Deloitte.

WBA Consultation Response.

Final Report

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Contents

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Executive Summary

Ofcom is currently seeking to apply a set of price controls to the Wholesale Broadband Access (WBA) Market 1. Typically, price controls in the telecommunications sector require the regulated company, in this case BT, to increase productivity to allow for three separate effects:

- **Comparative efficiency:** BT is expected to increase its relative efficiency in the current time period to match that of an agreed benchmark representing an efficient comparator;

- **Annual real cost change:** The annual increase in productivity, assuming constant volumes, that BT may be expected to experience during the price control period; and

- **Economies of scale:** The change in BT's unit costs that result from a change in volumes.

In relation to the first of these measures Ofcom has proposed that BT should be considered above the decile, and as such comparatively efficient.

Ofcom has proposed that the second adjustment, relating to the 'frontier shift', is in the range of 2% to 5%, with a central estimate of 2.5%. This report focuses on the validity of that range.

Ofcom's estimated range for the frontier shift is established by referring to previous estimates of the shift.

- **Stochastic frontier analysis (SFA)** – the WBA consultation cites the real cost reduction from Deloitte's SFA to be between 2% to 3%. We disagree with this interpretation of our analysis, which actually suggests a lower estimate of between 0.6% to 1.0%.

- **Real unit cost reduction** – Ofcom refers to its bottom-up unit cost analysis undertaken for leased line charge control (LLCC) as justification for the upper bound of the frontier shift at 5%. However, this upper limit does not include length related components which have been found to bias this analysis upwards. Taking these adjustments into account produces a much lower range of estimates, between 0.9% to 2.6%.

- **Törnqvist index** – Ofcom has raised issues regarding the output index specification used by Deloitte to estimate total factor productivity (TFP). Ofcom has instead proposed a Törnqvist specification using a prior-year weighting instead of a base-year weighting that Deloitte has used. However, we note from the literature that both approaches have precedent, and therefore it is inappropriate to dismiss the Deloitte approach out of hand. Furthermore, when we amend the specification to consider Ofcom's alternative approach we find that although TFP estimates increase, the increase is 0.4% over most econometric specifications. This suggests that the results are consistent with our previous estimates.

Measure	Range	Source
BT's real unit cost reduction (including distance-related costs and volumes)	0.9% to 2.6%	Ofcom (2009)
Standard TFP analysis	1.0%	Deloitte (2010)
Econometric TFP	1.1% to 2.4%	Deloitte (2010)
Econometric TFP (Ofcom's Törnqvist index)	2.8%	Deloitte (2011)
Stochastic frontier analysis (Deloitte)	0.6% to 1.0%	Deloitte (2011)
Stochastic frontier analysis (NERA)	2.5% to 3.0%	NERA (2008)
Econometric TFP (NERA)	~2.0%	Deloitte (2010)
Implied range from above measures[1]	**0.6% to 2.8%**	
Ofcom current WBA proposed range	**2.0% to 5.0%**	

Source: Where estimates relate to cost efficiencies, they have been presented as positive. Full references to the estimates are included in the body of this report.

The results from the various approaches to measure the frontier shift, as set out above, estimate the frontier shift to be between 0.6% and 2.8%. This range is lower and tighter than the range proposed currently by Ofcom. Further, Ofcom's base scenario of 2.5% appears to be at the higher end of this range.

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[1] We use the more recent Deloitte estimates from the Stochastic Frontier Analysis, given these estimates are based on more recent data.

1   Introduction

Ofcom released a consultation document setting out its proposals in relation to Wholesale Broadband Access (WBA) charge controls in January 2011[2]. Ofcom propose a catch-up efficiency adjustment of 0%, which is supported by the work undertaken by Deloitte for BT[3] and NERA for the purposes of Ofcom's proposed Leased Lines Charge Control[4]. Ofcom also propose an expected operating cost efficiency improvement range for BT of between 2% to 5%, with a central estimate of 2.5%.

