Biases and Errors in the Assessment of Market Boundaries for Ex Ante Regulation with an Application to Internet Services in the UK

by

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Abstract

The Hypothetical Monopolist Test is being applied as a means of establishing Relevant Economic Markets for the purposes of ex ante regulation in the EU. This paper points out some common types of bias and error in the application of the test. The likely consequence is that regulatory authorities will tend to find overly narrow economic markets (and this increases the subsequent chance of incorrectly finding market power at the level of the individual firm). Recent practice concerning broadband and narrowband internet market boundary assessments in the U.K. is used to illustrate the general arguments.

1. INTRODUCTION

The New Regulatory Framework (*NRF*) now developing in the EU requires National Regulatory Authorities (*NRA*s) to conduct market assessments prior to addressing the issue of whether an individual firm should be designated as having Significant Market Power (*SMP*) (EC[2002a]). The finding of the latter is a necessary precursor for then deciding whether or not to impose ex ante obligations on such firms (such as price controls and/or product unbundling). The assessment, of which products are 'in' and which are 'out' of the market, is a critical first step since, clearly, the wider the market boundaries under the *HMT*, the lower will be the consequent market shares, and the lower the chance that any particular undertaking will be assessed as having *SMP*.

The European Commission (EC) has recently embraced the Hypothetical Monopoly Test (*HMT*) as a conceptual 'device' for determining market boundaries (EC [2002a], [2002b], Monti [2001]). In practice, although *NRA*s such as Oftel or Ofcom[1] in the UK have fully accepted the *HMT* as a basis for establishing market boundaries, they have in practice generally 'established' boundaries through rather *ad hoc* qualitative considerations – of product characteristics and of the extent of substitutability against other products or services. Only in recent work (Oftel [2003 a-e], Ofcom [2004]) has there been any attempt to *quantify* market assessments. This has been exclusively through the use of survey evidence, and has focused on single product applications. The quantitative approach to boundary assessment in the *EU* is both new ground and important, not least since the information required for quantitative market boundary assessments is also required for the quantitative assessment of dominance once boundaries have been drawn.

Whilst there is a debate regarding the extent to which it is necessary to define market boundaries prior to assessments of dominance/*SMP* (see for example Fisher [1979]), and also issues over the use of the *HMT* (in particular, in applications to emergent or innovative markets - see Dobbs and Richards [2004]), this paper focuses on issues associated with practical application of the test. It first sets out a theoretical

[1] Note that the duties of Ofcom prior to December 2003 were carried out by Oftel; the references to Oftel documents are directed to the Ofcom website.

foundation for the test and then identifies and examines some important potential sources of error, inconsistency and bias and makes some proposals for how boundary assessments might better be undertaken in the future.

The *HMT* first came to prominence in the US department of Justice horizontal merger guidelines (DOJ [1984]), where it was explained as follows:

> "Formally, a market is defined as a product or a group of products and a geographical area in which it is sold such that a hypothetical, profit maximising firm, not subject to price regulation, that was the only present and future seller of those products in that area would impose a '***s**mall but **s**ignificant and **n**on-transitory **i**ncrease in **p**rice* above prevailing or likely future levels." (italics added)

The *HMT* is often referred to as a *SSNIP* test (as per the underlined italics above). In practice, the level of price increase for the test is generally set at 5 or 10%. A single product may constitute a market in its own right under the test, but if not, products are then grouped until the *HMT* indicates that a price increase across the set is profitable; market boundaries are based on the smallest sub-sets for which the *HMT* indicates a price increase is profitable. In merger analysis, existing prices are an appropriate initial benchmark (since the test is merely of whether the merger will facilitate further profitable price increases). By contrast, in market boundary assessments for ex ante regulation, the benchmark should be the competitive price level.[2] EC [2002b,c] sidesteps the potential difficulty of assessing the competitive price level by stating that, unless there is strong evidence to the contrary, existing prices will be assumed to be at 'competitive levels'

An empirical application of the *HMT* requires estimates of demand elasticities (own price and cross-price), price cost margins, and sales (revenue) figures. Whilst sales are relatively unproblematic, the assessment of marginal costs (and hence price cost margins) and elasticities are either judgemental or statistical estimates, and are subject to error. The consequences of potential statistical error can be studied through some form of robustness testing (at its minimum, a form of sensitivity analysis). However, a more important source of error may be termed 'conceptual error'; this arises when the test is not conducted in an appropriate manner. In what follows, conceptual errors

[2] Or quasi-competitive level – in the presence of fixed/sunk costs, the natural benchmark is the contestable markets price level. In the single product case, this is simply an average cost price.

are the primary focus. Various types of 'conceptual error' when attempting to assess market boundaries are identified; it is notable that these errors tend to point in the same direction – namely toward a finding of overly narrow assessments for market boundaries. As a consequence, there is danger of erroneously finding *SMP* and hence of inappropriate imposition of ex ante regulatory controls.

The paper is structured as follows. Section 2 sets out the general framework based on sales loss information (consequent on a price increase) of a type often reported in *NRA* survey work. Section 3 then examines sources of conceptual bias whilst section 4 examines the specific case of boundary assessments for the UK retail internet services in the light of the above analysis. Section 5 draws together the main conclusions.

2. A BASIC FRAMEWORK

Suppose there is an overall set of products or services under consideration, denoted $N = \{1,...,n\}$. Let S_{ij} denote the % change in sales for product *i* when price *j* is increased by a proportionate amount α (such that $\alpha = 0.1$ means a 10% increase). Thus $S_{ij} > 0$ denotes a sales gain and $S_{ij} < 0$, a sales loss. Let ε_{ij} denote the associated cross price elasticity; then by definition,

$$\varepsilon_{ij} = S_{ij} / (100\alpha) . \qquad (1)$$

In the *HMT*, all prices are increased by the same proportionate amount. Dobbs [2002] shows that, assuming, for the price changes under consideration, that

(i) demands are locally linear

(ii) own price effects outweigh (in absolute value) the sum of cross price effects

(iii) marginal costs are locally constant

then an α-price increase is profitable for a sub-set of products K $(K \subset N)$ if

$$\Delta_K^{\alpha} = \sum_{k \in K} R_k \left[1 + (m_k + \alpha) \sum_{i \in K} \varepsilon_{ki} \right] > 0, \qquad (2)$$

where R_k denotes sales revenue for the k^{th} product and

$$m_k = (p_k - MC_k) / p_k = 1 - (MC_k / p_k) \qquad (3)$$

is the price cost mark-up. In terms of the percent change in sales, from (1), this can be written as

$$\Delta_K^{\alpha} = \sum_{k \in K} R_k \left(1 + \left(\frac{m_k + \alpha}{100\alpha} \right) \sum_{i \in K} S_{ki} \right) > 0 \qquad (4)$$

If (4) holds (equivalently (2)), and if $\Delta_L^{\alpha} < 0$ for all (non-null) subsets $L \subset K$, then K is a ***relevant economic market*** (*REM)* under the *HMT*. That is a price increase is profitable for the set *K*, and for all subsets, the price increase is not profitable.

