. Various experiments have been conducted in this field. Locke (1968) conducted 12 studies in which specific goals are assigned to individuals and acceptance of those goals by individuals is checked before the experiment is conducted. He finds that so long as the goal, or the "reference point", is an accepted target (i.e. a target not thought of as impossible);[9]

"*The harder the goal the higher the level of performance. Although subjects with very hard goals reached their goals far less often than subjects with very easy goals, the former consistently performed at a higher level than the latter.*"

Two relationships stand out from Locke's experiments.

[7] Kahneman D. & Tversky A. (1979), "Prospect Theory: An Analysis of Decision under Risk". *Econometrica*, vol. 47(2), p. 263-292.

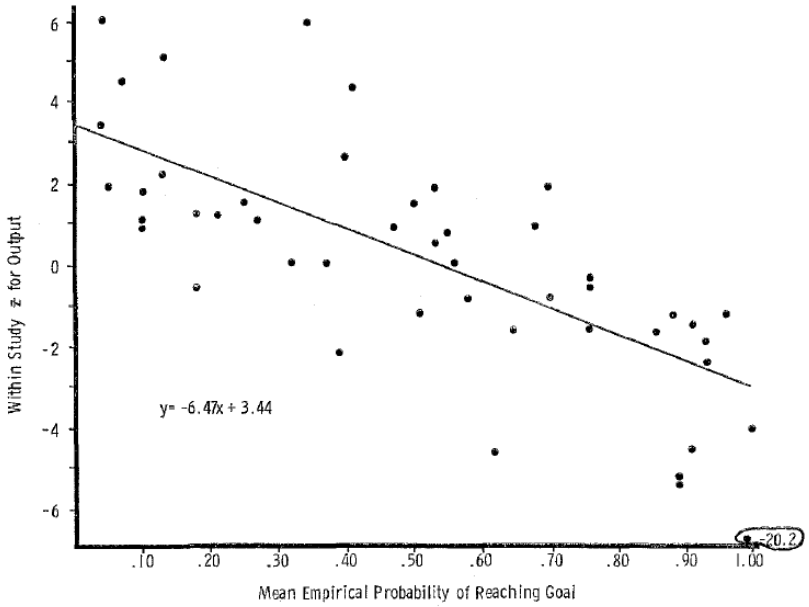
[8] Rablen M.D. (2010), "Performance Targets, Effort and Risk", *Journal of Economic Psychology*, vol. 31, p. 687-697.

[9] Locke E. (1968), "Toward a Theory of Task Motivation and Incentives", *Organisational Behaviour and Human Performance,* vol. 3, p. 157-189.

- Difficult targets motivate individuals to attain higher performance, given by some “outcome z”; and
- The difficulty of targets is inversely related to the probability of success.

Figure 1 below shows the negative relationship between the difficulty of the target and the likelihood of the target being achieved.

Figure 1: The negative relationship between target difficulty and the probability of achieving the target set



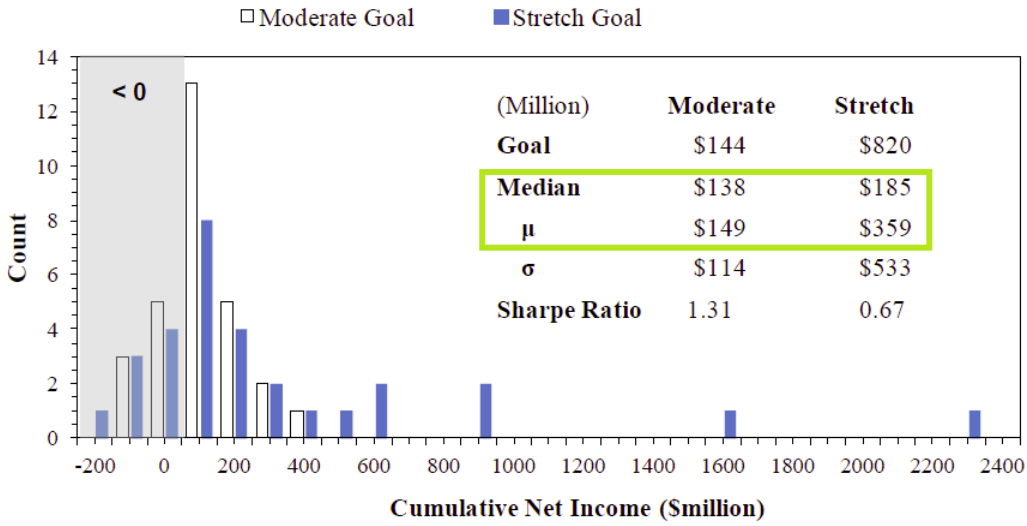
Source: Locke (1968)

Nevertheless, Locke reports that the level of performance of the individuals given stretch targets was consistently higher. This means that while individuals given stretch targets will tend to underperform relative to the explicit target set, they will perform better in absolute terms than those with moderate targets even though a moderate target will be achieved more often.

Shayne et al (2015) support this finding. They conducted an experiment in which 59 students of economics, management and other disciplines were asked to manage, as part of a class exercise, a simulated organisation with random assignments with a mixture of stretch and moderate goal conditions.[10] Their findings show that, while the variance in performance of the stretch target group was higher, the stretch target performance distribution was right-skewed with higher median and mean achievement (Figure 2).

[10] Shayne G.A., Yang M-H., Yetton P.W. & Steirman J. (2015), “Stretch Goals, Managerial Responses and Variance in Performance”, *Management Science* (under review).

Figure 2: Performance distribution at the end of the Shayne et al (2015) experiment for Stretch and Moderate Goal Conditions



Source: Shayne et al (2015)

As in Locke (1968) the stretch target group achieves higher performance but misses its goal more often (Table 1).

Table 1: Achievement and Probability of hitting the target under stretch and moderate goals

	Mean achievement	Failure to hit the target
Stretch target group	359	89%
Moderate target group	149	59%

Source: Shayne et al (2015)

In summary, business performance is optimised when performance targets are set as stretch targets, even though these targets are less likely to be met than when less ambitious targets are set. It is therefore rational for companies to set internal stretch targets. Some studies even suggest that the results that are the least likely to be achieved still produce the highest level of output, so firms may encourage setting performance targets that are very difficult to achieve in order to improve their performance.[11]

Numerous examples of this approach can be found. For example, stretch targets were adopted by Jack Welsh, CEO of General Electric (GE) in the early 1990s with the aim of improving organisational efficiency. To motivate his stretch approach Jack Welsh often used to reference the development of bullet trains in Japan saying that "had the goal been merely a modest improvement on speed or operating efficiency, then the designers and engineers would have unintentionally limited their thinking to relatively minor alterations. However, specifying levels of performance that were beyond what was currently being achieved required people to "think outside of the box" "[12]. Kerr and Landauer (2004) find that the immediate intention of stretch goals in GE might have been to achieve the designated targets but "the broader purpose was to get employees to conceive of their jobs and perform their tasks in fundamentally different and innovative ways. The message that GE was trying to convey was that most people typically access only a small portion of their creative energy – that most of us have a huge capacity to do things quicker, better and

[11] Fiegenbaum A., Hart S. & Schendel D. (1996), Strategic reference point theory. *Strategic Management Journal*, vol. 17, p. 219-235.