BT has asked Deloitte to:

1. Consider the proposals by Ofcom in relation to the expected efficiency improvements;

2. Provide analysis around the methodology Ofcom has used to determine this range; and

3. Respond to comments Ofcom have made regarding previous work undertaken on this topic.

This report is structured as follows:

- Section 2 provides some specific comments on Ofcom's approach to define their proposed range; and

- Section 3 considers specific comments made by Ofcom regarding the econometric total factor productivity (TFP) estimation process undertaken by Deloitte.

A brief appendix is also included which provides technical details of the index specifications discussed in this report.

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[2]   Ofcom, 2011, Proposals for WBA charge control, http://stakeholders.ofcom.org.uk/binaries/consultations/823069/summary/condoc.pdf, Accessed 02/02/2011

[3]   These include: "The Efficiency of BT's Network Operations" Deloitte (2008), "Further Analysis of the Efficiency of BT's Network Operations" Deloitte (2009), "The comparative efficiency of BT Openreach." NERA (2008) and "Comments on the Deloitte paper on "the efficiency of BT's network operations" NERA (2008).

[4]   Ofcom, 2009, Leased Lines Charge Control: Annexes, http://stakeholders.ofcom.org.uk/binaries/consultations/llcc/statement/llccannex.pdf, Accessed 02/02/2011

2   Critique of Ofcom's approach

Ofcom has proposed a range for the frontier shift to be applied in the WBA price control which is based on interpreting the range of frontier shift estimates available from other recent price control reviews. Specifically, the upper bound of their analysis appears to be supported by their real cost reduction model, whilst the lower bound is supported primarily by stochastic frontier analysis (SFA) and lower estimates from the real cost reduction model. Deloitte believes that Ofcom is inappropriately using estimates of the upper bound that have been subsequently amended by Ofcom, and is also misinterpreting the results of Deloitte analysis. As a consequence we believe Ofcom's proposed range for the frontier shift is not supported by existing evidence, as discussed in this section.

2.1   Real cost reduction model

Ofcom's real cost reduction model was originally used in the context of the 2009 Leased Line Charge Control (LLCC), as outlined in appendix 9 of Ofcom's report (2009)[5]. This model measures the average real unit cost change for individual leased line network components, holding volumes constant and controlling for BT's historic catch-up to the frontier.

This approach was critiqued in our response to the LLCC consultation for a number of methodological concerns including:

- The exclusion of distance-related network elements;

- Use of indices; and

- Lack of account for BTs catch-up to the frontier.

Based on Ofcom's amendments to account for these limitations, the final LLCC Statement concluded that the frontier shift was in the range of -1.9% to -3.5% or -0.9% to -2.6%, depending on whether distance and volume related costs are excluded or included respectively. This provided a lower and tighter range than 0% to 5% which was originally proposed by Ofcom.

Ofcom's use of the original 5% estimate to justify the upper bound in the WBA consultation therefore appears to reject the changes to the methodology that were accepted in the context of the LLCC Statement. It is not clear from the WBA consultation as to the rationale for this rejection. As such, we consider that the range of -0.9 to -2.6% remains the most appropriate estimate from the real cost reduction model.

2.2   Stochastic frontier analysis

The time trend coefficient in the SFA analysis of BTs comparative efficiency provides a further measure of the annual real cost change. This estimate is, however, sensitive to nominal pricing fluctuations and therefore provides only a nominal estimate of cost changes. It is therefore

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[5]   Ofcom, 2009, Leased Lines Charge Control: Annexes,
       http://stakeholders.ofcom.org.uk/binaries/consultations/llcc/statement/llccannex.pdf, Accessed 02/02/2011

standard practice, as recognised by Ofcom in previous network charge controls, to subtract a measure of price inflation from the estimated coefficient to obtain a pure measure of annual real cost change.

In Ofcom's WBA price control, Ofcom refer to Deloitte's recent estimate[6] of the time trend and imply this slope suggests a frontier shift of between 2% to 3%. It is not clear how Ofcom have interpreted the time trend estimates in our report to achieve this range. In Table 1 we present estimates of the implied frontier shift based on the regression results presented in our report.