Implementation of this quantitative approach to boundary testing requires price cost margin assessments and elasticity or sales loss information. The former are routinely estimated by *NRA*s, and it is also straightforward to conduct sensitivity analysis on these values. Elasticity or sales loss assessments can be obtained from econometric demand analysis or through customer surveys (the main approach adopted by Oftel).[3] Table 1 below illustrates the kind of data presented in this form of survey work. To date surveys have usually only revealed customer responses to a price increase for a single service. However, if there are *n* products or services under consideration, to assess boundaries, it is necessary to extend these surveys to include responses to a price increase for each and every product. This point is discussed further in the case study in section 4.

Table 1 here

The data typically presented in *NRA* work is outlined in Table 1. Here, x_{ij} denotes the % switching from service *i* to service *j* consequent on an α-increase in price of service *i*. In practice it is common to allocate "don't knows" (denoted x_{id} in Table 1) pro rata to those who gave a definite response. The other point to note in Table 1 is that x_{ii} is the % who stay with service *i*. Thus, if the maximal set of products or services under consideration is denoted *N* (where *N*={1,2,3,..,*n*} in Table 1), then the % sales loss, S_{ij} is calculated as

$$S_{ij} = \psi_i x_{ij} \text{ for } i, j \in N;\ i \neq j \qquad (5)$$

where

[3] Estimates derived from econometric analysis are unlikely to be robust unless the 'market' is fairly stable with a significant data history (telecom markets are more often characterised as emergent and innovative). Survey results are subject to the criticism that questions are 'hypothetical' and as a consequence less reliable than 'choices actually made' in the market place.

$$\psi_i = \left(\frac{100}{100 - x_{di}} \right) \quad \text{for} \qquad i \in N \,. \tag{6}$$

Finally, the loss of own sales consequent on the price increase is given as

$$S_{ii} = -\sum\nolimits_{j=0, j \neq i}^{j=n} S_{ij} \quad \text{for} \qquad i \in N \tag{7}$$

That is, the % sales lost by the i^{th} product is equal to the sum of switches to other services, including 'switchers' who exit (to "0" in Table 1). Equations (5)-(7) suffice to compute the $n \times n$ matrix of sales losses $\{S_{ij}\}$, and from this, the matrix of cross price elasticities $\{\varepsilon_{ij}\}$ can be computed using (1). The only other ingredient required for operationalising the testing of market boundaries lies with the price-cost margins $m_i, i \in N$. *NRA*s commonly make assessments of these. In the single product case, the above conditions simplify to the requirement that

$$R_i \left[1 + (m_i + \alpha) \varepsilon_{ii} \right] > 0 \Rightarrow 1 + (m_i + \alpha) \varepsilon_{ii} > 0 \tag{8}$$

or, using (1), that

$$S_{ii} > \frac{-100\alpha}{m_i + \alpha} \left(\equiv CSL_i \right) \tag{9}$$

where the right hand side of the inequality is defined as the ***critical sales loss***. For example, with $\alpha = 0.1$ and a mark-up of 0.5, $CSL = -0.1 \times 100 / (0.4 + 0.1) = -20\%$ (a fall in sales). That is, the product *i* constitutes a *REM* if the sales loss is less than this, and no *REM* exists if the sales loss is greater. For differentiated product markets by contrast, the computation is more complex. For example, for the two product case {1,2}, one would require that neither product is a *REM* on its own account under the test (9) above, and that, from (4),

$$\begin{aligned} \Delta^{\alpha}_{\{1,2\}} = {} & R_1 \left[1 + \left(\frac{m_1 + \alpha}{100\alpha} \right) \left(S_{11} + S_{12} \right) \right] \\ & + R_2 \left[1 + \left(\frac{m_2 + \alpha}{100\alpha} \right) \left(S_{21} + S_{22} \right) \right] > 0 \end{aligned} \tag{10}$$

In this case {1,2} would be a *REM* under the test. In terms of a methodology for assessing market boundaries, suppose that the focus is on product 1, and the question is that of determining the extent of the market for it. The first test is whether $\Delta^{\alpha}_{\{1\}} > 0$. If it is, then {1} is a *REM*. If not, then the test must be extended to the sets {1,2},

{1,3}, …,{1,*n*}. For example, if $\Delta^{\alpha}_{\{1,j\}} > 0$ and if $\Delta^{\alpha}_{\{1\}}$, $\Delta^{\alpha}_{\{j\}} < 0$ then {1,*j*} is a *REM*.[4] If no two product grouping constitutes a *REM*, then one moves on to 3 product groupings and so on.

This completes our discussion of the general theoretical framework, and the data sources required for implementation. The above framework is utilised in the case study reported in section 4 below, which examines recent practice in boundary assessments for internet services.

3. USE OF THE *HMT* IN SINGLE MARKET SETTINGS

Current practice has focused primarily on whether single products constitute a market under the *HMT*. In this section, the focus is on the nature of the conceptual errors that can arise in applying this simple test. Let:

$S_{ii}, MC_i / p_i$ denote the 'true but unobservable' values for the i^{th} product

$S^r_{ii}, MC^r_i / p^r_i$ denote the Regulator's assessments

Suppose the regulator applies the *HMT* test using its own assessments for the i^{th} product; in this case, from (8), the regulator will find a *REM* if

$$m^r_i < \left(-1/\varepsilon^r_{ii}\right) - \alpha \qquad (11)$$

where $\varepsilon^r_{ii} = S^r_{ii}/\alpha$ is the own price elasticity of demand at the current price level. Equation (11) suggests that the current mark-up has to be 'sufficiently small' if there is to be scope for a profitable price increase.[5]

[4] Notice that markets may not be unique; for example it is possible that both {1,2} and {1,3} might be *REM*s under the *HMT*. The issues raised by this are discussed in OFT [1992], Dobbs [2002].

[5] Its interpretation is slightly subtle; the well known inverse elasticity rule suggests the profit maximising mark-up would be $-1/\varepsilon^r_{ii}$, and (11) seems to suggests the mark-up must be at least α below this for the price increase to be profitable. This might seem puzzling at first (since one might expect a price increase that carries the price from below to slightly above the profit maximising price to be still a profitable price increase). The point however, is that the elasticity in (11) is evaluated at the current price. Under local linearity, elasticity varies with price. Equation (11) requires that the current price has to be at least α below $-1/\varepsilon^r_{ii}$, where the latter is evaluated at the current price (the elasticity at the profit maximising price level would actually be different).