[12] S.Kerr and S.Landauer, (2004) "Using Stretch Goals to Promote Organisational Effectiveness and Personal Growth: General Electric and Goldman Sachs", *The Academy of Management Executive* (1993-2005) Vol 18, No 4, Decision-Making and Firm Success, pp 134-138.

cheaper. GE's stretch goal initiative allowed it to become more effective along a variety of financial and productivity dimensions".[13]

Thompson et al (1997) use the example of Motorola as support for the effectiveness of stretch goals:

"The use of stretch targets by Motorola to reduce cycle time, the time it takes to complete a process is a good example of how stretch targets can lead to creative changes." They further add that "Motorola has used stretch targets to support their quality efforts for years."[14]

Ghoshal and Bartlett (1995) explore Intel's ability to remain successful during across the decades through management that focused on "challenging the organisation continuously to higher levels of operational and strategic performance" while creating "the energy and enthusiasm necessary for the organisation to accept the perpetual stretch that such challenging implies.[15]

Companies also use stretch targets to improve performance in non-financial areas of their business. For example, in an article for Forbes, "In Praise of Stretch Goals", Steve Denning quotes the example of Alcoa under its former CEO Paul O'Neil. O'Neil set a zero injuries in the workplace target for his organisation. "Alcoa under O'Neil never did get to zero accidents of course, but they did make massive improvements in worker safety and it laid the basis for Alcoa's growth and prosperity"[16].

Setting stretch targets is a common approach in companies. This is an effective means of improving performance even though these targets are frequently not met. However, it means that these internal targets are likely to be inappropriate for use as estimates of the efficiencies that an operator can reasonably be expected to achieve during a charge control period. In Sections 3.1.2 and 3.1.3, BT's usage of stretch targets for internal performance management is discussed.

3.1.2 BT's approach to setting PVEOs

PVEOs were introduced within each LoB following a request from BT Group management, in order to increase the transparency and granularity of the forecasting process. [17] As the name suggests, PVEOs are intended to break down cost forecasts for the following year into four separate components:

- **Price:** this reflects changes in revenues and/or cost which are due to expected changes in prices;
- **Volume:** this component is intended to reflect changes in cost which are due to expected changes in input volumes although in practice this captures almost exclusively changes in the direct costs and does not take into account scale effects;
- **Efficiency:** this component includes various efficiency targets, with respect to a number of cost items as well as other effects such as changes in regulated input prices (for example when the regulated price of Openreach services changes, this is reflected in the E component of the Wholesale PVEO for those services that Wholesale buys from Openreach). Effectively this component is used as a balancing figure between the aspirational profit targets and the changes captured under the V and P component; and
- **Other:** this includes one-off adjustments as well as a contingency element.

The process for determining PVEOs starts with high-level margin/profit targets which the Group management sets for each individual LoB. In line with the discussion on management targets above, the overall profit targets set by BT Group management are typically very ambitious. This approach is consistent with the evidence on stretch targets discussed above.

Each LoB is then tasked with estimating how these profit targets can be achieved, through a combination of changes in volumes, prices and efficiencies. Changes in prices and volumes (P and V) are generally calculated first. Once the changes in revenues and costs through volume and price changes are

[13] S.Kerr and S.Landauer, (2004) "Using Stretch Goals to Promote Organisational Effectiveness and Personal Growth: General Electric and Goldman Sachs", *The Academy of Management Executive* (1993-2005) Vol 18, No 4, Decision-Making and Firm Success, pp 134-138.
[14] K.R.Thompson, W.A. Hochwarter, N.J. Mathys (1997), "Stretch Targets: What makes them effective?", *The Academy of Management Executive*, Vol 11, No 3 pp.48-60.
[15] S.Ghoshal, C.Bartlett (1995), "Building the Entrepreneurial Corporation: New Organisational Processes, New Managerial Tasks", *European Management Journal*, Vol 13, No 2, pp 139-155.
[16] S. Denning, In Praise of Stretch Goals, Forbes Online: http://www.forbes.com/sites/stevedenning/2012/04/23/in-praise-of-stretch-goals/
[17] The information in this section comes from interviews with BT staff in Wholesale, Openreach and TSO.

estimated, BT management is able to compute the “efficiencies” (E) required to achieve performance targets.

The E element is generated through a bottom-up approach in which a combination of separate targets is set, each applicable to different cost items. A significantly larger proportion of the efficiency targets relate to operating expenditures or own capitalised labour cost, and much more limited efficiencies are generally identified for capital expenditures. This is because a large proportion of capex is related to contracts with external contractors for construction works. These contracts often cannot be renegotiated and, to the extent they are, have generally seen a price increase rather than decrease in line with the general trend of construction prices. Also, for legacy networks and services capex is primarily related to equipment replacement for which very limited efficiency gains exist.

In practice, the E component is retrospectively adjusted to match the ambitious profit targets set by BT Group. This suggests that it is a) not based on an unbiased analysis of what performance targets can be realistically achieved; and b) determined by the need to meet ambitious financial performance targets met by the business as a whole.

3.1.3 Comparison of BT’s targets with realised actuals

Internal evidence from BT indicates that performance targets are set as stretch targets and frequently not achieved. Business Unit Review (BUR) documents produced by BT provide quarterly updates on performance against a number of targets set by management. These documents are only available for the Openreach business and not for BT as a whole but there is no evidence to suggest that the conclusions from this analysis do not apply to other parts of the business.

Eight BUR documents produced by Openreach covering a two-year period between 2012/13 and 2014/15 were reviewed for this study. The focus of the BURs shifts over time. Documents from six of the quarters only assessed quality of service targets while two quarters focused on PVEOs. This change in focus across the period means that is not possible to analyse trends over the whole two-year period but some clear conclusions can be drawn.

From 2013/14 Q3 to 2014/15 Q2 an efficiency summary is presented in the BURs. This highlights gaps between the efficiency targets set and the performance that was delivered for each of the four quarters. The analysis is shown in charts, financials and is explicitly stated in the documents. These clearly demonstrate an ongoing inability to reach the targets set, despite the performance figures showing that year-on-year improvements were made.

In its 2012/13 Q3 BUR, for example, Openreach noted that it failed to meet in full the targets for improvements in service delivery metrics, despite an otherwise strong year-on-year improvement of [✂]%. It is noted that the targets set for 2012/13, in comparison to the 2011/12 performance, appear high in percentage terms (c. [✂] % for October 2012) and it is therefore perhaps unsurprising that these targets were not met.

It is clear across the period covered by the BUR documents that BT has consistently set targets above the level of performance that has historically been achieved. The ongoing practice of setting targets that are unlikely to be achieved, or which do not take into account known factors that will reduce performance, suggests that BT’s internal figures fall into the category of stretch targets, which are deliberately ambitious.

In view of this, it is not appropriate to use these internal management targets as the primary basis for setting the efficiency factor since they are likely to overestimate the efficiency targets that BT can reasonably be expected to achieve.

3.2 The use of internal data for setting efficiency adjustments in charge controls

Charge controls should be designed to incentivise regulated companies to both improve productivity and to pass on these gains to customers over the medium-term. The incentive properties of RPI-X forms of charge controls have been widely discussed by academics and regulators across sectors and jurisdictions. RPI-X charge controls provide regulated entities with an incentive to achieve efficiencies over and above those implied by the X factor by allowing them to achieve a higher than expected level of profit during the period of the charge control.

The use of ambitious, internally-derived targets for the efficiency improvements that can be achieved during the charge control period creates three issues for the overall RPI-X framework:

- The asymmetry of risks of setting the X factor;
- The ratchet effect; and
- Overstating catch-up effects due to the use of historical data.