Table 1: Stochastic frontier analysis

Model	Time trend over whole period	Implied frontier shift
Preferred specification	2.4%	-0.6%
One structural breaks	2.0%	-1.0%
Unweighted switch minutes	2.4%	-1.0%

Source: Deloitte 2010. Inflation assumed at 3% based on IMF. 2010. World Economic Database. All estimates are statistically significant at the 1% level.

Assuming an inflation rate of around 3% during this period implies a frontier shift of between 0.6% and 1.0% across the entire period, this is considerably below Ofcom's suggestion of 2% to 3%[7]. This estimate is not materially altered by considering the time trend from 2004 to 2007 as the difference in trends is statistically insignificantly different.

The results of Deloitte's SFA analysis are based on the most recent reports by the US Local Exchange Carriers (LECs) on their costs and outputs, covering 1996 to 2007. We believe that Ofcom should use these results, as opposed to earlier research undertaken by NERA and commissioned by Ofcom, which does not include the latest year of data.

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[6] "The Efficiency of BT's Network Operation" Deloitte (2010)

[7]   NERA has previously used an inflation rate of 2.5%, however the IMF reports a much higher inflation rate for 2007. NERA. March 2008. *The Comparative Efficiency of BT Openreach*.

3   Törnqvist index analysis

In previous Deloitte reports, further estimates of the frontier shift based on employing TFP approaches have been considered. In the Annex to Ofcom's Statement on the LLCC[8] and subsequently in Ofcom's WBA Charge Control Proposal[9], Ofcom suggested that the results from these approaches may be biased due to the specification of the underlying index.

In this section we briefly assess the existing literature on the use of the Törnqvist index and discuss precedent for the base-year specifications. We also re-run our previous analysis under the alternative specification proposed by Ofcom and find that our results are consistent with our prior TFP estimates. We maintain that Ofcom should use the TFP analysis to inform the WBA price control.

3.1   Specification

In the 2008/09 and 2009/10 reports produced on behalf of BT, Deloitte define the Törnqvist specification as follows:

$$Q_t^T = \prod_{m=1}^{M} \left(\frac{q_t^m}{q_0^m} \right)^{0.5(w_0^m + w_t^m)}$$

$$\text{where } w_t^m = \frac{p_t^m q_t^m}{\sum_{m=1}^{M} p_t^m q_t^m} \text{ is output } m\text{'s nominal output share}$$

The Törnqvist index weights each output using both the current and base year revenue share. This allows for the differing importance of each output to be captured over time. Ofcom's contention that the appropriate weighting methodology is in fact the previous year, rather than a base year, concerns the exponent of the expression above. Specifically, Ofcom believe it should be specified as $0.5(w_{t-1}^m + w_t^m)$, instead of $0.5(w_0^m + w_t^m)$.

3.2   Literature

To consider the validity of our previous specification we have undertaken a brief literature review to confirm that the base-year approach is deployed and discussed elsewhere in academic and professional literature. We note that government statistical services, central banks and university research centres make reference to a base-year specification. For example:

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[8]   Ofcom, 2009, Leased Lines Charge Control: Annexes,
      http://stakeholders.ofcom.org.uk/binaries/consultations/llcc/statement/llccannex.pdf, Accessed 02/02/2011

[9]   Ofcom, 2011, Proposals for WBA charge control,
      http://stakeholders.ofcom.org.uk/binaries/consultations/823069/summary/condoc.pdf, Accessed
      02/02/2011

- Statistics New Zealand references the Törnqvist index in its Statistical Glossary and defines the index as in Appendix A[10]. In the index, the weighting components are denoted as a base period, 0, and the current period, *t*. This is in agreement with the Deloitte specification.

- In a working paper on producing a hedonic price index the Centre for Productivity and Efficiency Analysis (CEPA), part of the University of Queensland Economics Department, also define the Törnqvist in terms of the final year *t* and undefined base year.[11] The specification is a more generalised than the previous specifications as it allows the sample sizes to vary across periods.

- The Philippines Central Bank uses a base-year Törnqvist index to construct an augmented Geometric Mean CPI index[12] as shown in Appendix A.