Consider the marginal cost to price ratio MC_i / p_i ; in a competitive market it must be the case that price is equal to average cost; hence the ratio MC_i / p_i can also be assessed by examination of the cost structure – in particular by an assessment of cost elasticity at the current output level[6] (and regulators routinely make assumptions about the extent to which marginal costs lie below average costs, the extent to which there are economies of scale in production).

Viewed in terms of the cost-price ratio and sales loss, the regulator finds *REM* under the *HMT* if, using (3) in (8),

$$Z_R \equiv 1+\alpha-\left(MC_i^r / p_i^r\right)+\left(\alpha / S_{ii}^r\right)<0. \qquad (12)$$

whilst in fact, there is *REM* under the *HMT* only if

$$Z_T \equiv 1+\alpha-\left(MC_i / p_i\right)+\left(\alpha / S_{ii}\right)<0. \qquad (13)$$

Viewed as a function of S_{ii} and MC_i / p_i, the equation Z_T =0 divides unprofitable from profitable price increases. That is:

$$S_{ii} \begin{matrix} > \\ = \\ < \end{matrix} \frac{-\alpha}{1+\alpha-\left(MC_i / p_i\right)}\left(\equiv CSL_i\right) \Rightarrow \quad price\ increase\ is \begin{cases} profitable \\ zero \\ unprofitable \end{cases} \qquad (14)$$

It is useful to plot the impact of cost/price on the level of critical sales loss; this is provided in Table 2 below. This shows that as MC_i / p_i increases, so the *CSL* increases at an increasing rate. Table 2 suggests that, up to a value for MC_i / p_i of 0.4 or so, the *CSL* does not change very much. Beyond this level however, the critical values rise quite rapidly (that is, above 0.4, the *HMT* assessment is relatively sensitive to the estimate of the cost-price ratio).

Table 2 and Figure 1 about here

Figure 1 illustrates this point, and of how (14) partitions sales loss/cost-price space into two areas; the upper area being that in which the product is found to be a *REM* (and hence open to an assessment for ex ante regulation) and the lower area, non-*REM*. In what follows, it is argued that bias tends to be in a "NW" direction, so creating possibilities that non-*REM* products are deemed by the *NRA* to be *REM* under the *HMT* (see Figure 1).

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[6] In this case, $MC / p = MC / AC = \varepsilon_c$ where ε_c denotes the cost elasticity; that is $\varepsilon_c \equiv \left(dC / dq\right)\left(q / C\right) = MC / AC$.

Suppose null and alternate hypotheses are defined as:

H_0 : There is no *REM* under the *HMT*

H_1 : There is a *REM* under the *HMT*

Then a Type 1 error arises when the null hypothesis is rejected when it is true, whilst a Type 2 error arises when the null hypothesis is accepted when it is false (The concern with type 1 and 2 errors is quite popular in the law literature; see for example Sidak, Singer and Teece [1999]). Table 3 illustrates the possibilities:

Table 3 about here

Having set out the above structure, we are now in a position to discuss the types of error and bias common in applications, and hence to be able to identify the overall direction of this bias.

Sources of Type 1 and Type 2 Errors

Referring to equations (12) and (13), suppose that, under the true parameters, $Z_T > 0$ (no *REM*). Then from (12), for $Z_R < 0$ (regulator finds *REM*), this can happen if:

(a) the regulator assesses market demand as more inelastic than it really is; and/or

(b) the regulator assesses the ratio of marginal cost to price as larger than the true ratio.

By contrast, if, under the true parameters, $Z_T < 0$ (there is *REM*), then from (12), for $Z_R > 0$ (the regulator to find no *REM*), this could occur only if

(c) the regulator assesses demand as more elastic than it really is; and/or

(d) the regulator assesses the ratio of marginal cost to price as smaller than the true ratio.

Why might such errors arise? Apart from simple errors in assessment of parameter values (statistical error), errors can arise from the regulator taking an inappropriate time horizon. In general, the longer the time horizon taken, the more elastic the view will be of demand, and the more elements of cost will be viewed as variable and so

the higher will be the assessment of marginal cost.[7] Logically, the same time horizon should be chosen for both demand and cost assessments. As the time horizon is varied from short term to long term, notice that the effects on Z_R work in opposite directions.

For example, suppose the regulator uses short run assessments when a longer term view is more appropriate. On the demand side, this tends to mean the use of a more inelastic parameter value (increasing the chance of a Type 1 error, decreasing the chance of the Type 2 error), and on the cost side, too low an assessment of marginal cost (mitigating the chance of a Type 1 error but increasing the chance of a Type 2 error). The converse applies moving back from a longer-term assessment to a shorter one.

What this suggests is that, if the only error is that of taking an inappropriate time horizon, errors in application tend to offset to some degree and so it is ***possible*** that decisions ***may*** not be unduly biased.

Of more concern is the case where the regulator takes (implicitly or explicitly) inconsistent time horizons for the assessments. Thus if the regulator takes a long run view on demand elasticity (i.e. more elastic) and a short run view of marginal cost; this gives a bias toward getting a Type 2 error (of there being *REM* under the *HMT* but the regulator finding none). By contrast, if the regulator takes a short term view of demand elasticity (views demand as more inelastic) whilst at the same time takes a long run view on costs (tending to increase marginal cost relative to average cost), this creates a bias toward making a Type 1 error, namely that of the regulator finding *REM* under the *HMT* where in fact there is none.

It would appear that the kind of mis-match in regulatory assessments that is most common is to take inconsistent time periods for the parameters – short run for demand, and long run for costs (see section 4 below); this increases the chance of making a Type 1 error in which market boundaries are drawn too tightly (and hence of finding *REM* and *SMP*). Although it is possible to have a philosophical debate regarding

[7] Since the concern is with a price increase, and hence with an output reduction, the possible impact of capacity constraints on short run marginal cost (*SRMC*) are less likely to apply; that is, *SRMC* will tend to be less than *LRMC* for output reductions.

what time horizon is appropriate, clearly using different time horizons (for costs and demands) is an inconsistency that should not feature in market boundary assessments.