3.2.1 Asymmetric impact of regulation

The asymmetric consequences of setting the "wrong" charge control have been widely discussed in the regulatory process. Generally, setting a charge control that leads to a less ambitious efficiency adjustment is seen as less risky than setting an overly ambitious target. A report for Water UK states:

"*The trade off the regulator faces is one where setting a smaller X which companies can beat will delay customer receipt of efficiency benefits, while setting a larger X which turns out to be unattainable may limit the ability of the company to raise finance to fund investment at the margin, or may in the extreme result in company insolvency. Where the anticipated financial position is tight, the regulator might therefore justifiably conclude that the uncertainties about possible efficiency savings, and the different consequences of upward and downward mistakes, warrant determination of an X which is more conservative than the central estimate of anticipated efficiency gains."* [18]

The risks associated with overestimating the potential efficiency gains are of particular concern when considering the large amount of network investment that is expected from BT over the charge control period.

As discussed above, relying on internal performance targets is likely to overestimate the efficiency improvements that BT can be reasonably expected to achieve. In view of the asymmetric impact of underestimates versus overestimates of potential efficiency improvements, a more conservative approach seems warranted.

3.2.2 The ratchet effect

The ratchet effect is another well-known issue that might arise in RPI-X types of charge controls. This effect refers to the perverse incentives which are created for the regulated entity if good performance during one charge control is carried over in the target for the following control period.

Meyer and Vickers[19] state:

"*The ratchet effect describes the dampening of a firm's incentives to reduce current costs because of its anticipation that future price reductions will result".*

NERA[20] similarly states:

"*More widely, company incentives to reduce costs today will be affected by their expectations of future X-setting methods, and especially by links between current company outperformance and future setting of P0, "challenges" and the X. These links are known as the "ratchet effects". Strong apparent links will undercut the company's efficiency incentives."*

Finally, Oxera also discusses the challenge:

"Good performance in the first control period might induce the regulator to judge the company's performance against a higher standard … in the second period.""

Ofcom's approach in this respect presents some concerns. It has used some evidence of BT's outperforming previous X targets as justification for increasing the X factor in this charge control. In its annexes to the June 2015 LLCC Consultation, Ofcom stated that "BT's adjusted outturn returns in 2013/14 were significantly above the level we forecast in the 2013 LLCC (i.e. 29.2% compared to 15.3%)."[21] This gap between BT's returns and costs forecast in a previous charge control were used as one of the justifications for adjusting the proposed efficiency target in this charge control. This appears to be a clear demonstration of the ratchet effect. Further, by aligning efficiency targets within the charge control with

[18] NERA (2002), "The General Efficiency Assumption: Setting X in RPI-X. A report for Water UK", p. 4.

[19] Meyer, M.A. & Vickers, J. (1997), "Performance Comparisons and Dynamic Incentives", *Journal of Political Economy*, vol. 105(3), p. 554.

[20] NERA, "The General Efficiency Assumption: Setting X in RPI-X. A report for Water UK", October 2002, p. 4.

[21] Ofcom (2015), "Business Connectivity Market Review – Annexes: Leased lines charge controls and dark fibre pricing", Para A5.26, p. 18.

those set internally by BT management, Ofcom is reducing incentives for BT to try to outperform its targets, as any benefit would only result in even higher targets being set in future.

This is a significant shortcoming of Ofcom's approach. Removing incentives to "beat the target" undermines the positive incentive properties of the RPI-X charge control. This might have negative consequences not only for the current, but also future controls.

3.2.3 Overstating catch-up effects due to the use of historical data

In the June 2015 LLCC Consultation[22] Ofcom stated that the evidence it has considered in its determination of the charge control does not allow for a distinction to be made between catch-up and frontier shift efficiency improvements, although it clarifies that its estimates include both components. Ofcom's overall estimate nonetheless implies a significant catch-up efficiency gain each year, since annual frontier shifts are typically small. It has been estimated that the annual rate of frontier shift for telecoms operators is in the range of 0.6% to 2.8%, based on a range of different methodologies employed by Ofcom, Deloitte, and NERA.[23] Ofcom's base case estimate of a 5% annual improvement in efficiency therefore implies a catch up factor of approximately 2.2% to 4.4% per year during the charge control period.

In previous years BT has made large efficiency improvements but the rate at which these can be made is likely to fall over time. Ofcom acknowledged in its consultation document[24] that cost reductions would be more difficult to achieve in the future. This is also confirmed by independent analysts. For example, Deutsche Bank acknowledged in an analyst's report that the scale of efficiency improvements BT had already attained would not be as easy to replicate in future years, describing the situation as the "low-hanging fruit" having already been picked.[25] Ofcom summarised that although there are still opportunities to reduce costs, future cost reductions would not come as easily as those already achieved.

Ofcom has failed to reconcile these two positions: a) that there will be fewer opportunities in future for BT to achieve efficiency benefits from catch up; and b) that the efficiency factor in the charge control implicitly assumes that BT will achieve approximately 2.2% to 4.4% catch up efficiency improvements per year over the charge control period.

3.3 Differences in the definition of efficiency within BT's PVEOs and Ofcom's charge control model

The previous sections of this report outlined the reasons why using BT's internal performance targets as the basis for the efficiency factor in the LLCC is inappropriate in principle. There are further reasons to believe that Ofcom's approach is incorrect because of the way in which it has applied the E component in the charge control calculation. These reasons are discussed in more detail in the following sections.

3.3.1 Double counting of some economies of scale effects

The approach used by Ofcom in its charge control model involves the calculation of expected costs, driven by forecast volumes, on the basis of detailed elasticities for each main cost item. These assumptions relate to the way in which the various types of costs are expected to vary with volumes, and are intended to reflect the degree of variability of costs. In other words, elasticity can capture the effect of economies of scale, as volume increases. Once these costs have been estimated in Ofcom's analysis and economies of scale effects captured, the efficiency adjustment is then applied.

This is significantly different from the approach used by BT in the preparation of its PVEOs. Interviews with managers have confirmed that the V component of PVEOs is often calculated in a simplified manner. Generally, the calculation involves isolating the "addressable base", i.e. the proportion of costs that is to some extent variable with volumes, rather than fixed. The addressable base is then assumed to change

[22] Ofcom (2015), "Business Connectivity Market Review: Leased lines charge controls and dark fibre pricing – Consultation", Para. A8.145, p. 119.

[23] Deloitte (2011), "WBA Consultation Response", p. 3.

[24] Ofcom (2015), "Business Connectivity Market Review: Leased lines charge controls and dark fibre pricing – Consultation", Para. A8.235, p. 135.

[25] Deutsche Bank (2014), "BT Group Plc Alert: Reinforcing credibility on costs ahead of deals, content and convergence", Para. 1-3.

broadly linearly with volumes. For costs that are assumed to be variable, no economies of scale are taken into account.

Instead, most “efficiencies” which are due to economies of scale (in particular in the context of growing volumes) are included in the E component. Thus, by cherry picking the E component from PVEOs without any adjustment, Ofcom is double counting some economies of scale effects.

3.3.2 Double counting of efficiencies across LoBs

In its analysis, Ofcom has taken into account the total E component in each PVEO across BT’s businesses, including both “efficiencies” related to own LoB costs, as well as internally transferred costs.