As well as finding precedent for the base-year specification, we also found support for Ofcom's preferred specification. As a consequence we have investigated the impact of Ofcom's preferred specification and suggest both should be considered.
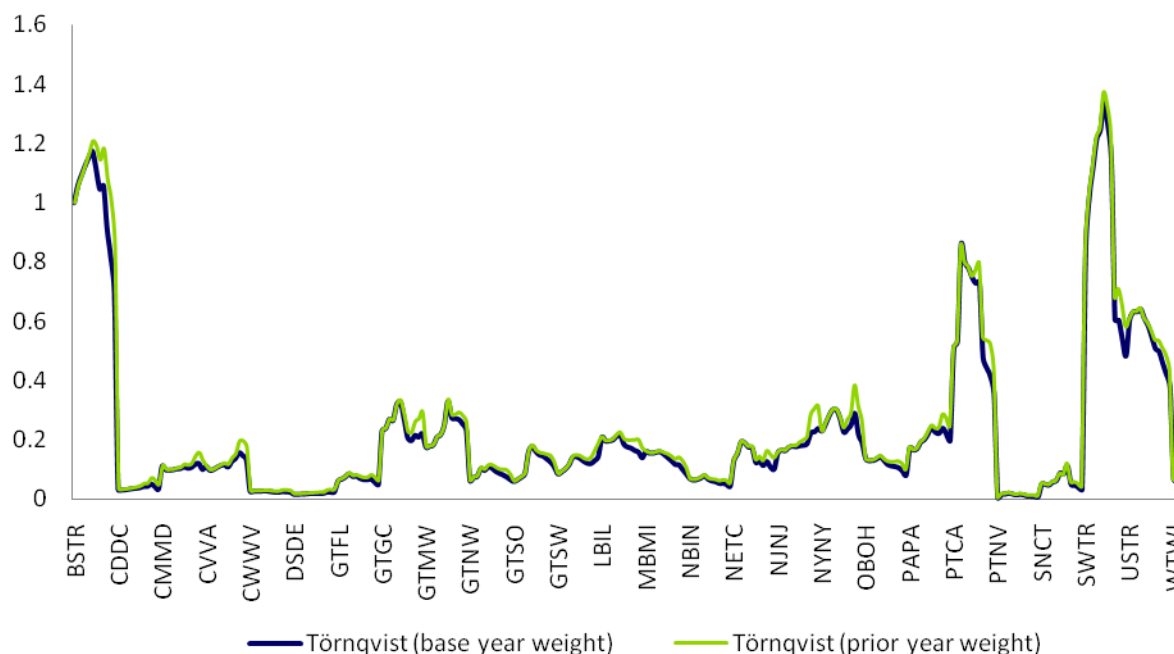
3.3   Analysis

We note that the revenue shares used as weights exhibit relatively low variation across the period under consideration, which gives an *a priori* expectation that changes to the index should only have small impacts. After adapting the index we observe a small variation in the final index that is used in the model. As Figure 1 illustrates, the base year weighting appears to slightly under estimate the output index and this may lead to a lower estimate of efficiency when compared to the prior year weighting method.

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[10]   Statistics New Zealand, Online Statistical Glossary,http://www2.stats.govt.nz/domino/external/omni/omni.nsf/wwwglsry/tornqvist+index+and+other+log-change+index+numbers, Accessed 02/02/2011

[11]   Cominos, H. et al, 2006, Centre for Efficiency and Productivity Analysis, Working Paper Series No. 01/2007, *"Hedonic Imputed Housing Price Indicies from a Model with Dynamic Shadow Prices Incorporating Nearest Neighbour Information"*, http://www.uq.edu.au/economics/cepa/docs/WP/WP012007.pdf, Accessed 02/02/2011

[12]   Bayangos, V. And Estigoy, T., 2010, Bangko Sentral ng Pilipinas, Economic Newsletter No. 10-03

Figure 1: Plot of both Törnqvist indices, arranged by company

Source: Deloitte analysis

Re-running our previous econometric TFP estimation procedures using the Ofcom preferred approach, reported in Table 2, we find that our results are broadly consistent to our previous estimate. There are some specifications where the size of the time trend has risen. In particular the time trend in our primary fixed effects specification, has risen from 2.4% to 2.8%.