4. USE OF THE *HMT* FOR INTERNET SERVICE MARKET ASSESSMENTS

The EC [2002c] has designated that the provision of broadband wholesale services (the network inputs required to offer retail services) is a relevant economic market which may justify ex ante regulation. As part of the introduction of the *NRF*, Oftel [2003a-e] has undertaken market assessments (and used the concept of the *HMT*) on a range of retail services providing Internet access. Oftel drew the conclusion that both 'downstream' narrowband and broadband retail markets could be viewed as distinct and separate *REM*s.[8] This section re-examines this analysis using the principles established above. In order to discuss in detail this market analysis, Tables 4-6 summarise the 'raw' survey evidence used by Oftel and the calculations of sales loss figures from it.[9]

Table 4,5 about here

Table 4 gives the results of a range of surveys conducted over the calendar year 2003 by Oftel. Table 5 then computes the sales loss data implied by the results in table 4, using equations **(5)-(7)**. Although not central to the present exercise, two preliminary points are worth remarking; firstly the survey sample sizes vary over time, and in the case of Table 4 Panel 2, the fall in numbers in the survey over time is significant which suggests a decline in survey reliability. The second observation is that the number of categories is not consistent over time for some of the surveys (see Table 4 panels 2 and 4); while this does not affect at all the ability to test for single product *REM* (which was the primary concern of the *NRA*), it does unfortunately affect the usefulness of the data for multi-service testing. In order to illustrate the latter, but using the latest survey figures, the data in the merged cells (Table 4 line 3) is partitioned pro rata to the frequencies observed in the last previously available survey

[8] The narrowband Internet service is provided over the PSTN and the essential distinction between that and broadband service to the end user is one of access speed (bandwidth). Other ways of accessing the Internet include across the ISDN and leased lines (LL).

[9] This evidence is available from Ofcom at web address http://www.ofcom.org.uk/consultations/past/wbamp/response/unt.pdf. The original surveys can be accessed from Ofcom at web address http://www.ofcom.org.uk/static/archive/oftel/publications/research/2003/

(line 2) for which disaggregated evidence was available. Thus, for example, in Table 5 panel 2 line 3, the figure of 10.42% in the August 2003 survey is disaggregated into the three categories (unmetered NB, metered NB, stop) as 3.72, 2.98, and 3.72% in line 4; this is in the same proportions as in these categories in the May survey (line 2). Having done this, Table 6 presents in summary form what has been revealed by the surveys (based on the latest surveys only) for the case of Residential customers and SMEs respectively.

Table 6 about here

Table 6 makes clear that it is possible on the evidence to undertake single service tests for BB and unmetered NB, and also to consider a two service test for these jointly.[10] However, on the basis of the survey evidence, clearly nothing can be said about the other services (metered NB and ISDN/LL). Having established the demand side evidence, in what follows we examine the *NRA*s boundary assessments for these services.

Single Service Market Assessments

Table 7 below shows the ranges of *MC/P* and *CSL* values actually used by Oftel [2003a-f]/Ofcom[2004] in their market reviews for retail Internet services – unmetered narrowband access and broadband retail access (served by the fixed broadband networks of copper and cable), along with our assessments (based on the same survey evidence). The (latest) survey evidence is also been presented with a ±10% error margin (corresponding broadly to a 95% confidence interval – although there can be debate as to the precise magnitude of this, all parties would agree that it is at least a 5% error margin[11]).

Table 7 about here

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[10] Although the latter is possible only by disaggregating the latest figures for uNB and mNB as explained above (one could also conduct 2-service tests using the earlier survey results, with similar results).

[11] See Collins [2004] and Millward Brown [2004] for discussion of this in the context of the Oftel survey work, and also more generally on problems with these types of survey (which involve hypothetical questions).

For a detailed analysis of the Oftel reports, see BT [2004], Dobbs [2004]; in what follows we concentrate on the key features only. These are

(a) the use of long run assessments of marginal cost by Oftel and

(b) the measurement of own price elasticity of demand (equivalently, the overall sales loss %)

These are dealt with in turn.

Cost Analysis

Throughout the assessments (Table 7), Oftel uses fairly high assessments for the marginal cost to price ratio. That is, MC_i / p_i is generally taken to be in excess of 40%, with upper bound values of up to 80%. Midpoints are often around 50-60%. Oftel explicitly argues that the appropriate cost concept for use in this analysis is long run incremental cost (*LRIC*). However, *LRIC* includes imputed costs of capital assets with long lives extending well in excess of five years. This is of course, a time horizon significantly longer than the time horizon explicitly stated for the market review (which is 1-2 years). In practice, on that shorter time horizon, for output reductions (consequent on the hypothetical price increases), clearly marginal cost could be really quite low. Our assessment is that the ratio of marginal cost to average cost is likely to be lower than the numbers used by Oftel, at around 30% for the time horizon of 1-2 years, with 40% regarded as an upper value for the ratio.[12] Naturally, there is scope for debate over this, given that only fairly rudimentary cost modelling has been undertaken. It is worth noting that Oftel in its subsequent assessment of market power suggests that there are significant economies of scale; however, in a single product setting, 'significant economies of scale' (implies a low value for cost elasticity) implies a significant difference between marginal and average cost; this would appear to be inconsistent with the ranges used by the *NRA* for market boundary assessment.

Sales Loss Estimates

Oftel has tended to emphasise that what bind products into the same market is the extent to which they are substitutes (have high cross price elasticities of demand). However, in assessing whether a single service is a relevant market under the *HMT*,

the relevant measure is not that of substitution to another service, but the totality of all substitution (in the present case, including exit from the set of telecom services in their entirety). Oftel, in focusing purely on switching to another single service, has often significantly underestimated the level of sales loss; putting to one side the issues raised over cost analysis, this practice will suffice to ensure that incorrect assessments of market boundaries are drawn with respect to narrowband internet services.

The errors primarily manifest themselves in panels 1, 2 and 4 of Table 7. In panel 1, the Oftel [2003c, p.131] assessment of 14% can be traced back to Table 4, where the 14% is simply the number of customers of uNB who said they would switch to broadband if uNB price increased by 10%. However, as explained in this paper, the relevant sales loss is the totality of all who switch; that is in Table 4 panel 1 line 2, it is 14+7+5+2+6%+an allocation for the 'don't knows' (which we calculated above at 4.2%), making a total of 38.2%, equivalent to an own price elasticity of -3.82.

The same problem arises in Table 7 panel 2 line 1, where the Oftel figure of 3.45% is likewise purely for those who switch from uNB to BB. The correct figure, including all the other services to which individual might switch is 44.8%! (i.e. from table 4, panel 3, the sum of 3.45+16.09+18.39+0.00+6.90). Finally, in panel 4 of the Table, the figure of 4% is likewise erroneous – the total from all who switch is in fact 32.3%.