Ofcom does mention a limited number of adjustments made to remove specific items within the PVEOs of particular LoBs. However, from discussions with managers across the three LoBs, it appears that the extent of double counting is more extensive than Ofcom seems to account for. For example, LoBs confirmed that, since TSO transfers 100% of its costs internally to the other LoBs, some of the efficiencies identified within the TSO PVEOs will also be reflected in Openreach or Wholesale management accounts, to the extent that those TSO costs are recharged to Openreach or Wholesale. However, it is not possible to identify separately within Openreach or Wholesale PVEOs the part of the E which is related to TSO’s efficiencies. As correctly identified by Ofcom, this is not explicit within the PVEOs, i.e. it is not possible to match a line in the E component of the TSO PVEO with a corresponding line within the Openreach of Wholesale PVEO. However, the full extent of cost savings identified by TSO will also be reflected within the receiving LoB.

Therefore, the TSO PVEO should be excluded from the analysis, as in any case any TSO related efficiency will be captured, explicitly or implicitly, in the PVEO of the receiving LoB. By only making partial adjustments for TSO costs, Ofcom appears to be effectively double counting a significant element of the cost reductions. In general, care has to be exercised when analysing internal cost items in the PVEOs as efficiencies may appear in the PVEO of more than one LoB.

3.3.3 The E component does not only relate to “efficiency”

The E component in PVEOs does not only reflect cost “efficiencies”. As discussed above, the economies of scale effect that in the Ofcom model would be included under volume driven effects, is captured under the E. However, this is not the only element of the E that is unrelated to efficiency.

For example, the PVEO of Wholesale would include under the E component any savings which are driven by regulatory changes in the price of services bought by Wholesale from Openreach. These savings are clearly exogenous and not operational efficiencies which should be included in a charge control.

Another example relates to inventory cleansing. Wholesale has confirmed that over recent years it has conducted significant data improvements on its inventory, which would appear as cost reductions in the E part of its PVEO. These are accounting adjustments which do not reflect real cost savings and therefore should also not be included in a charge control.

In addition to the above, PVEO only measures gross cost movements without taking into account the investment needed to reduce costs of operation. In practice this means that the benefits of investing in new technology are not offset by the initial cost of the investment.

3.3.4 Efficiency initiatives vary significantly across products

BT recognises that it is not possible to break down all the initiatives included within the E component by product, especially in the case of Openreach and TSO, because these initiatives often relate to costs that are shared across a large number of products. However, all managers interviewed agreed that efficiency initiatives do not relate to all products uniformly.

Efficiencies tend to be more readily available from certain products. Cost reductions are fairly common in new products, such as broadband, where the cost base and volume of usage is growing. The effectiveness of providing new products tends to improve due to the fact that operators can develop their delivery of these products over time, they have greater incentives to invest in products with growing demand and that it is easier to maintain infrastructure in a cost-effective way after the initial investments have been made. Though new products can often see large reductions in costs over time, those with rapidly growing cost bases, driven by large volume increases, may also be more difficult to manage as year on year changes can be volatile.

There is little new efficiency associated with the “20C” network and products, which include TI services. For these legacy products significant efficiency improvement have either already been made in the past or they are experiencing large decreases in volumes, reducing the operator’s incentive to make further investments. BT has indicated that voice products tend to have negligible E components.

Applying a uniform efficiency adjustment across both Ethernet and TI services, and indeed an efficiency adjustment that is reflective of overall network operations rather than the efficiencies that can be achieved in the delivery of specific products may lead to a significant overestimation of the achievable efficiencies.

3.3.5 Efficiencies linked to capex are significantly smaller than for opex

Ofcom has applied a single efficiency target to both opex and capex. This contradicts the evidence from the PVEOs. All BT managers interviewed agreed that cost reduction initiatives in relation to capex are consistently much smaller than for operating costs, and in general not very large. This is because a large proportion of capex is related to contracts with external contractors for construction works. These contracts often cannot be renegotiated and, to the extent they are, have generally seen a price increase rather than decrease in line with the general trend of construction prices. Also, for legacy networks and services capex is primarily related to equipment replacement for which very limited efficiency gains exist.

Ofcom should also consider that to some extent efficiencies related to capex, and in particular replacement capex for legacy equipment, are already captured in the Modern Equivalent Asset (MEA) valuations which are included in Ofcom’s model.

Therefore, applying the same efficiency target to both opex and capex significantly overestimate what BT’s own management accounts suggest in relation to capex.

3.4 Summary

The analysis in this section provides support for the view that Ofcom’s reliance on internal data from BT in setting the efficiency factor in the LLCC is inappropriate without further adjustments or additional benchmarking. This is for the following reasons:

- Research indicates that companies optimise business performance by setting ambitious “stretch” targets, even though this means that businesses are less likely to meet the targets in practice.
- BT also sets ambitious performance targets and evidence from within BT indicates that business units often fail to meet them. Basing pricing controls on solely these optimistic goals will likely result in unrealistic efficiency targets that will damage an operator’s ability to invest and improve its services.
- There are two main challenges with setting overly ambitious charge controls. Firstly, an excessive X factor will hurt business and potentially damage future delivery of services by reducing the ability to generate revenue. Secondly, if current efficiency gains are punished in the future, firms’ incentives to reduce costs will be dampened.
- Apart from lacking an external benchmark, Ofcom’s current analysis of the “E” measure from PVEOs has a number of issues that are not fully accounted for. BT does not currently prepare these internal management documents in a way that could be easily applied to a charge control.

4 Efficiency estimates based on the Total Factor Productivity methodology

As discussed previously in this report, efficiency benchmarking based on external data is an important tool for regulators. External data supplements the regulated operator's internal data by providing a check on the appropriateness of an estimated control by comparing it with the performance of operators in other markets.

In this section, a standard efficiency analysis is presented, which is based on public data from a number European incumbent operators. This analysis builds on similar analysis undertaken previously for BT in the context of past charge control reviews.

4.1 The 2008 Deloitte efficiency study for BT

In 2008 Deloitte conducted a study for BT assessing its efficiency in the context of Ofcom's then-proposed 2009 LLCC in relation to services provided by BT.[26] The methodology used in that study included two separate approaches to efficiency estimation:

- **Comparative efficiency analysis:** Using panel data for a sample of US Local Exchange Carriers (LECs), a Stochastic Frontier Analysis (SFA) approach was employed to estimate comparative efficiency with structural breaks. SFA measures the average real unit cost change for individual network components holding volume constant and controlling for operators' historical catch-up to the frontier. The SFA was estimated by regression analysis using panel data, i.e. across operators and over time. Costs were defined as a function of the output variables with cost efficiency estimated against the SFA line of best fit.
- **Total Factor Productivity analysis**: Again using panel data for the LECs as well as European fixed-line operators, efficiency was estimated following the Total Factor Productivity (TFP) approach. This was modelled in two ways:
  - Using an indexation approach which describes the additional output that can be produced from a given set of inputs. This can be assessed using year-on-year changes in productivity and can accommodate a number of measures of inputs and outputs, meaning certain data inconsistencies between operators do not prohibit the estimation of comparative efficiency figures. Following the estimation of the change in TFP, regression analysis was used to control for volatility in TFP growth due to volume effects: volatility in TFP growth that is due to fluctuation in output followed by sluggish input adjustment rather than due to changes in efficiency.
  - Using an econometric approach in the form of a fixed-effects growth model based on a Cobb-Douglas production function.

BT was found to be in the top decile of operators in terms of efficiency and sensitivity checks found the results to be relatively insensitive to changes in specification or assumptions. The estimated movement in the efficiency frontier, i.e. the efficiency of the 'best-in-class' operators, was estimated to be in the range of 0.5% – 1.1% per annum.

4.2 The updated analysis

BT has commissioned Deloitte to update its assessment of BT's efficiency in relation to the 2015 LLCC. The analysis contained in this report builds on some of the work undertaken for the 2008 study discussed above, updated to include the most recent data and taking into consideration the current regulatory and market environment. Data limitations and time constraints meant that only the TFP approach was considered in this analysis.