Table 2: Comparison of TFP time trend results

Estimation procedure	TFP time trend (Original)	TFP time trend (Ofcom Preferred)
Fixed effects	2.40%	2.80%
Fixed effects (hetroskedasticity)	2.40%	2.80%
Fixed effects (Driscoll-Kraay)	2.40%	2.80%
Fixed effects (AR1)	2.40%	2.80%
Random effects (AR1)	1.80%	3.20%
Random effects (GEE)	1.70%	3.00%
Prais-Winsten (AR1 and correlated panels)	1.80%	3.10%
GLS (AR1 and hetroskedastic panels)	1.10%	2.60%
GLS (Panel-specific AR1 and hetroskedasticity)	1.40%	3.50%

Source: Deloitte analysis

We note that as discussed in our 2009 report, we continue to support the results from fixed effects estimations[13].

3.4   Conclusion

Ofcom's WBA consultation document suggests a range of 2% to 5% efficiency gain per year and a central estimate of 2.5%. Given the existing econometric evidence produced by Deloitte and NERA, we believe this range is both too high and wide. Deloitte's initial analysis placed the range at between 0.5% and 1%, NERA's estimates on behalf of Ofcom pointed to a range of 2% to 2.5% (with the caveat that the rate may be slowing since 2002). Using one year of additional data points, Deloitte developed a range of 1.1% to 2.4%. Based on the additional analysis undertaken in this report an appropriate range appears to be 0.6% to 2.8%.

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[13] This is due to their being unobserved heterogeneity correlated to other explanatory variables, as supported by correlation statistics and the Hausman test. Estimation procedures not explicitly accounting for this correlation will lead to inconsistent parameter estimates. The fixed effects estimation procedures do account for this correlation.

Appendix A   Törnqvist Specification

Statistics New Zealand Törnqvist specification

Tornqvist 'Cost of Living' index:

$$I_{t,0}^{T} = \prod_{i=1}^{n} \left\{ \frac{P_i^t}{P_i^0} \right\}^{\left\{ \frac{1}{2} \frac{P_i^0 X_i^0}{\sum\limits_{i=1}^{n} P_i^0 X_i^0} + \frac{1}{2} \frac{P_i^t X_i^t}{\sum\limits_{i=1}^{n} P_i^t X_i^t} \right\}}$$

Where p_i^t = Price of item i (i = 1,.....,m) in period t

p_i^0 = Price of item i (i = 1,.....,m) in the base period

x_i^t = Quantity of item i purchased in period t

x_i^o = Quantity of item i purchased in base period

CEPA Törnqvist specification

$$I_{s,t}^{T2} = \left(I_{s,t}^{GP} \right)^{\frac{N_t}{N_t+N_s}} \times \left(I_{s,t}^{GL} \right)^{\frac{N_s}{N_t+N_s}}$$

$$= \left[\left(\prod_{h=1}^{N_t} \frac{\hat{P}_t^h(x_t^h)}{\hat{P}_s^h(x_t^h)} \right)^{\frac{1}{N_t}} \right]^{\frac{N_t}{N_t+N_s}} \left[\left(\prod_{h=1}^{N_s} \frac{\hat{P}_t^h(x_s^h)}{\hat{P}_s^h(x_s^h)} \right)^{\frac{1}{N_s}} \right]^{\frac{N_s}{N_t+N_s}}$$

Philippines Central Bank Törnqvist specification

$$CPI^T = \prod_i \left(\frac{{}_iP_t}{{}_iP_0} \right)^{\frac{1}{2}({}_iw_o + {}_iw_t)}$$

where

${}_iP_t$ = Price of item i in comparison period t

${}_iP_0$ = Price of item i in base period **0**

${}_iw_0$ = Expenditure on item **i** in base period **0**, divided by expenditures on all items in base period **0**

${}_iw_t$ = Expenditure on item **i** in comparison period **t**, divided by expenditures on all items in comparison period **t**