Given the survey evidence, and correctly assessing the sales loss (own price elasticity) figures, the conclusions are reasonably clear-cut – for unmetered narrowband services, neither *SME*s nor Residential customers constitute a relevant economic market under the *HMT*. The same holds true for *SME* broadband users. The only case where there is *any* survey evidence for a service being a *REM* under the *HMT* lies with residential Broadband users. Here, the survey result of 10.4% switching compares with a 10-14% *CSL*. This result is certainly not statistically significant, given the confidence interval for the survey evidence which is certainly greater than $\pm 5\%$ and probably in excess of $\pm 10\%$ (Collins [2004]). The previous two Oftel consumer surveys on broadband would have revealed ***no*** *REM* (with sales losses of 15.8% and 14.9% in Table 5 panel 2). These surveys show a possible trend toward inelasticity but the

[12] In a regulatory context of price control, Oftel [2001] used a figure of 0.31 extending over 5 years as

evidence for this is somewhat contentious, given that there were significant promotional price reductions for retail broadband over the year. Current rankings for broadband retail prices show the UK as having some of the lowest prices in Europe (Analysys [2003]). It may be that increasing inelasticity reflects this fall in price (at higher prices, broadband customers might be more likely to switch consequent on a further price increase). The issue of what constitutes the 'competitive price level' thus may be important for the overall assessment.

Evidence on BB elasticity across other (geographic) markets is generally limited, but it is worth remarking that US work has tended to find greater elasticity values and the recent econometric work on the UK broadband market has actually found that own price elasticity is increasingly elastic over time; Table 8 give a brief review of recent results. To sum up, it can be argued that at the present time, there are not yet strong grounds for finding *REM* for the BB residential market either.

Table 8 here

Overall, the above analysis suggests that the parameter values used by Oftel in its market assessments have tended to be rather extreme - both too high for the cost to price ratio, and too inelastic for demand. This combination increases the likelihood, as discussed above, of a finding of an overly narrow market (*REM*) based on broadband internet access alone - and hence of making a Type 1 error.

The principal error in Oftel's [2003e] application of critical sales loss in the above lies in the emphasis on substitution effects rather than the overall effects following a price increase. That is, market boundary assessments are based on a partial assessment of price constraining impacts.[13] In this assessment, the regulator argues that the own

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the basis of the regulation of network services across the PSTN for example.

[13] This may be judged from the following quotes from Oftel [2003e]:

-'own elasticity figures are not strictly appropriate for the process of market definition as they include income effects, which are not possible to isolate. In defining markets, it is the substitution effect that is of interest'. 'However, 11% of consumers switching away is likely to be an overestimation on two main counts….Firstly, the data may include some income effects (fn4) which, given the current data, the director is unable to exclude. As explained above, for the purposes of market definition it is substitution effects that are of interest…' whilst Oftel [2003e] footnote 4 (referred to above) continues '…..In assessing the extent of switching in response to a price rise for the purposes of market definition, the director is only interested in the substitution effect of the price rise, not the income effect.'

This view, focusing exclusively on substitution to related services, is clearly ***inconsistent*** with the use of the *HMT* (as explained in this paper) – and Oftel ***does*** approve the *HMT* methodology; for example, in the Explanatory Statement and Notification (Oftel [2003, Dec.]) at paragraph 2.11,

price elasticity is not of relevance to the application of the *HMT*. This however is clearly not the case as shown above.

Multi-Service Testing

Table 6 makes clear that, given the survey information gathered by the NRA, nothing can be said about ISDN/leased Lines or about metered narrowband services. Naturally, it would have been preferable if the surveys had been designed to gain a more complete range of information, along the lines identified in Table 1. However, some investigation of results for BB and uNB is possible, and this is of some interest, given that, for residential customers, BB is marginal whilst uNB is not a REM under the single service tests. To undertake the test, we need market shares and assessments of mark-ups. Market share evidence at the time of the Survey is available from Oftel, in terms of the percentage of households; around 10% of households have BB and 50% have NB,[14] whilst prices in 2003 were around £25 p.a. for BB (Oftel [2003e, p. 158]) and £13-17 for uNB (Oftel [2003d, p. 71]). Using the midpoint of the latter range (£15), this allows rough revenue shares to be calculated as[15]

$$R1 = (25 \times 0.1) / (25 \times 0.1 + 15 \times 0.5) = 0.25$$
$$R2 = (15 \times 0.5) / (25 \times 0.1 + 15 \times 0.5) = 0.75$$

Table 9 gives some results for both single service and multi-service tests. In fact, as indicated in the Table, on the existing figures, a sales response of 10.4% for BB makes this a *REM*. However it was noted that the confidence interval was from 0.4-20.4%. In fact, for any sales response greater than 12.5%, BB is not a *REM* under the

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> "The concept of the hypothetical monopoly test' is a useful tool to identify close demand side and supply side substitutes. A product is considered to constitute a separate market if a hypothetical monopoly supplier could impose a small but significant, non-transitory price increase (SSNIP) above the competitive level without losing sales to such a degree as to make this unprofitable. If such a price rise would be unprofitable, because consumers would switch to other products or because suppliers of other products would begin to compete with the monopolist, then the market definition should be expanded to include the substitute products."

The Ofcom [2004a] final determination (despite submissions detailing the conceptual errors described in this paper) sticks to the Oftel [2003a-f] original position, as detailed above.

[14] See website http://146.101.202.226/legacy_regulators/oftel /oftel_internet_broadband_brief/?a=87101#9

[15] Note that only relative shares are required in order to compute the measure Δ_K^{α}, as only the sign matters, not the absolute figure.

HMT. To see this, note that $MC_1 / p_1 = 0.3$ implies a mark-up $m_1 = 1 - 0.3 = 0.7$, so from (9), $S_{11} = -100\alpha/(m_1 + \alpha) = -10/0.8 = -12.5\%$, or to put it the other way, $\Delta_{\{1\}}^{0.1} = 0$ when $S_{11} = -12.5\%$. Suppose that this was the case – that $S_{11} = -12.5\%$. Then it becomes of interest to ask whether the two services combined constitute a *REM* under the *HMT*. Clearly from the Table, this is not the case. Setting out the calculation makes clear why this is the case: taking $m_1 = m_2 = 0.7$ as above, so that $(m_i + \alpha)/100\alpha = 0.08$ when $\alpha = 0.1$, then from (10),

$$\Delta_{\{1,2\}}^{0.1} = 0.25\left(1 + 0.08 \times (-12.5 + 3.72)\right) + 0.75\left(1 + 0.08 \times (15.73 - 38.2)\right) = -0.524$$

Clearly, the cross price effects help to draw the services into the same market, but the key feature is that uNB has very elastic demand; the own price effect on this service swamps the contributions of the cross price effects and renders the price increase across the two services unprofitable.