[26] Deloitte (2009), "Further Analysis of the Efficiency of BT's Network Operations", Appendix I.

It is recognised that historically, SFA has been the preferred methodology in the previous studies and previous work prepared for Ofcom by NERA suggests that SFA is considered the most reliable methodology for analysing efficiency change.[27] However, the SFA approach has significant data requirements. In particular, SFA requires that:

- Data is consistent across all operators and across periods; and
- Data is as specific as possible to the product in question.

In the past, an appropriate dataset could be constructed through the use of disaggregated data from US LECs. This is no longer reported and publicly available.[28] Data available for European operators, used in this report, has a number of constraints such as missing variables, structural breaks and susceptibility to measurement error. This makes the available dataset unsuitable for SFA analysis.

However, the data requirements for the TFP growth analysis are less strict. It was therefore possible to undertake this analysis using publicly available information. The following sections outline the theoretical basis for the analysis of changes in TFP and present the results.

4.3 Theoretical basis of Total Factor Productivity

The TFP analysis focuses on the changes in output that are not explained by changes in the inputs used in production. Use of TFP growth rates to measure changes in efficiency in the context of price cap regulation is a widely accepted practice. For example, the Office of Rail and Road (ORR) commissioned a report assessing the scope for efficiency improvement by Network Rail and specifically asked CEPA to estimate TFP change as one of the efficiency measures.[29] The US communications regulator, the FCC, uses a TFP indexation approach to measure annual productivity changes for US local exchange carriers and to inform the efficiency factor in its charge controls.[30]

TFP growth is measured using an index generated by subtracting a firm's rate of output growth from its rate of input growth.[31] This index therefore indicates the residual growth output or the portion of output growth that has occurred as a result of productivity gains rather than changes in the scale of inputs. In addition to the intuitive simplicity of the approach, the TFP approach has a practical advantage: unlike partial metrics of productivity growth, growth in TFP measures allow all relevant input measures (such as capital and labour) to be combined into a single input index. Similarly, a range of a firm's output measures (for example traffic and number of lines) are combined into an output index. These are then combined to calculate TFP growth, as described in Section 4.4.1.

A key strength of TFP change indexation is its ability to accommodate a number of different measures of inputs and outputs, so that a reliable estimation of comparative efficiency can be obtained despite heterogeneity of data reported by operators.

In a report for Ofcom on measuring efficiency[32] it was noted that previous efficiency improvements, whether firm-specific or for the industry as a whole, may be useful for informing the expected rate of efficiency improvement that could be made in future years. A report prepared for the ORR[33] makes the same observation, noting that UK regulators have taken historical TFP growth rates into account when setting price caps. Ofcom itself has also acknowledged that past increases in efficiency provide a useful benchmark for efficiency gains that could be achieved in the future.[34]

4.4 Approach to growth in TFP estimation

This section sets out the approach to estimating TFP growth for a selected sample of European operators and discusses the context, the data used for the study, and the approach to undertaking the modelling.

[27] NERA (2008), "The Comparative Efficiency of BT Openreach", p. i.

[28] Whilst Ofcom does not explicitly mention a lack of LEC data, this data limitation might be one of the key reasons Ofcom has also not undertaken any SFA analysis in this charge control.

[29] ORR (2012), "Scope for improvement in the efficiency of Network Rail's expenditure on support and operations: Supplementary analysis of productivity and unit cost change", p.1.

[30] FCC (1999), "Price Cap Performance Review for Local Exchange Carriers".

[31] Growth in TFP is often measured as the growth rate of the ratio between outputs to input. However, the difference approach used here yields effectively identical results in the sample considered.

[32] NERA (2013), "Approaches to Measuring The Efficiency of Postal Operators: Final Report for Ofcom", p. 20.

[33] Oxera (2008), "What is Network Rail's likely scope for frontier shift in enhancement expenditure over CP4?", p. 17.

[34] Ofcom (2013), "Business connectivity market review – final statement", Annex 8, paragraph A12.77.

4.4.1 Choice of indices

There are a number of alternative index methodologies which could be used for TFP analysis.

The Törnqvist index's weighting of inputs and outputs makes it more suitable than alternative indices such as the Paasche and Laspeyres indices for the calculation of TFP growth, as it places importance on the weighting of variables in the most recent year. This approach recognises that the importance of various components will vary over time by attaching equal importance to them in each period.

An alternative measure, The Fisher relative quantity index, is the geometric mean of the Paasche and Laspeyres indices and is often used in the computation of general economic statistics. As with the Törnqvist index, the Fisher index assigns equal weighting to the component indices.

$$\bar{y}_{it}^{Fisher} = \left(\bar{y}_{it}^{Laspeyres}\, \bar{y}_{it}^{Paasche}\right)^{0.5} \quad \text{(Equation 1)}$$

Given the changing balance of inputs and outputs in the dataset, and for consistency with previous studies, the Törnqvist index was used in this analysis.[35]

Two approaches can be used for the calculation of the index. One approach weights inputs and outputs based on an average of their share in the current and base years (fixed-base Törnqvist). Alternatively, a chained index methodology can be used, in which the weights shift each year (chained Törnqvist).

In its 2009 LLCC Final Statement, Ofcom stated:

"We do not agree that it is appropriate to anchor the weights to a base year. The Törnqvist index is viewed as a discrete approximation to a continuous Divisia index, a chain index in which the weights are changed continuously. Hence, the share weights should [be] revised each year so that, for example, the cost index would be calculated using the relative compensation shares of the components in two adjacent years."[36]

In order to take Ofcom's comment into account, both approaches (fixed-base and chained) have been used. As shown below, the results under the two approaches are similar.

For the purposes of the discussion below, the terminology 'year x' refers to the base year in the case of the fixed-base index and to the prior year (t-1) in the case of the chained index.

The indices are individually weighted by their contribution to total inputs or outputs in year t. For a representative input or output k the value for firm i is:

$$\bar{y}_{it,x}^{k} = \frac{y_{it}^{k}}{y_{ix}^{k}} \quad \text{(Equation 2)}$$

The indices are then weighted based on the revenue share of each service in relation to total revenue in year t (w_t^k) and in year x (w_k^x) respectively to form a single index:

$$\bar{y}_{it,x} = \prod_{k=1}^{K} \left(\bar{y}_{it,x}^{k}\right)^{0.5\left(w_{ix}^{k} + w_{it}^{k}\right)} \quad \text{(Equation 3)}$$

For the chained index, this only represents the Törnqvist index for one particular year, and the product with previous years must be taken to derive the chained Törnqvist value for that year:

$$\bar{y}_{it}^{chain} = \prod_{t=1}^{t} \bar{y}_{it} \quad \text{(Equation 4)}$$

[35] See UN statistics division: http://unstats.un.org/unsd/sna1993/tocLev8.asp?L1=16&L2=3

[36] Ofcom, "Leased Lines Charge Control – Annexes. Statement", 2 July 2009, p. 75.

4.4.1.1 Ouput indices

Each type of output (such as the volume of leased lines) is used to construct an output index. Based on the contribution of each output category to the operator's revenue, a single weighted index is then estimated.

Output quantities are taken from the statutory accounts of the benchmark companies as well as documents published by regulators. The total output measure defined for this study has been updated to include additional products to reflect internet usage lines (volume of broadband lines and internet traffic), and comprises the following:

- Access lines: Total number of PSTN and ISDN channels;
- The total number of internet lines (this is an addition to previous work);
- Local and internet minutes: Total local and internet minutes including fixed to mobile minutes and calls to ISPs; and
- Long-distance minutes.

4.4.1.2 Input index

Factor inputs can broadly be classified into three categories: labour, materials, and capital. Indices reflecting quantity changes for each of these categories were constructed and weighted based on their share of payments to inputs to form a single input index.

The labour input index measures the amount of labour used in production. The level at which operators' employee bases were presented in the statutory accounts did not allow for a construction of a labour-specific input measure that accounted for the varying contribution across different types of labour and so the total number of employees was used as the factor input measure. This is a reasonable measure since fixed-line telecommunications companies are not likely to have a widely different composition of labour force, for example in terms of part-time vs full-time workers or skilled vs unskilled workers. The general economy-wide inflation rate was used to deflate the cost of labour.

$$\bar{L}_{it,x} = \left(\frac{c_{it}^{L}}{c_{ix}^{L}}\right) \qquad \text{(Equation 5)}$$

The material input index measures the quantity of materials used in production. The cost of materials for this purpose was measured using operating costs less staff costs and depreciation costs ('material and residual operating costs'). The material index was also deflated using the general economy-wide inflation rate.

$$\bar{M}_{it,x} = \left(\frac{c_{it}^{M}}{c_{ix}^{M}}\right) \qquad \text{(Equation 6)}$$

The capital input index measures the quantity of capital used in production. The Perpetual Inventory Method was used to estimate the level of capital stock employed. This method involves consideration of all categories of fixed assets; data on NBV was obtained directly from the operators' published accounts. The capital stock employed during the year is estimated by adding deflated capital additions (less disposals) to the net asset balance at the start of the year (net of the current year's depreciation) as demonstrated below.

$$Capital\ Stock_{it} = NBV_{Opening_{it}} + \left(\Delta NBV_{Closing_{it} - Opening_{it}}\right) \cdot \frac{I_{i0}}{I_{it}} \qquad \text{(Equation 7)}$$

where $\frac{I_{i0}}{I_{it}}$ *is the ratio of the asset price ratio in the base year to the asset price ratio in the current year.*

In order to compute capital stock using the perpetual inventory method, investments must be measured in constant prices. An asset price index was used to translate the value of capital expenditure into current prices. However, the rate of inflation for this purpose differs according to the type of asset and so companies with different compositions of asset base have different asset price indices. The individual asset price indices were therefore weighted accordingly, by the amount of each asset type in the asset base, to calculate an overall individual asset price trend.

The next step is to calculate the capital stock quantity index from the measure of capital stock derived above. This is calculated as follows.

$$\bar{K}_{it,x} = \left(\frac{c_{it}^{K}}{c_{ix}^{K}}\right) \quad \text{(Equation 8)}$$

The final step, following construction of input quantity indices for each of the three factors of production, is the computation of a composite input index using each factor's relative share of payments in the production process.

To compute the relative shares of payments, denoted w_{it}, the following payments to each factor are used:

- Payments to labour are measured by total staff costs;
- Payments to material inputs are material and residual operating costs; and
- Payments to capital are measured by depreciation.

A Törnqvist input quantity index is then calculated as follows:[37]

$$\bar{C}_{it,x} = \left(\bar{L}_{it,x}\right)^{0.5\left(w_{ix}^{L} + w_{it}^{L}\right)}\left(\bar{M}_{it,x}\right)^{0.5\left(w_{ix}^{M} + w_{it}^{M}\right)}\left(\bar{K}_{it,x}\right)^{0.5\left(w_{ix}^{K} + w_{it}^{K}\right)} \quad \text{(Equation 9)}$$

4.4.1.3 Determination of growth in TFP

Once time and operator specific input and output indices have been calculated, the TFP growth rate is computed by deducting the growth rate of the input index from the growth rate of the output index. The result is the annual change in productivity, including volume effects.

The productivity index is subject to some instability over time within any given company since its volatility may be affected by a number of factors, including:

- **Economy of scale effects:** Without economies of scale exclusions large output increases may be mistakenly attributed to productivity advances.[38] However, this does not appear to be an issue since output in the observed dataset is relatively stable.
- **Capacity utilisation:** If factor inputs are not fully or efficiently used, changes in outputs may not be reflected by efficient changes to inputs. This lack of efficiency may create both positive and negative bias in TFP growth estimation; a positive bias could occur where a firm is under-utilising capacity before increasing output by reaching efficient utilisation, a negative bias could occur from falling outputs in the face of sticky inputs.[39]
- **Financial reporting issues:** Technical reporting issues such as labour capitalisation, company acquisitions and mergers, and write-off policies, may weaken the immediate link between movements in the output index and the input index and therefore skew estimated growth in TFP. This issue has been addressed by removing significant outliers in the sample.

Estimates of growth in TFP have been averaged across time using a simple average. The result is a single annual average productivity across both time and companies. This helps to avoid any volatility created from the factors identified above.

Changes in volume and capacity utilisation may have an impact on the TFP growth calculation without reflecting a true underlying change in an operator's ability to produce output. In order to estimate a change in TFP which controls for changes in output that would cause scale effects, an econometric specification is employed for this analysis which controls for the change in output growth rates over time. Panel data for 9 operators over 2003-2014 was used to conduct a fixed effects estimation. However, as discussed further in Section 4.6 this specification does not provide significant results.

[37] Again using $x$to denote the base year for the fixed-base index and the prior year for the chained index.
[38] By calculating TFP growth in this way returns to scale are implicitly assumed to be constant.
[39] Capacity utilisation has been discussed at length in the Real Business cycle literature. For example see Jeremy Greenwood, Zvi Hercowitz, Gregory W. Huffman (1988), "Investment, Capacity Utilization, and the Real Business Cycle", *The America Economic Review*, vol. 78 (3), p. 402-417.

4.5 Data used

The data used for this TFP growth estimation was obtained from a number of sources. For most operators, data from 2002 to 2007 was taken from the 2008 study. Additional data, for the years 2008 to 2014, was taken from annual and other quarterly reports, regulators' websites, industry reports and other publicly available documents published by the operators in the sample. This significantly extended sample addresses one of the main concerns raised by Ofcom in the context of the previous study i.e. the limited size of the data used.

The fixed-line operators considered in this estimation were chosen from a selection of comparable European fixed-line incumbent operators, with similar characteristics to those of BT. The shortlisted sample was then refined based on suitability and data availability for the selected operators across the relevant time period. The initial list of operators to be assessed in the growth in TFP calculations, in addition to BT, was as follows:

- KPN (Netherlands);
- Magyar Telekom (Hungary);
- Telecom Italia;
- TPSA (Poland);
- Eircom (Republic of Ireland);
- Telekom Austria;
- Belgacom (Belgium); and
- Telenor (Norway).

Where data was unavailable it was necessary to estimate data based on available information. Some examples of issues faced in estimation include: data only available at the group level (rather than fixed-line operations only) or information such as staff numbers not published at the necessary level for certain years.

Adjustments were nevertheless kept to a minimum since, as discussed above, one of the main advantages of the TFP growth measure over other techniques is that consistency of data only needs to be achieved within each company across years and not necessarily across companies.

Since growth in TFP is calculated within each company over time, rather than between companies, it is not necessary to adjust the data for comparability. However, for consistency the same set of output and input measures was used across the companies. The input and output data collected for each company is presented in Table 2 below.