The above calculation illustrates the fact that it is erroneous to focus on cross price effects (and ignore own price effects) when deciding on whether services are in the same market or not (and the UK *NRA* , whilst subscribing to the *HMT* methodology, continues to emphasise cross price effects rather than own price effects; see Ofcom [2004, e.g. para. 2.70]).

In practice, there has been no *explicit* testing of multiple services, although it is possible to interpret some of the Oftel work as making an *implicit* multi-service test. This occurs in the Oftel [2003e] market review for SMEs. Oftel note that 4% switch to NB and 8% to "others" and add 1%, an allocation of the "don't knows", to get a figure of 13% as a sales loss. The 18% (plus an allocation of "don't knows") who switch to ISDN/LL are explicitly ignored – Oftel's reasoning here is that ISDN/LL is really another BB product. Unfortunately, this is an incoherent argument. If one puts the two services together, one needs to have information on how individuals respond when ***both*** services face the 10% increase in price. Clearly the 18% who switch to ISDN/LL would be unlikely to do so if that service also had an increase in price; some

might, but most would either stay with BB or choose one of the other alternatives.[16] The problem is that the survey does not reveal the relevant information. No questions have been posed to ISDN/LL customer as to their responses to a price increase, yet this is clearly necessary if one is to draw any conclusions regarding this particular set of market boundaries. The survey evidence marshalled so far allows conclusions ***only*** regarding BB (excluding ISDN/LL) and/or uNB. Oftel's analysis of the single service "Broadband excluding ISDN" is incorrect simply because the assessed switching % is incorrect.

To sum up, this section has examined the quantitative approach taken by the NRA to market boundary assessment for UK internet services, and found several areas where the analysis was problematic. It was noted that the survey evidence generated by the NRA was rather incomplete and of variable quality (in terms of sample size and degree of aggregation) and that there were various errors manifest in the analysis. Whilst quantitative evidence is not the only evidence marshalled by the NRA in reaching its determination of market boundaries, in so far as it is used, there is a clear need to develop a more robust methodology along the lines developed in section 2 above.

5. CONCLUSIONS

*NRA*s appear in recent work to be trying to develop a more rigorous approach to the assessment of market boundaries and subsequent assessment of dominance. This is commendable; although recent practice has been criticised in this paper, it is supportive of the aim toward marshalling more than merely impressionistic evidence for market boundaries. However, an examination of recent practice by the UK Telecoms regulator has identified a range of potential biases and errors in the application of the HMT in market boundary assessment. While the information requirements are clear enough, there are important issues and problems with market boundary assessments which call for greater care in the structuring of such work. Furthermore, where multi-service assessments need to be made, this must be reflected in the design of the surveys (and likewise in econometric work if this route is taken).

[16] It is also an inconsistency on Oftel's original definitions; Oftel originally ruled ISDN/LL out as a BB service because it did not have the last of Oftel's three supposedly key characteristics (fast, >128k; always on; simultaneous BB and voice telephony).

In particular, the need is to assess consumer responses to a price increase for each of the services under examination.

Whether deliberate or not, recent market assessment work has erred on the side of drawing boundaries too tightly (and of hence potentially drawing conclusions for the need for ex ante regulation where this is likely to be inappropriate). Oftel [2003a-f]/Ofcom [2004a] argued that both narrowband and broadband retail markets are relevant economic markets in their own right. This paper has demonstrated that a range of errors were committed in that analysis, and that unmetered narrowband is almost certainly **not** a relevant market in its own right, whilst the evidence for the broadband market is circumstantial at best.[17] Putting to one side the possible motivation that regulators may have for wanting to draw market boundaries as tightly as possible (so giving them greater scope for interventionist activity[18]) it would appear that the errors committed in these reviews at least in part arose because the basic principles for operationalising the hypothetical monopoly test are still relatively poorly understood by EU regulators. The aim of this paper has been to highlight problems with recent market boundary assessments and to clarify procedures for future work when a quantitative approach is being adopted.

REFERENCES

Analysys, 2003, Broadband market comparisons, Report to the Department of Trade and Industry, October 2003.

BT, 2004, Response to Wholesale access broadband market: Explanatory statement and notification (available on the Ofcom website at http://www.ofcom.org.uk/consultations/past/wbamp/response/unt.pdf

Collins M., 2004, Wholesale access broadband market: Response to the Explanatory statement and notification (available on the Ofcom website at http://www.ofcom.org.uk/consultations/past/wbamp/response/pmc.pdf)

[17] Imposing regulation in emerging markets is also fraught with difficulties; the usual counsel is that the benefits of short term intervention should be absolutely clear-cut – as the danger of short term regulation is an adverse impact on long term investment in research, innovation and capacity. The issues involved are well established in the literature – see for example Lind et al [2002].

[18] For the dangers of, and incentive for, regulatory short termism in the telecom context, see for example Lind et al [2002], Laffont and Tirole [2002, ch. 7], Dobbs and Richards [2004].

Dobbs I.M., 2002, Defining markets for ex ante regulation, University of Newcastle upon Tyne Business School working paper (available at web address http://www.staff.ncl.ac.uk/i.m.dobbs/).

Dobbs I.M., 2003, Demand, cost elasticities and pricing benchmarks in the hypothetical monopoly test: the consequences of a simple SSNIP, 10, 545-548 (also available at http://www.staff.ncl.ac.uk/i.m.dobbs/)

Dobbs I.M., 2004, Comments on Wholesale access broadband market: Explanatory statement and notification (available on the Ofcom website at http://www.ofcom.org.uk/consultations/past/wbamp/response/unt.pdf)

Dobbs I.M. and Richards P., 2004 forthcoming, Innovation and the New Regulatory Framework for Electronic Communications in the EU, European Competition Law review (working paper available at http://www.staff.ncl.ac.uk/i.m.dobbs/)

EC, 2002a, Directive of the European Parliament and of the Council on a common regulatory framework for electronic communications networks and services, April, 2002.

EC, 2002b, European Union - Commission guidelines on market analysis and the assessment of significant market power under the Community regulatory framework for electronic communications networks and services, (2202/C 165/03) 11/7/2002.

EC, 2002c, Commission Recommendation on relevant product and service markets within the electronic communications sector susceptible to ex ante regulation in accordance with Directive 2002/21/EC. OJ L 114 , 08/05/2003 P. 0045 – 0049. The Commission also published a Memorandum associated with the Recommendation available at http://europa.eu.int/information_society/ topics/telecoms/regulatory/maindocs/documents/explanmemoen.pdf

Fisher F.M., 1979, Diagnosing Monopoly, Quarterly Review of Economics and Business, 19, 7-33.

Hausman J.A., Sidak J.G. and Singer H.J., 2001, Residential demand for broadband telecommunications and consumer access to unaffiliated internet content providers, Yale Journal on Regulation, 18, 129-173.