Table 2: Input and output data for indexed growth in TFP analysis data

Output data	Data for weighting outputs	Input Data	Data for weighting inputs
Volume of total voice traffic minutes	Revenue from total voice traffic	Staff numbers	Staff costs
Volume of PSTN lines, including ISDN lines	Revenue from PSTN Lines	Closing NBV	Depreciation
Volumes of internet traffic minutes	Revenue from internet traffic minutes	Operating expenses	Operating expenses
Volumes of broadband lines	Revenue from broadband lines		

The following assumptions were made during the data collection process:

- Where the operator was an integrated fixed and mobile operator or the business operated across multiple countries, costs and volumes associated with the mobile business or outside the country of

focus were removed using segmental analysis in the accounts. In general, this was calculated using the relative segmental proportions of revenues, depreciation, EBITDA or staff costs.

- Where data was missing for particular years, estimates were used based on historic ratios or trends. These estimates were cross-checked with other available information in the given year to ensure they were reasonably in line with an operator's financial data. Estimates with significant inconsistencies with the reported data have been omitted in some cases.

4.6 Results

Following the methodology described in the previous section, the results for the operators considered are presented in Table 3.

Table 3: Estimates of growth in TFP using the Törnqvist fixed-base and chained indices

Operator	Fixed-base (%)	Chained (%)	Time period[40]
BT Group	1.18%	1.01%	2004 – 2014
KPN	-2.23%	-2.00%	2004 – 2014
Magyar Telekom	-1.42%	-1.44%	2009 – 2014
Telecom Italia	-0.10%	0.41%	2004 – 2014
TPSA Poland	4.33%	4.09%	2006 – 2014
Eircom	-0.39%	-0.07%	2009 – 2014
Telekom Austria	0.12%	2.48%	2004 – 2014
Belgacom	2.14%	2.68%	2005 – 2014
Telenor Norway	0.03%	-0.96%	2004 – 2014
Average [median] TFP growth across operators	**0.49% [0.12%]**	**0.65% [0.66%]**	**All periods above**

Source: Deloitte Analysis

These results indicate that productivity improvements achieved by a selection of fixed-line incumbent European telecommunications operators over recent years have been small and, in some cases, negative[41]. These numbers are far below the 5% per annum efficiency factor that Ofcom has proposed for the charge control. The difference between this average TFP growth and Ofcom's efficiency factor is even more significant when it is considered that the benchmark number includes both catch-up and frontier shift effects whereas the previous studies have concluded that BT is within the top decile of efficiency.

There is some volatility when examining the annual growth in TFP but this is to be expected. Ofcom acknowledges volatility in annual productivity measurements in its 2015 consultation document.[42] Growth in TFP and GDP for the UK as a whole is also volatile on an annual basis.[43] Similarly, results at the individual operator's level are not necessarily informative. An examination of a single operator across a series of years may still be affected by idiosyncratic effects that will fail to reflect the overall development of the industry. Instead, an average across the sample of operators can produce a good estimate of the general trend within the industry.

Although negative numbers may seem counterintuitive, this may be explained for some of the operators due to decreasing outputs. Current trends in telecommunications such as increasing competition and fixed-to-mobile substitution have resulted in significant declines in volumes of some products for incumbent

[40] The annual reports for these European operators were not always reported on a consistent basis year to year. Changes in reporting occasionally caused significant fluctuations in the calculation of TFP growth rates. In order to minimise the effect of these anomalies, the largest proportional changes have been excluded as outliers. The time periods examined vary for operators because outlier years driven by potential discrepancies in financial reporting were omitted.

[41] Negative numbers can be expected to occur for some operators due to issues such as accounting changes, financial problems, mergers or acquisitions, accounting errors that affect the data in annual reports. Furthermore, current trends in telecommunications such as fixed-to-mobile substitution are likely to result in diseconomies of scale for fixed businesses as volumes decline.

[42] Ofcom (2015), "Business Connectivity Market Review: Leased lines charge controls and dark fibre pricing – Consultation", Para A8.168, p. 124.

[43] Hills S.H., Thomas R. & Dimsdale N. (2010), "The UK recession in context – what do three centuries of data tell us?", *Bank of England Quarterly Bulletin*.

operators, which in turn may led to diseconomies of scale to the extent that operators are not able to adjust costs at the same rate as volume changes. However, these effects are difficult to isolate or quantify. To understand the sensitivity of the results to these negative numbers, a sensitivity analysis was conducted by removing KPN and Magyar Telekom from the sample. This is because the significant negative results for these operators could also be the result of changes in reporting in the annual statement across years. The following table show the results once KPN is removed from the sample.

Table 4: TFP growth estimates excluding operators showing negative growth

Additional operators omitted	Average growth in TFP across sample, fixed-base index [Median]	Average growth in TFP across sample, chained index [Median]
KPN, Magyar Telekom	1.15% [0.39%]	1.33% [1.04%]

Source: Deloitte Analysis

While TFP might fluctuate fairly significantly it is unlikely that an operator would see substantial improvements or reductions in productivity in a single year unless there are extraordinary circumstances such as acquisitions, mergers or crises. It is likely that the largest TFP changes are caused by issues in annual reporting changes, restatements on old information or accounting errors that do not reflect changes in underlying operator operations. In order to examine TFP changes under ordinary circumstances, years where growth in TFP calculations have changed by more than a specified amount in either direction have been omitted. Table 5 presents how the average growth in TFP over the period changes when different limits to the annual change are applied.

Table 5: Allowing for different absolute annual growth rates in TFP

Maximum TFP growth jump	Average growth in TFP across sample, fixed-base index [Median]	Average growth in TFP across sample, chained index [Median]
10%	0.49% [0.12%]	0.65% [0.66%]
15%	0.31% [0.03%]	0.15% [-0.12%]
20%	0.08% [0.39%]	-0.32% [-0.12%]

Source: Deloitte Analysis

The medians of growth in TFP are consistently positive, suggesting that large negative results are causing the average result to be slightly negative when larger TFP growth rates are allowed. These results are also fairly consistent with previous TFP change analyses.

Some econometric analysis was used to try to isolate variation in productivity that is explained exclusively by output fluctuations. However, the econometric results failed to find evidence that volume variation significantly affect productivity. This result was primarily driven by the fact that there was insufficient year on year variation in output across time for a given operator to identify the volume effect parameter. Variation as a result of volume fluctuation is thus an insignificant component of TFP change making the original estimate of TFP growth a clean measure of productivity changes over time.

5 Conclusions

The RPI – X charge control methodology relies on an estimate of the efficiency improvements that an operator can be reasonably expected to achieve during the charge control period. This report has presented an assessment of:

- The importance of analysing both internal and external data in setting the efficiency factor;
- Ofcom's methodology in estimating the efficiency factor in the charge control under consultation; and
- External data analysis to test whether the efficiency factor included in the proposed charge control is consistent with historical efficiency improvements achieved by a benchmark set of European operators.

The conclusion of such assessment is that Ofcom's efficiency factor estimates appear overstated for a number of reasons, as summarised below.

The use of internal and external data in setting charge controls

Ofcom's dependence on BT's internal data when calculating the X element of the RPI – X charge control is likely to result in an inaccurate estimate of the efficiency factor because of the way that internal performance targets are set and the adverse incentive effects that this type of analysis can create.

The efficiency factor in a charge control should be a target which the regulated company can be reasonably expected to achieve and possibly exceed. However, research on management incentives indicates that companies raise performance by setting "stretch" targets for business units, even though these targets are less likely to be met than moderate targets. This is also the approach adopted by BT. Internal management targets are therefore unlikely to be an appropriate basis for setting the efficiency factor in the charge control.

The use of internally-derived targets for the efficiency improvements that can be achieved during the charge control period, if not complemented by an analysis of external benchmarking data, also presents other concerns:

- **Asymmetric impact of regulation:** A charge control that is too demanding may reduce an operator's ability to operate viably. Without an external analysis of benchmarking data Ofcom cannot confirm the degree to which internal management documents overstate the potential for efficiency improvements.
- **The ratchet effect:** Good performance by an operator in one period is "punished" in later charge controls, reducing the incentive to reduce costs.
- **Overstating catch-up effects due to historical data:** Basing future charge controls on previous cost savings will overstate the potential for future efficiency improvements if past savings have included catch-up as well as frontier-shift effects. The closer an operator gets to the frontier, the less they can be expected to reduce costs in the future beyond the frontier shift.

Ofcom's methodology in estimating the efficiency factor

In addition to the challenges created by focusing on internal data in setting a charge control, interviews with BT managers have also highlighted practical and computational issues with the E component from PVEOs which do not appear to have been fully taken into account by Ofcom in its analysis:

- **Double counting of economies of some scale effects:** BT and Ofcom have different methodologies for estimating economies of scale efficiencies. If Ofcom takes the efficiencies estimated by BT and additionally estimates economies of scale from volume changes it will overstate the extent of economies of scale.
- **Double counting of efficiencies across LoBs:** Internal cost items in the PVEOs are transferred between business units within BT so multiple teams may benefit from a single E component. For example, BT confirmed that its Technology, Service and Operations (TSO) division transfers 100% of its

costs internally to other LoBs, so some of the efficiencies identified within the TSO PVEOs will also be reflected in Openreach or Wholesale management accounts. However, it is not possible to identify separately within Openreach or Wholesale PVEOs the part of the efficiency which is related to TSO's efficiency.

- **The E component does not only relate to "efficiency":** The E component in PVEOs does not only reflect cost "efficiencies". Economies of scale effects, that in the Ofcom model would be included under volume driven effects, are partially captured under the E.
- **Efficiency initiatives vary significantly across products:** The scope for efficiency gains varies across products. There is little new efficiency associated with the "20C" network and products, which include TI services.
- **Efficiencies linked to capex may be significantly smaller than for opex:** Ofcom has applied a single efficiency target to both opex and capex. All BT managers interviewed agreed that the scope for cost reduction initiatives for capex is consistently much smaller than for operating costs. This is because a large proportion of capex is related to contracts with external contractors for construction works. These contracts often cannot be renegotiated and, to the extent they are, have generally seen a price increase rather than decrease in line with the general trend of construction prices. Also, for legacy networks and services capex is primarily related to equipment replacement for which very limited efficiency gains exist.

External data analysis

External data supplements the regulated operator's internal data by providing a check on the appropriateness of an estimated control while also comparing efficiency to operators in other markets. Eight European operators, in addition to BT, were studied to assess how TFP has been changing on an annual basis from 2004-2014. The external benchmarking results suggest recent historical productivity improvements are far below Ofcom's proposed range of 4% to 7%. Analysis suggests that telecom operators across Europe are seeing average annual efficiencies of between 0.49% - 1.33% on average when examining both the fixed-base and chained methodologies and considering the omission of operators that present negative TFP growth results. This range is significantly less than Ofcom's proposed annual improvement.

Appendix: Follow-up note on methodology

Ofcom requested a meeting to discuss the methodology and implications presented in this report following its submission.

In the meeting, held between Ofcom, BT and Deloitte on 9th October 2015, Ofcom asked two specific clarifying questions. These were the implications on the result of:

- Omission of some products from the output index; and
- Inclusion of two types of product with different product quality within the same output category when they have opposing growth rates (e.g. inclusion in the broadband output category of both superfast broadband lines and DSL).

This note was prepared on 11 November 2015 for BT and is meant to further clarify why TFP was used as a measure of productivity and to respond to the two questions of clarification raised by Ofcom.

Why was TFP used as a measure of productivity?

TFP growth is an aggregate measure of how a firm's ability to convert inputs into outputs changes over time. TFP growth is a function of changes in technical efficiency, changes in technology and returns to scale. The measure does not distinguish between these factors, nor does it control for factors such as the quality of outputs.

There are both advantages and disadvantages of TFP growth as a measure of long-term efficiency improvements in telecom operators. It is an aggregate measure which does not distinguish between the three different drivers of productivity change. It was therefore not possible to estimate the specific impact of technical efficiency as distinct from the other factors. However, the aggregate nature of the measure makes it suitable when there are data limitations, as is the case here. Importantly, it only requires data that is consistent for individual operators over time. It is not a panel data analysis and therefore does not require data to be consistent across operators.

The purpose of carrying out a TFP growth estimate was to demonstrate the magnitude of the difference between the average growth of TFP in a selection of fixed line operators and the estimate of efficiency growth included in Ofcom's price control. It was not intended to be an accurate estimate of the forecasted efficiency of BT's business.

How will the omission of products from the output index affect the calculation of TFP?

Output volume data was collected for the operators in the analysis over the period. The products included were limited to those for which data was available on a consistent basis over time. Products for which there was no data were omitted from the aggregate measure of output used in the analysis.

It can be expected that the omission of products from the measure of change in outputs will have a significant impact on the overall estimate of TFP growth if the growth rates of the omitted products were systematically different from the growth rates of the included products or if there were significant changes in the proportion of the total outputs which were included in the calculation of the output index.

There is limited data available on the omitted products. They include products such as interconnection, other wholesale services, enterprise products, data and equipment. This is a heterogeneous set of products and there is no reason to believe that the changes in the volume of their outputs would be systematically different from the products that are included in the output index.

The products included in the output index account for around 65% of the total fixed revenues of the operators in the dataset. This figure is relatively stable over time for each operator. There is therefore

limited evidence to suggest that there are major changes in the proportion of the companies' total outputs included in the output index over time.

How will the aggregation of comparable products with different quality affect the calculation of TFP?

The estimates of product volumes for telecommunications operators are, in practice, aggregates of many different types of sub-products. TFP is an aggregate measure of productivity and therefore the aggregation would not be expected to unduly affect the results. However, if this aggregation made it difficult to identify a significant change in the average quality of outputs, this could potentially have an impact on the outcome of the analysis.

High-quality products can be assumed to require more inputs than low-quality products. A shift in a firm's outputs from low-quality to high-quality, with an associated increase in the required inputs, could be reflected in a reduction in the estimate of TFP growth because TFP analysis does not control for the quality of outputs. A systematic and significant change in the types of products produced from low-quality to high-quality over the period could therefore, in principle, affect the result.

In this case, Ofcom's question focused on a shift from DSL-based broadband to Fibre-optic based broadband which can be characterised, for the purpose of this analysis, as a shift from low-quality to high-quality broadband products. This could potentially offset the effects of any returns to scale and efficiency improvements included in the TFP growth estimate.

In this case, there are reasons to consider that the impact of this effect on the result is limited. Firstly, the analysis period varies for each operator but was generally between 2004 and 2014. The penetration of superfast broadband for much of this period was relatively low and only reached significant levels later in the period. This suggests that it would have been unlikely to have had a major impact on the results of the analysis which were averaged over the period. Secondly, if the growth of superfast broadband has had an impact on the TFP growth, then this should be visible in the data. However, there is no discernible relationship between superfast broadband and TFP growth in the dataset.

For these reasons, it is considered unlikely that superfast broadband would have an effect on the outcome of the TFP growth analysis.