Langenfeld J. and Li W., 2001, The use and misuse of critical loss analysis, LECG perspectives, 2, 1-4 (available at Web-address: http://www.lecg.com).

Lind R.C., Muysert P., and Walker M., 2002, Innovation and competition policy, Economic Discussion Paper 3, Office of Fair Trading, London (available at Web-address: http://www.oft.gov.uk)

Massey P., 2000, Market definition and market power in competition analysis: Some practical Issues, ***The Economic and Social Review***, 4, 309-328.

Millward Brown, 2004, Response to Wholesale access broadband market: Explanatory statement and notification (available on the Ofcom website at http://www.ofcom.org.uk/consultations/past/wbamp/response/mb.pdf)

Monti M., 2001, Market definition as a cornerstone of EU Competition Policy, Speech given at a workshop on Market Definition, Helsinki, October 5 (available at Web address: http://europa.eu.int/comm./comptititon/speeches/)

Nankervis J. C., 2004, Advertising and price elasticities of ADSL Access, Comment in relation to Wholesale access broadband market: Explanatory statement and notification (available on the Ofcom website at http://www.ofcom.org.uk/consultations/past/wbamp/response/univ_sx.pdf

Oftel, 2001, Proposal for network Charge and Retail Price Controls from 2001, February 2001 (available at Web address: http://www.ofcom.org.uk/static/archive/oftel/publications/pricing/pcr0101.htm)

Oftel, 2002, Direction to resolve a dispute between BT, Energis and Thus concerning xDSL interconnection at the ATM switch, 21 June (available at Web-address: http://www.ofcom.org.uk)

Oftel, 2003a, Review of Fixed Narrowband Retail Markets, Consultation document, 17/3/2003, (available at Web-address: http://www.ofcom.org.uk)

Oftel, 2003b, Review of wholesale unmetered narrowband internet termination market, Consultation document, 17/3//2003, (available at Web-address: http://www.ofcom.org.uk)

Oftel, 2003c, Review of broadband wholesale access market, Consultation document, 28/4/2003, (available at Web-address: http://www.ofcom.org.uk)

Oftel, 2003d, Review of wholesale unmetered narrowband internet termination market, Explanatory Statement and Notification, 26/8/2003, (available at Web-address: http://www.ofcom.org.uk).

Oftel, 2003e, Wholesale access broadband market: Explanatory statement and notification, 16/12/2003 (available at http://www.ofcom.org.uk/consultations /past/wbamp/wbam/wbam.pdf?a=87101)

Ofcom, 2004, Review of the wholesale broadband access market: Identification and analysis of markets, Determination of market power and setting of SMP conditions: Final Explanatory Statement and Notification (available at http://www.ofcom.org.uk)

OFT, 1992, Market definition in UK competition policy, Report by NERA for the Office of Fair Trading, OFTRP1, London (available at Web-address: http://www.oft.gov.uk)

OFT, 1998, A guide to the provisions of the Competition Act 1998: Market Definition, Office of Fair Trading, London, (available at Web-address: http://www.oft.gov.uk)

OFT, 1999, Market Definition, OFT403, Office of Fair Trading, London, (available at Web-address: http://www.oft.gov.uk)

OFT, 2001, The role of market definition in monopoly and dominance enquiries, Economic Discussion paper 2, OFT342. A report by NERA for the Office of Fair Trading, London, (available at Web-address: http://www.oft.gov.uk)

Sidak J.G., Singer H.J. and Teece D.J., 1999, A general framework for competitive analysis in Wireless Telecommunications, Hastings Law Journal, 50, 1639-1672.

US Department of Justice and the Federal Trade Commission, 1984, Horizontal Merger Guidelines, Washington DC. Revised: 1994, 1997. (available at website: http://www.usdoj.gov)

Table 1: Survey Evidence required for implementation of *HMT*

	Responses - x_{ij} = % switching from service *i* to service *j*					
Action	*d* - Don't know	0 (exit market)	1	2	…..	*n*
Raise p_1	x_{1d}	x_{10}	x_{11}	x_{10}	…..	x_{10}
Raise p_2	x_{2d}	x_{20}	x_{21}	x_{10}	…..	x_{10}
Raise p_3	x_{3d}	x_{30}	x_{10}	x_{10}	….	x_{10}
..	..	..	..	..	….	..
Raise p_n	x_{nd}	x_{n0}	x_{10}	x_{10}	….	x_{10}

Table 2: *CSL* as a function of the Cost-Price ratio for a Single Product

MC/P Ratio	***Critical Sales Loss (%)***
0	9.1
0.1	10.0
0.2	11.1
0.3	12.5
0.4	14.3
0.5	16.7
0.6	20.0
0.7	25.0
0.8	33.3
0.9	50.0
1.0	100.0

Table 3: Regulatory Decisions and Potential Errors

	$Z_R < 0$	$Z_R > 0$
$Z_T < 0$ (H_0 false) *REM* exists	**Correct Decision** Regulator finds no *REM* when *REM* does not exist.	**Type 2 error** Regulator finds no *REM* when *REM* exists
$Z_T > 0$ (H_0 true) No *REM*	**Type 1 error** Regulator finds *REM* when *REM* does not exist.	**Correct Decision** Regulator finds *REM* when *REM* exists.

Table 4: Ofcom Sales Loss Surveys - Consequences of a 10% Price Increase

Panel 1: Residential Consumers on Unmetered Narrowband

			1	2	3	4	5	0	6
	Survey Date	Sample Size	% Continue to use PSTN	% Switch to BB	% Switch to metered PSTN	% to ISDN	% Other	% Stop	% Don't Know
1	Feb 2003	364	56	10	8	-	-	5	21
2	May 2003	308	55	14	7	5	2	6	11

Panel 2: Residential Consumers on Broadband (128K and above)

			1	2	3	0	4
	Survey Date	Sample Size	% Continue to use BB	% Switch to unmetered NB	% Switch to metered NB	% Stop	% Don't Know
1	Feb 2003	250	80	8	2	5	5
2	May 2003	193	80	5	4	5	6
3	August 2003	133	85	10			4

Panel 3: SMEs on Unmetered Narrowband

			1	2	3	4	5	0	6
	Survey Date	Sample Size	% Continue to use PSTN unmetered	% Switch to BB	% Switch to metered PSTN	% to ISDN/ Leased Line	% Other	% Stop	% Don't Know
1	Feb 2003	113	50	3	14	16	-	6	13

Panel 4: SMEs Broadband (128K and above)

			1	2	3	4	5	0	6
	Survey Date	Sample Size	% Continue to use BB	% Switch to unmetered NB	% Switch to metered NB	% ISDN/ LL	% Other	% Stop	% Don't know
1	Feb 2003	153	55	8	1	17	-	8	11
2	May 2003	196	71	2		16	7	-	4
3	August 2003	244	63	4		18	8	-	7

Table 5: Implied Sales Loss/Gain Figures

Panel 1: Residential Consumers on Unmetered Narrowband (response to price increase in unmetered NB)

		1	2	3	4	5	0
Survey Date		% change in use of unmetered PSTN	% change in BB	% change in metered PSTN	% change to ISDN/LL	% Other	% Stop
1	Feb-03	-29.11	12.66	10.13	0.00	0.00	6.33
2	May-03	-38.20	15.73	7.87	5.62	2.25	6.74

Panel 2: Residential Consumers on Broadband (response to a price increase in BB)

		1	2	3	0
Survey Date		% change in BB	% Switch to unmetered NB	% Switch to metered NB	% Stop
1	Feb-03	-15.79	8.42	2.11	5.26
2	May-03	-14.89	5.32	4.26	5.32
3	Aug-03	-10.42	10.42		
4	Aug-03 rev.	-10.42	3.72	2.98	3.72

Panel 3: SMEs on Unmetered Narrowband (response to price increase in unmetered NB)

	1	2	3	4	5	0
Survey Date	% change in use of unmetered PSTN	% change in BB	% change in metered PSTN	% change to ISDN/LL	% Other	% Stop
Feb-03	-44.83	3.45	16.09	18.39	0.00	6.90

Panel 4: SMEs Broadband (response to a price increase in BB)

		1	2	3	4	5	0
Survey Date		% change in BB	% change in unmetered NB	% change in metered NB	% ISDN/LL	% Other	% Stop
1	Feb-03	-38.20	8.99	1.12	19.10	0.00	8.99
2	May-03	-26.04	2.08		16.67	7.29	0.00
3	Aug-03	-32.26	4.30		19.35	8.60	0.00
4	Aug-03 rev.	-32.26	3.82	0.48	19.35	8.60	0.00

Table 6: Implied Results from latest Surveys

Panel 1: Internet Services – Residential - %sales loss/gain

Elasticities in parentheses

	1	2	3
Price Change	BB	uNB	mNB
1. Price increase in BB	-10.42 (-1.04)	3.72 (0.37)	2.98 (0.30)
2. Price increase in unmetered NB	15.73 (1.57)	-38.20 (-3.82)	7.87 (0.79)
3. Price Increase in metered NB	?	?	?

Panel 2: Internet Services – SMEs - %sales loss/gain

Elasticities in parentheses

	1	2	3	4
Price Change	BB	unNB	mNB	ISDN/LL
1. Price increase in BB	-32.26 (-3.23)	3.82 (0.38)	0.48 (0.05)	19.35 (1.93)
2. Price increase in unmetered NB	3.45 (0.34)	-44.83 (-4.48)	16.09 (1.61)	18.39 (1.84)
3. Price Increase in metered NB	?	?	?	?
4. Price Increase in ISDN/LL	?	?	?	?

Table 7: Comparison of Critical Sales Loss (*CSL*) and Survey Switching Percentages using latest survey evidence (latest of the surveys reported in tables 5.6)

Panel 1: Consumers on Unmetered Narrowband

		% Sales loss		*MC/p*	Implied Critical Sales Loss
1	Oftel's (incorrect) assessment	14	Oftel assessment	0.41-0.81	15-35
2	Actual SS%	38.2			
3	Actual SS% with ± 10% confidence interval	28.2-48.2	Our assessment	0.3 (0.1-0.4)	12.5 (10-14)

Panel 2: SMEs on Unmetered Narrowband

		% Sales loss		*MC/p*	Implied Critical Sales Loss
1	Oftel's (incorrect) assessment	3	Oftel assessment	0.41-0.62	15-21
2	Actual SS%	44.8			
3	Actual SS% with ± 10% confidence interval	34.8-54.8	Our assessment	0.3 (0.1-0.4)	12.5 (10-14)

Panel 3: *Consumers on Broadband (128K and above)*

		% Sales loss		*MC/p*	Implied Critical Sales Loss
1	Oftel assessment	10.4	Oftel assessment	0.38-0.58	14-19
2	Actual SS%	10.4			
3	Actual SS% with ± 10% confidence interval	0.4-20.4	Our assessment	0.3 (0.1-0.4)	12.5 (10-14)

Panel 4: *SMEs Broadband (128K and above)*

		% Sales loss		*MC/p*	Implied Critical Sales Loss
1	Oftel (incorrect) assessment	13	Oftel assessment	0.41-0.62	15-21
2	Actual SS%	32.3			
3	Actual SS% with ± 10% confidence interval	23.3-43.3	Our assessment	0.3 (0.1-0.4)	12.5 (10-14)

Table 8: Estimates of Broadband Own Price Elasticity

Source	Derivation	Elasticity
Varian. (2001) The demand for Bandwidth: evidence form the Index Project, mimeo, University of California, Berkeley.	A study of 70 (US) volunteers able to choose from a range of bandwidths within a budget.	-2.0 (128kbit service)
Rappaport et. al. (2002) Residential demand for access to the Internet. In Madden, G. (Ed.), *International Handbook of Telecommunications Economics, Volume II.*	A sample survey of 20000 (US) households carried out in January to March 2000.	-1.49 (copper) -1.46 (cable)
Crandall et. al. (2002) The empirical case against asymmetric regulation of broadband internet access, *Berkeley Technology Law Journal* 17:3	Survey data on 7000 (US) respondents for the 4th quarter of 2000 and 1st quarter of 2001.	-1.18 (copper) -1.22 (cable)
Ofcom (2003). Consumers use of Internet Oftel residential survey. Available at - www.ofcom.gov.uk	UK Surveys conducted in February, May and August 2003 respectively of 250, 193 and 133 broadband users, including responses to the impact of a hypothetical increase in prices.	-1.6 (Feb 03) -1.52 (May 03) -1.1 (Aug 03)
Nankervis (2003). Advertising and price elasticities of ADSL access.	Econometric modelling of monthly time series data, April 2001 to January 2003 (UK).	-2.2 (copper)

Table 9: BB and uNB Residential Market HMTs

S_{11} =	-10.42%	-14%
$\alpha(\%)$ =	10%	10%
$\Delta^{\alpha}_{\{1\}}$ (BB)	0.0416	0.0
$\Delta^{\alpha}_{\{2\}}$ (uNB)	-1.542	-1.542
$\Delta^{\alpha}_{\{1,2\}}$ (Both)	-0.482	-0.524

Figure 1: *Profitability of Price Increase as a function of MC_i/p_i and S_{ii}*